TEST REPORT
on
EXHAUST EMISSIONS
from two
WESTINGHOUSE MODEL W301-G GAS TURBINES
at the
SUN OIL REFINERY
in
PHILADELPHIA, PENNSYLVANIA

Prepared For
Sun Refining and Marketing Company

May 1991

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INTRODUCTION

Exhaust emissions from two gas turbine units were monitored to determine compliance with the City of Philadelphia, Department of Health, Air Management Services Permit issued on December 12, 1988. The testing procedures followed the Environmental Protection Agency (EPA) regulation entitled "Standards of Performance for Stationary Gas Turbines" (40 CFR 60, Subpart GG). A complete set of compliance tests were performed on one of the turbines and a second identical turbine unit was spot checked for emissions at load conditions equivalent to the first to demonstrate compliance at similar operation settings. The turbine units tested were located at the Sun Oil Refinery in Philadelphia, Pennsylvania. The tests were conducted on April 30-May 2, 1991.

The unit's power sources are two Westinghouse Model W301-G gas turbines powering electric generators. The generators produce peak power for use as both the refinery's and the city of Philadelphia's auxiliary power system during potential "brown out" periods of power consumption.

Quantities of nitrogen oxides (NOx), carbon monoxide (CO), particulate matter (PM), and other combustion products were measured in the turbine exhaust stacks. The units were fired on fuel oil, which is the only fuel source provided for these turbines (See Appendix C for fuel analyses).

The turbine test matrix consisted of performing three test runs at each of four different load conditions (test runs C-1 through C-12) to document the water-to-fuel ratio required to assure exhaust emissions of NOx less than 0.3 lbs/MMBtu. The water injection rate, fuel flow, turbine load, and other key operational parameters were monitored during each test run. An additional series of four tests (test runs C-13 through C-16) were conducted on the second turbine at load conditions similar to the first to demonstrate that its emissions were the same under the equivalent water-to-fuel ratios.

The emission tests were conducted by Cubix Corporation. The tests followed the procedures set forth in the Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 1, 2, 3a, 4, 5, 9, 10, 20 and 25a. Fuel samples were collected for the analysis of sulfur by ASTM method D-4294. Table 1 summarizes the background information pertinent to these tests.

This test report has been reviewed and approved for submittal to the City of Philadelphia, Department of Health, Air Management Services, and the U.S. Environmental Protection Agency (EPA) by the following representatives:

Sun Refining and Marketing Co.

Cubix Corporation

Table 1
Background Data

Source Owner/Operator:	Sun Refining and Marketing Company Philadelphia Refinery 3144 Passyunk Ave. Philadelphia, Pa. 19145 Attn: Bob Partridge
Test Contractor:	Cubix Corporation 9925 Lockhart Hwy Austin, Texas 78747 Attn: Rick Krenzke (512) 243-0202
Process Description:	Two Westinghouse Model W301-G fuel oil fired combustion turbines powering electric generators. The turbines are equipped with water injection for NOx control.
Permits and Regulations:	City of Philadelphia Air Management Services Permit issued on December 12, 1988.
Test Dates:	April 30-May 2, 1991
Location:	Sun Oil Refinery, Philadelphia, Pa.
Emission Sampling Point:	Power turbine exhaust stack. See Appendix H for diagrams.
Test Participants:	**City of Philadelphia, Environmental Protection, Air Management Services** Robert W. Scott Bill Bianco, Jr. **Sun Oil Philadelphia Refinery** Bob Partridge **Power Tech Associates Inc.** Jim Borden

Cubix Corporation
Rick Krenzke
John Survis
Kevin Janak

Test Methods:

NOx and O_2 by EPA Method 20.
CO by EPA Method 10.
CO_2 by EPA Method 3a.
Hydrocarbons by EPA Method 25a.
Volumetric flow by EPA Methods 1 and 2.
Volumetric flow by EPA stoichiometric calculations (EPA O_2 based "F" Factors)
Exhaust moisture by EPA Method 4.
Particulate matter by EPA Method 5.
Opacity readings by EPA Method 9.
Fuel Sulfur content by ASTM D-4294.

SUMMARY OF RESULTS

Exhaust emissions from a Westinghouse Model W301-G gas turbine unit were tested to determine compliance with the emission limits set forth in the City of Philadelphia Permit issued on December 12, 1988. A second identical turbine unit was also spot checked for emissions at load condititons equivalent to the first to demonstrate compliance at similar water-to-fuel ratio settings. These tests followed the procedures established in The Code of Federal Regulations, Title 40, Part 60, Subpart GG. The power generation units tested are located at the Sun Oil Refinery in Philadelphia, Pennsylvania. The tests were conducted on April 30-May 2, 1991.

Tables 2 and 3 summarize the test conditions and observed emissions during the 12 test runs when turbine unit #2 alone was fired on fuel oil. These tables represent the results of three test runs conducted at each of four turbine power load conditions ranging from lower to peak load conditions. These runs were performed at the predetermined water-to-fuel ratio (0.3:1) required to meet the NOx mass emission rate limits at all load conditions. Table 4 is a summary of the test conditions and observed emissions during the 4 test runs when turbine unit #1 was fired on fuel oil at the same 0.3:1 water-to-fuel ratio as the other turbine. These results also demonstrate NOx emissons ≤0.3 lbs/MMBtu limit.

Figure 1 is a graphical summary of the NOx emission measurement data obtained from preliminary tests designed to determine the appropriate water-to-fuel ratio required to meet the NOx mass emission rates over the applicable range of power turbine loads. This graph presents the NOx emissions as a function of turbine power load (megawatts) and water-to-fuel ratio. The graph demonstrates the optimum water-to-fuel ratio (0.3:1) required to meet the NOx mass emission rate limits.

Tables 5 and 6 summarize the particulate matter emission tests from the firing of the turbine unit #2 on fuel oil. Test runs numbered PM-1, PM-2 and PM-3 were conducted with the turbine at 100% load. Subsequent test runs numbered PM-4 through PM-6 were conducted with the turbine at 90% load. The particulate matter emissions are reported in terms of both the EPA and Pennsylvania Department of Environmental Resources' (PDER) definitions of particulate matter. The EPA defines particulate matter as the material captured in the nozzle, probe, and filter (front-half analysis). By comparison, the PDER defines particulate matter as including the material captured by the nozzle, probe, filter and the insoluble matter collected in the water impingers (front-half + back-half insoluble analysis). As approved by PDER, this back-half analysis was conducted on only one run from each set of particulate matter tests. See Comments and Observations for a detailed discussion of the results of these tests.

The EPA's regulation entitled "Standard of Performance for New Stationary Gas Turbines" (40 CFR 60, Subpart GG) limits turbine emissions by specifying a maximum NOx emission concentration standard. While this standard is not applicable for the purposes of this permit, the emission concentrations are still reported using these units of 15% O_2 at ISO day conditions for comparison. A sample calculation for correcting NOx to 15% O_2 and ISO day is shown in Appendix A.

The City of Philadelphia Air Management Services Permit also regulates the maximum allowable sulfur content in the fuel oil. For these units, the maximum allowable sulfur content is 0.2% by weight. The results of the fuel oil sulfur analyses for these tests are presented in Appendix C of this report. All samples were below this value.

The maximum allowable mass emission rates, as stated in the City of Philadelphia Air Management Services Permit for both power turbine units firing fuel oil are summarized below:

	Fuel Oil Firing
NOx (lbs/MMBtu)	0.3
Sulfur (% in Fuel Oil)	0.2
PM (lbs/MMBtu)	0.1

The actual measured mass emission rates (average of 3 test runs per unit) determined by this testing program (fuel oil firing) are summarized below:

	Fuel Oil Firing Unit #2
NOx (lbs/MMBtu)	0.28
Sulfur (% in Fuel Oil)	0.15
PM (lbs/MMBtu-100% Load)	0.084
PM (lbs/MMBtu-90% Load)	0.045

The exhaust flow rate values were estimated by two methods. The first method involved stoichiometric calculation of the exhaust flow based on EPA F factors, fuel flow, and the observed O_2 concentrations. The second method used an S-type pitot tube coupled with a manometer per the specifications of EPA Methods 1 and 2. Comparison of the two methods revealed a significant difference between the flow measurements. Upon further analysis of this discrepancy, it was determined that the stoichiometric EPA O_2 "F" factor calculation was the most accurate of the two flow measurements. Thus, all gaseous and particulate emissions are based on the stoichiometric flow calculations. For a detailed discussion of this comparison, see the Comments and Observations and the Analytical Techniques section.

Table 2 : Summary of Results
Gaseous Emission Test Runs C-1 to C-6
Unit # 2, Fuel Oil

Sun Oil Corporation
Cogen Philadelphia, PA
Westinghouse 301-G

Unit # Test Number	#2 C-1	#2 C-2	#2 C-3	#2 C-4	#2 C-5	#2 C-6
Date	4/30/91	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91
Start Time	1648	815	901	948	1034	1118
Stop Time	1839	847	933	1020	1106	1150
Turbine Operation						
Power (MW)	18.3	17.9	17.7	21.83	21.75	21.75
Power Turbine Speed (rpm)	3600	3600	3600	3600	3600	3600
Exhaust Temp. (TTXC-°F)	684	656	663	724	733	735
Compressor Discharge (psig)	73.5	72.5	72.5	73.8	74.0	74.0
Reference CPD (psia)	86	86	86	86	86	86
Fuel Flow (gal./min)	38	37.4	37.2	42	42.5	42.2
Fuel Flow (lbs/hr)	16142	15888	15803	17842	18054	17927
Heat Input (MMBtu/hr)	311.8	306.8	305.2	344.6	348.7	346.2
H2O Flow (lbs/hr)	4843	4766	4741	5352	5416	5378
H2O Flow (gal/min)	9.804	9.649	9.598	10.836	10.965	10.888
H2O-to-fuel Ratio (lb/lb)	0.300	0.300	0.300	0.300	0.300	0.300
Fuel Specific Gravity	0.82	0.82	0.82	0.82	0.82	0.82
Fuel Heating Value (Btu/lb)	19313	19313	19313	19313	19313	19313
Ambient Conditions						
Barometer (in. Hg)	29.88	29.9	29.9	29.9	29.9	29.90
Temperature (°F dry)	77	70	70	76	76	78
Temperature (°F wet)	69	58	58	61	61	62
Humidity (lbs/lb of air)	0.0131	0.0074	0.0074	0.0078	0.0078	0.0080
Measured Emissions						
NOx (ppmv)	32.5	32.5	32.8	38.1	38.7	39.5
NOx (ppm @ 15% O2)	66.1	67.3	67.9	70.2	69.6	71.1
NOx (ppm @15% O2, Humidity)	75.1	68.6	69.2	72.2	71.6	73.3
NOx (ppm @15% O2, ISO Day)	70.4	66.0	66.6	67.8	67.1	68.3
CO (ppmv)	35.0	34.0	34.0	32.0	32.4	33.0
O2 (%)	18.00	18.05	18.05	17.70	17.62	17.62
CO2 (%)	2.22	2.09	2.10	2.43	2.44	2.48
THC (ppmv)	2.5	3.0	1.8	1.8	2.3	2.5
Stack Flow Rates (SCFH)						
O2 Stoichiometry	2.07E+07	2.07E+07	2.06E+07	2.07E+07	2.05E+07	2.03E+07
Fuel Fo Factor	1.31	1.36	1.36	1.32	1.34	1.32
Mass Emissions						
NOx (lbs/hr)	80.39	80.51	80.81	94.39	94.65	95.93
NOx (lbs/MMBtu)	**0.26**	**0.26**	**0.26**	**0.27**	**0.27**	**0.28**
CO (lbs/hr)	52.64	51.21	50.94	48.21	48.18	48.73
THC (lbs/hr as methane)	2.15	2.58	1.54	1.55	1.91	2.11

Table 3 : Summary of Results

Gaseous Emission Test Runs C-7 to C-12
Unit # 2, Fuel Oil

Sun Oil Corporation
Cogen Philadelphia, PA
Westinghouse 301-G

Unit # Test Number	#2 C-7	#2 C-8	#2 C-9	#2 C-10	#2 C-11	#2 C-12
Date	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91
Start Time	1201	1246	1331	1438	1521	1610
Stop Time	1233	1318	1403	1511	1555	1643
Turbine Operation						
Power (MW)	24.8	24.8	24.8	26.25	26.7	26.9
Power Turbine Speed (rpm)	3600	3600	3600	3600	3600	3600
Exhaust Temp. (TTXC-°F)	792	795	805	836	835	837
Compressor Discharge (psig)	75.5	75.0	74.8	75.8	75.8	75.5
Reference CPD (psia)	86	86	86	86	86	86
Fuel Flow (gal./min)	45.75	46.25	46.1	49.03	49.1	49
Fuel Flow (lbs/hr)	19435	19647	19583	20828	20858	20815
Heat Input (MMBtu/hr)	375.3	379.4	378.2	402.3	402.8	402.0
H2O Flow (lbs/hr)	5830	5894	5875	6248	6257	6245
H2O Flow (gal/min)	11.804	11.933	11.894	12.650	12.668	12.642
H2O-to-fuel Ratio (lb/lb)	0.300	0.300	0.300	0.300	0.300	0.300
Fuel Specific Gravity	0.82	0.82	0.82	0.82	0.82	0.82
Fuel Heating Value (Btu/lb)	19313	19313	19313	19313	19313	19313
Ambient Conditions						
Barometer (in. Hg)	29.90	29.90	29.90	29.90	29.90	29.90
Temperature (°F dry)	80	81	82	82	83	84
Temperature (°F wet)	62	63	62	62	63	63
Humidity (lbs/lb of air)	0.0075	0.0079	0.0070	0.0070	0.0075	0.0072
Measured Emissions						
NOx (ppmv)	43.8	44.5	45.2	47.0	47.0	47.5
NOx (ppm @ 15% O2)	70.8	71.5	73.1	71.1	71.1	70.9
NOx (ppm @15% O2, Humidity)	72.4	73.7	74.1	72.1	72.6	72.2
NOx (ppm @15% O2, ISO Day)	66.5	67.8	67.9	65.7	66.1	65.6
CO (ppmv)	29.0	29.0	27.0	26.0	26.0	25.2
O2 (%)	17.25	17.23	17.25	17.00	17.00	16.95
CO2 (%)	2.78	2.81	2.79	3.00	3.00	3.00
THC (ppmv)	2.5	2.0	2.0	2.3	2.0	2.0
Stack Flow Rates (SCFH)						
O2 Stoichiometry	1.98E+07	1.99E+07	2.00E+07	1.99E+07	1.99E+07	1.96E+07
Fuel Fo Factor	1.31	1.31	1.31	1.30	1.30	1.32
Mass Emissions						
NOx (lbs/hr)	103.63	105.86	107.76	111.53	111.69	111.23
NOx (lbs/MMBtu)	**0.28**	**0.28**	**0.28**	**0.28**	**0.28**	**0.28**
CO (lbs/hr)	41.72	41.95	39.14	37.52	37.57	35.88
THC (lbs/hr as methane)	2.06	1.65	1.66	1.90	1.65	1.63

Table 4 : Summary of Results

Gaseous Emission Test Runs C-13 to C-16

Unit #1, Fuel Oil

Sun Oil Corporation
Cogen Philadelphia, PA
Westinghouse 301-G

Unit # / **Test Number**	#1 **C-13**	#1 **C-14**	#1 **C-15**	#1 **C-16**
Date	5/1/91	5/1/91	5/1/91	5/1/91
Start Time	1657	1809	1856	1947
Stop Time	1729	1841	1928	2019
Turbine Operation				
Power (MW)	17	22.5	25.2	28
Power Turbine Speed (rpm)	3600	3600	3600	3600
Exhaust Temp. (TTXC-°F)	667	743	787	818
Compressor Discharge (psig)	71.0	71.0	74.0	78.0
Reference CPD (psia)	86	86	86	86
Fuel Flow (gal./min)	37	43	47	50
Fuel Flow (lbs/hr)	15718	18266	19966	21240
Heat Input (MMBtu/hr)	303.6	352.8	385.6	410.2
H2O Flow (lbs/hr)	4715	5480	5990	6372
H2O Flow (gal/min)	9.546	11.094	12.126	12.900
H2O-to-fuel Ratio (lb/lb)	0.300	0.300	0.300	0.300
Fuel Specific Gravity	0.82	0.82	0.82	0.82
Fuel Heating Value (Btu/lb)	19313	19313	19313	19313
Ambient Conditions				
Barometer (in. Hg)	29.90	29.90	29.90	29.90
Temperature (°F dry)	84	79	78	77
Temperature (°F wet)	63	61	60	60
Humidity (lbs/lb of air)	0.0072	0.0071	0.0067	0.0069
Measured Emissions				
NOx (ppmv)	36.2	43.0	48.5	50.0
NOx (ppm @ 15% O2)	73.6	73.5	75.9	74.7
NOx (ppm @15% O2, Humidity)	74.9	74.6	76.4	75.6
NOx (ppm @15% O2, ISO Day)	69.8	70.6	71.3	69.1
CO (ppmv)	36.0	32.0	29.0	28.0
O2 (%)	18.00	17.45	17.13	16.95
CO2 (%)	2.15	2.67	2.90	3.09
THC (ppmv)	2.0	1.0	1.5	1.5
Stack Flow Rates (SCFH)				
O2 Stoichiometry	2.02E+07	1.97E+07	1.97E+07	2.00E+07
Fuel Fo Factor	1.35	1.29	1.30	1.28
Mass Emissions				
NOx (lbs/hr)	87.18	101.17	114.13	119.47
NOx (lb/MMBtu)	**0.29**	**0.29**	**0.30**	**0.29**
CO (lbs/hr)	52.72	45.78	41.50	40.68
THC (lbs/hr as methane)	1.67	0.82	1.23	1.25

Figure 1 : NOx Emissions vs. Turbine Power Load (MW)
Unit # 2

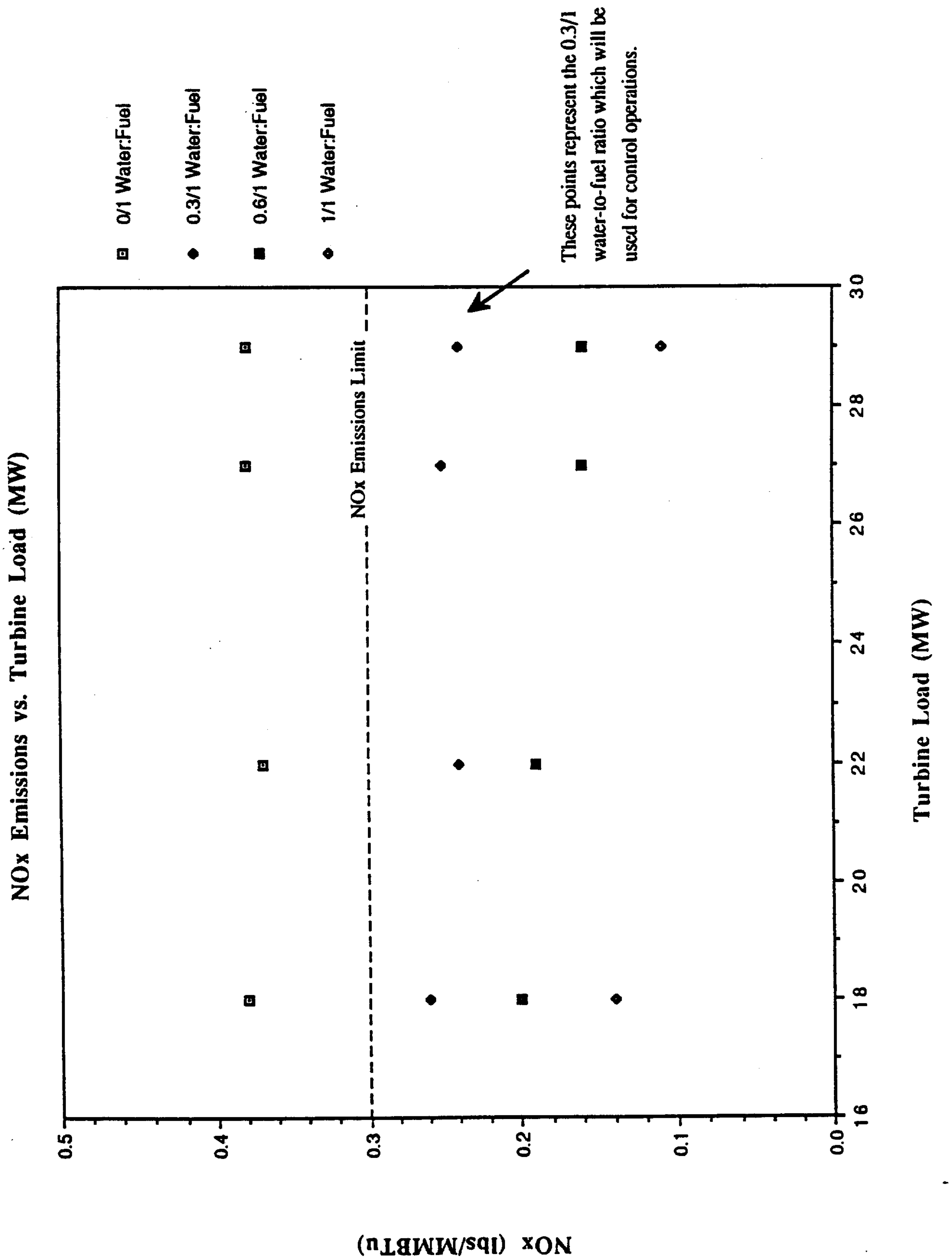


Table 5 : Particulate Matter Test Data
Fuel Oil
Stack Flow Rate Data

Sun Oil Corporation
Cogen Philadelphia, PA
Westinghouse 301-G

Unit # / Test Number	#2 PM-1	#2 PM-2	#2 PM-3	#2 PM-4	#2 PM-5	#2 PM-6
Date	5/1/91	5/2/91	5/2/91	5/2/91	5/2/91	5/2/91
Start Time	1610	940	1205	1555	1705	1920
Stop Time	1643	1124	1345	1628	1846	2056
Turbine Operation						
Power (MW)	26.9	29.5	29.5	26.5	26.5	26.5
Power Turbine Speed (rpm)	3600	3600	3600	3600	3600	3600
Exhaust Temp. (TTXC-°F)	837	819	819	780	779	775
Compressor Discharge (psig)	75.5	80.0	79.5	78.0	78	78.5
Reference CPD (psia)	86	86	86	86	86	86
Fuel Flow (gal./min)	49	52.2	51.8	48.2	48.1	48.1
Fuel Flow (lbs/hr)	20815	22175	22005	20475	20433	20433
Heat Input (MMBtu/hr)	402.0	428.3	425.0	395.4	394.6	394.6
H2O Flow (lbs/hr)	6245	6652	6601	6143	6130	6130
H2O Flow (gal/min)	12.642	13.468	13.364	12.436	12.410	12.410
H2O-to-fuel Ratio (lb/lb)	0.300	0.300	0.300	0.300	0.300	0.300
Fuel Specific Gravity	0.82	0.82	0.82	0.82	0.82	0.82
Fuel Heating Value (Btu/lb)	19313	19313	19313	19313	19313	19313
Ambient Conditions						
Barometer (in. Hg)	29.90	29.82	29.82	29.92	29.92	29.92
Measured Emissions						
O2 (%)	16.95	16.83	17.2	17.2	17.28	17.25
CO2 (%)	3.00	3.14	3.12	2.87	2.85	2.85
Stack Flow Rates (SCFH)						
O2 Stoichiometry	1.96E+07	2.03E+07	2.21E+07	2.06E+07	2.10E+07	2.08E+07
Fuel Fo Factor	1.32	1.30	1.19	1.29	1.27	1.28

Sun Oil Refinery
Philadelphia, Penn.
Westinghouse 301G Turbine Unit #2
Technicians: KJ,RK,JS

Fuel Oil
Weights, Blanks and Emission Calculations

Unit Load Condition (%)	100	100	100	90	90	90
Test Number	PM-1	PM-2	PM-3	PM-4	PM-5	PM-6
Date	5/1/91	5/2/91	5/2/91	5/2/91	5/2/91	5/2/91
Start Time	17:25	14:00	15:25	11:58	12:47	13:37
Stop Time	18:53	15:03	16:25	12:35	13:22	14:07
Stack Gas Sampling Data						
Box No.	2	1	3	1	2	3
Sample Time Length (min)	88	82	82	84	84	84
Atmospheric Pressure (" Hg)	29.90	29.87	29.82	29.92	29.92	29.92
Avg. Stack Temperature (°R)	1270	1266	1266	1226	1222	1218
Avg. Meter Temperature (°R)	551	524	532	537	541	544
Average √ΔP	1.300	1.301	1.295	1.308	1.313	1.36
Average ΔH	1.07	1.02	0.99	2.14	2.07	2.04
Sample Volume Metered (ft3)	58.800	57.800	58.400	56.500	58.200	58.200
Sample Volume at STP (DSCF)	56.02	57.34	57.46	55.47	56.70	56.33
Moisture (% volume)	4.22	3.55	3.91	3.44	3.46	3.41
Molecular Weight (lbs./lb-mole)	28.69	28.78	28.75	28.76	28.76	28.77
Stack Velocity (ft/min)	6812	6805	6783	6726	6744	6999
Stack Flow,dry (DSCFH)	25059067	25227402	25010935	25813228	25958263	27032259
Stack Flow,dry (DSCFH) O2 Stoichiometry	19600000	20300000	22100000	20600000	21000000	20800000
Nozzle Area (ft2)	0.000250	0.000250	0.000250	0.000250	0.000250	0.000250
% Isokinetic	93.09	101.42	102.51	93.16	94.71	90.35
Weights(g)						
Filter #	00004	000018	00019	00020	00003	00021
Avg. Tare Wt.	0.3459	0.3442	0.3420	0.3430	0.3430	0.3449
Avg. Final Wt.	0.4159	0.3563	0.3533	0.3564	0.3579	0.3602
Filter Weight Gain	0.0700	0.0121	0.0113	0.0134	0.0149	0.0153
Filter Blank #	00060	00060	00060	00060	00060	00060
Avg. Tare Wt.	0.3385	0.3385	0.3385	0.3385	0.3385	0.3385
Avg. Final Wt.	0.3387	0.3387	0.3387	0.3387	0.3387	0.3387
Filter Blank Weight Gain	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Front Half Beaker #	8	7	4	B	07	1
Volume (Acetone)	230	260	325	380	315	315
Avg. Tare Wt.	102.3620	102.3228	101.6691	103.1063	100.9361	100.4876
Avg. Final Wt.	102.3857	102.3321	101.6750	103.1145	100.9440	100.49510
Front Half Weight Gain	0.0237	0.0093	0.0059	0.0082	0.0079	0.0075
Back Half (0.8 um) Filter #		300			400	
Volume (H2O)		415			325	
Avg. Tare Wt.		.0723			.0709	
Avg. Final Wt.		.0727			.0709	
Back Half Weight Gain		0.0004			0.0000	
Back Half (0.45 um) Filter #		100			200	
Volume (H2O)		415			325	
Avg. Tare Wt.		.0800			.0802	
Avg. Final Wt.		.0794			.0800	
Blank Weight Gain		-0.0006			-0.0002	
Back Half (0.2 um) Filter #		500			600	
Volume (H2O)		415			325	
Avg. Tare Wt.		.0866			.0864	
Avg. Final Wt.		.0864			.0864	
Blank Weight Gain		-.0002			.0000	
Probe Rinse Blank Beaker #	A	A	A	A	A	A
Volume (Acetone)	215	215	215	215	215	215
Avg. Tare Wt.	100.7151	100.7151	100.7151	100.7151	100.7151	100.7151
Avg. Final Wt.	100.7157	100.7157	100.7157	100.7157	100.7157	100.7157
Blank Weight Gain	.0006	.0006	.0006	.0006	.0006	.0006
Back Half (0.8 um) Blank Filter #		A			A	
Avg. Tare Wt.		.0720			.0720	
Avg. Final Wt.		.0715			.0715	
Back Half Weight Gain		-.0005			-.0005	
Back Half (0.45 um) Blank Filter #		C			C	
Avg. Tare Wt.		.0838			.0838	
Avg. Final Wt.		.0832			.0832	
Blank Weight Gain		-.0006			-.0006	
Back Half (0.2 um) Blank Filter #		B			B	
Avg. Tare Wt.		.0872			.0872	
Avg. Final Wt.		.0866			.0866	
Blank Weight Gain		-.0006			-.0006	
USEPA blank weight correction	0.00084	0.00093	0.00111	0.00126	0.00108	0.00108
USEPA / PDER blank weight correction		-0.00077			-0.00062	
USEPA Total sample weight	0.09370	0.02140	0.01720	0.02160	0.02280	0.02280
USEPA / PDER Total sample weight		0.02100			0.02260	
Blank Corrected Total Sample Wts.:						
USEPA Particulate Matter (g)	0.09286	0.02047	0.01609	0.02034	0.02172	0.02172
USEPA / PDER Particulate Matter (g)	0.00000	0.02177	0.00000	0.00000	0.02322	0.00000
Heat Input (MMBtu/hr)	402.0	428.3	425.0	395.4	394.6	394.6
Particulate Emissions						
USEPA (lbs./dscf)	3.65E-06	7.87E-07	6.17E-07	8.08E-07	8.45E-07	8.50E-07
USEPA (lbs./hr.) •	71.63	15.98	13.65	16.65	17.74	17.68
USEPA (lbs./MMBtu)	0.178	0.037	0.032	0.042	0.045	0.045
USEPA / PDER (lbs./dscf)		8.37E-07			9.03E-07	
USEPA / PDER (lbs./hr.)		16.99			18.96	
USEPA / PDER (lbs./MMBtu)		0.040			0.048	
USEPA 3-run average (lbs./hr.)		33.75			17.36	
USEPA 3-run average (lbs./MMBtu)		0.082			0.044	
USEPA / PDER 3-run ave. (lbs./hr.)		34.09			17.77	
USEPA / PDER 3-run ave. (lbs./MMBtu)		0.083			0.045	

Note: USEPA definition of particulate matter includes only front half analysis (nozzle, probe, and filter).
USEPA / PDER definition of particulate matter includes front-half plus back-half analyses (nozzle, probe, filter, and impingers by vacuum filtration). This was performed on only one run per each load condition.
* Suspected contamination from sample system O-ring degradation during particulate matter run 1.
Particulate emissions are based on O2 stoichiometric exhaust flow rates.

COMMENTS AND OBSERVATIONS

The testing of emissions from the Westinghouse turbines located in the Sun Oil Refinery, Philadelphia, Pa., offered several technical challenges to Cubix Corporation. Items such as high exhaust temperatures (due to the fact that these were simple cycle turbines with no heat recovery), stack configuration, port location, and the design of the turbine inlet air system required special attention to testing techniques and the approval of testing approaches by the city agency personnel. This section of the report will discuss the problems discovered by and the solutions employed by Cubix during the field testing program.

The location of the test ports did not meet EPA criteria for velocity determination by EPA Methods 1-4. It was determined that the ports were located in an area of turbulent flow, thus invalidating the stack velocities determined by EPA Methods 1-4. The velocities determined by the EPA "F" factor calculations appeared to be more accurate. Based on vendors data on fuel consumptions, it was easily determined that the fuel flow that would be required to produce the amount of exhaust gases determined by pitot tube measurements were not at all realistic or even possible. This data was presented to Mr. Robert Scott of the City of Philadelphia Air Management Services. From this data, an approach was conceived to use the stoichiometric "F" factor flow rates for gaseous testing. Particulate matter tests were conducted isokinetically using the pitot tube Δ P's. The results of the particulate matter tests were expressed in terms of lbs/dscf. This result was then multiplied by the volumetric flow rate determined by "F" factors for each run, resulting in particulate emissions expressed as lbs/hr. This term was then divided by MMBtu/hr of heat input, resulting in mass emission rates of particulate matter as lbs/MMBtu (per permit requirements).

The PM testing of unit #2 went smoothly (ie., % isokinetics, sample vacuum, predicted volumes, and leak checks were all within expected limits), however, two observations were made during the testing which may qualify in explaining the results. On run PM-1, when the filter and probe wash were examined, tiny pieces of rubber were found. It was believed that the high stack temperatures (> 800 °F) caused deterioration of the viton o-ring used to seal the probe liner and probe sheath. This viton o-ring was replaced with high temperature fiberglass string to prevent this deterioration. The particles of rubber were not removed from the filter or probe wash; Cubix believes that this was the reason that the results from PM-1 were high. It may be more accurate to determine the actual PM emissions from the second and third test runs only.

At the beginning of the the second test run (PM-2), the wind was blowing at about 20-30 mph. Upwind of the turbine inlet were several piles of sand used for plant construction. It was noted by Cubix that clouds of sand were being blown by the wind directly into the turbine air inlet ducts. These ducts did not employ filters, thus it was assumed that these sand particles could travel the entire combustion gas path unobstructed and would be captured on the particulate matter filter. Cubix notified Sun of this potential problem and Sun watered the sand to keep it from becoming airborne. A visual observation of the particulate matter filter confirmed that a few grains of sand did appear on the filter. No attempts were made to remove this sand, and still the emission rate for this run demonstrated compliance with the particulate matter lbs/MMBtu limit.

Along with the PM test runs, opacity readings and total hydrocarbon (THC) concentrations were recorded. This was done to help predict if the particulate matter emissions from the #1 turbine unit (not tested for PM) were similiar (by comparing the opacity and THC emissions) to the unit tested. The opacity and THC concentration results from unit #1 were slightly lower than from unit #2. From this observation, it may be safe to assume that the actual PM emissions from the #1 turbine are equal to or less than the unit #2's PM emission rate.

Finally, as required by PDER regulations, one test run from each test series was chosen to perform back-half analysis on. This analysis included saving the impinger catch from these runs and pouring this catch through a series of preweighted filters with different filtering size characteristics. The results of these back-half analyses are included in Table 6 and, as expected, make little difference in the final mass emission rates reported.

PROCESS DESCRIPTION

Sun Refining and Marketing Company owns and operates the Sun Oil Refining facility in Philadelphia, Pennsylvania. Within this refinery are two Westinghouse Model W301-G simple cycle turbines coupled with electric generators for the production of electricity. The exhaust emissions from these units are the subject of this report. The turbines are rated at 29,000 Peak KW at 3600 rpm and bare the serial numbers 17A1744-1 & 2 (designated as units #1 and #2 respectively). The generators will each supply approximately 29 MW (depending on ambient conditions) at peak load to both the refinery's and the city of Philadelphia's electric utility grid only during periods of electricity curtailment. The hot exhaust gases from the turbine are ducted through a horizontal section and then through a series of straightening vanes installed within the vertical section of the exhaust stack. These straightening vanes were positioned approximately 4 ft. upstream of the sampling ports.

Each unit has one exhaust stack located downstream of the turbine. Sampling on unit #2 was performed from four sample ports located on the 14 ft. I.D. vertical vent stack approximately 44 ft. from ground level. Sampling on turbine unit #1 was conducted from the horizontal section of the exhaust duct. Field sketches of the turbine stack configurations are contained in Appendix H of this report.

ANALYTICAL TECHNIQUE

Turbine exhaust emissions from a Westinghouse Model W301-G gas turbine were tested to determine the quantities of specific compound emissions. These measurements are the subject of this report. A second identical turbine unit was also spot checked for emissions at load condititons equivalent to the first to demonstrate compliance at similar water-to-fuel ratio settings. Exhaust gas measurements were performed by Cubix Corporation on April 30-May 2, 1991 in order to determine compliance with the City of Philadelphia, Department of Health, Air Management Services Permit issued on December 12, 1988. This section of the report outlines the test methods and procedures used during the tests as established by the Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 1, 2, 3a, 4, 5, 6, 9, 10, 20, 25a.

Twelve gaseous emission test runs were conducted on the Westinghouse W301-G turbine unit #2. Three test runs were performed at each of four different loads. The testing at four different load conditions conformed to the procedures established by the The Code of Federal Regulations, Title 40, Part 60, Subpart GG (§ 60.335(2)). The purpose of this testing was to demonstrate the water-to-fuel ratio required to meet the concentration emission limit for NOx (0.3 lbs/MMBtu).

Four more gaseous emission test runs were conducted on the Westinghouse turbine unit #1 to confirm that the same water-to-fuel ratio established on unit #2 would meet the concentration emission limit for NOx on unit #1.

Finally, six test runs were conducted to determine particulate matter emission rates on unit #2; three at 100 % load and three at 90 % load. The particulate matter test runs were supplemented with opacity readings and measurements of total hydrocarbon concentrations. This was done to better predict if the unit not tested for PM (unit #1) was also in compliance with PM limits.

Test run C-1 served to satisfy Method 20's requirement for an initial O_2 traverse to identify the 8 sample points of lowest O_2 concentration among the 48 sample traverse points in the exhaust stack. No identifiable differences in the emission concentrations were found during the 48-point sampling traverse of the gas turbines' exhaust. After this initial determination of a well mixed exhaust, all subsequent sampling was performed at eight randomly selected points in the stack (all from the same port due to ease of access).

The sampling and analysis procedures used during these tests conformed with those outlined in 40 CFR 60, Appendix A. Method 20 was used to determine nitrogen oxide (NOx) and oxygen (O_2) concentrations; Method 10 was used to determine carbon monoxide (CO) concentrations; Method 25a was used to determine total unburned hydrocarbon (THC) concentrations; Method 3a was used to determine carbon dioxide (CO_2) concentrations; Method 5 was used to determine particulate matter emissions (PM); Method 9 was used to determine stack emission opacity; an EPA stoichiometric "F" factor was used to determine stack volumetric flow.

Gaseous Emissions

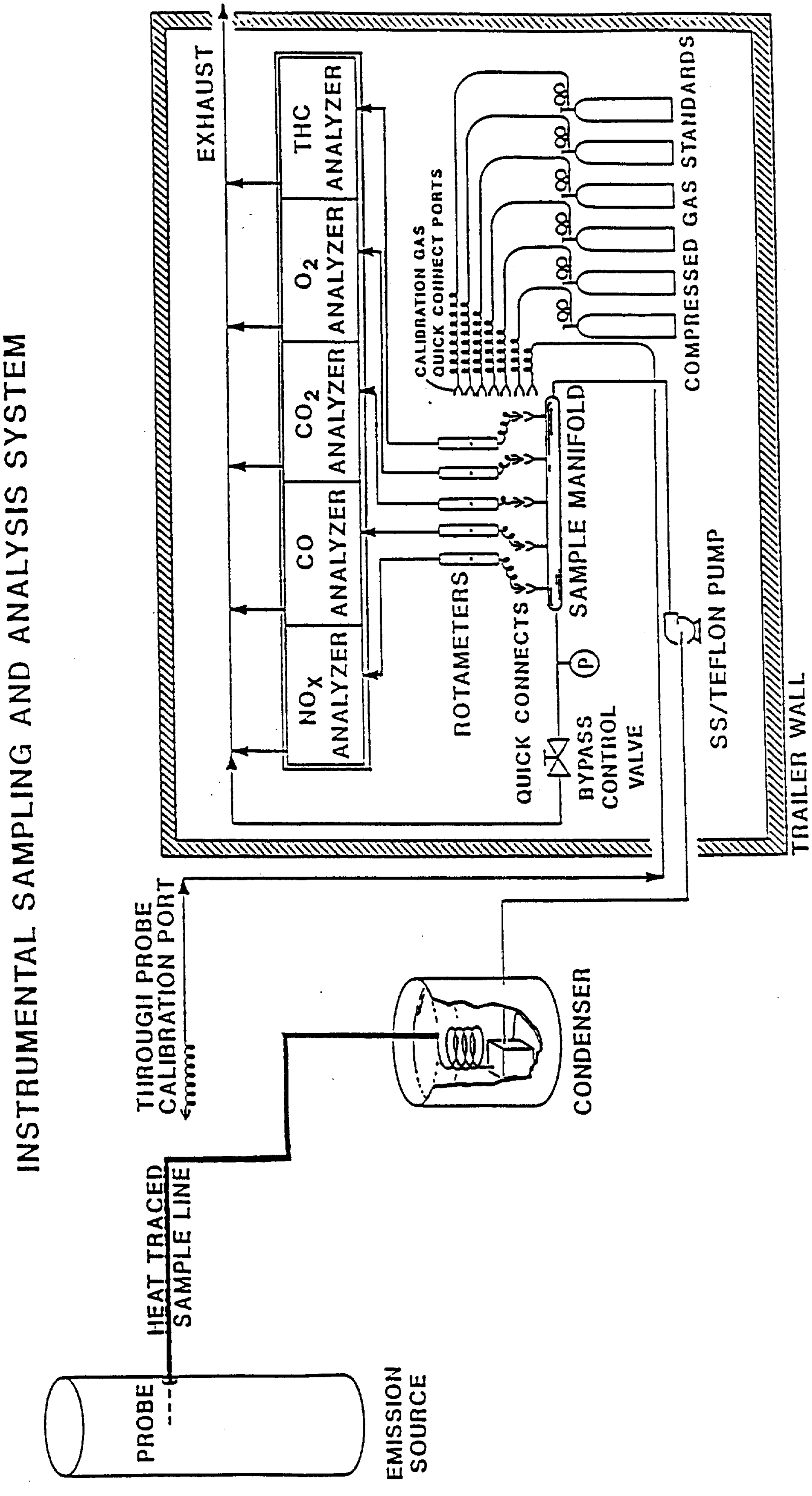
The sampling and analysis system used to determine gaseous emission concentrations is depicted in Figure 2. Stack gas enters the system through a stainless steel probe with a glass wool filter. The sample is transported via 3/8-inch heat-traced Teflon® tubing to a specially designed stainless steel minimum-contact condenser which dries the sample without removing NOx. The sample is then passed to ground level through 3/8" Teflon® sample line via a stainless steel/Teflon® diaphragm pump and into the sample manifold. From the manifold, the sample is partitioned to the analyzers through glass and stainless steel rotometers for flow control of the sample.

All instruments were housed in an air conditioned, trailer mounted, mobile laboratory. Gaseous calibrations standards were provided in aluminum cylinders with the concentrations certified by the vendor. EPA Protocol No. 1 was used to determine the cylinder concentrations where applicable. Provisions were made to introduce the calibration gases to the instruments via two methods: 1) directly to the instruments via the sample manifold quick-connects and rotometers, and 2) through the complete sampling system including the sample probe, filter, condenser, sample line, manifold and rotometers. The former method was used for quick convenient calibration checks. The latter method was used to demonstrate that no alteration of the sample occurred due to leakage, reactions, or absorption within the sampling system (Sample System Bias Check). NOx calibration gases were introduced into the sample system and the response was compared with that of the gas introduced directly to the instrument. No appreciable difference was noted (<2%). NOx calibration gas was used for this check because it is the most reactive pollutant measured.

The stack gas analyses for NOx, CO, CO_2, O_2, and THC were performed by continuous instrumental monitors. Table 7 lists the instruments and detection principles used for these analyses.

NOx and O_2 measurements were made by EPA Method 20. The NOx analysis employed a chemiluminescent analyzer and the O_2 analysis used a paramagnetic analyzer. The NOx values were calculated as if all the NOx was in the form of NO_2. This approach corresponds to EPA's convention, however, it tends to overestimate the actual NOx mass emissions since the majority of the NOx is in the form of NO which is less dense (i.e. lbs of emissions per ppmv concentration) than the NO_2 form of NOx.

Figure 2 : Instrumental Sampling and Analysis System



Cubix Corporation

Table 7 : Analytical Instrumentation

Analytical Instrumentation

Parameter	Model and Manufacturer	Common Use Ranges	Sensitivity	Response Time (sec.)	Detection Principle
NOx	TECO 10AR	0-10 ppm 0-100 ppm 0-200 ppm 0-500 ppm 0-1,000 ppm 0-5,000 ppm	0.1ppm	1.7	Thermal reduction of NO2 to NO. Chemiluminescence of reaction of NO with O3. Detection by PMT. Inherently linear for listed ranges.
CO	TECO 48	0-10 ppm 0-20 ppm 0-50 ppm 0-100 ppm 0-200 ppm 0-500 ppm 0-1000 ppm	0.1ppm	10	Infrared absorption, gas filter correlation detector, micro-processor based linearization
CO_2	Horiba PIR 2000	0-5% 0-15% 0-25%	0.02%	5.0	Infrared absorption, Luft detector, analog linearization
O_2	Taylor Servomex	0-5% 0-10 % 0-25%	0.1%	15.0	Paramagnetic cell, inherently linear.
THC	Shimadzu Mini-2	0-10,000ppm	0.2 ppm	5.0	Flame ionization of hydrocarbons inherently linear over 2 orders of magnitude.
Temperature	Omega HH82	-256 to 2502°F	0.1°F	n/a	Chromel-alumel, K-type thermo-couple with digital thermometer Response time based on thermo-couple design.

NOTE: Higher ranges available by sample dilution
Other ranges available via signal attenuation.

The stack gas analyses for CO_2 concentrations were performed by Method 3a. An instrumental analysis (infrared absorption) was used in lieu of an Orsat or a Fyrite procedure due to the greater accuracy and precision provided by the instruments.

Total hydrocarbon (THC) emission concentrations were monitored during the tests using EPA Method 25a. The flame ionization detector calibration was based on methane equivalents.

CO emission concentrations were quantified by EPA Method 10. A continuous nondispersive infrared analyzer was used for this purpose. The detector used was of the gas filter correlation type. This type of detector eliminates any possible interference due to water vapor or CO_2 in the sample.

All emission and calibration data from the continuous monitoring instruments were recorded on two synchronized 3-pen strip chart recorders (Soltec Model 1243). These recorders were operated at a chart speed of 30 centimeters/hour and record over a 25-centimeter width. Strip chart records may be found in Appendix B of this report.

Stack volumetric flow measurements were conducted in accordance with EPA Methods 1 and 2 and additionally by EPA's stoichiometric "F" factor calculation. Twenty-four velocity traverse points were selected by EPA Method 1. An S-type pitot tube coupled with a calibrated Magnehelic guage was used to determine the pressure head at each traverse point in the stack. Velocity traverses were made prior to test run C-1 since mass emission rate standards (lbs/MMBtu) were applicable. The pitot tube used for these measurements met the dimensional criteria of EPA Method 2.

The two stack volumetric flow methods were compared prior to beginning compliance test C-1. This comparison revealed that the pitot tube flow measurements were approximately 20% higher than the stoichiometrically calculated flow. Further investigation showed that the pitot flow measurements were probably the least accurate of the two methods due to three contributing factors: 1) The sample ports were located approximately 0.3 stack diameters downstream of a flow disturbance (straightening vanes) and 0.4 stack diameters upstream of a flow disturbance (exit). These sample port locations did not meet the dimensional criteria for EPA Method 1 (2 dimeters downstream, 0.5 diameters upstream). 2) The delta P's for the pitot flow readings varied from 0.8 to 3.0 and were pulsing badly, thus indicating turbulent flow probably associated with the straightening vanes being located too close to the sample ports, and 3) turbulent flow would normally indicate higher than actual exhaust flow, which was demonstrated in this case. In addition, evidence to support the stoichiometric flows was exemplified by the fuel Fo calculatons falling within the predicted Fo range for fuel oil combustion (1.26-1.43). Because of these factors, and with approval from the City of Philadelphia Air Management Services, all volumetric flows were determined by EPA "F" factor calculations based on fuel flow and O_2 exhaust concentrations.

Process data were collected by Cubix personnel from the available control room instrumentation during each test run. Key operation data collected included steam injection rate, compressor discharge pressure (i.e. combuster inlet pressure), turbine speed, power output (MW electricity) and fuel flows. The unit operators also keep logs of unit operations. Copies of these operational data sheets can be found in Appendix I of this report. During the tests the operation load of the turbine was maintained as steady as possible within the operating constraints of the system.

Cubix personnel collected ambient temperature, absolute pressure and humidity data during each test run. A wet/dry bulb sling psychrometer was used to determine temperature and humidity conditions. An aircraft-type aneroid barometer (altimeter) was used to measure absolute atmospheric pressure.

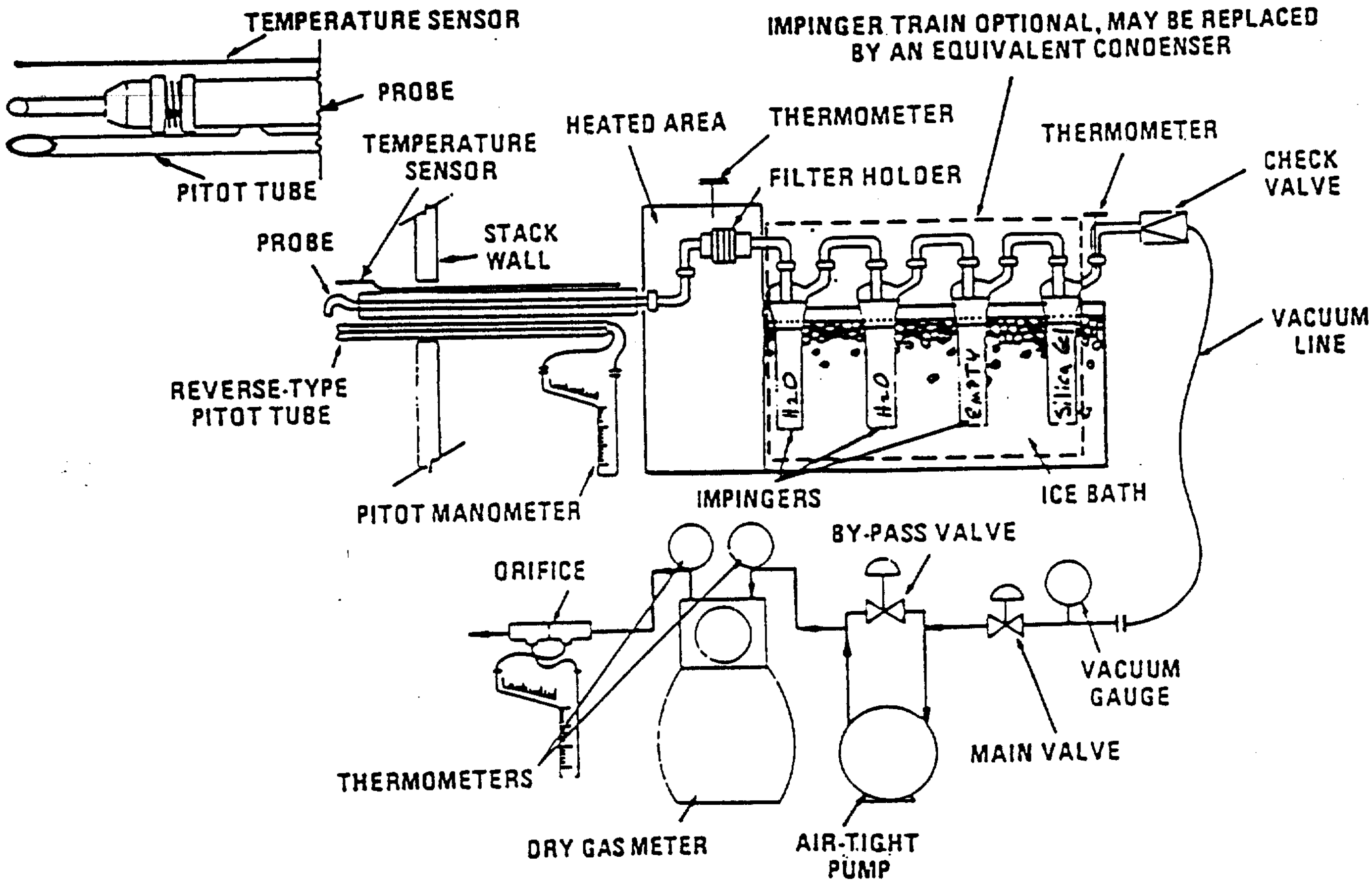
Particulate Matter (PM)

The sampling and analysis procedures used during these tests conform in principle with the methods outlined in the Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 1, 5, EPA's stoichiometric "F" Factors and the Pennsylvania Department of Environmental Resources Source Testing Manual.

The sampling system used to determine particulate matter emissions is depicted in Figure 3. The particulate matter sampling equipment used was a Nutech Model 201 sampling train manufactured by Nutech Corporation of Research Triangle Park, North Carolina. Stack gas enters the system through a heated stainless steel probe with a stainless steel nozzle. The sample is then passed through a heated glass fiber filter. The filter has been preweighed in accordance to the specifications set forth in EPA Method 5. The sample is then transferred through an ice bathed impinger train. This impinger train contains four preweighed impingers. The first two impingers contained approximately 250 ml of deionized water, the third impinger was empty, and the fourth contained silica gel desiccant. The exhaust gas is then drawn through an air-tight pump. After the pump, the gas volume is measured by a calibrated dry gas meter and exhausted. (A copy of the calibration certification of the meter, orifice and nozzle can be found in Appendix E.)

Particulate matter sampling was conducted at twenty-four sample points, in accordance with EPA Method 1. The sampling was conducted isokinetically for 3.5 minutes at each point. The total sample time was 84 minutes for each run. The volume collected was approximately 54 dscf. Particulate matter field data sheets can be found in Appendix D of this report.

Figure 3
Particulate Matter Sampling System Diagram



At the completion of each particulate matter test run, the sampling train was leak checked. All test runs met the requirements for leak checks. All leak checks were conducted with at least 10" Hg vacuum. After the post-test leak check, the probe and nozzle were washed with acetone to remove adhering particulate matter. The front end washes were preserved for evaporation. Also, a blank of deionized water and acetone was kept for analysis of contaminants.

Stack gas physical properties, moisture content and molecular weight, were determined for each test run via EPA Methods 1-4. Velocity head pressures were taken at twenty-four traverse points during each test run. Stack volumetric flow measurements were calculated in accordance with EPA's stoichiometric "F" factors since it was determined prior to testing that the "F" factor calculations were a more accurate assessment of the actual stack volumetric flow.

The stack gas analyses for CO_2 and O_2 concentrations (molecular weight determination) were performed in accordance with procedures set forth in EPA Method 3a. Instrumental analyses were used in lieu of an Orsat or a Fyrite procedure due to the greater accuracy and precision provided by the instruments. A nondispersive infrared analyzer was used for CO_2 concentration analyses. O_2 concentration analyses were performed via a paramagnetic analyzer.

A preliminary test run was conducted on April 29, 1991 to determine stack emission parameters such as stack velocity, stack temperature, flue gas molecular weight, and moisture content. These parameters provided data to calculate a K-factor and to allow selection of a nozzle. The K-factor used was 0.68. The nozzle size selected was 0.00025 ft^2.

After the preliminary tests were completed, six independent test runs were performed on the unit while the turbine was firing fuel oil. Three test runs were performed with the unit at 100% load and three runs were conducted at 90% load. The arithmetic average of the three test runs for each set of conditions is reported as the emission rate from this source.

All six runs were conducted isokinetically. All six test runs were within the ten percent margin for isokinetic sampling. See Appendix A of this report for isokinetic calculation worksheets.

QUALITY ASSURANCE ACTIVITIES

Gaseous Emissions

Each instrument's response was checked and adjusted in the field prior to the collection of data. The instrument's linearity was checked by first adjusting the instrument's zero and span responses to zero nitrogen and an upscale calibration gas in the range of the expected concentrations. The instrument response was then challenged with other calibration gases of known concentration. The instrument's response was accepted as being linear if the response of the other calibration gases agree within ± 2 percent of range from the predicted values. (The response of the infrared absorption type CO and CO_2 analyzers is electronically linearized.)

As a minimum before and after each test run, each analyzer was checked for zero and span drift. This allows each load condition to be bracketed by calibrations and documents the precision of the data just collected. The criterion for acceptable data is that the instrument drift no more than 2 percent of the full scale response. Results of these zero and span checks may be found on the strip chart data (Appendix B) and on QA worksheets (Appendix F) in this report.

Interference response tests on the instruments were conducted by the instrument vendors and Cubix Corporation. The sum of the interference responses for the NOx, CO, CO_2 and O_2 analyzers is less than 2 percent of the applicable full scale span value. The instruments used for the tests meet the performance specifications for EPA Methods 10 and 20. Documentation of the manufacturer's interference response tests are contained in Appendix F.

The residence time of the sampling and measurement system was estimated using the pump flow rate and the sampling system volume. The pump's rated flow rate is 0.8 SCFM at 5 psig. The sampling system volume is 0.139 scf. Therefore, the minimum sample residence time is approximately 10.4 seconds.

The NOx and O_2 sampling and analysis system was checked for response time per the procedures outlined in EPA's Method 20. The average NOx analyzer's response times were 0.61 minutes upscale and 0.65 minutes downscale. The O_2 analyzer's response times were 0.76 minutes upscale and 0.88 minutes downscale. The results of these response time tests are contained in Appendix F.

The sampling system's integrity was tested by comparing the response of the NOx analyzer to a calibration gas introduced via two paths. The first path was into the analyzers via the zero/span calibration manifold. The second path was to introduce a calibration gas into the sample line at the sample probe. Any difference in the instrument responses by these two methods was attributed to sampling system bias. The criteria for acceptance is agreement within 2% of the full scale range of the analyzer. NOx sampling system bias checks are required by Method 20. Results of the sample system bias check are presented in Appendix F.

The sampling system was leak checked by demonstrating that it could hold a vacuum greater than 10" Hg (17" Hg actual) for at least 1 minute with a decline of less than 1" Hg. No leakage was detected.

The efficiency of the NO_2 to NO converter housed in the NOx analyzer was checked by having the analyzer sample a mixture of NO in N_2 standard gas and zero air from a Tedlar® bag. When this bag is mixed and exposed to sunlight the NO is oxidized to NO_2 over approximately a 30 minute period. If the NOx instrument's converter is 100% efficient, then the NOx response does not decline as the NO in the bag is converted to NO_2. The criterion for acceptability is a demonstrated NOx converter efficiency greater than 90%. Results of the converter efficiency test are presented in Appendix F.

The calibration gases used to calibrate the instruments were analyzed and certified by the compressed gas vendors to ± 1% accuracy. EPA Protocol No. 1 was used, where applicable, to assign the concentration values traceable to the National Institute of Standards and Technology (formerly the National Bureau of Standards), Standard Reference Materials (SRM's). Calibration gas certifications may be found in Appendix E of this report.

Particulate Matter (PM)

EPA Method 5 quality assurance activities began during preparation for sampling. All glassware was thoroughly acid washed, rinsed, dried and stored with protection to prevent contamination. Preweighed glass fiber filters were installed into the filter holders and capped with rubber septa. Other filters were sealed against contamination and packed safely. The meter box was checked for proper operation and calibration. Fresh deionized water was brought for the washing of the sampling train. A blank of this water was kept in a sample container and retained for evaporation and weighing for contaminants.

All EPA Method 5 particulate matter weighings were conducted on a Mettler H6T balance. This balance has a 160 gram capacity and a 0.0001 g sensitivity. The balance was leveled and zeroed before each series of weighings. All weighings of filters were repeated until there was a 0.0005 gram agreement between consecutive weighings, thus indicating a constant weight. All items were desiccated for 24 hours before weighing and 6 hours between consecutive weighings.

The sample train was leak checked with the nozzle in place before and after every test run. In all cases the leakage rate was less than 0.02 CFM. Likewise the pitot tube lines were leak checked at 5" of water for a minimum of 15 seconds to ensure that stack pressure head measurements were accurate.

Particulate matter emission testing was performed using Nutech Model 201 sampling equipment manufactured by the Nutech Corporation of Research Triangle Park, North Carolina. All equipment meets EPA guidelines for EPA Methods 2 and 5. An 8-foot heated probe was used to collect the sample. Buttonhook nozzles were used to sample the gas stream. During sampling, the filters were heated to 250 °F (± 25 °F). The condensate was collected in glass impingers. A standard rotary-vane pump was used to draw the sample from the source, and the amount of gas collected was measured by a calibrated dry gas meter.

At the completion of each particulate run, the probe, nozzle and filter holder were washed to remove adhering particulate matter. The front end washes for the six test runs and one set of back-half catches for each test series were preserved for evaporation and filtration. As specified by the Pennsylvania Department of Environmental Resources Source Testing Manual, only the back-half analysis for insoluble particulate was conducted on one run from each set of particulate matter tests. This involved pouring the impinged liquid through a series of preweighed Whatman cellulose nitrate filters (0.8 um, 0.45 um, and 0.2um) while pulling a vacuum on the system to collect any remaining insoluble particulate matter.

Filter blanks and blanks of all solutions were prepared and analyzed for contaminants in exactly the same manner as the samples were handled and analyzed. These blanks met the requirements set for the amount of contaminants in being less than 0.001% by weight.

Equipment calibrations and certifications may be found in Appendix E of this report.

SIGN IN SHEET

JOB NAME: Sun Refining + Marketing DATE: 5 / 1 / 91

LOCATION: Philadelphia, PA PERMIT #

SOURCE(S): Westinghouse 301-G

PARTICIPANTS: Cubix Corporation

City of Philadelphia

Sun Refining + Marketing

NAME:	AFFILIATION:	PHONE NUMBER:
Bill Bianco Jr.	City of Phila. AMS	215-875-5632
Bob Scott	" "	"
Rick J. Krenzke	Cubix Corp.	512-243-0202
Kevin W. Janak	" "	"
Bob Partridge	Sun Oil	215-339-2296 215-961-6900 PgR
Charles A. Jones, Jr.	Sun Oil	215-339-2328
James W. Blanck	Sun Oil	215-339-2327
Stanley E. LeSueuer	Sun Oil	215-339-2324
Steven Kestel	Sun Oil	215-339-2375
John H. Lusher	" "	215-339-2327

EXAMPLE CALCULATION

O_2 BASED F FACTOR EMISSION CALCULATIONS

Date: 5-1-91
Plant: Sun Oil Philly
Stack: Westinghouse 301-G*2
Technician: KJ, RJK, JJ
Test Run: #C-1

Gaseous Fuel

Fuel Flow (SCFH) na
Gross Calorific Value (Btu/SCF) na
Fuel Specific Gravity na
F_g Factor (DSCF/MMBtu) na

Other Fuel Fuel Oil #2

NOx 70.4 CO_2 2.22
NO na THC 2.5
NO_2 na O_2 18.00
CO 35.0

Fuel Flow (lb/hr) 16142
Gross Calorific Value (BTU/lb) 19313
Fuel Specific Gravity 0.82
F_1 Factor (DSCF/MMBtu) 9220

Calorific Fuel Flow

Gaseous Z_g(MMBTU/hr) = SCFH Fuel Flow x Btu/SCF x 10^{-6}
na = na x na x 10^{-6}

Other Fuel Z_1(MMBtu/hr) = lb/hr Fuel Flow x Btu/lb x 10^{-6}
311.75 = 16142 x 19313 x 10^{-6}

Flue Gas Flow (DSCF/hr)

$Q_d = (Z_g \times F_g) + (Z_1 \times F_1)$

2.87×10^6 = (na x na) + (311.75 x 9220)

Emissions (lbs/hr)

E (lbs/hr) = [C (lbs/DSCF)] x Q_d (DSCFH) x $^{20.9}/_{20.9 - \%\ O2}$

E_{NO_x} 80.39 = [32.5 ppm x 11.94(10^{-8})] x 2.87×10^6 x $^{20.9}/_{20.9}$ - 18.00 %

E_{NO_x} (lb/mm Btu) = 80.39 lbs/hr / 311.8 mmBtu/hr = 0.26 lbs/mmBtu

E_{CO} 52.56 = [35.0 ppm x 7.26(10^{-8})] x 2.87×10^6 x $^{20.9}/_{20.9}$ - 18.00 %

EMISSION CALCULATION WORKSHEET

Date: 5-1-91
Plant: Sun Oil Philly
Source: Westinghouse 301-6 #2
Technicians: KT, RK, TS
Run: # C-1
Time: Start 1648 Stop 1839

Average Concentration (dry basis)
NO_x 32.5 ppm
CO 35.0 ppm
O_2 18.00 %
CO_2 2.22 %
THC 2.5 ppm

EXAMPLE CALCULATION

Dry Stack Volumetric Flow (SCFH dry basis)

$$Qd = 60 \times Qa \times \frac{528°R}{Ts} \times \frac{Ps}{29.92\text{" Hg}} \times Fd$$

$$Qd = 1058.8 \times Qa \times \frac{Ps}{Ts} \times Fd$$

2.07×10^7 = O_2 F Factor Stoichiometric Flows

NA = 1058.8 x NA ACFM x $\frac{\text{NA " Hg}}{\text{NA °R}}$ x $\frac{\text{NA \%}}{100}$

NOx Emissions as NO2 (lbs/hr)

$$E_{NOx} = 11.94 \times 10^{-8} \times Qd \times C_{NOx}$$

80.39 = $11.94 \times 10^{-8} \times 2.07 \times 10^7$ SCFH x 32.5 ppmv

CO Emissions (lbs/hr)

$$E_{CO} = 7.26 \times 10^{-8} \times Qd \times C_{CO}$$

52.56 = $7.26 \times 10^{-8} \times 2.07 \times 10^7$ SCFH x 35.0 ppmv

THC Emissions (lbs/hr)

$$E_{THC} = 4.15 \times 10^{-8} \times Qd \times C_{THC}$$

2.15 = $4.15 \times 10^{-8} \times 2.07 \times 10^7$ SCFH x 2.5 ppmv

Turbine Exhaust Concentration Standards
(40 CFR 60 Subpart GG and Appendix A, Method 20)

Date 5-1-91
Plant Sun Oil Philly
Stack Westinghouse 301-G #2
Technician KT, RTK, TS
Test Run #C-1
Time- Start 1648 Stop 1839

Measured Concentrations
NOx 32.5
SO2 na
O2 18.00

EXAMPLE CALCULATION

Adjust Concentrations to 15% O2

$$NOx\ @\ 15\%\ O2 = NOx\ Measured \times \frac{5.9}{20.9 - \%O2\ Measured}$$

$$66.1 = 32.5 \times \frac{5.9}{20.9 - 18.00\ \%}$$

Calculate NOx Concentration at ISO Standard Day Conditions

$$NOx\ (EPA\ Corrected) = NOx\ (@\ 15\%\ O2) \times \left(\frac{P\ ref\ psia}{\frac{"\ Hg}{2.036} + P\ obs\ psig}\right)^{0.5} \times 2.718^{19(H\ lb/lb - 0.00633)} \times \left(\frac{519\ °R}{460 + T\ amb}\right)^{1.53}$$

$$70.4 = 66.1 \times \left(\frac{(86\ psia)}{\frac{(29.88\ "\ Hg)}{2.036}+(73.5\ psig)}\right)^{0.5} \times 2.718^{19(0.0131\ lb/lb - 0.00633)} \times \left(\frac{519\ °R}{460 + 77\ °F}\right)^{1.53}$$

1.137 0.95

Definitions

Standard ISO Day: Temperature = 519°R, Pressure = 29.92 " Hg, Humidity = 0.00633 lbs/lb dry air
NOx (EPA Corrected) : Predicted NOx emission concentration at ISO Day Conditions and 15% O2
NOx (@ 15% O2) : Predicted NOx concentrations with 15% O2 in the flue gas assuming 20.9% O2 in air
P ref : Absolute pressure at combuster inlet at 29.92 " Hg ambient pressure
P obs : Absolute pressure at combuster inlet at ambient pressure test conditions
H : Ambient specific humidity (lbs moisture/ lb dry air)
T amb : Ambient temperature at test conditions (°F)

[illegible]

Date: 4-30-91

Plant: Sun Oil Philly

Stack: Westinghouse 301-6 Unit #2

Technician: KJ, JS

Dry Gas Meter No. Nutech

DGM Correction Factor (Kd) 0.9921

DGM Absolute Pressure (Pm) 29.92

Test Run No. R-

EXAMPLE CALCULATION

Impinger Number	1	2	3	4	5	6	
Contents							
Final Wt.	688.8	655.5	455.9	738.0			2538.2
Initial Wt.	671.7	653.7	454.8	731.8			2512.0

Total Weight Gain of all Impingers (MWC) = 26.2 grams H_2O

	Time	Meter Rd. (ft^3)	Leak Check (ft^3/min)	Meter Temp. (°F)
Initial	11:24	287.5	0.0 at 21" Hg	68
Final	12:01	310.6	0.0 at 21" Hg	81
		V_{net} 23.1	Average Temp.	74.5

Tm = Average Temp °F + 460   534.5 °R = 74.5 °F + 460

$V = V_{net} \times K_d$ 22.9 ft^3 = 23.1 ft^3net X 0.9921 (Kd)

$$\text{Moisture Fraction} = \frac{(MWC)\ (1.335)\ \frac{\text{liters}}{\text{gm } H_2O}}{\left[(MWC)\ (1.335)\ \frac{\text{liters}}{\text{gm } H_2O}\right] + \left[\frac{(V)\ \cdot\ (PM)}{(TM)}\ (499.4)\ \frac{\text{liters } °R}{ft^3 \text{ in. Hg}}\right]}$$

$$0.0518 = \frac{(26.2)\ (1.335)}{\left[(26.2)\ (1.335)\right] + \left[\frac{(22.9)(29.92)}{(534.5)}\ (499.4)\right]}$$

	Molecular Weights		Moisture Fraction	Partial Mol. Wt.
H_2O	(18)		[0.0518 X] =	0.93
		Orsat Fraction	Dry Gas Fraction	
CO_2	(44)	(0.0303)	[0.9482 X] =	1.26
O_2	(32)	(0.170)		5.16
CO	(28)	(0.7997)		21.23
N_2	(28)	( )		

Molecular Weight of Stack Gas 28.58

Stack Velocity and Flow Rate Worksheet

Date 4-30-91
Plant: Sun oil Philadelphia, PA
Stack: Westinghouse 301-6 #2
Technician(s): KS, SS, RK
Test Run No.: P-
Time Start: ______ Stop ______

Pitot Tube No. S-type
Pitot Tube Factor (Kp) 0.84
Atm. Press (Pb) 29.92 in. Hg
Avg. Stack Temp.(Ts) 792 °F
Stack Gas Mol. Wt. 28.58 lb/lb-mole
Stack Static Pressure (Pg) -1.5 in H_2O
Stack Area (A) 153.9 ft^2

Traverse Point	ΔP (inches H_2O) A	B
1	2.3	0.80
2	3.0	1.00
3	3.0	1.20
4	2.8	1.45
5	2.0	1.50
6	1.75	2.20
7	1.75	1.30
8	1.45	2.2
9	1.50	1.05
10	2.5	1.0
11	3.3	1.20
12	2.6	.91

Absolute Stack Pressure (Ps)

$$Ps = Pb + (Pg \times 0.0735)$$

29.81 = 29.92 + (-1.5 x 0.0735)

Average $\sqrt{\Delta P}$

$$\text{Average } \Delta P = \frac{\Sigma \sqrt{\Delta P}}{\text{No. of Traverse Points}}$$

1.330448 = (63.86152601) / (48)

EXAMPLE CALCULATION

Stack Velocity (V)

$$V = 5128.8 \times Kp \times \text{Average}\sqrt{\Delta P} \times \sqrt{\frac{Ts}{Ps \times MW}}$$

6,948.3713 ft/min = 5128.8 x 0.84 x 1.330448 x $\sqrt{\frac{792\ ^\circ F + 460}{29.81 \text{ in Hg} \times 28.58 \text{ MW}}}$

Stack Volumetric Flow, Qa, (at stack conditions)

$$Qa = V \times A$$

1,069,354 acfm = 6,948.3713 ft/min x 153.9 ft^2

Stack Volumetric Flow, Qd, (dry basis at 68 °F and 29.92 in Hg)

$$Qd = Qa \times 1059 \times \frac{Ps}{Ts} \times Fd$$

25,566,730 scfh = 1,069,354 acfm x 1059 x $\frac{29.81 \text{ in. Hg}}{792\ ^\circ F + 460}$ x 0.9482 Fd

= 2.56 x 10^7

Field Check of Percent Isokinetic

Sample # PM-1
Source Westinghouse 301-G
Company name Sun Oil
Plant Philly

Step 1

Nozzle Volume at Stack Conditions (ft3)	Corrected Dry Gas Volume (ft3)	Average Stack Temperature (°F)	Average Meter Temperature (°F)	Dry Gas Fraction
135.483	56.3	810	91	0.9578

Step 2

Avg. Corrected Stack Velocity (ft/sec)	Molecular Weight	Stack Pressure ("Hg)	Average√Δp
113.633	28.69	29.87	1.3

Step 3

Nozzle Area	Sample Time (minutes)
0.00025	85

% Isokinetic
93.51

Date 5-1-91

Signed [signature]

Testing by Cubix Corporation

Nozzle and K Determination

Company name Sun Oil Refinery **Plant** Philadelphia, PA

Step 1

Stack Velocity Standard Conditions (ft/min)	Preliminary Velocity (ft/min)	Dry Gas Fraction	Stack Pressure ("Hg)	Stack Temp. Average (°F)
2772	6939	0.948	29.9	792

Step 2

Desired Nozzle Area (ft2)	Desired Flow Rate (at STP) (ft3/min)
0.000216	0.6

Step 3

Nozzle No.	Area of Nozzle
	0.00025

Step 4

Flow Rate of Nozzle (SCFM)
0.6931

Total Sample Volume (ft3 at STP dry)	Total Time (min)
58.219	84

Step 5

Calculate ΔH by checking orifice curve

ΔH ("H2O)
1.2

Step 6

Δp ("H2O)	Average√Δp
1.769	1.33

Step 7

K Factor
0.68

Date 5-2-91

Signed [signature]

Testing by Cubix Corporation

Field Check of Percent Isokinetic

Sample # PM-2
Source Westinghouse 301-G
Company name Sun Oil
Plant Philly

Step 1

Nozzle Volume at Stack Conditions (ft3)	Corrected Dry Gas Volume (ft3)	Average Stack Temperature (°F)	Average Meter Temperature (°F)	Dry Gas Fraction
143.322	57.34	805	65	0.964

Step 2

Avg. Corrected Stack Velocity (ft/sec)	Molecular Weight	Stack Pressure ("Hg)	Average$\sqrt{\Delta p}$
113.232	28.78	29.87	1.3

Step 3

Nozzle Area	Sample Time (minutes)
0.00025	84

% Isokinetic
100.46

Date 5-2-91

Signed Rick J Kempke

Testing by Cubix Corporation

Field Check of Percent Isokinetic

Sample # PM-3
Source Westinghouse 301-G
Company name Sun Oil
Plant Philly

Step 1

Nozzle Volume at Stack Conditions (ft3)	Corrected Dry Gas Volume (ft3)	Average Stack Temperature (°F)	Average Meter Temperature (°F)	Dry Gas Fraction
143.475	57.94	806	72	0.961

Step 2

Avg. Corrected Stack Velocity (ft/sec)	Molecular Weight	Stack Pressure ("Hg)	Average√Δp
113.336	28.75	29.87	1.3

Step 3

Nozzle Area	Sample Time (minutes)
0.00025	84

% Isokinetic
100.47

Date 5-2-91

Signed Rick J. [signature]

Testing by Cubix Corporation

Field Check of Percent Isokinetic

Sample # PM-4
Source Westinghouse 301-G
Company name Sun Oil
Plant Philly

Step 1

Nozzle Volume at Stack Conditions (ft3)	Corrected Dry Gas Volume (ft3)	Average Stack Temperature (°F)	Average Meter Temperature (°F)	Dry Gas Fraction
132.716	56.05	766	76	0.966

Step 2

Avg. Corrected Stack Velocity (ft/sec)	Molecular Weight	Stack Pressure ("Hg)	Average$\sqrt{\Delta p}$
112.369	28.76	29.87	1.31

Step 3

Nozzle Area	Sample Time (minutes)
0.00025	84

% Isokinetic
93.74

Date 5-2-91

Signed Rik J. Kenyke

Testing by Cubix Corporation

Field Check of Percent Isokinetic

Sample # PM-5
Source Westinghouse 301-G
Company name Sun Oil
Plant Philly

Step 1

Nozzle Volume at Stack Conditions (ft3)	Corrected Dry Gas Volume (ft3)	Average Stack Temperature (°F)	Average Meter Temperature (°F)	Dry Gas Fraction
135.514	57.74	761	78	0.967

Step 2

Avg. Corrected Stack Velocity (ft/sec)	Molecular Weight	Stack Pressure ("Hg)	Average√Δp
112.140	28.76	29.87	1.31

Step 3

Nozzle Area	Sample Time (minutes)
0.00025	84

% Isokinetic
95.91

Date 5-2-91

Signed [signature]

Testing by Cubix Corporation

Field Check of Percent Isokinetic

Sample # **PM-6**
Source **Westinghouse 301-G**
Company name **Sun Oil**
Plant **Philly**

Step 1

Nozzle Volume at Stack Conditions (ft3)	Corrected Dry Gas Volume (ft3)	Average Stack Temperature (°F)	Average Meter Temperature (°F)	Dry Gas Fraction
137.128	59.43	757	86	0.966

Step 2

Avg. Corrected Stack Velocity (ft/sec)	Molecular Weight	Stack Pressure ("Hg)	Average$\sqrt{\Delta p}$
116.209	28.77	29.87	1.36

Step 3

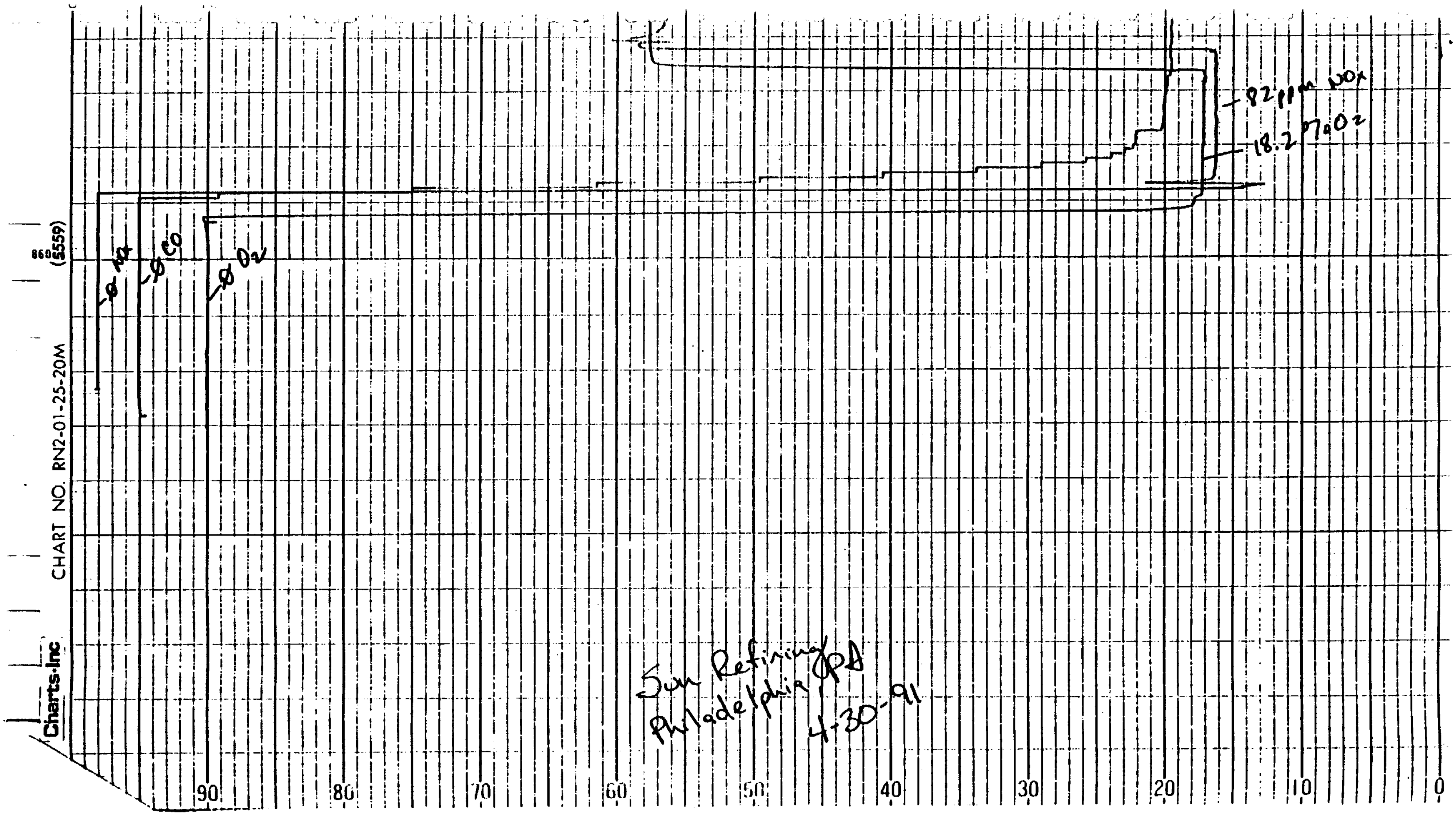
Nozzle Area	Sample Time (minutes)
0.00025	84

% Isokinetic
93.65

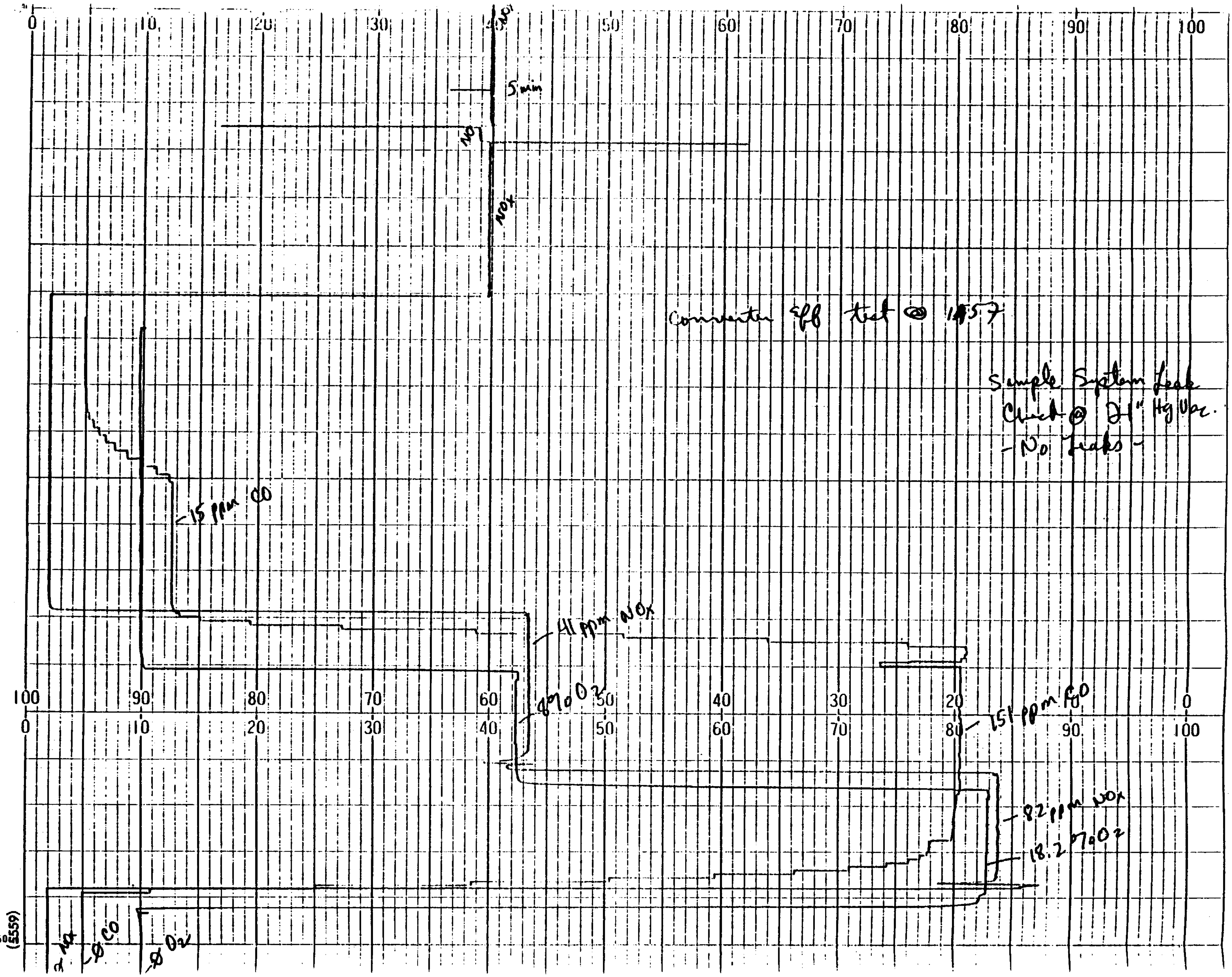
Date 5-2-91

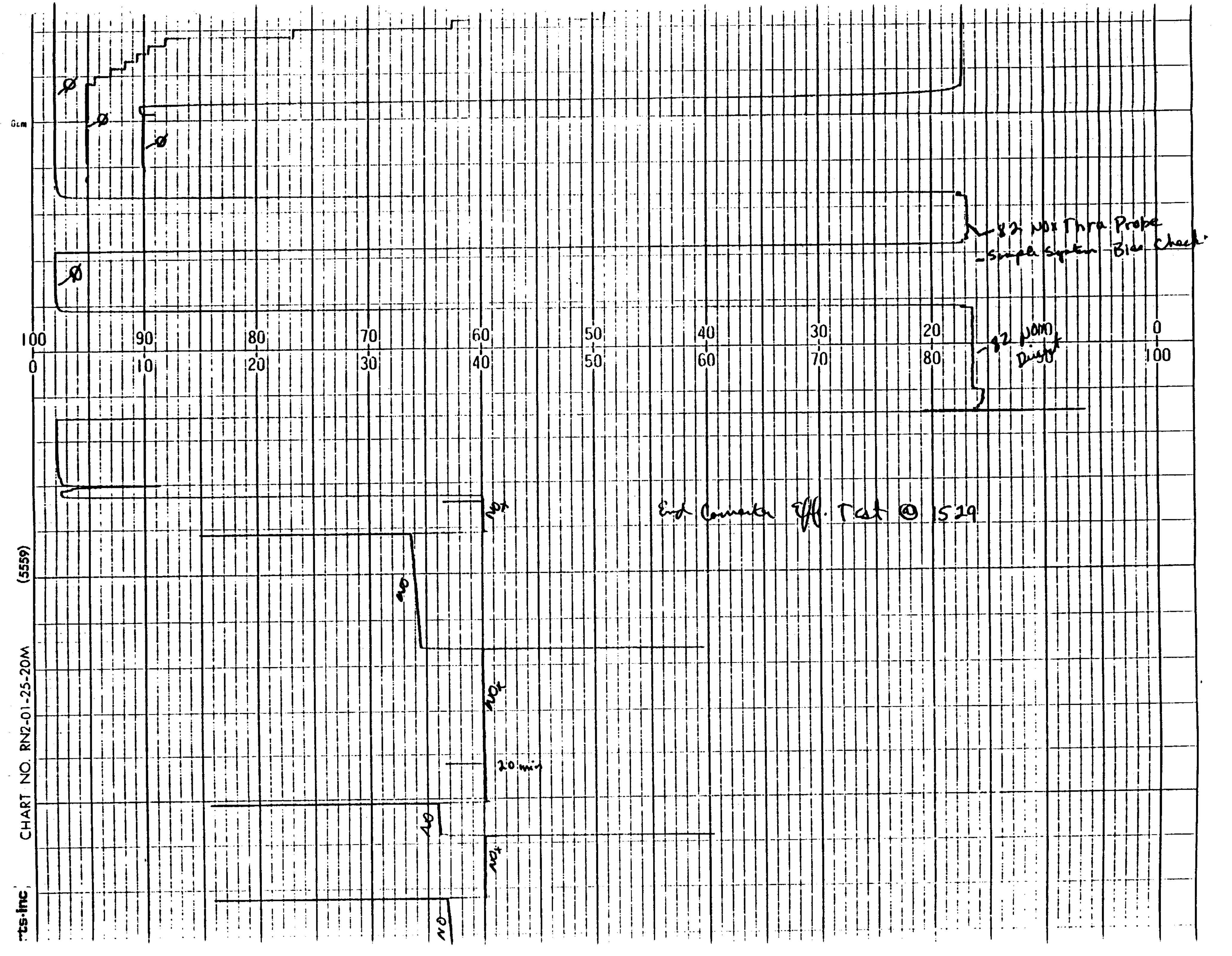
Signed Rik J. Kempfe

Testing by Cubix Corporation

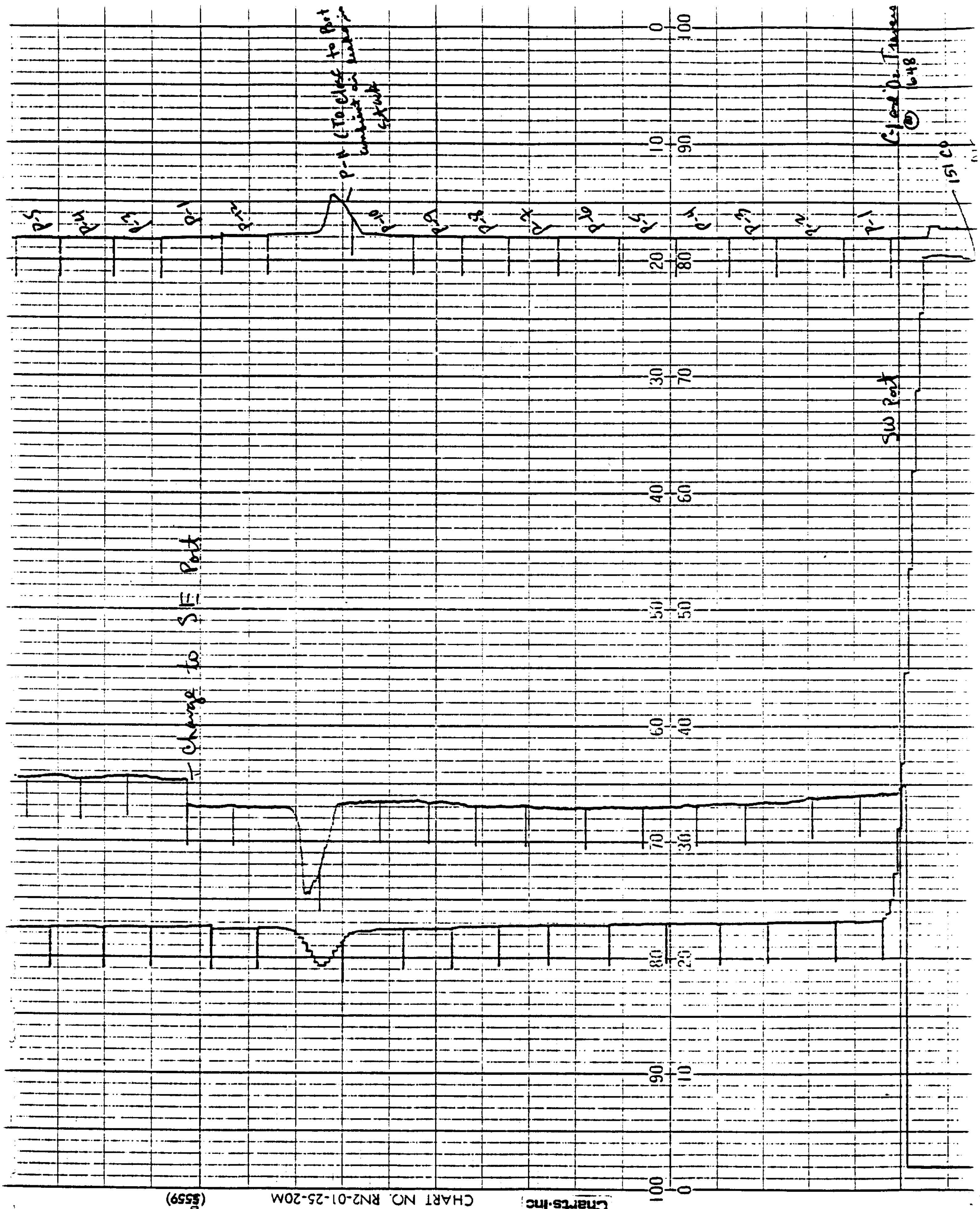


82 ppm NOx
18.2% O2
Ø NOx
Ø CO
Ø O2
Sun Refining
Philadelphia
4-30-91
0
10
20
30
40
50
60
70
80
90
860 (5559)
CHART NO. RN2-01-25-20M
Charts-Inc


5 min
NO
NOx
Converter eff test @ 1457
Sample System Leak
Check @ 21" Hg Vac.
- No Leaks -
-15 ppm CO
-41 ppm NOx
8% O2
151 ppm CO
-82 ppm NOx
18.2 % O2
Ø NOx
Ø CO
Ø O2
(5559)



-82 NOx Thru Probe
-Sample System Bias Check
-82 NO(N) Direct
End Converter Eff. Test @ 1529
NOx
NO
20 min
CHART NO. RN2-01-25-20M
(5559)


Change to SE Port
SW Port
CHART NO. RN2-01-25-20M
Charts-Inc

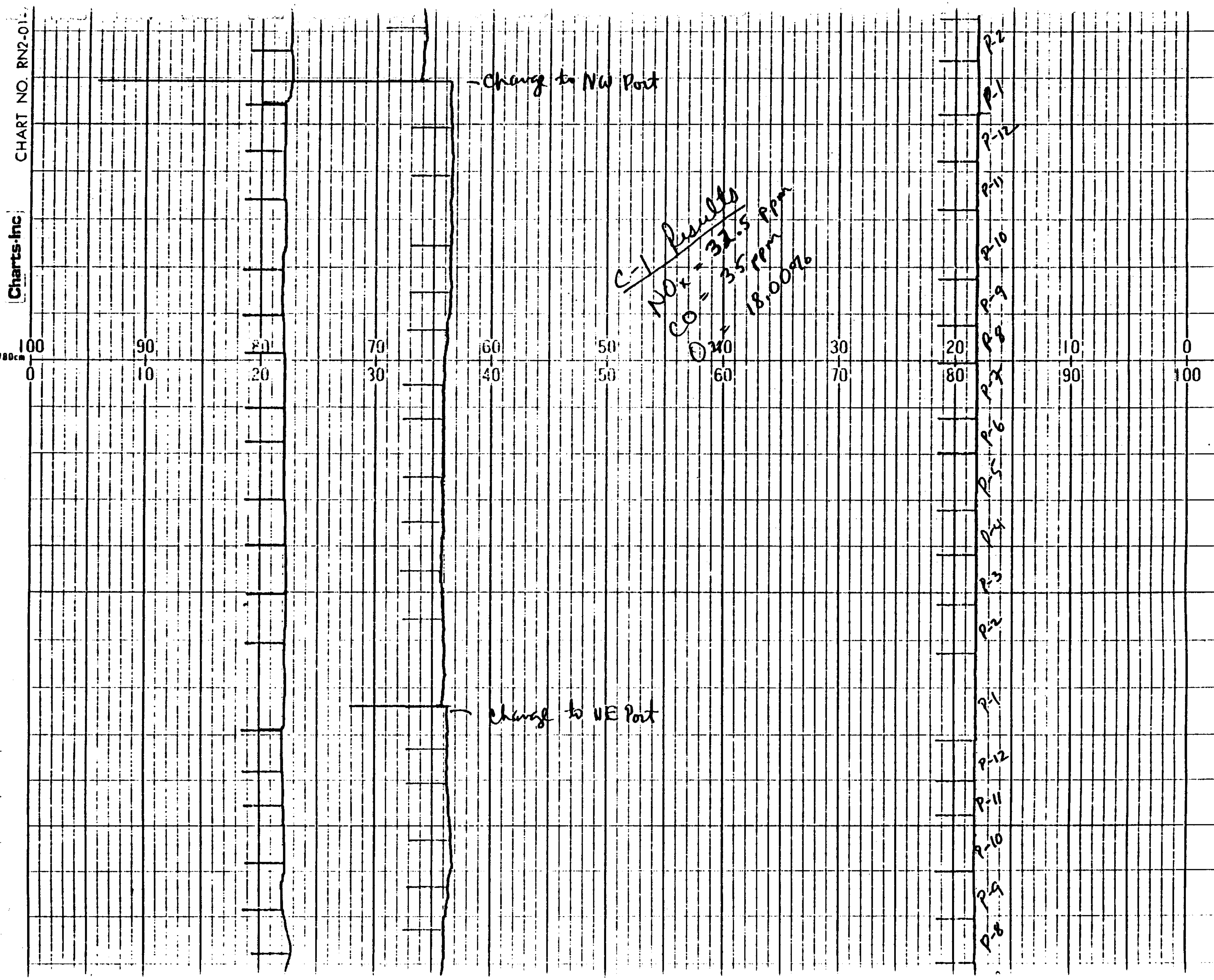
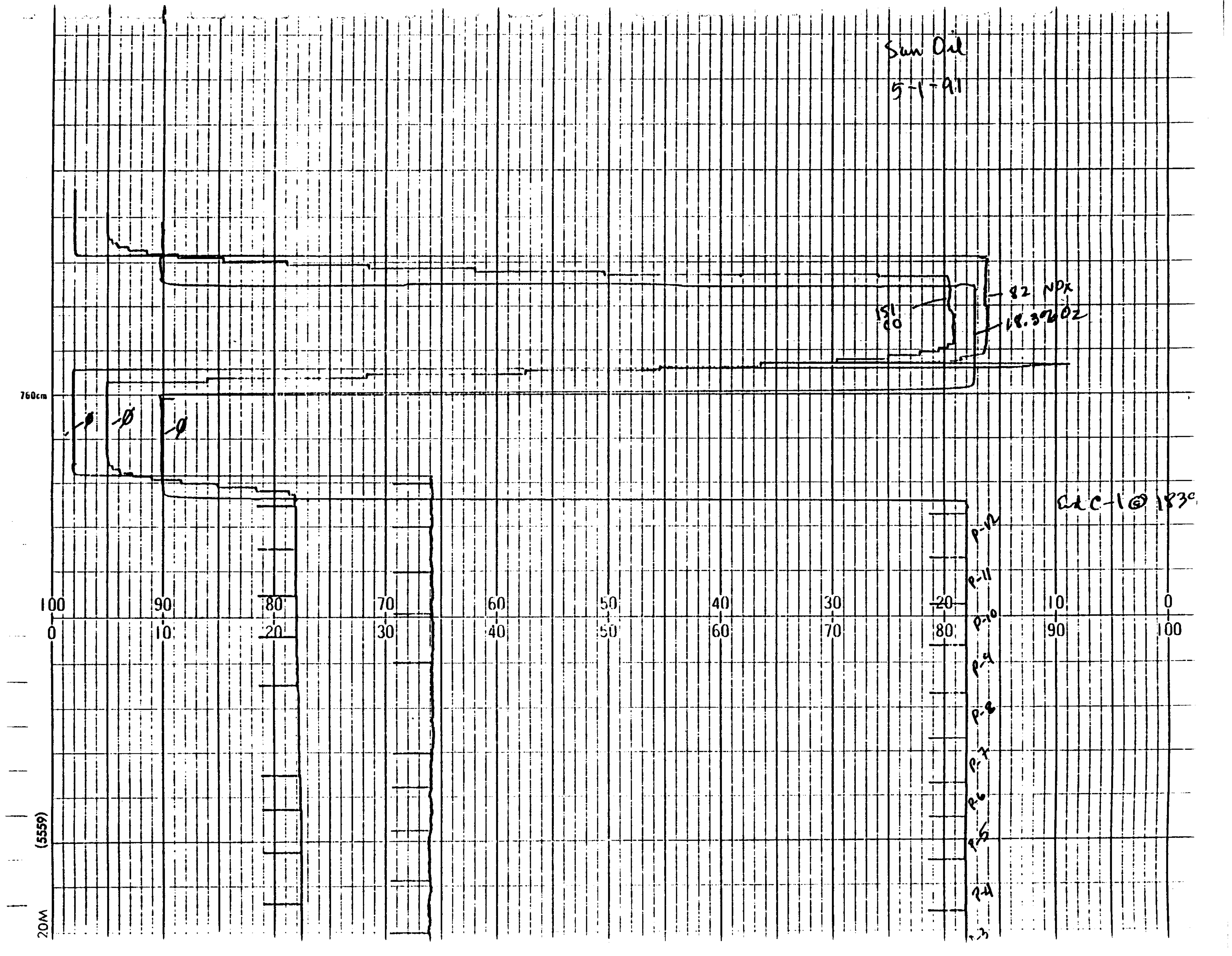
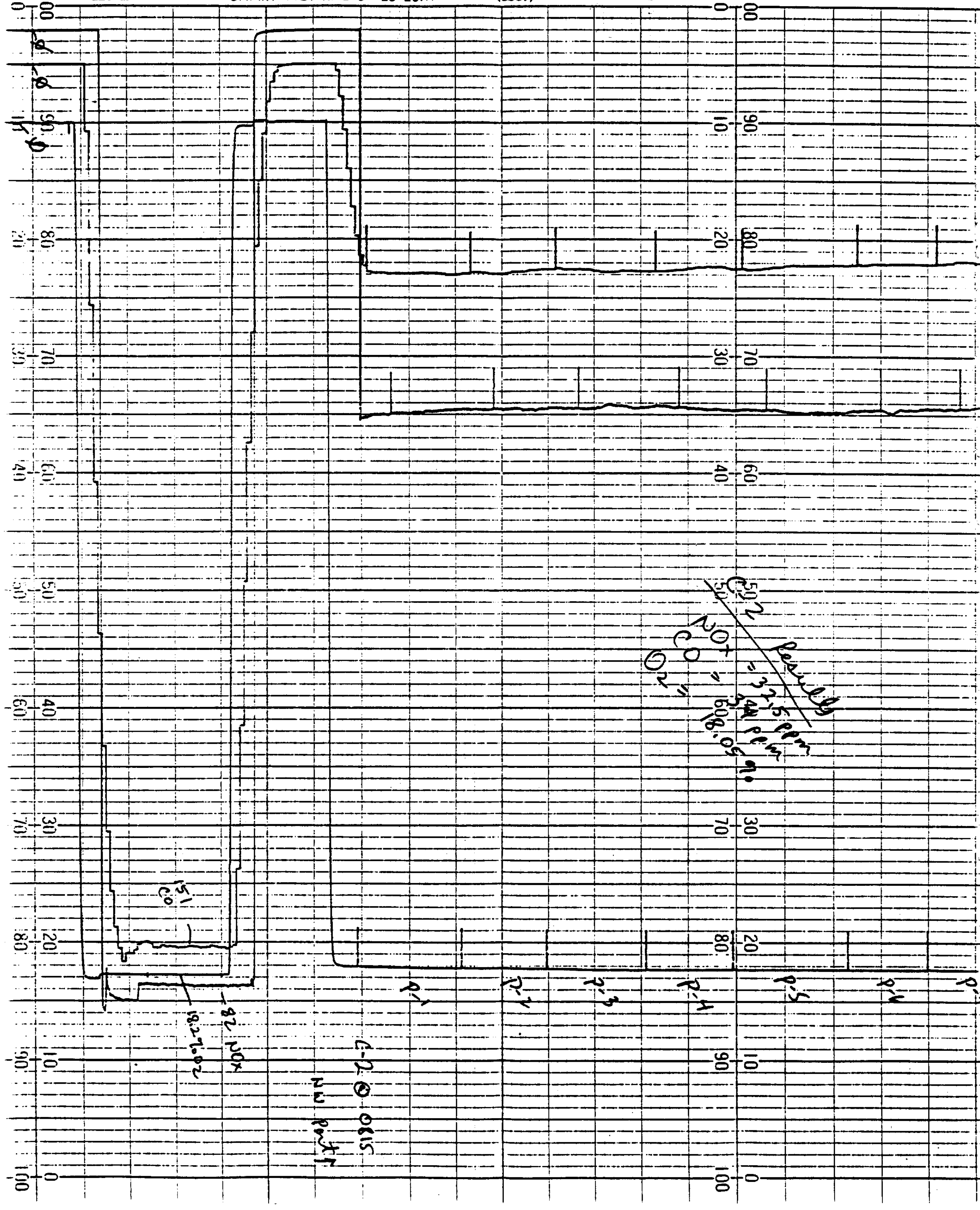


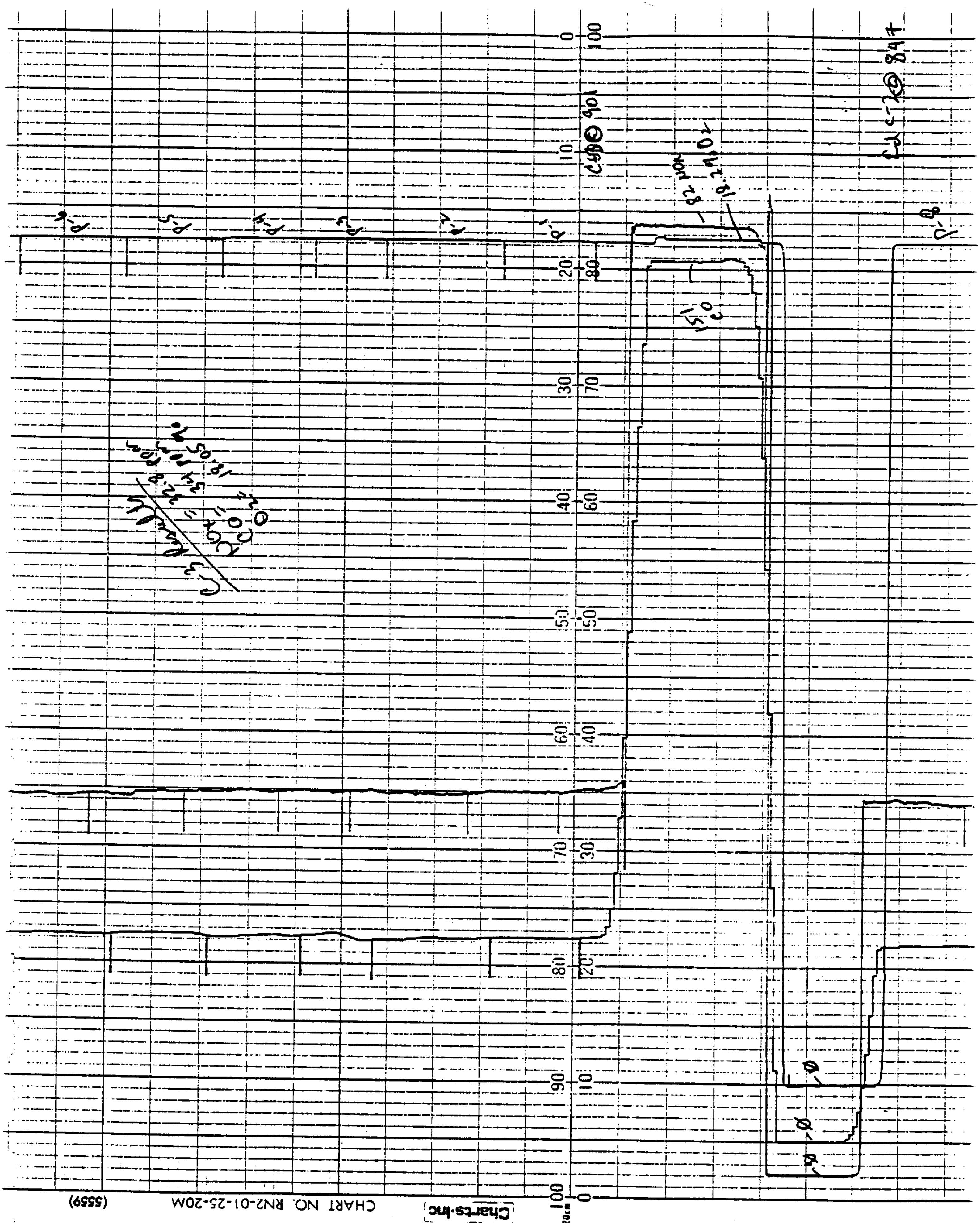
CHART NO. RN2-01
Charts-Inc
780cm
- Change to NW Port
C-1 Results
NOx = 32.5 ppm
CO = 3.5 ppm
O2 = 18.00%
Change to NE Port
P-2
P-1
P-12
P-11
P-10
P-9
P-8
P-7
P-6
P-5
P-4
P-3
P-2
P-1
P-12
P-11
P-10
P-9
P-8

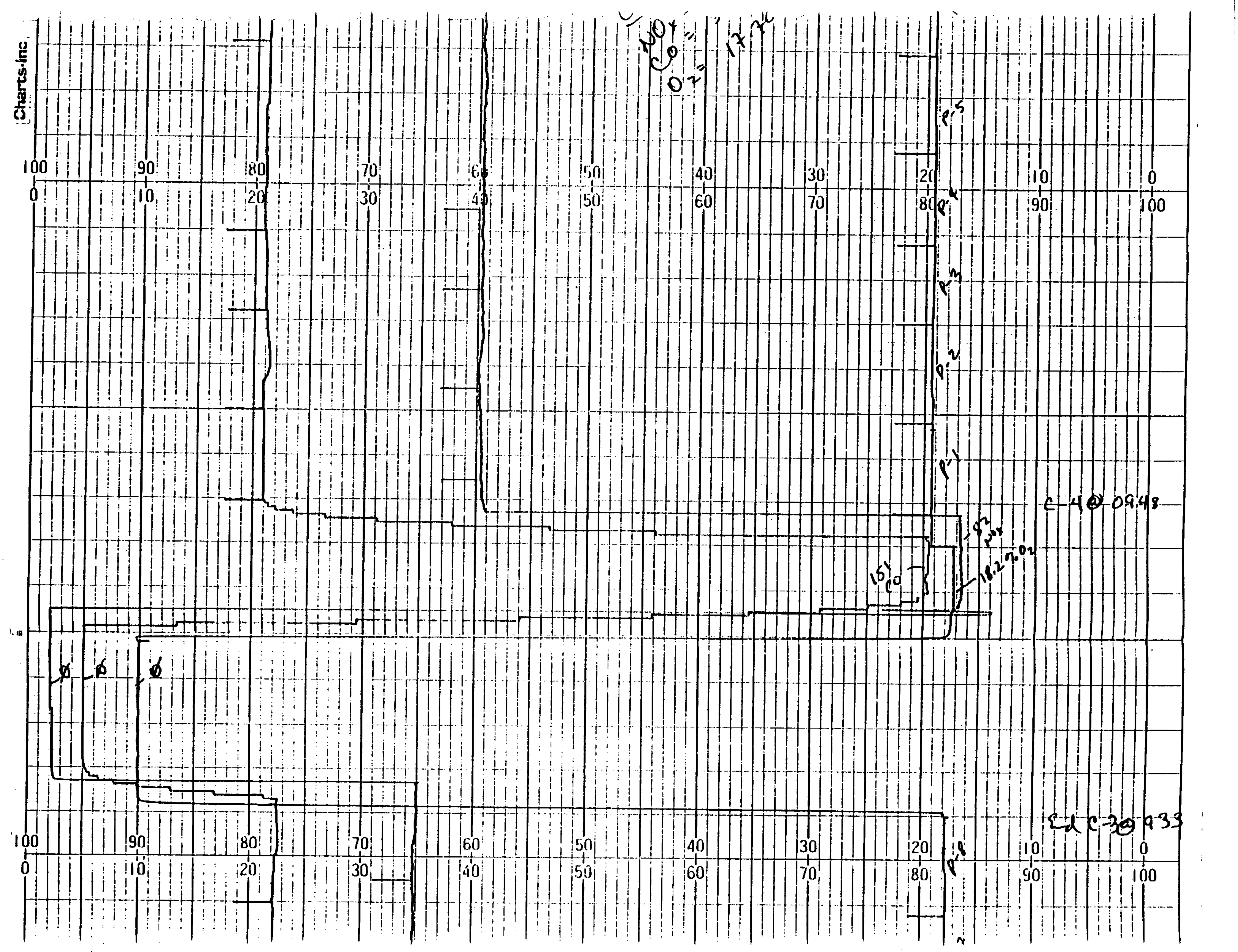


Sun Oil
5-1-91
82 NOx
18.3% O2
151 CO
Cal C-1 @ 183°
100
90
80
70
60
50
40
30
20
10
0
760cm
(5559)
20M

Charts-Inc CHART NO. RN2-01-25-20M (5559)




Charts-Inc
CHART NO. RN2-01-25-20M
(5559)
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
P-1
P-2
P-3
P-4
P-5
P-6
P-8



Charts-Inc
C-4 @ 0948
O2 = 17.7%

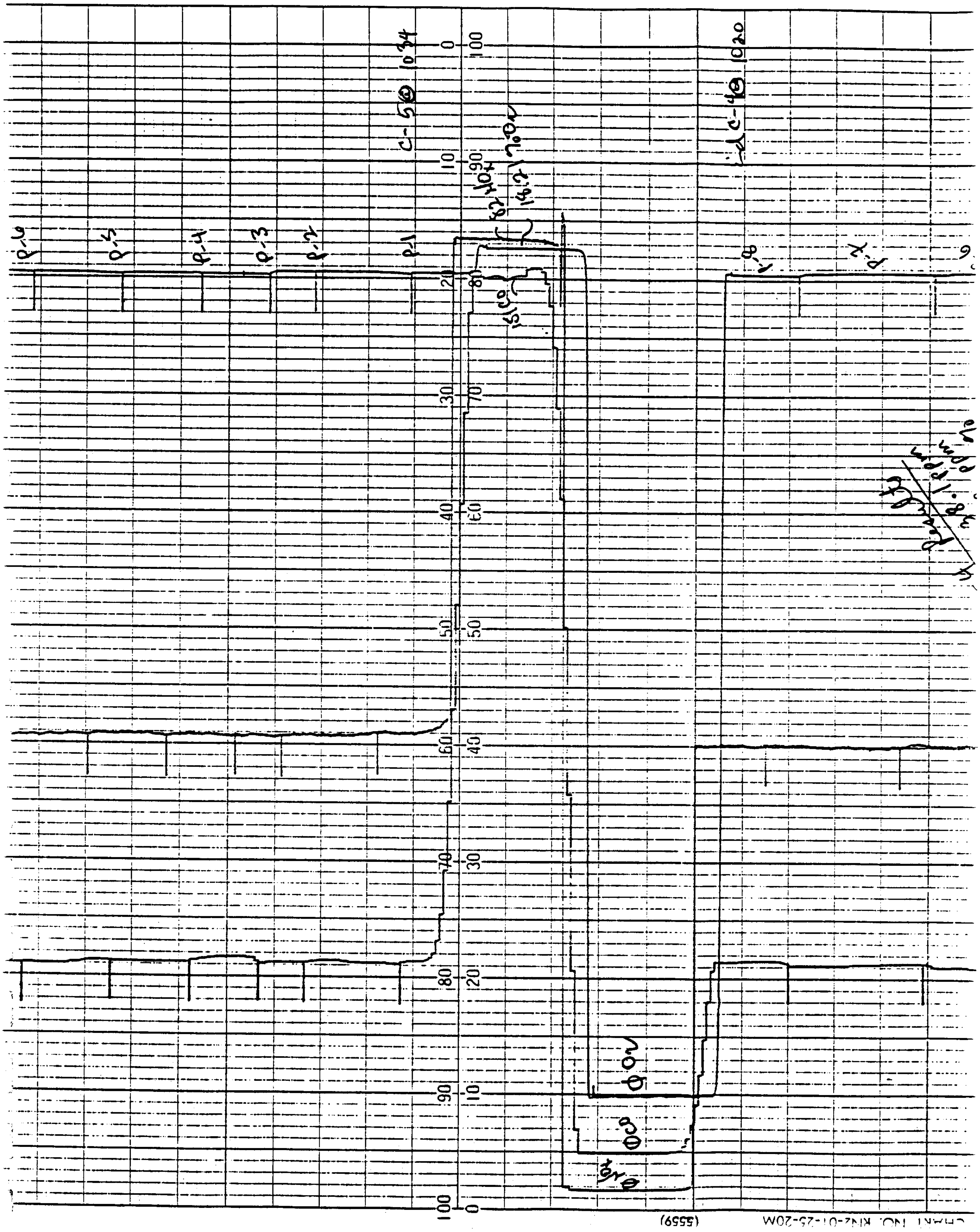


CHART NO. KNZ-01-25-20M
(5559)

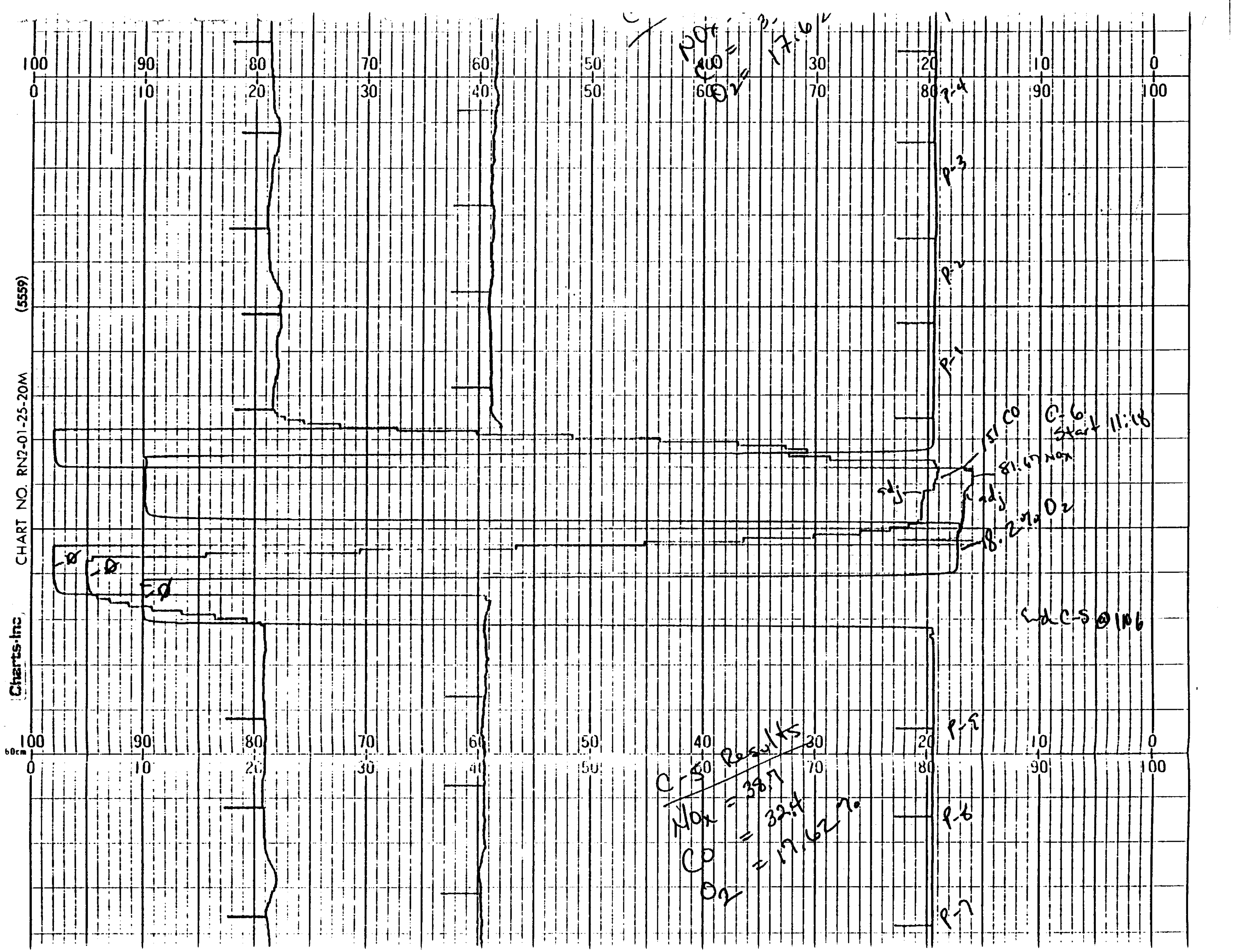
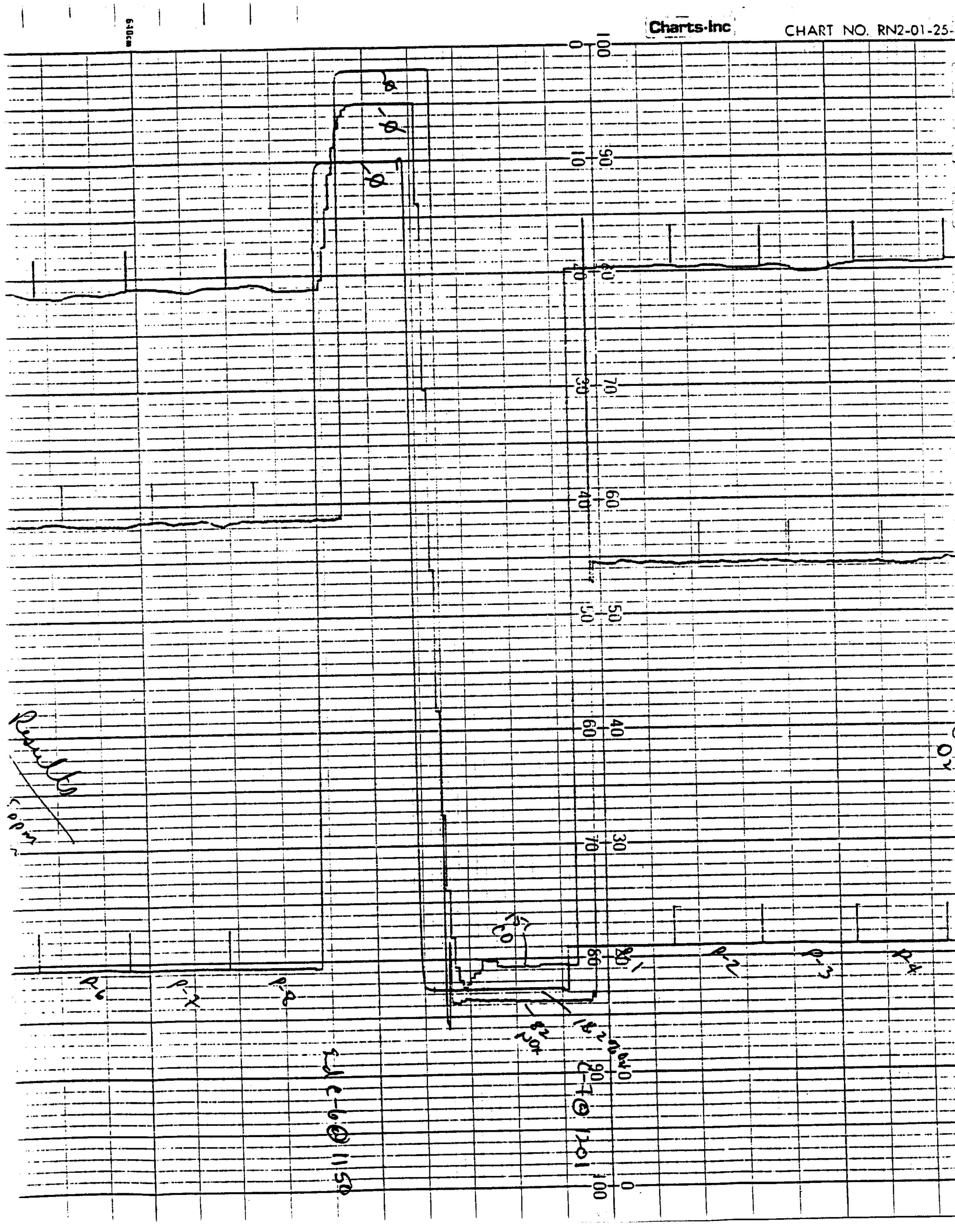
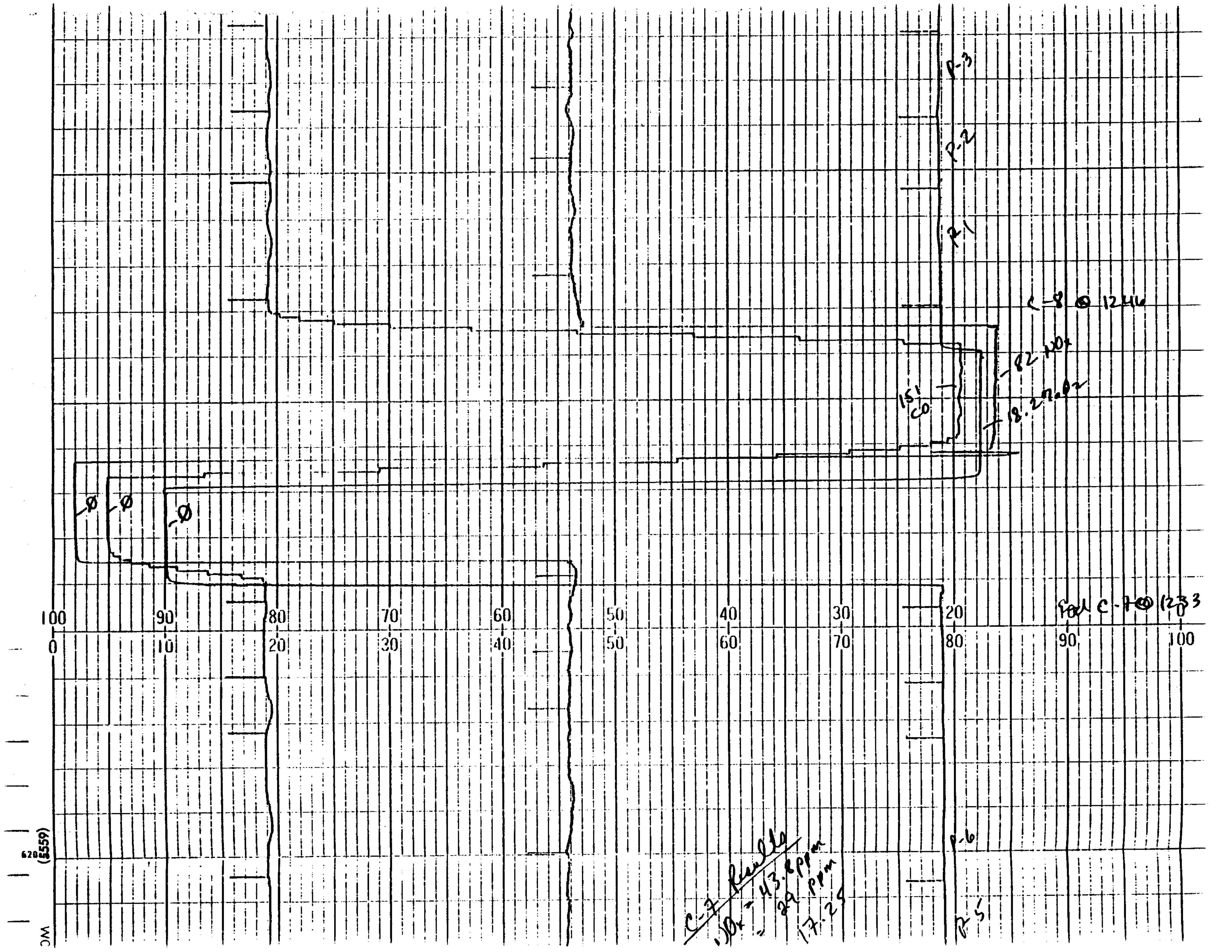
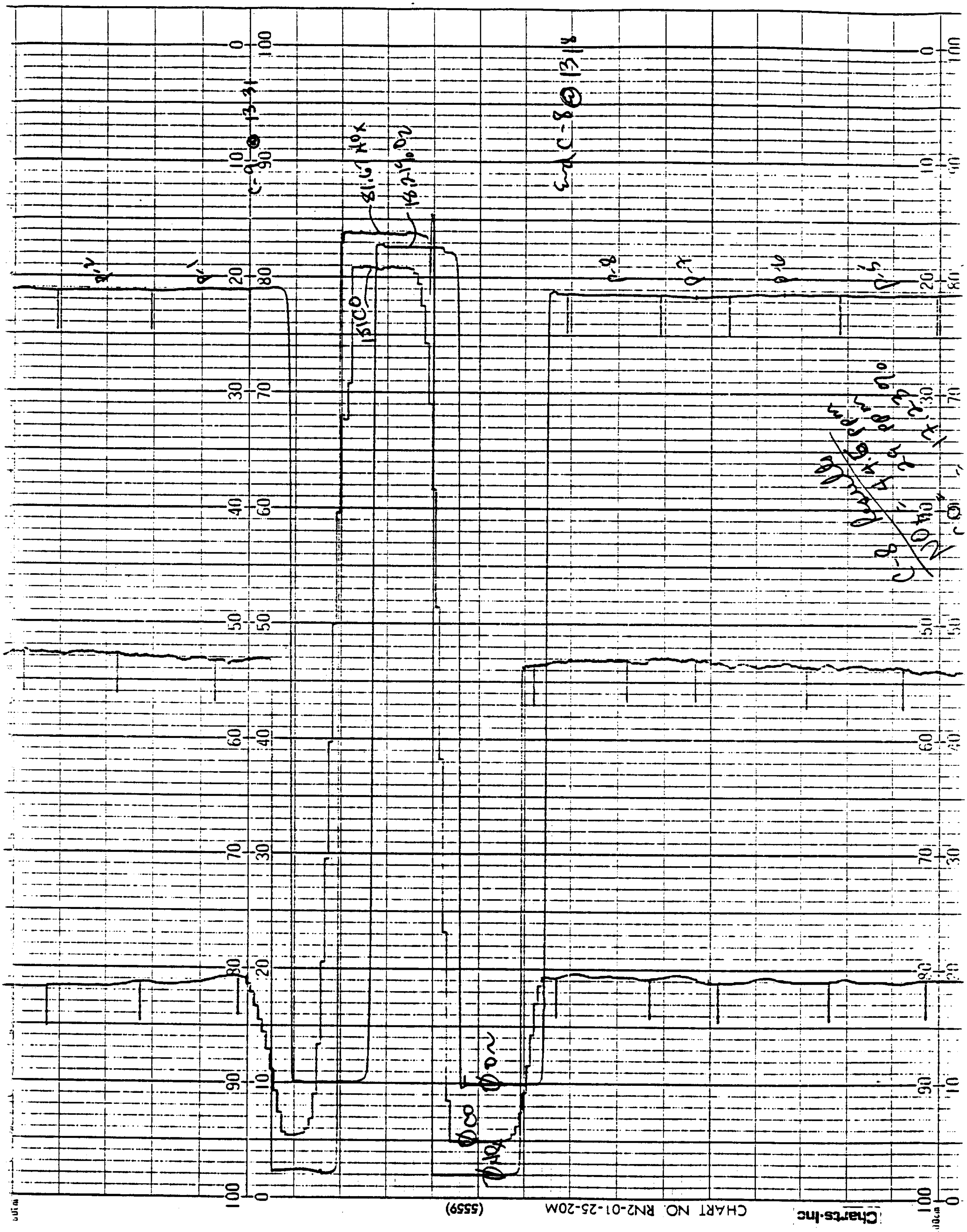


CHART NO. RN2-01-25-20M
(5559)
Charts-Inc
C-6 Start 11:18
151 CO
81.47 NOx
adj
8.2% O2
End C-5 @ 1106
C-5 Results
NOx = 38.7
CO = 32.4
O2 = 17.62%


Charts-Inc
CHART NO. RN2-01-25-

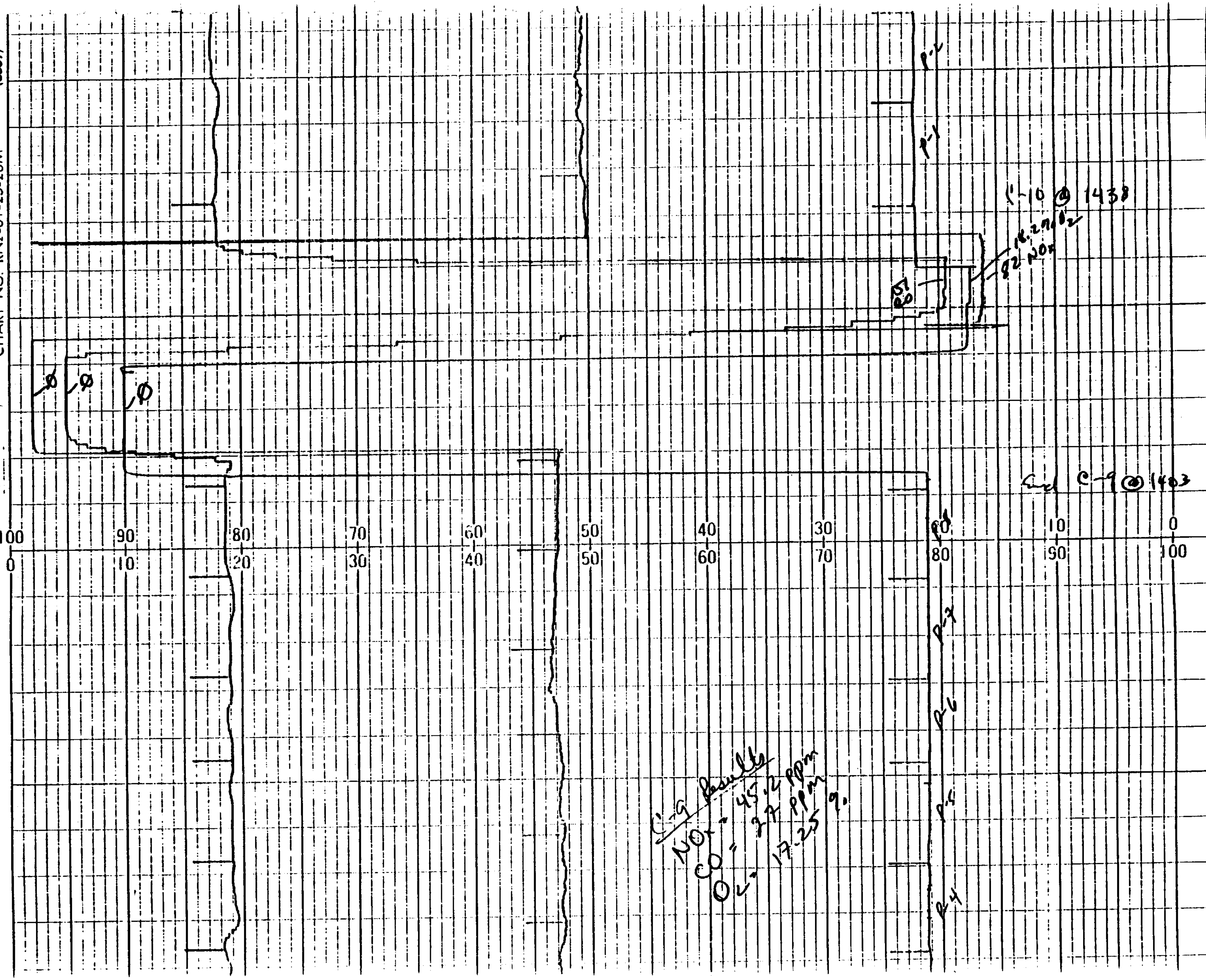


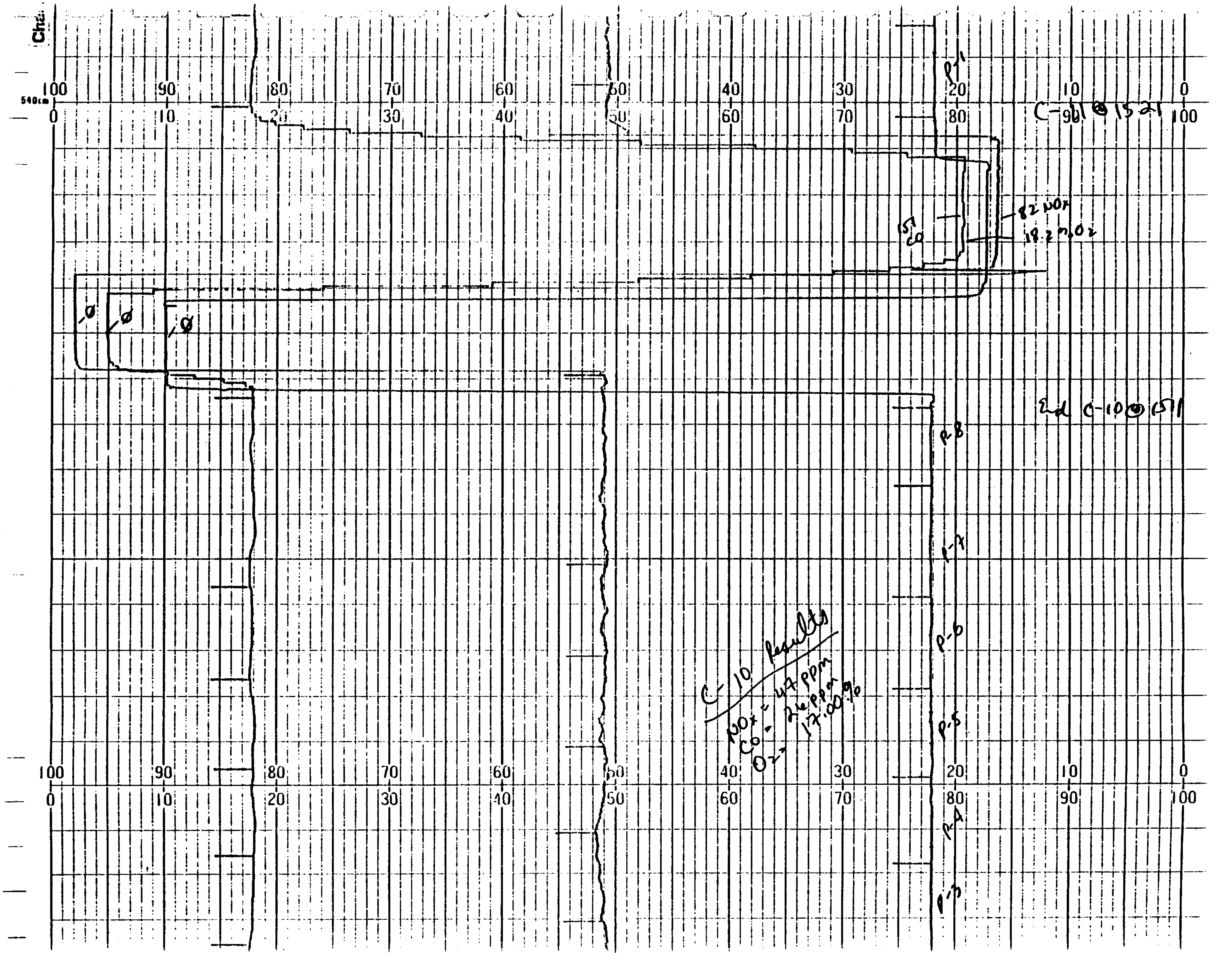
P-3
P-2
P-1
C-8 @ 12:46
15' CO
-Ø
-Ø
-Ø
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
P-6
P-5
C-7 Results
WC



C-9 @ 13:31
End C-8 @ 13:18
CHART NO. RN2-01-25-20M
(5559)
Charts-Inc

Charts-inc CHART NO. RN2-01-25-20M (5559)





100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
C-9 @ 1521
82 NOx
18.2 % O2
15 CO
Ø
Ø
Ø
End C-10 @ 1511
P-1
P-8
P-7
P-6
P-5
P-4
P-3
C-10 Results
NOx = 47 ppm
CO = 26 ppm
O2 = 17.00%

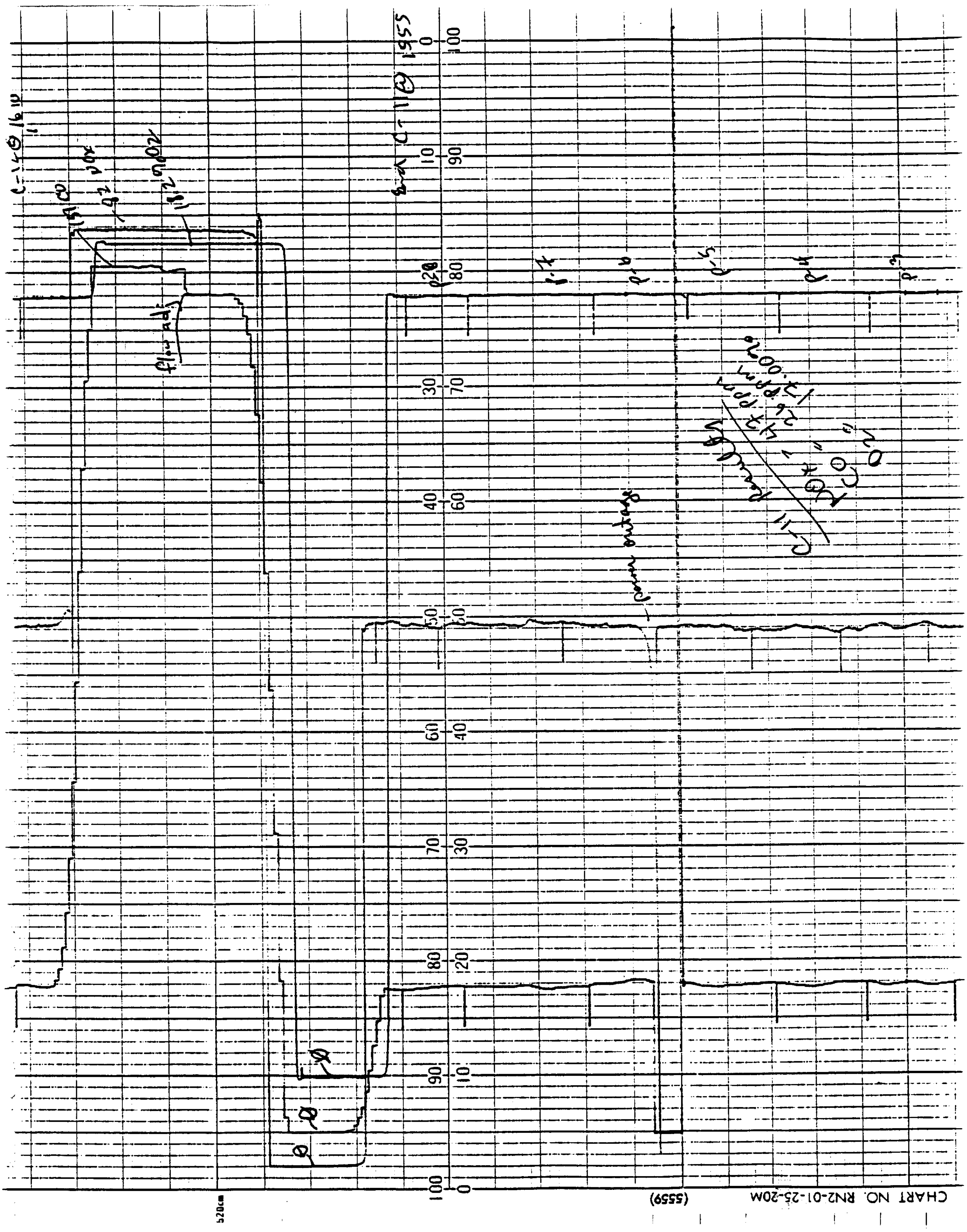


CHART NO. RN2-01-25-20M
(5559)

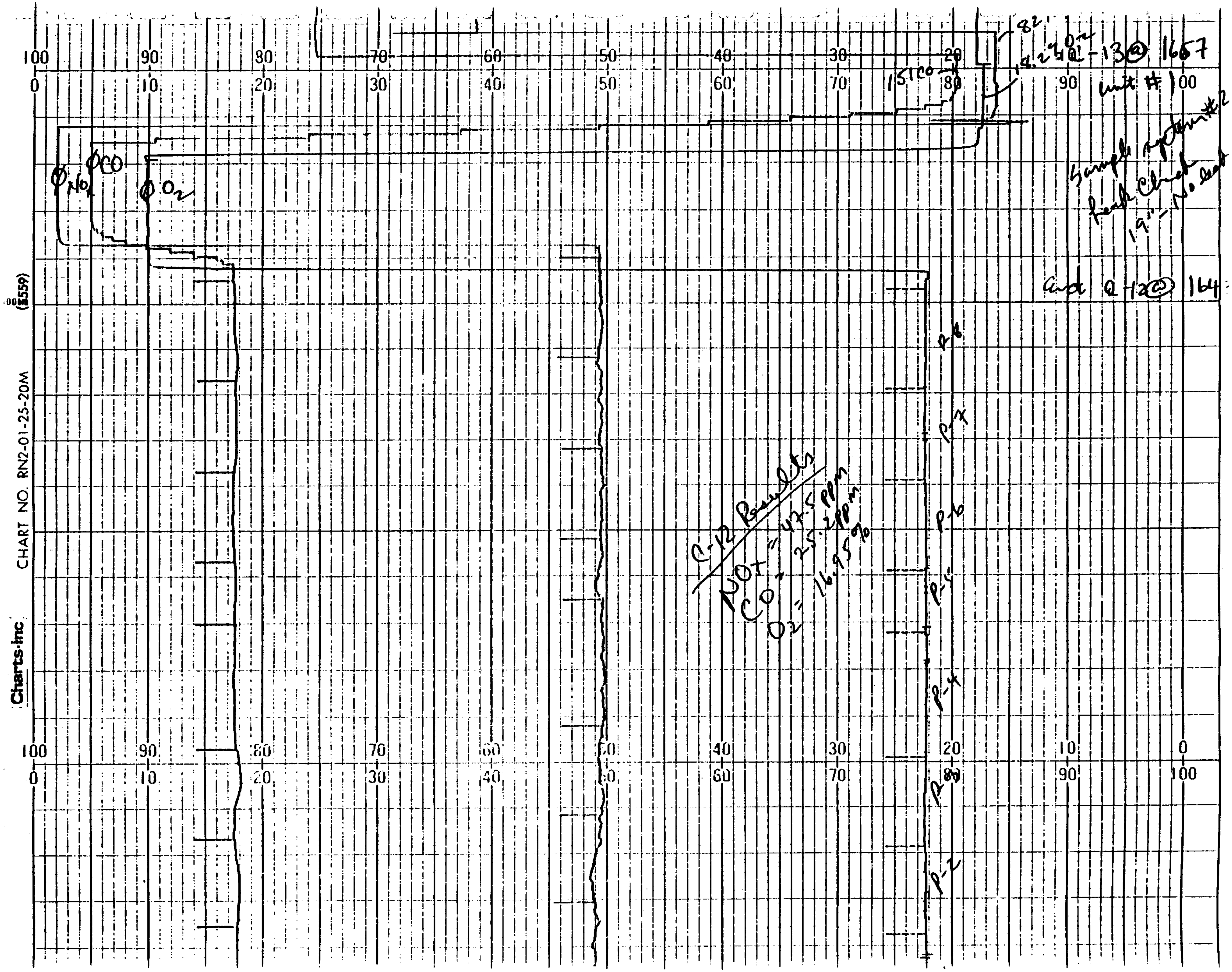


CHART NO. RN2-01-25-20M
Charts-Inc
(5559)
unit # 100
C-12 Results
NOx = 47.5 ppm
CO = 25.2 ppm
O2 = 16.95%
P-8
P-7
P-6
P-5
P-4
P-2

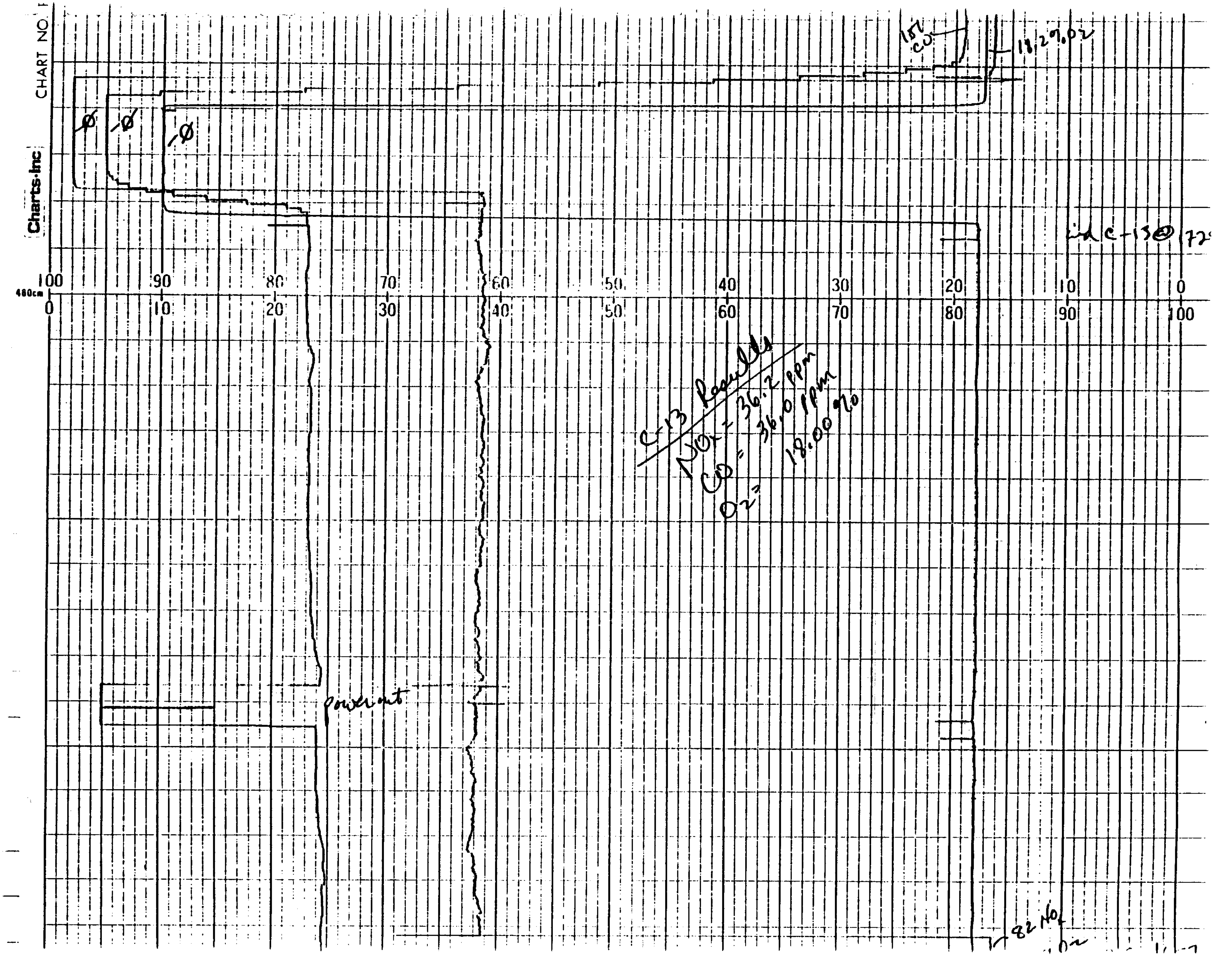
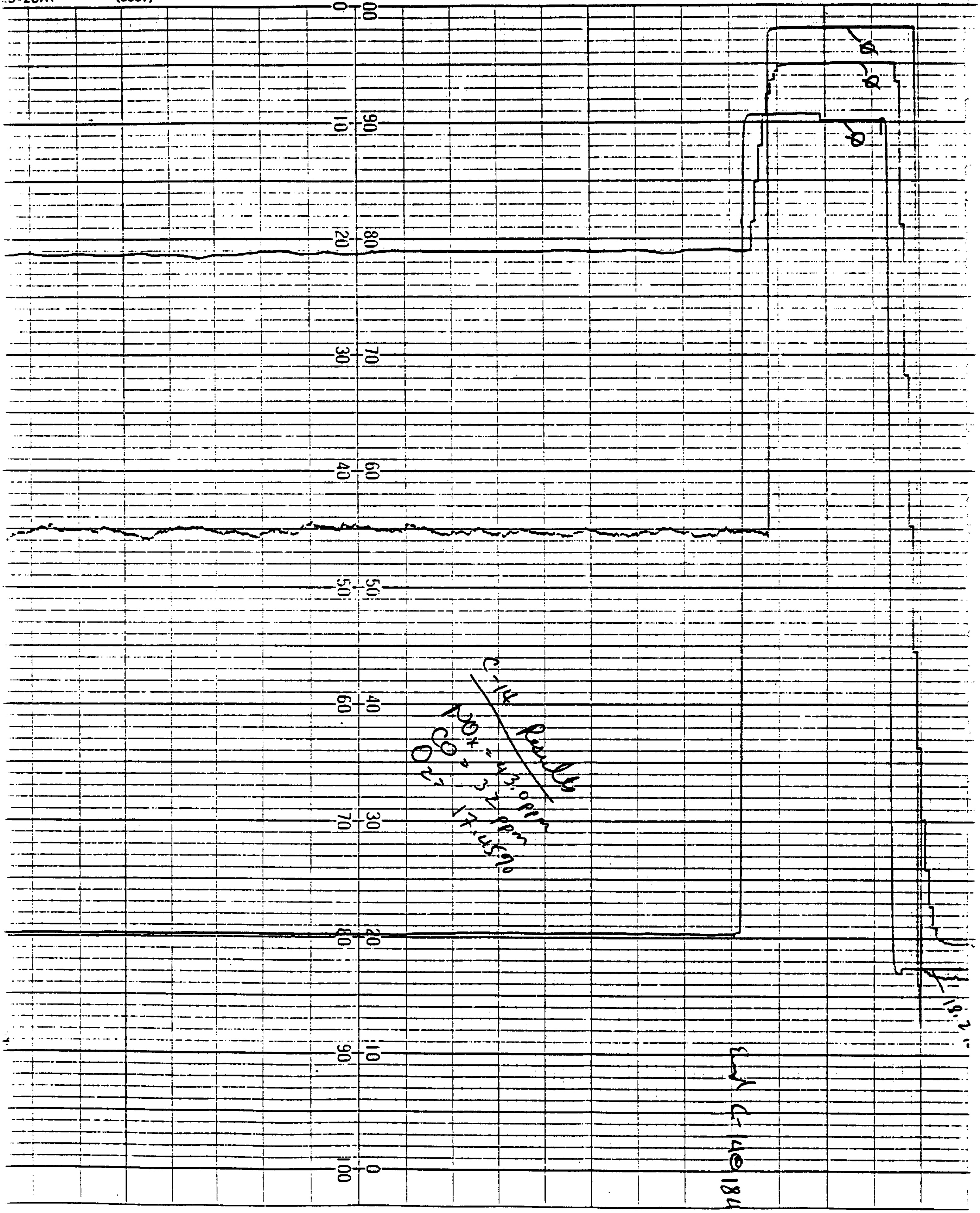
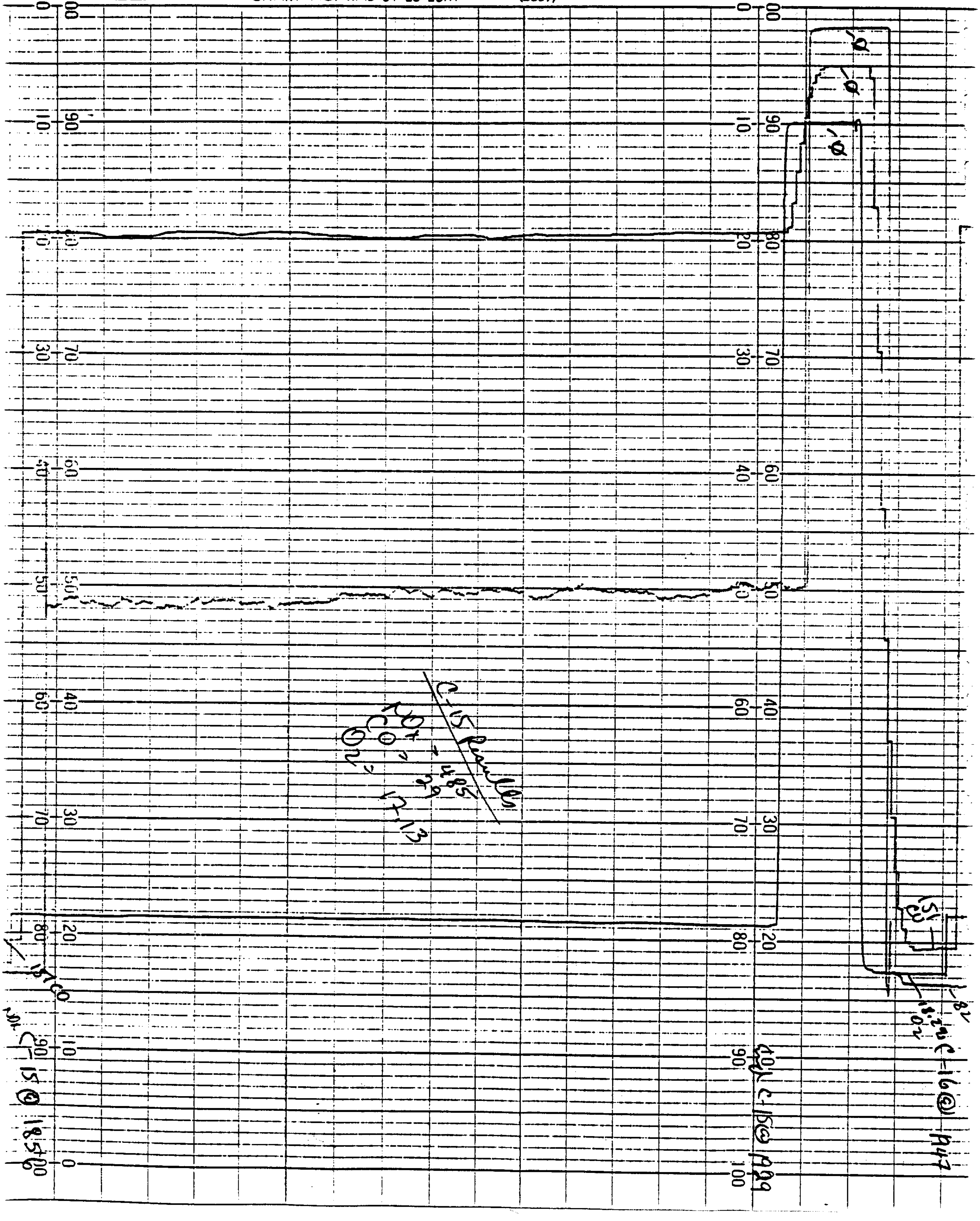


CHART NO.
Charts-Inc
480cm
C-13 Results
NOx = 36.2 ppm
CO = 36.0 ppm
O2 = 18.00%
powerout

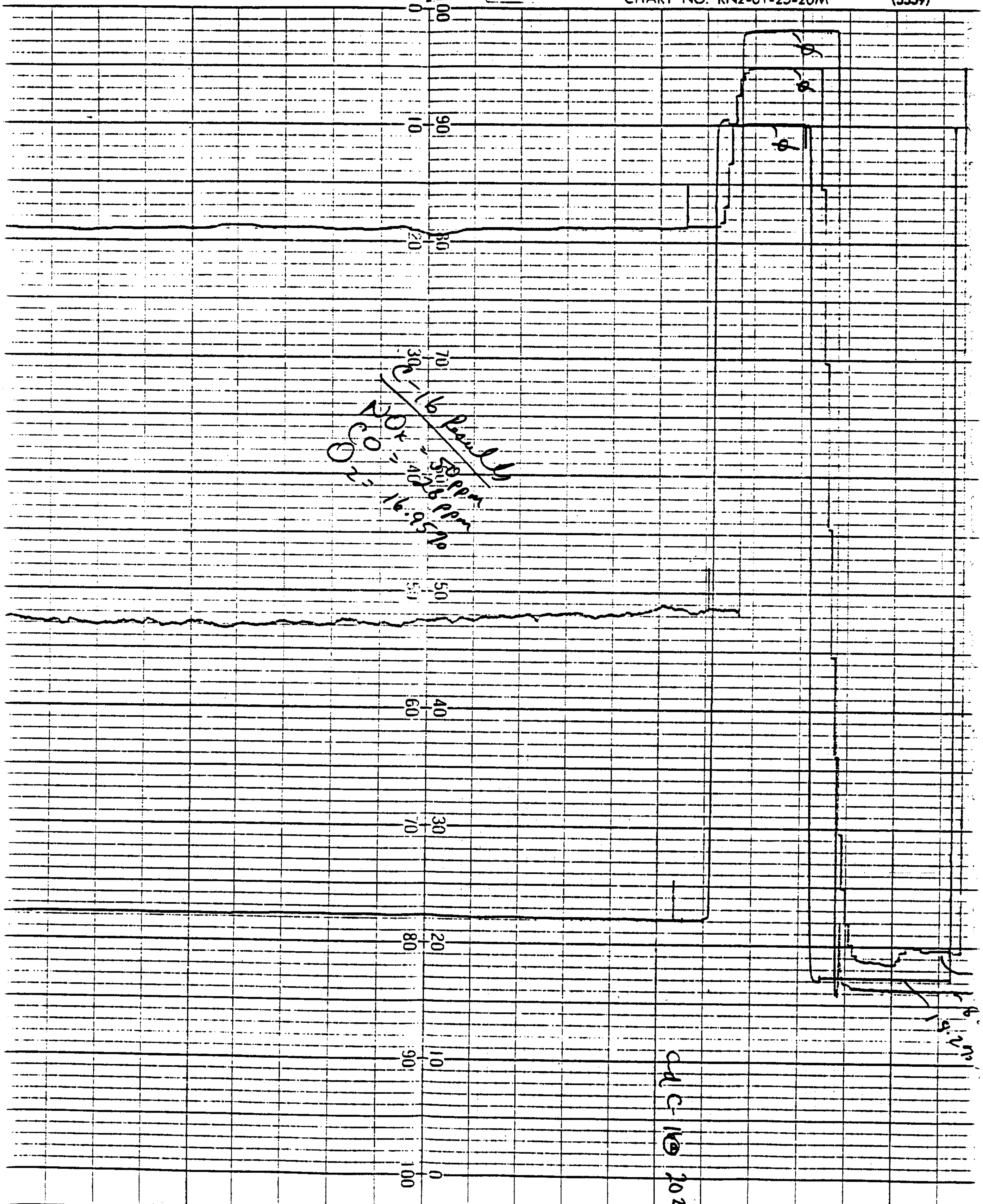
25-20M (5559)



Charts·Inc CHART NO. RN2-01-25-20M (5559)



Charts-Inc CHART NO. RN2-01-25-20M (5559)



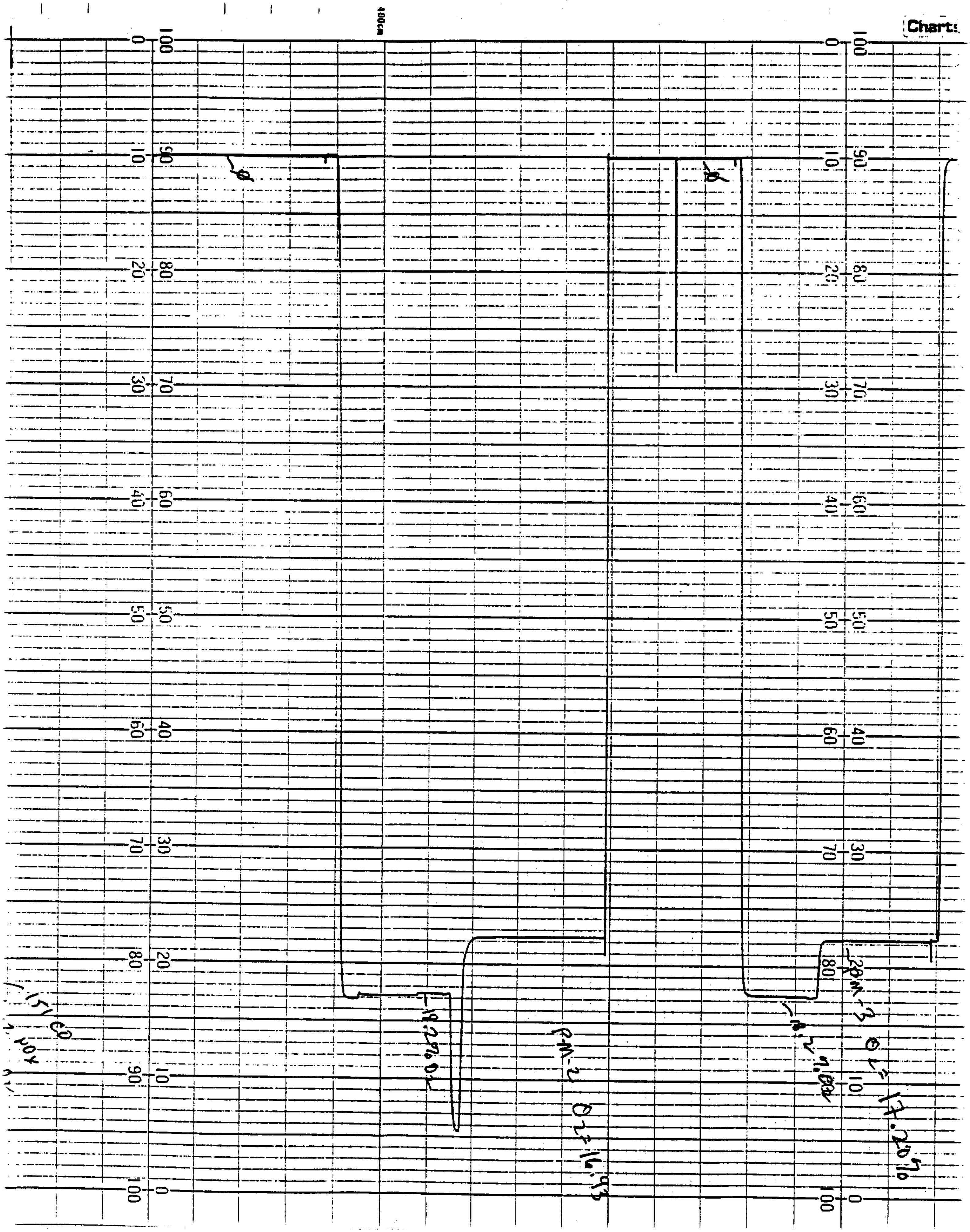
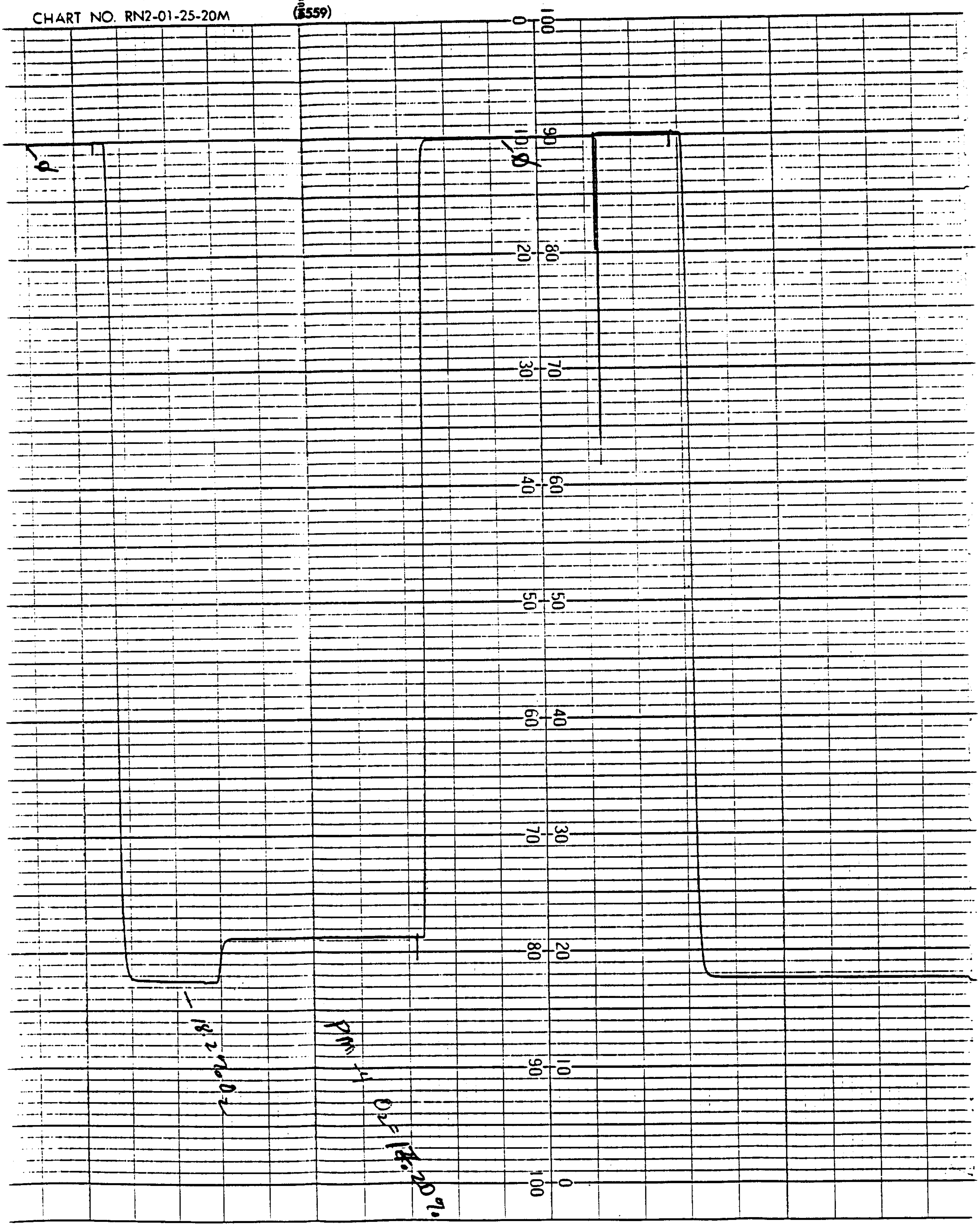
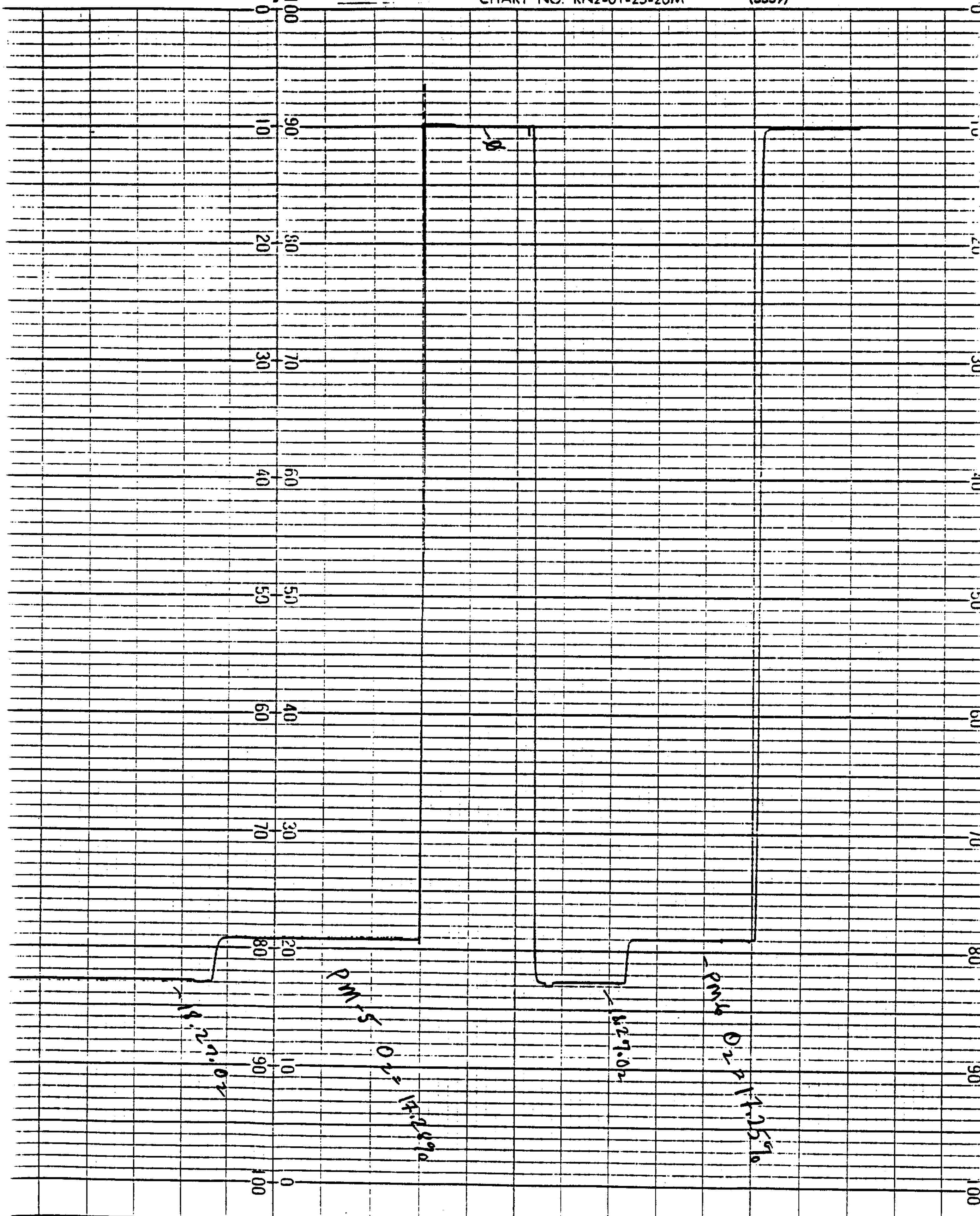
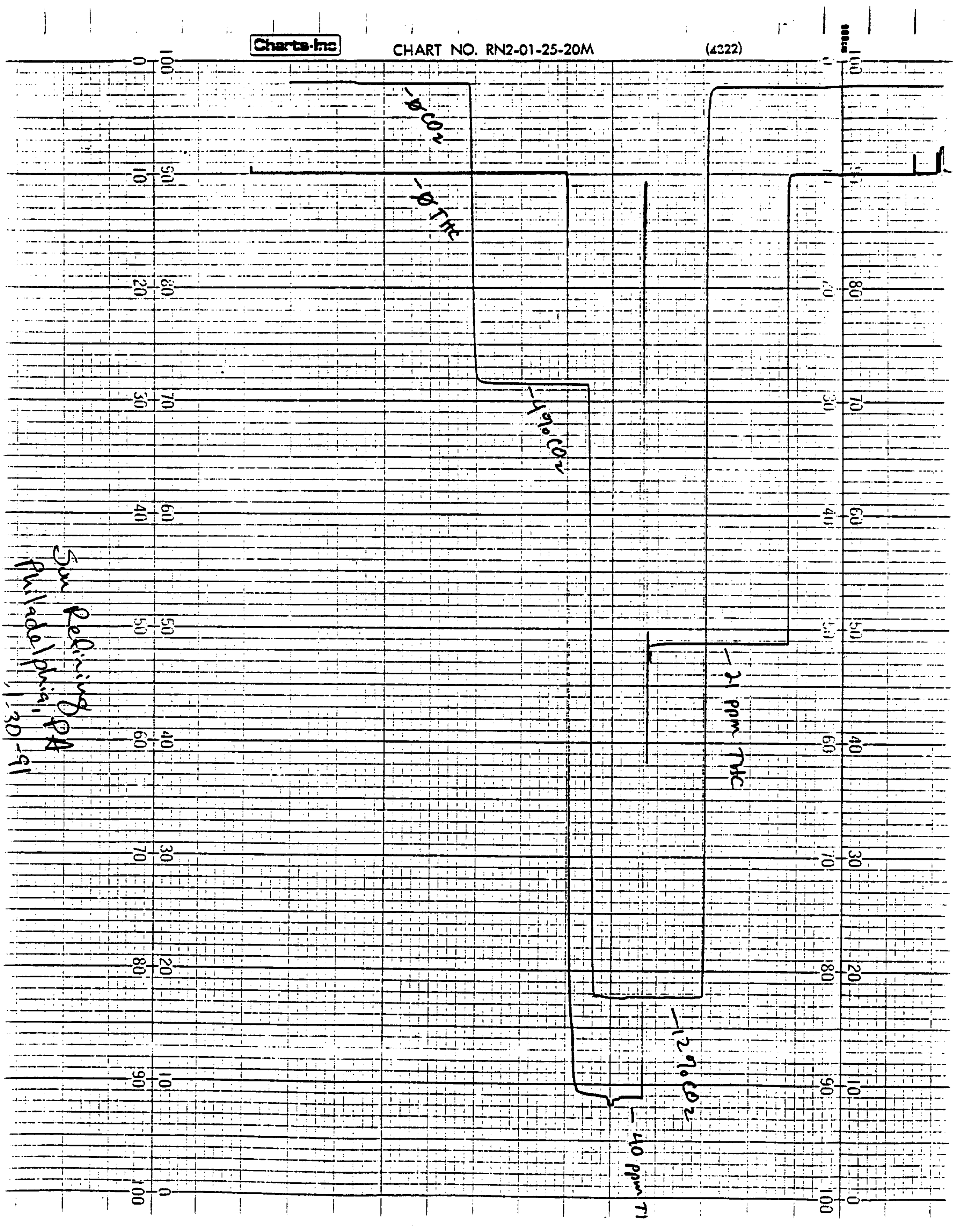

Charts
400cm

CHART NO. RN2-01-25-20M (#559)

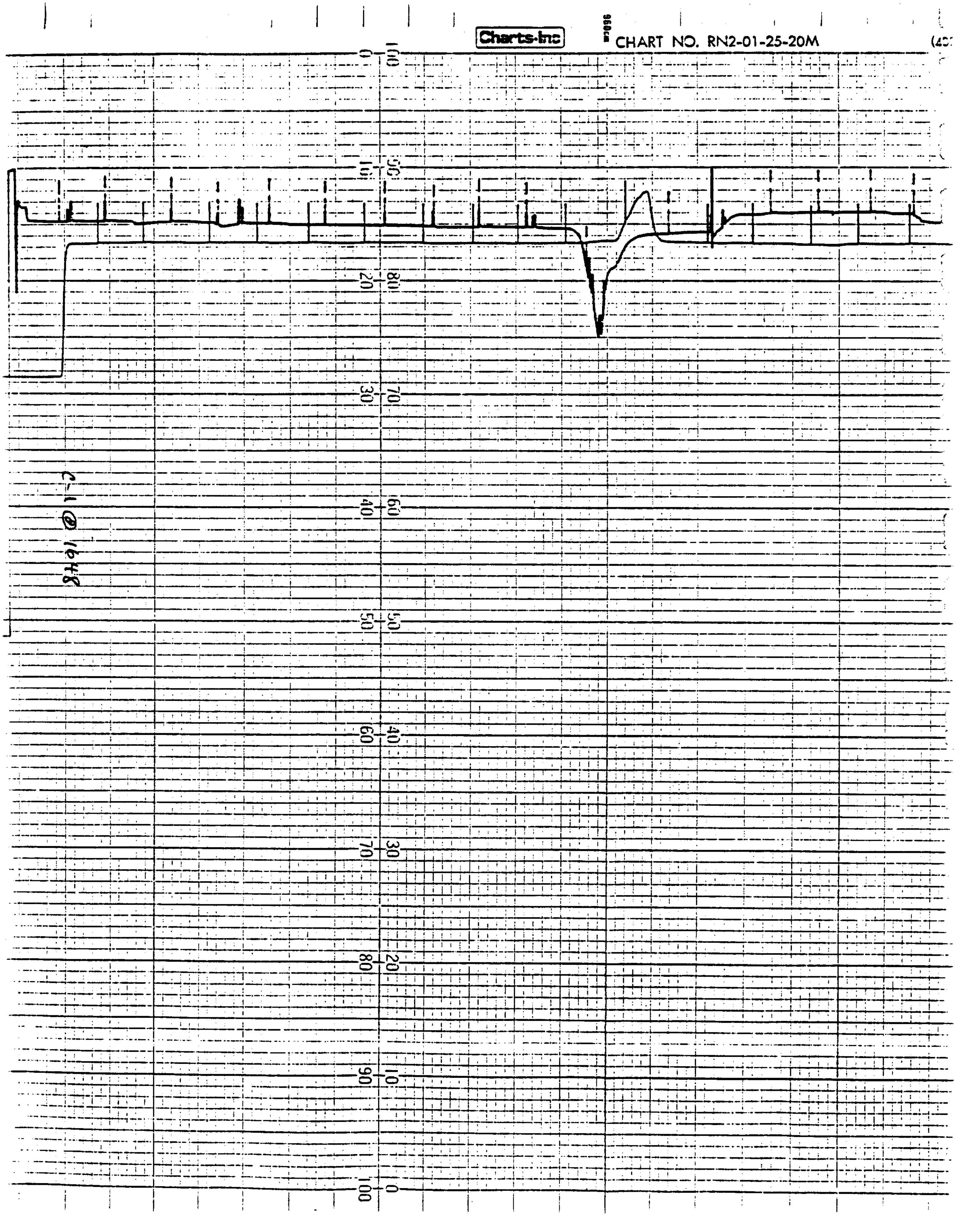


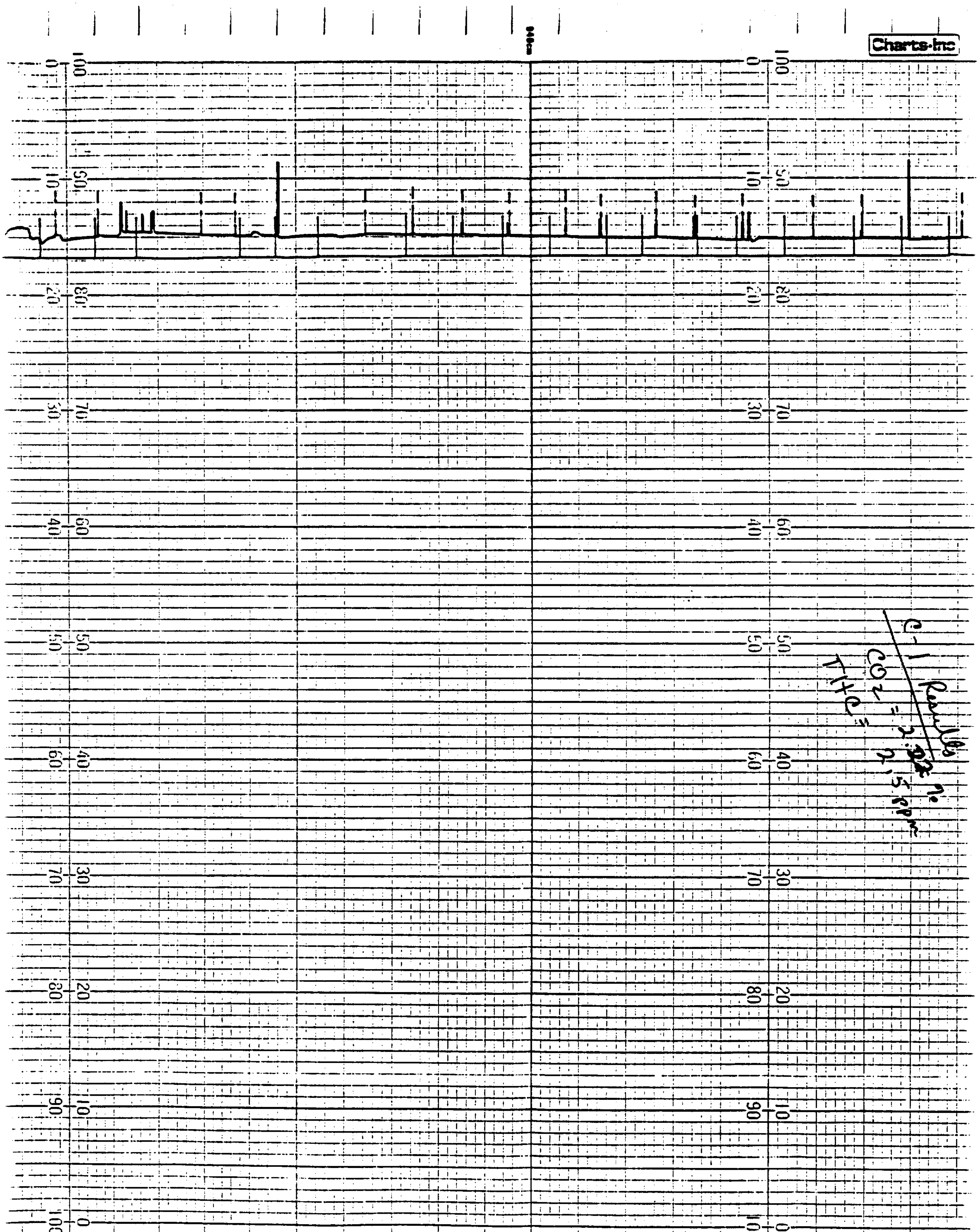
Charts-Inc CHART NO. RN2-01-25-20M (5559)





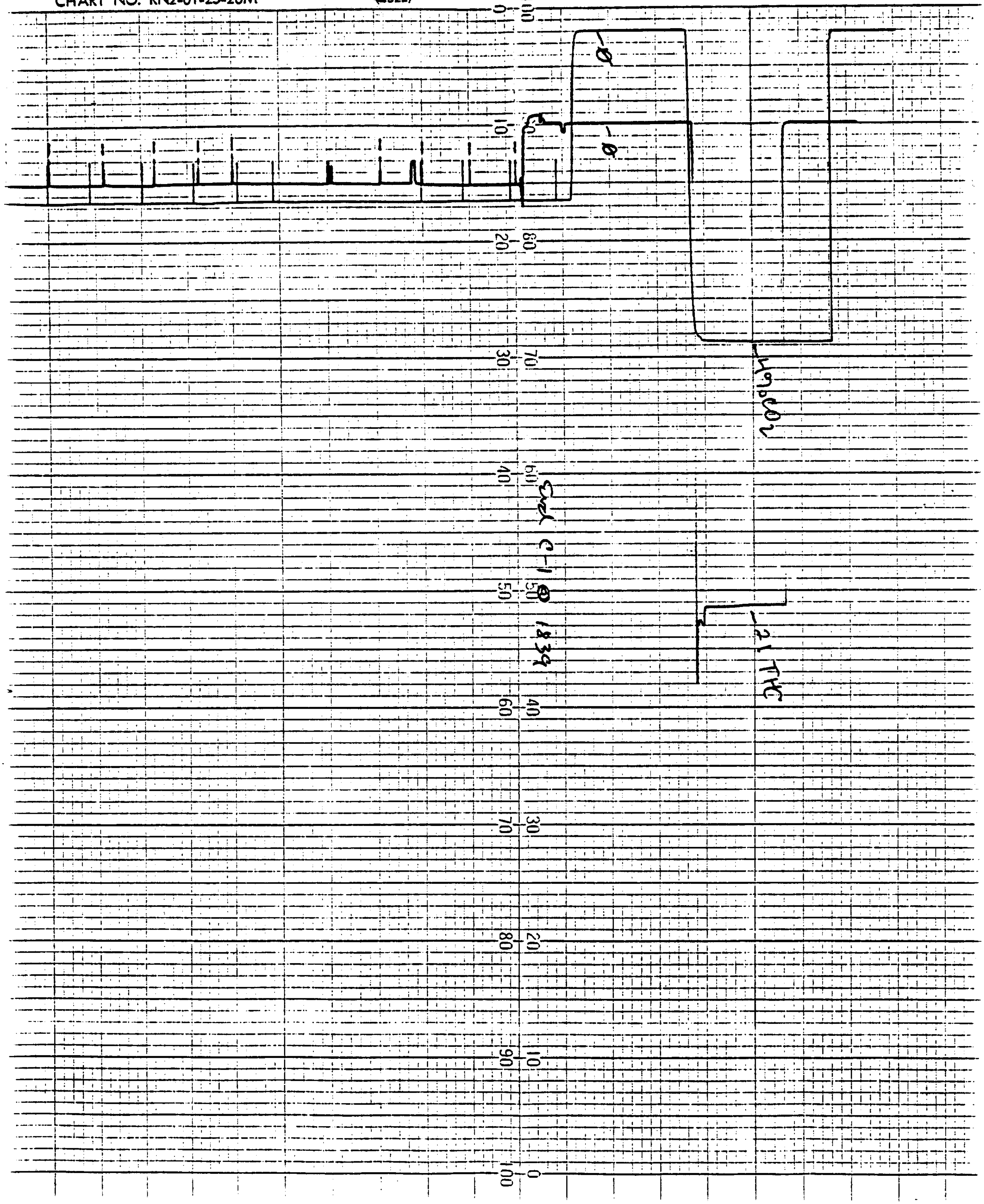
Charts-Inc
CHART NO. RN2-01-25-20M
(4222)
-φ CO2
-φ THC
-4% CO2
-21 PPM THC
-12% CO2
-40 PPM T
Sun Refining
Philadelphia, PA
1-30-91

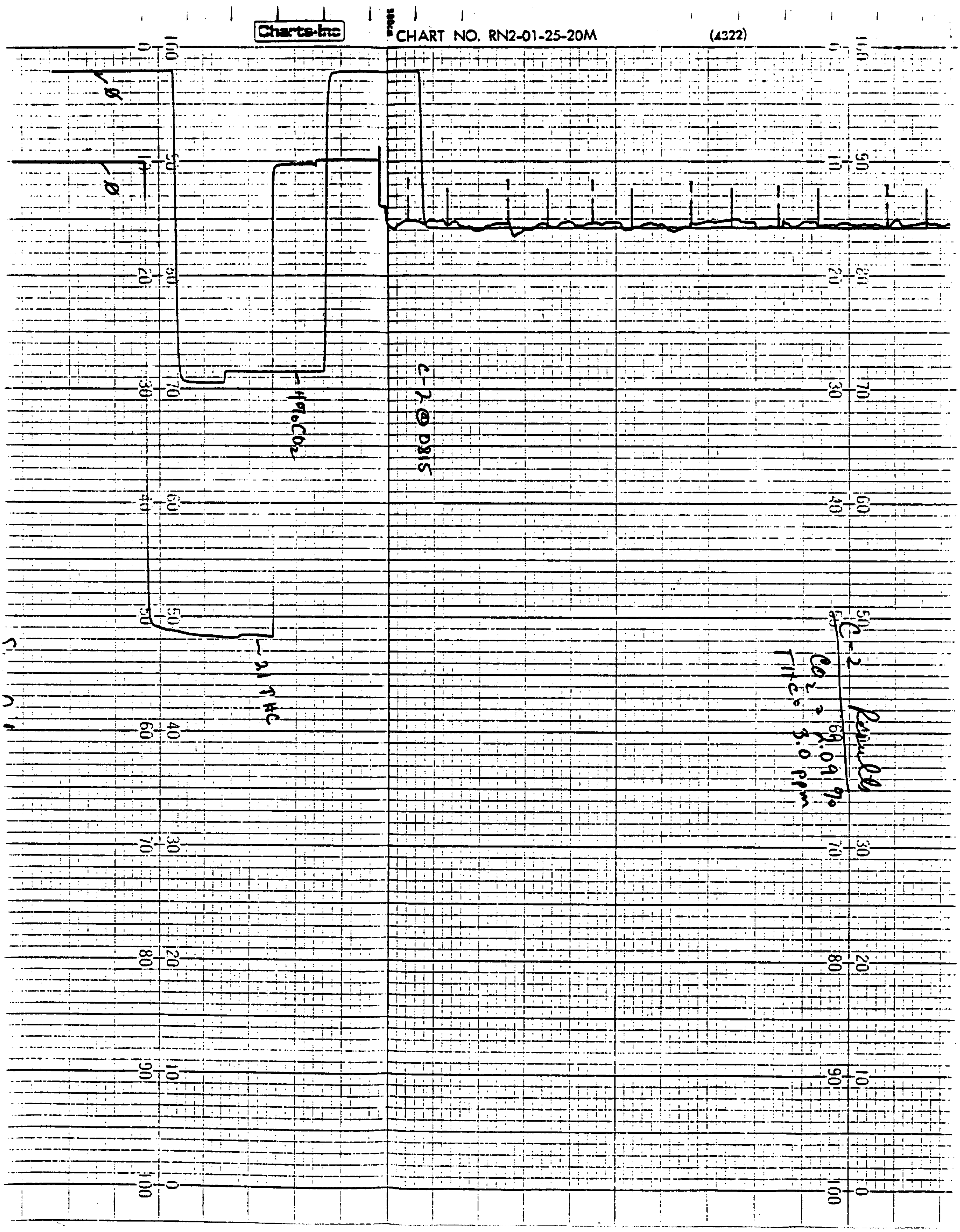

Charts-Inc
CHART NO. RN2-01-25-20M
C-1 @ 1648



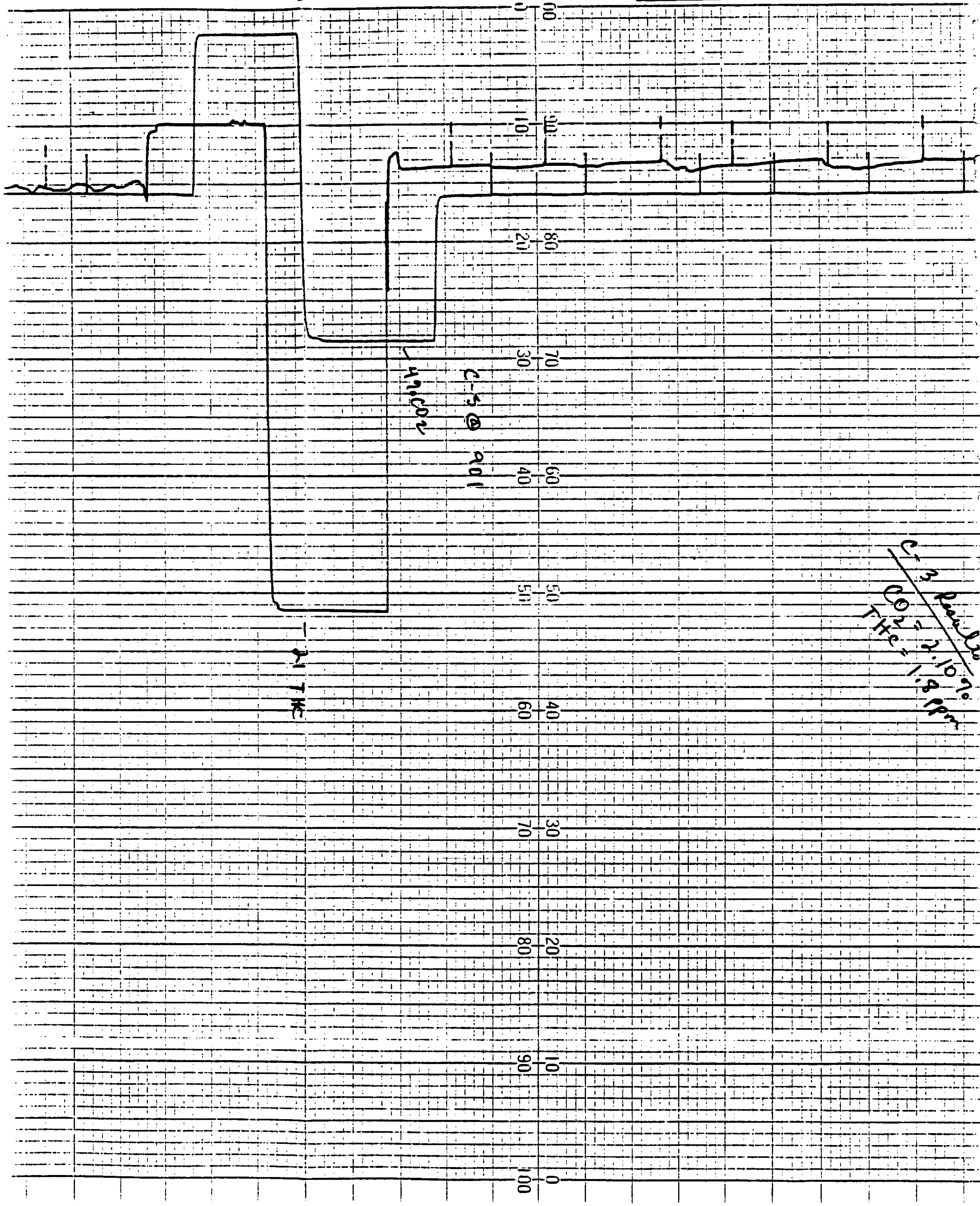
Charts-Inc
C-1 Results
CO_2 = 2. %
THC = 2.5 ppm

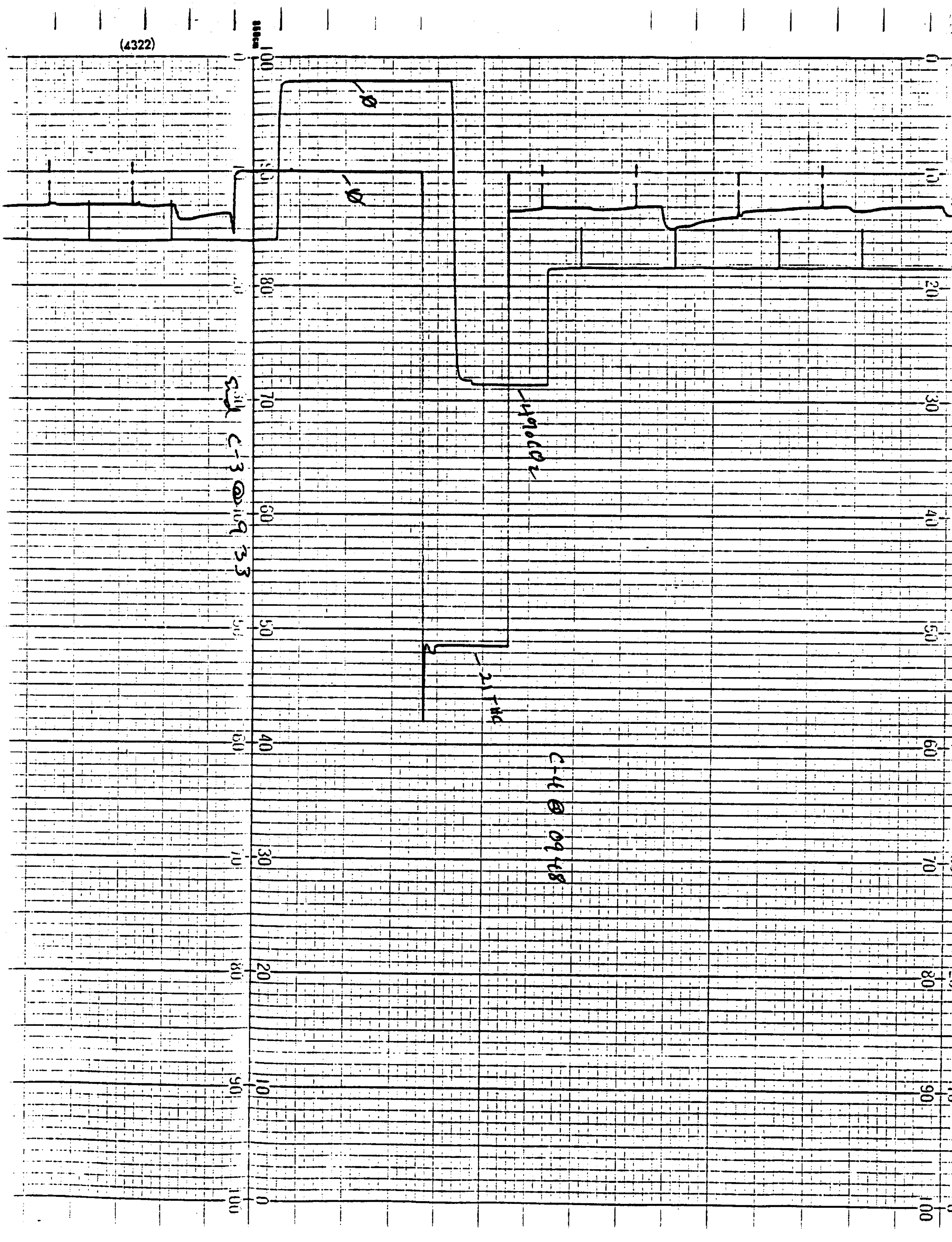
CHART NO. RN2-01-25-20M (4322)




Charts-Inc
CHART NO. RN2-01-25-20M
(4322)
~4% CO2
C-2 @ 0815
~21 THC
C-2 Results
CO2 = 2.09 %
THC = 3.0 ppm

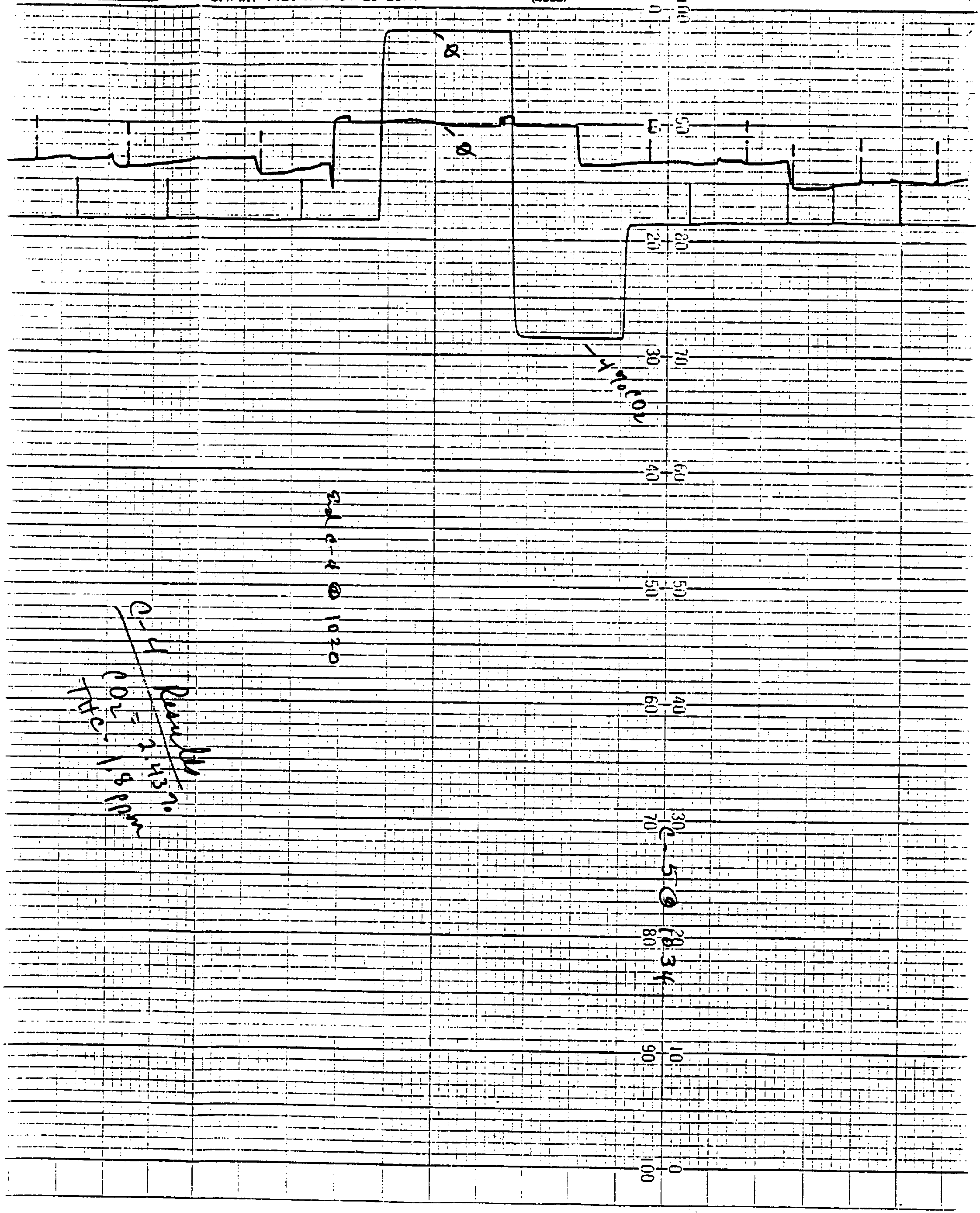
Charts-inc CHART NO. RN2-01-25-20





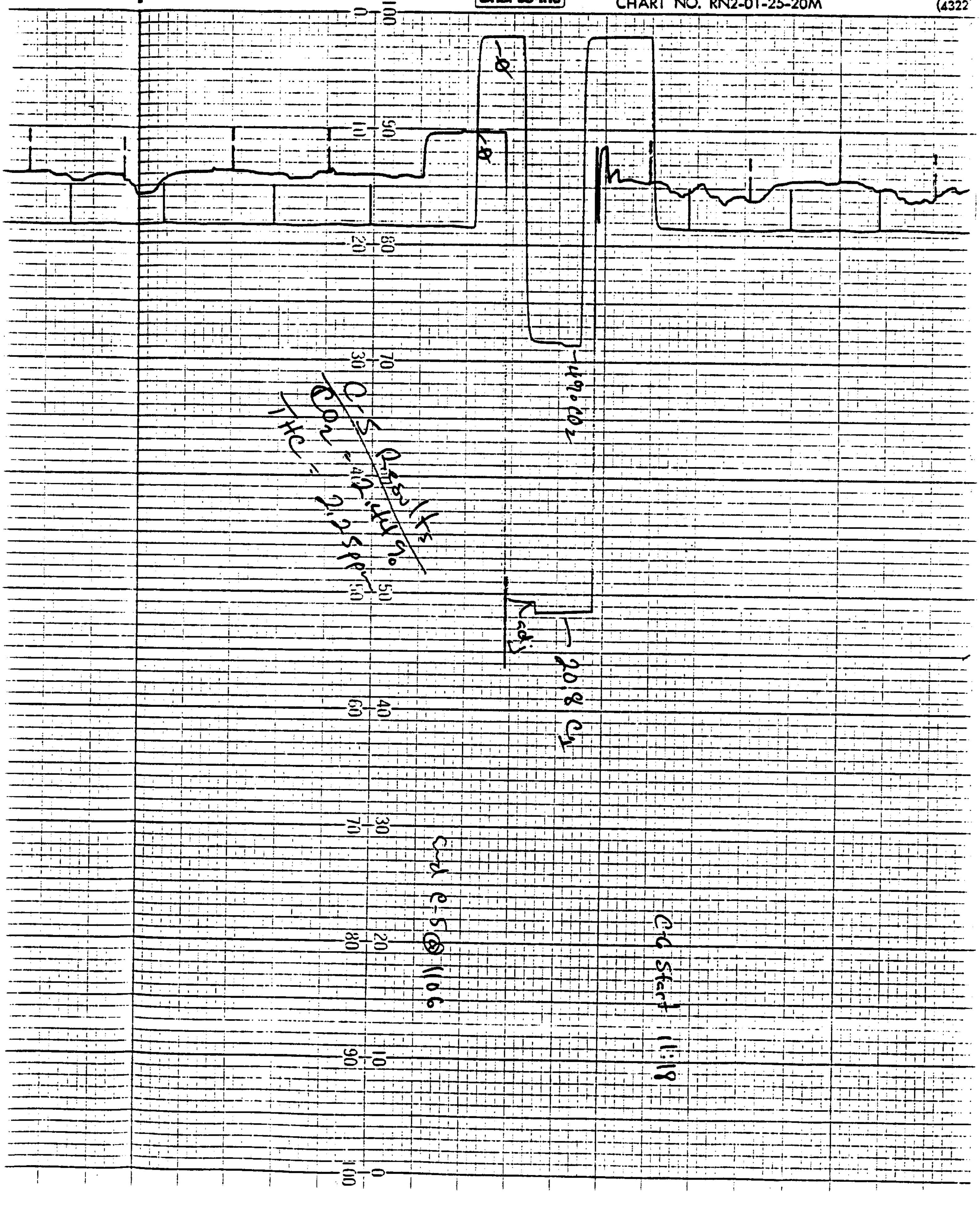
(4322)
C-3 @ 0933
C-4 @ 0948

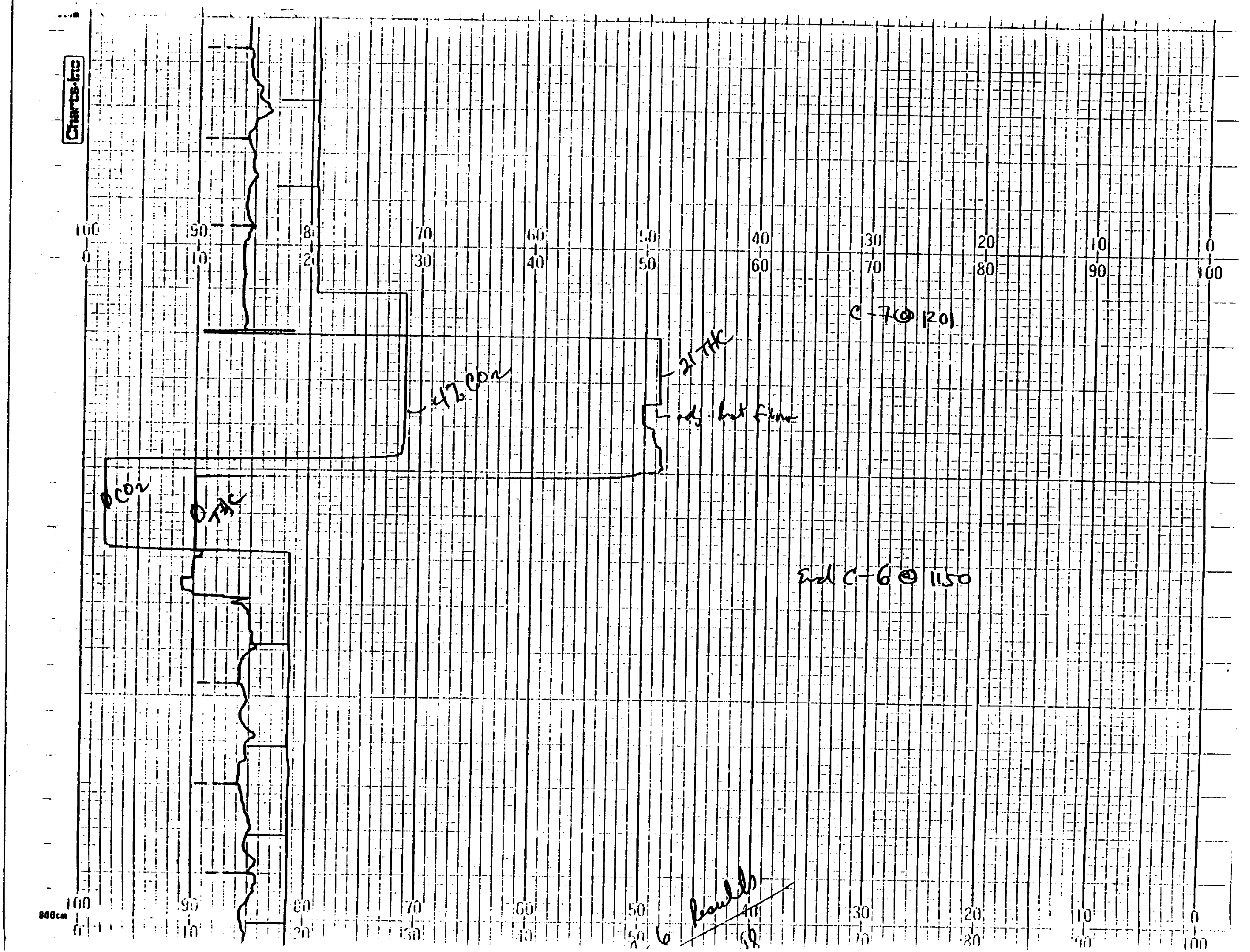
Charts-Inc CHART NO. RN2-01-25-20M (4322)



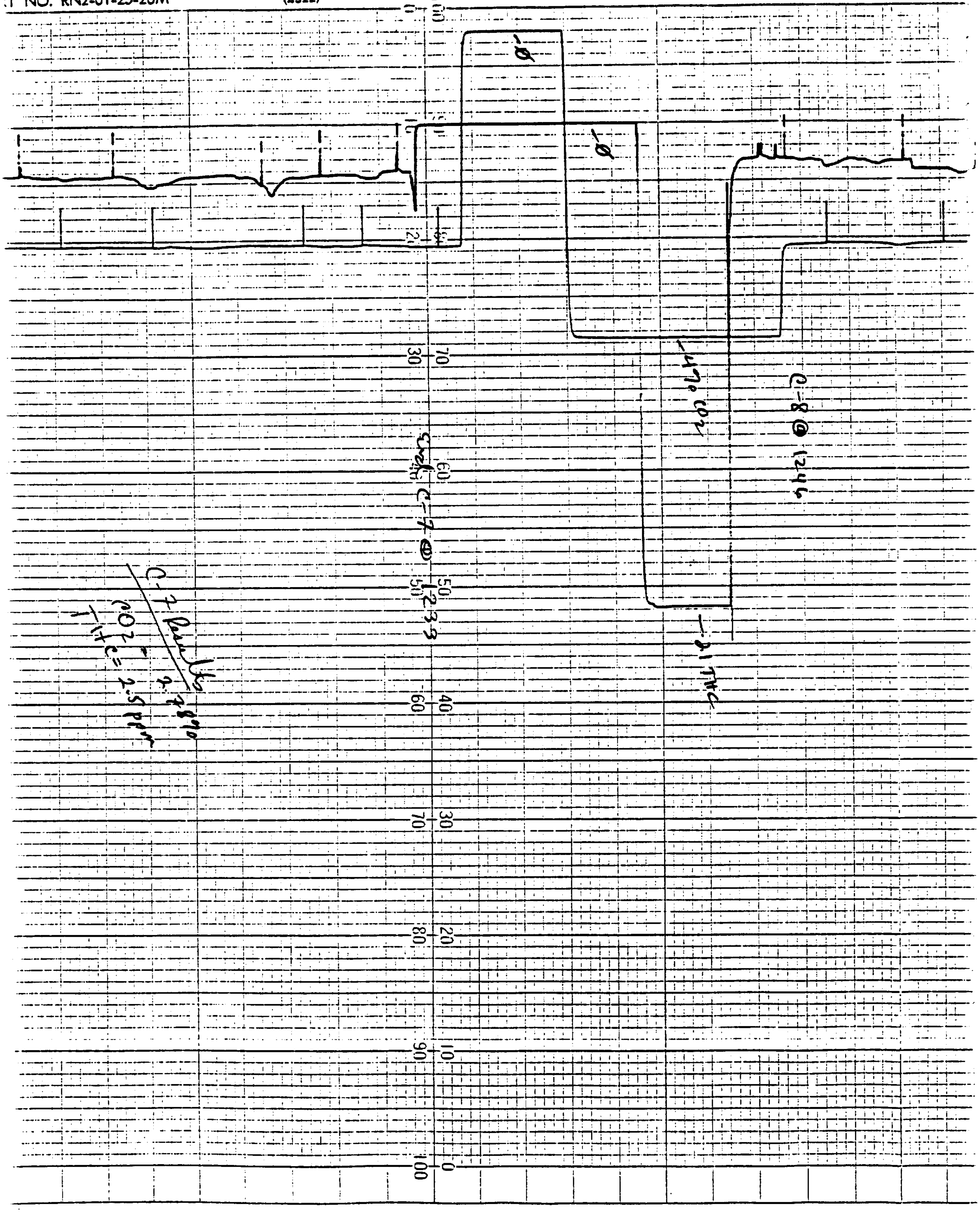
Charts-Inc

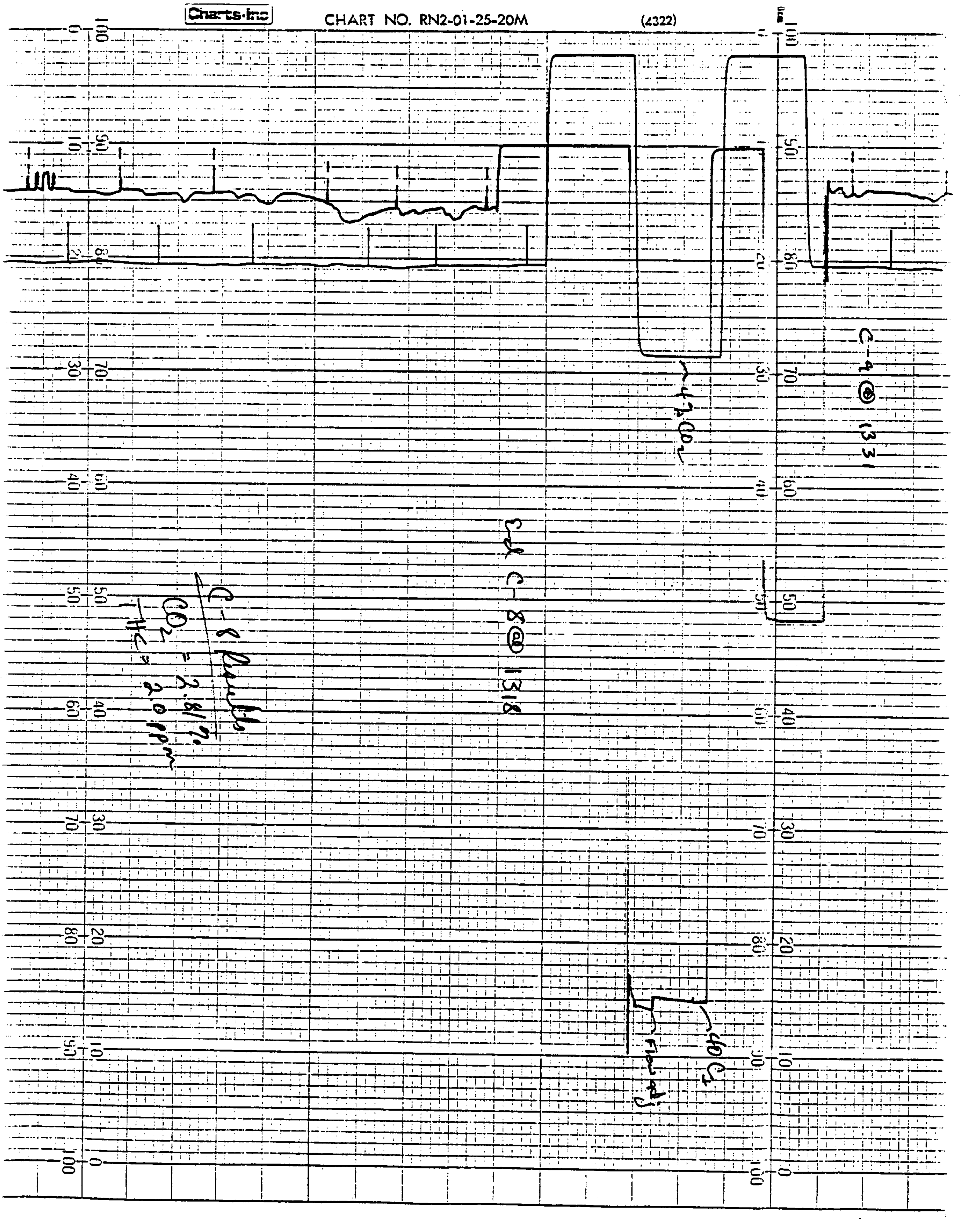
CHART NO. RN2-01-25-20M (4322

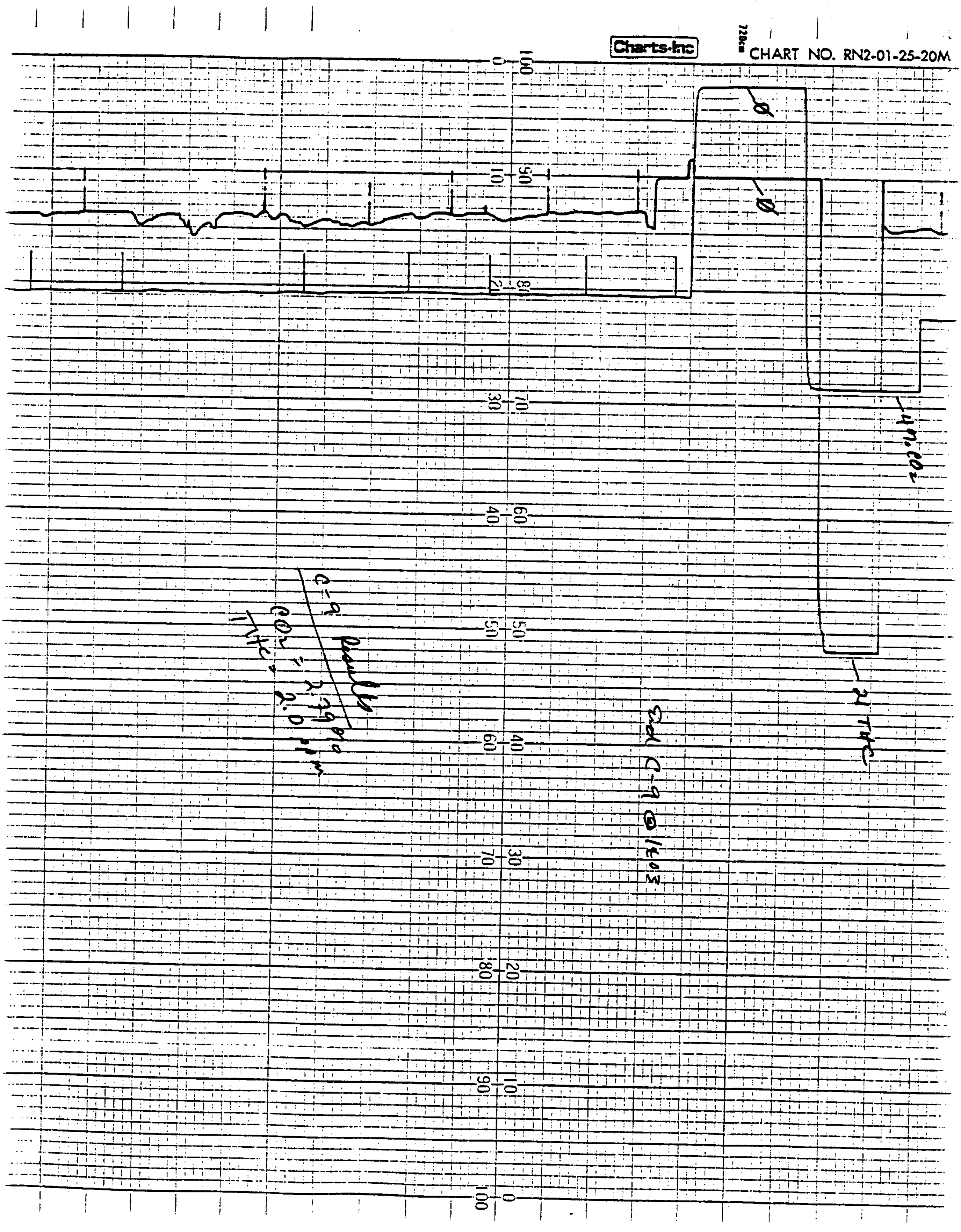


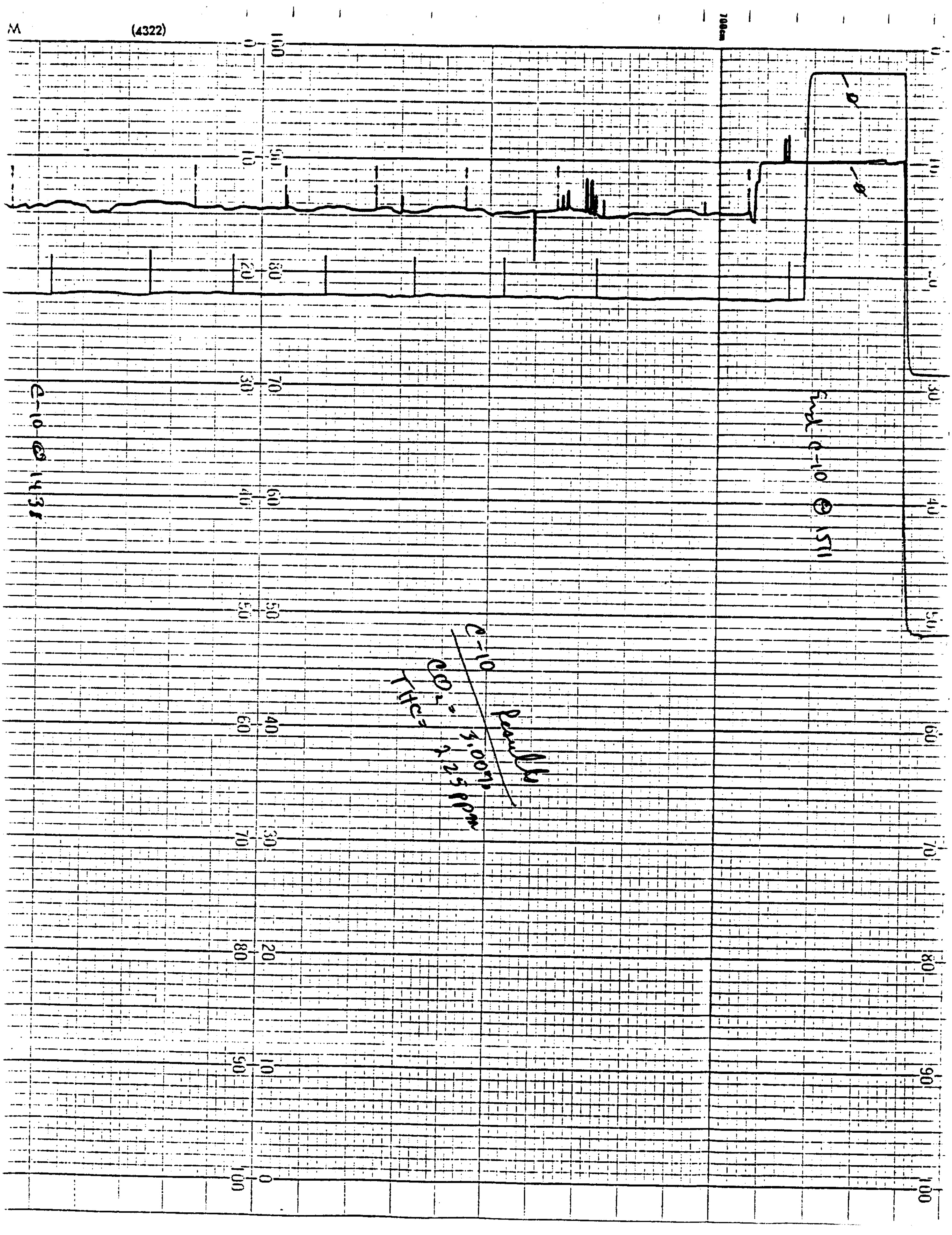

Charts-inc
0 CO2
0 THC
42 CO2
21 THC
adj. fuel flow
C-7 @ 1201
End C-6 @ 1150
C-6 results

T NO. RN2-01-25-20M (4322)

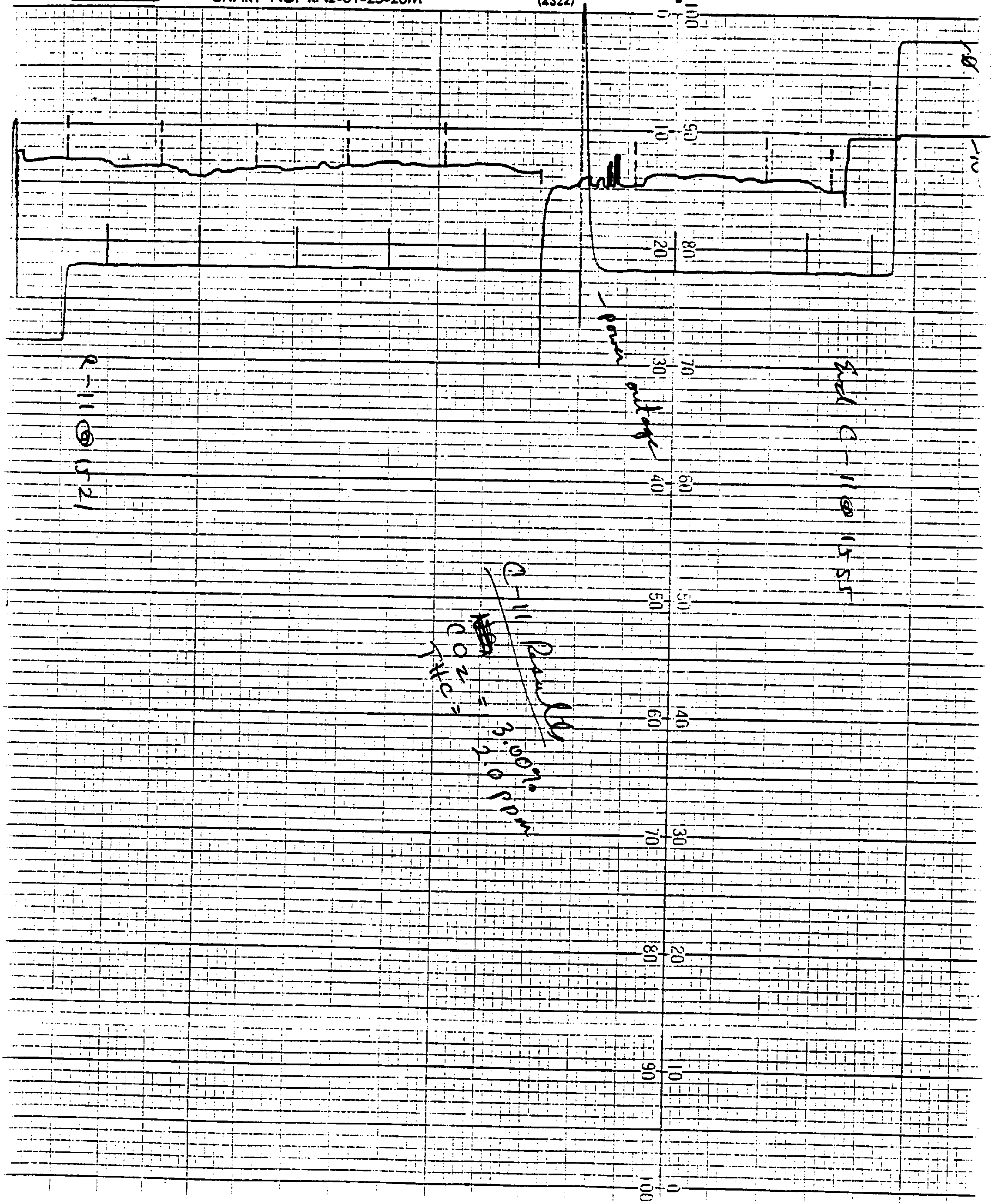


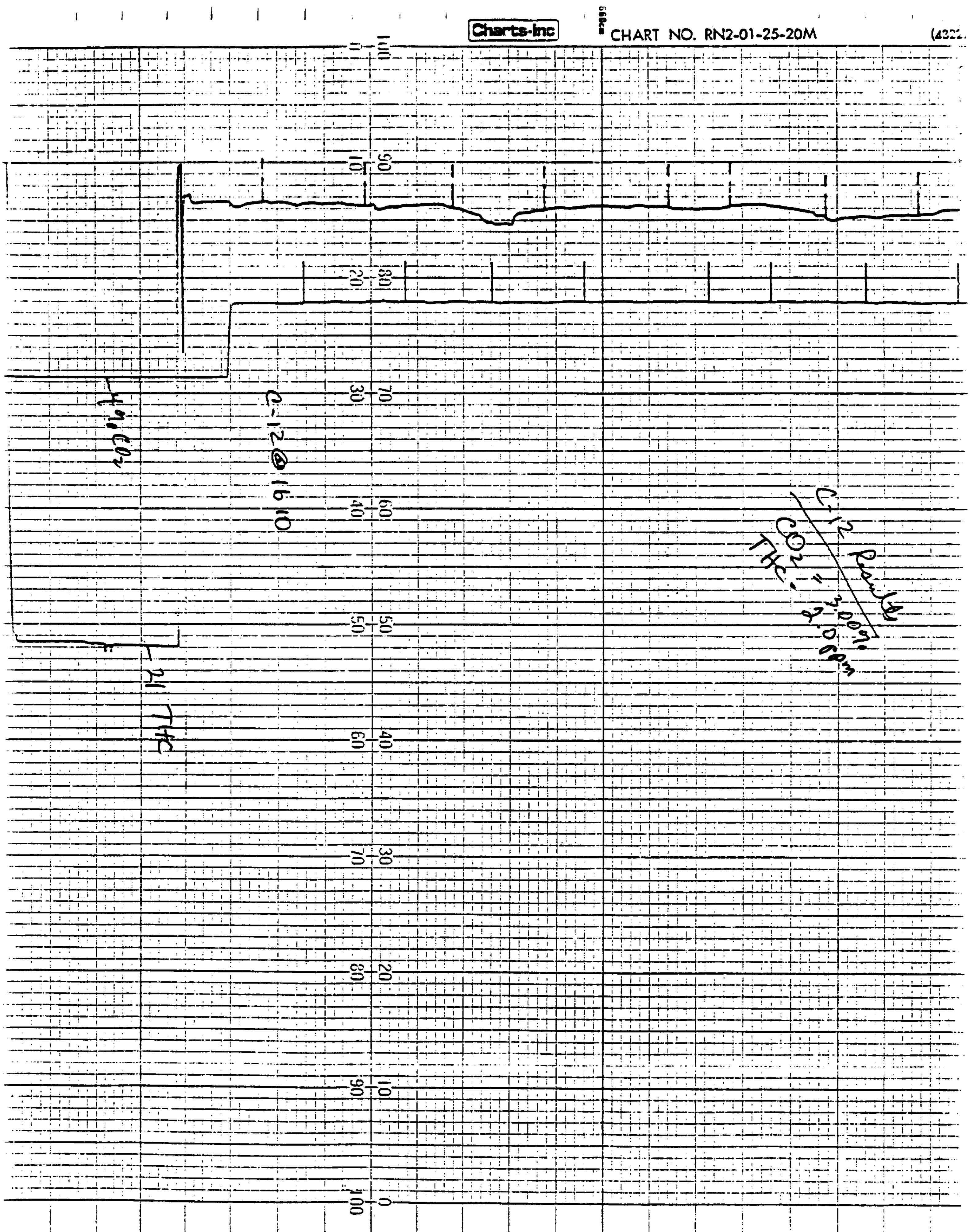

Charts-inc
CHART NO. RN2-01-25-20M
(4322)
C-9 @ 1331
~47 CO2
End C-8 @ 1318
C-8 Results
CO2 = 2.81%
THC = 2.0 ppm
~40 C1
Flow adj


Charts-Inc
CHART NO. RN2-01-25-20M
Ø
Ø
4% CO2
24 THC
C-9 Results
CO2 = 2.79%
THC = 2.0 ppm
End C-9 @ 1403

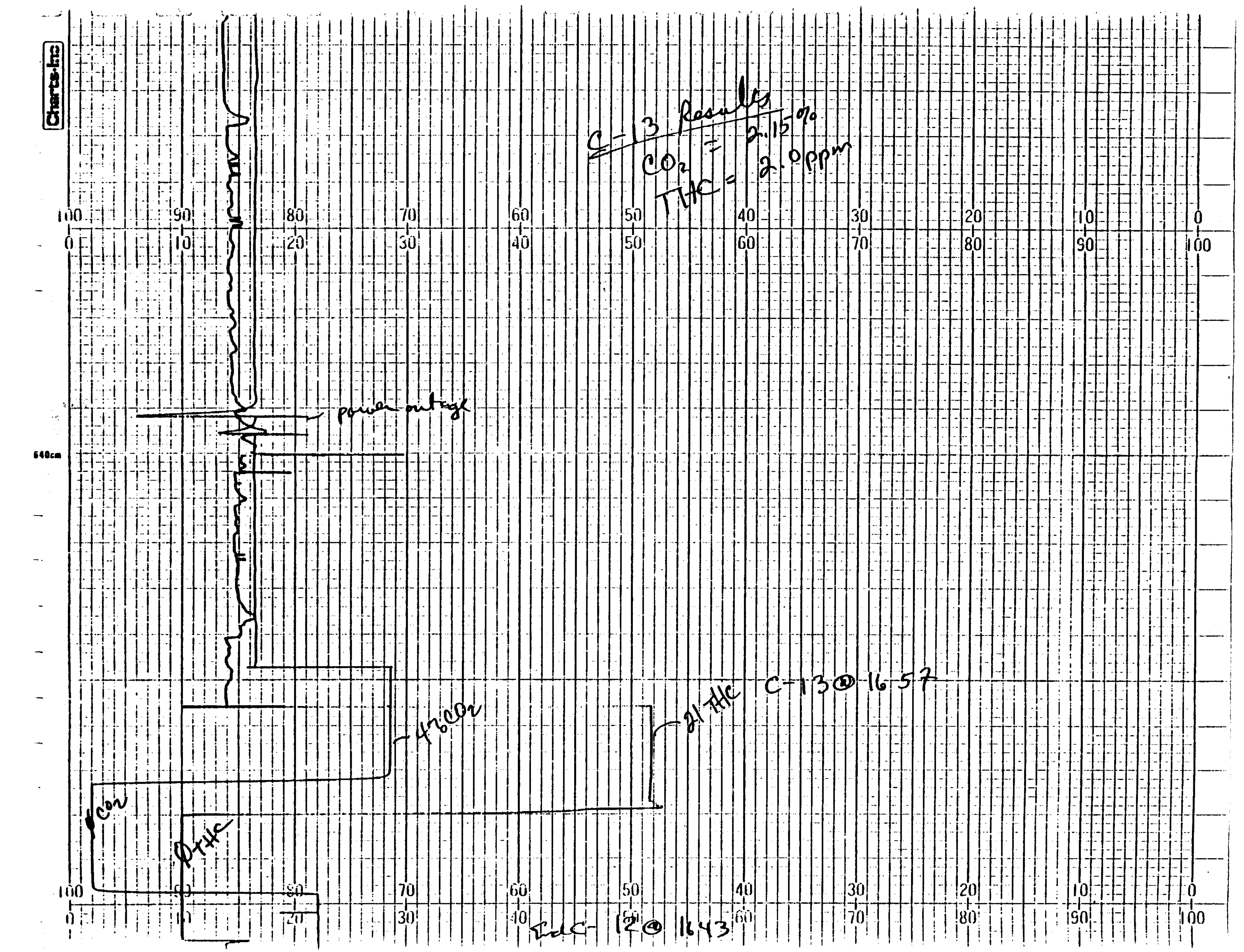

(4322)
C-10 @ 1438
End C-10 @ 1511
C-10 Results
CO2 = 3.00%
THC = 2.25 ppm

Charts-Inc CHART NO. RN2-01-25-20M (4322)



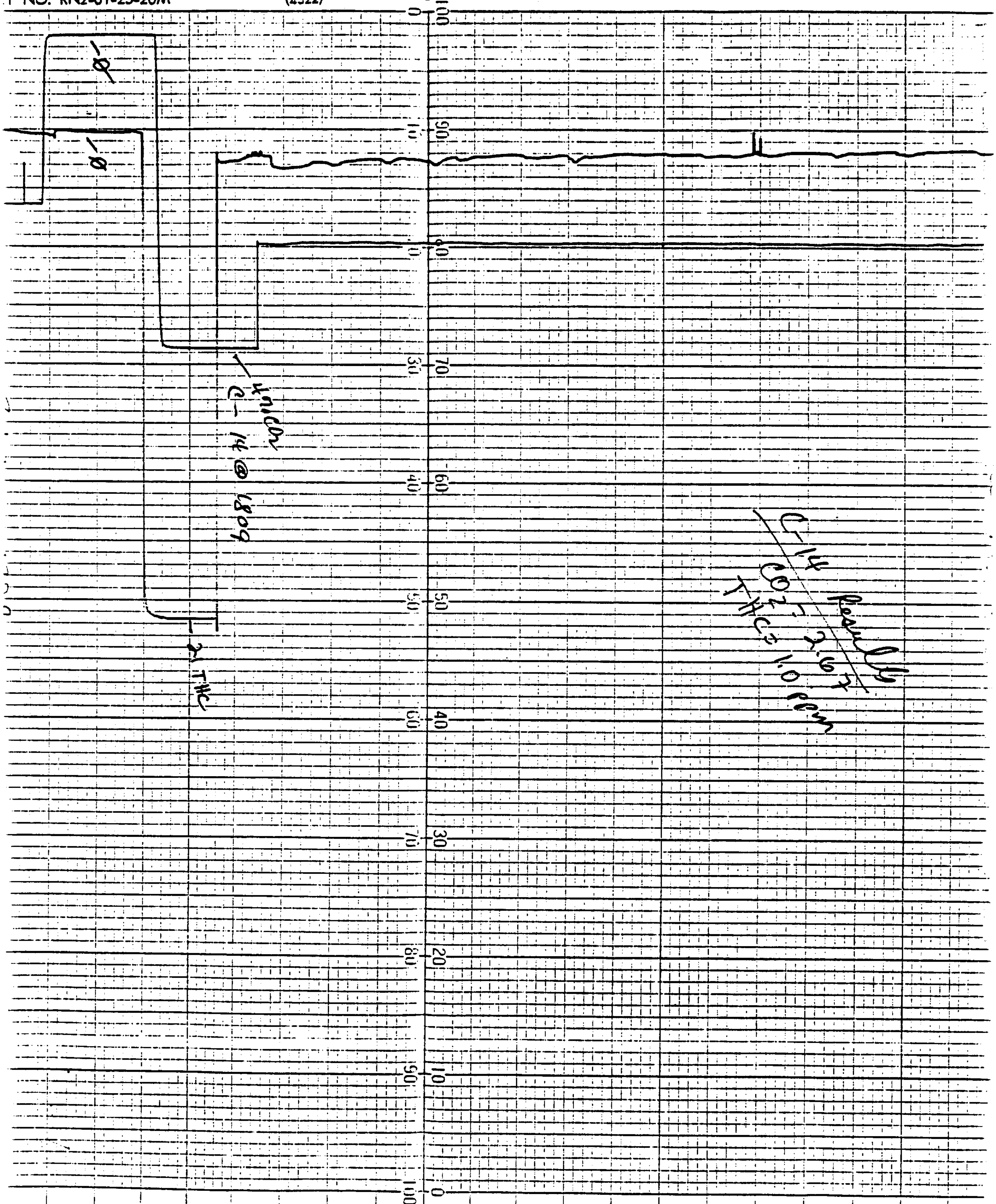


Charts-Inc
CHART NO. RN2-01-25-20M
(4322
4% CO2
C-12 @ 1610
21 THC
C-12 Results
CO2 = 3.00%
THC = 2.0ppm

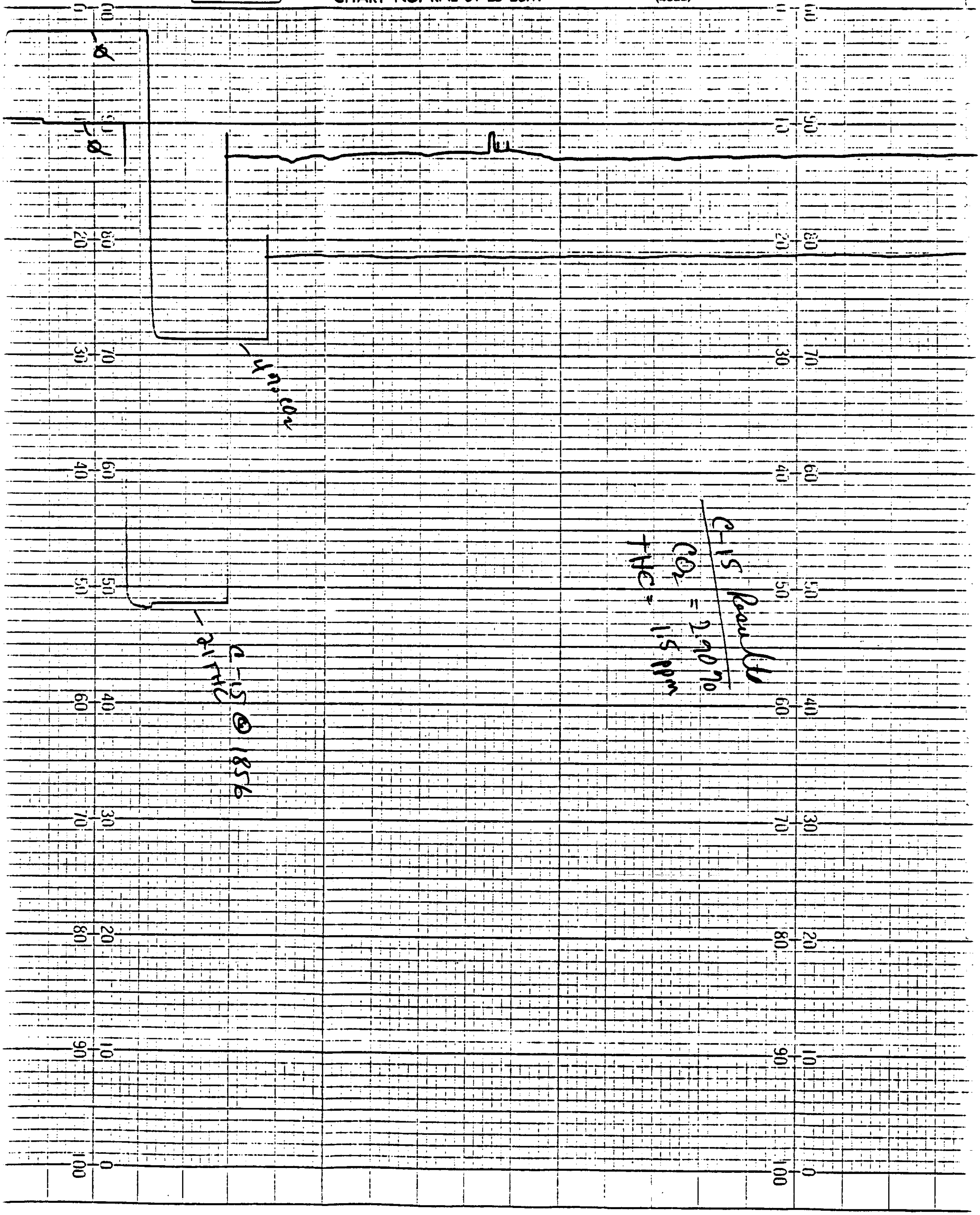


Charts-Inc
C-13 Results
CO_2 = 2.15%
THC = 2.0ppm
power outage
640cm
4% CO_2
21 THC
C-13 @ 16 57
$0CO_2$
0 THC
End C-12 @ 1643

T NO. RN2-01-25-20M (4322)

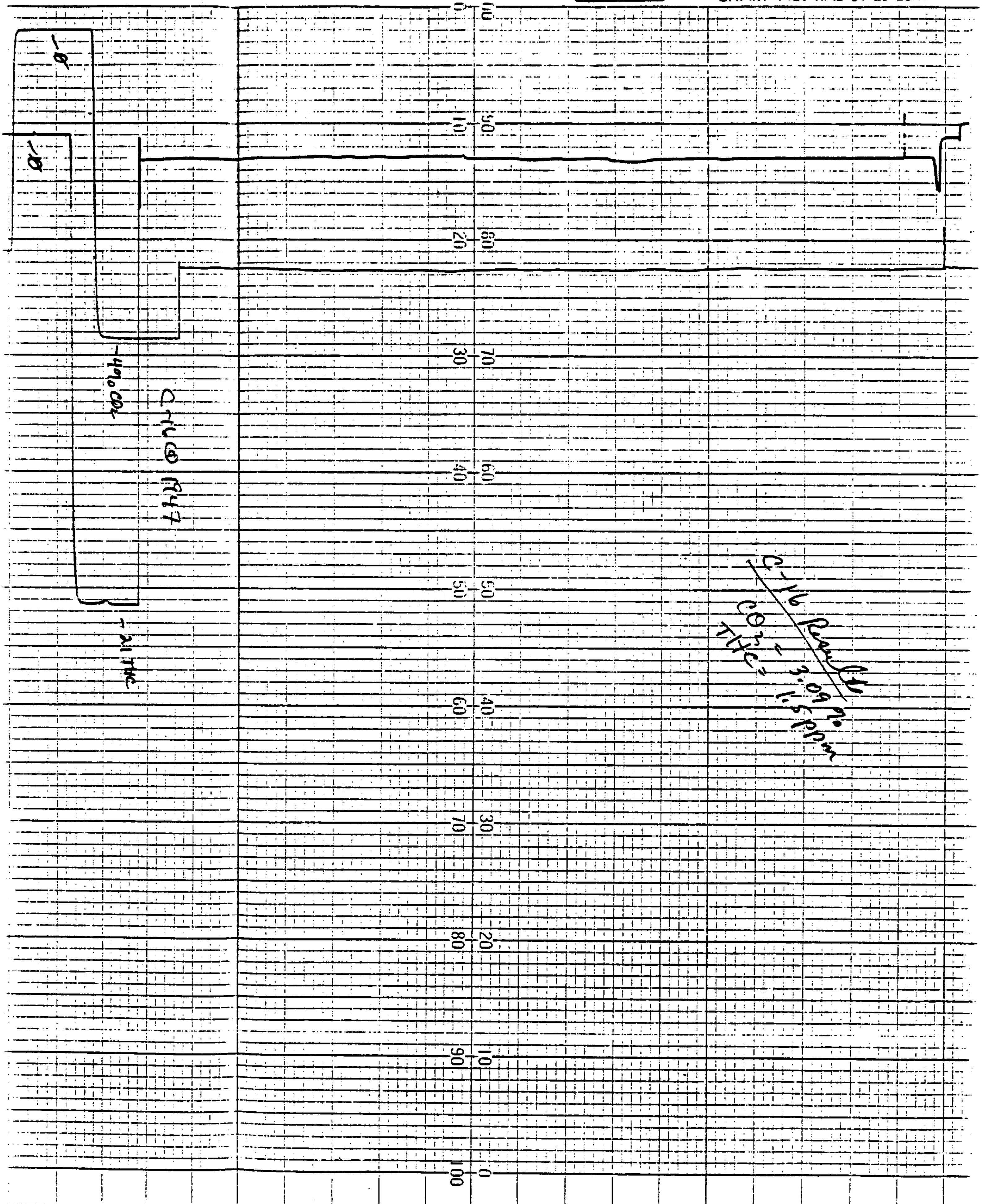


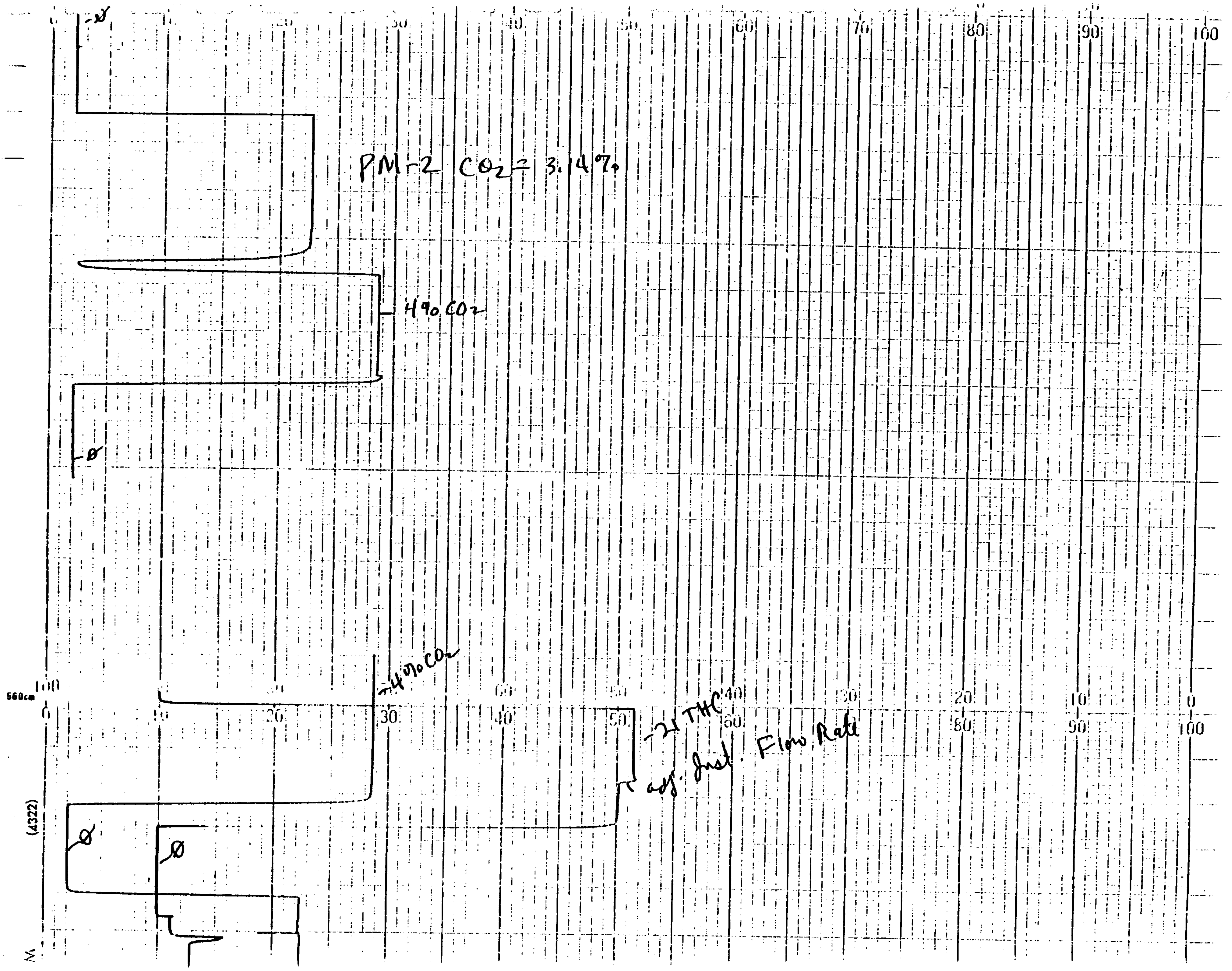
Charts-Inc CHART NO. RN2-01-25-20M (4322)



Charts-Inc

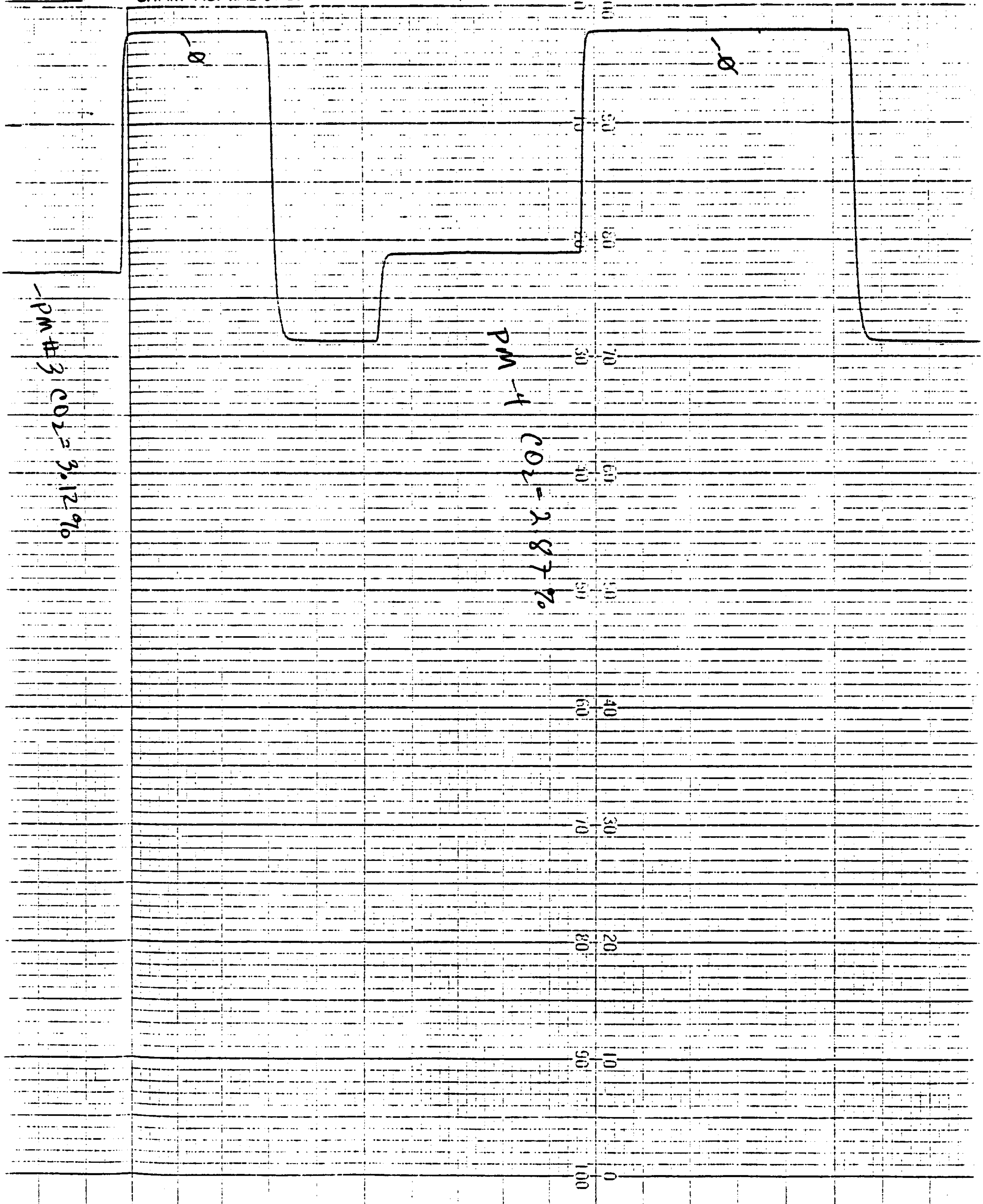
CHART NO. RN2-01-25-20M



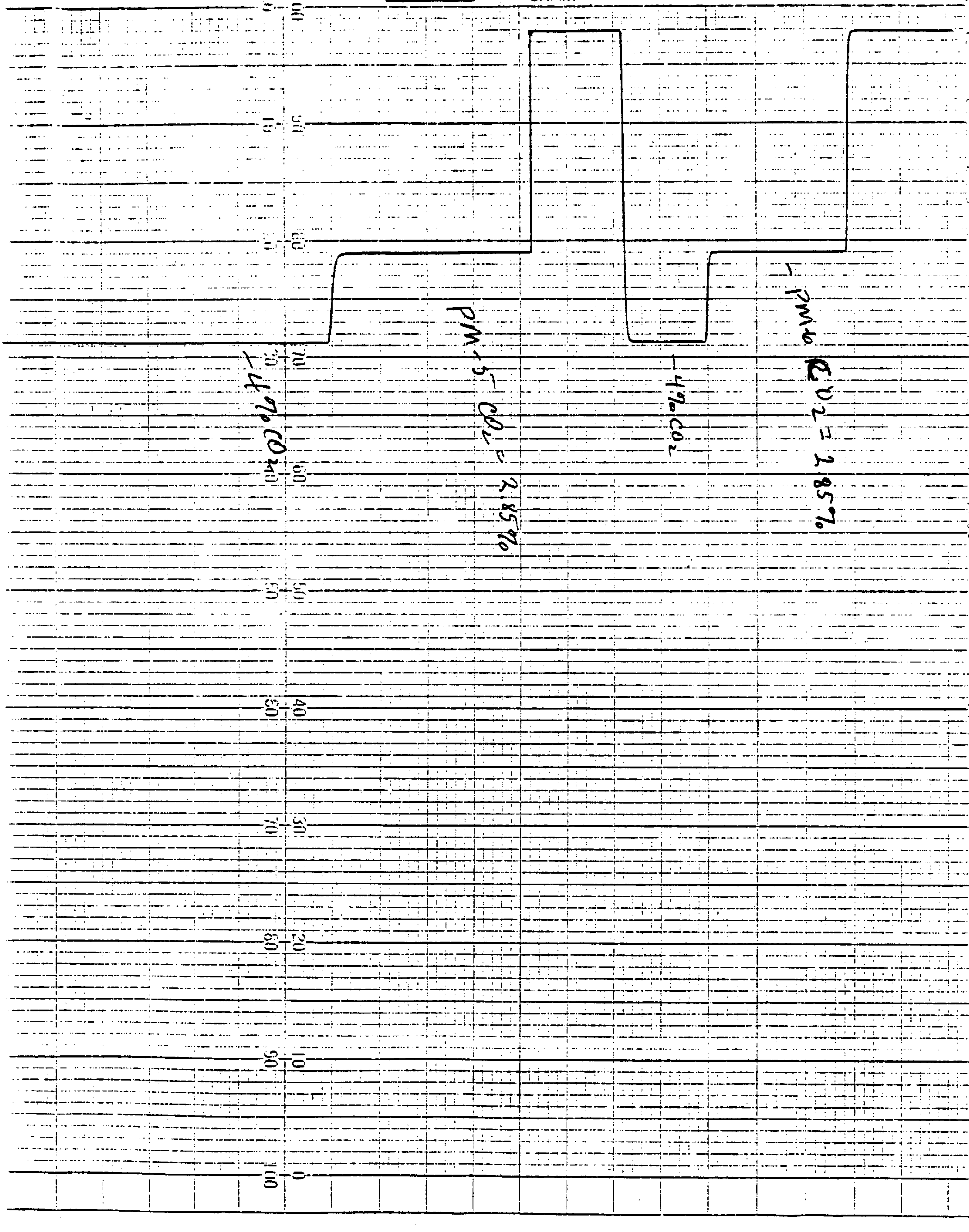


PM-2 CO2 = 3.14%
4% CO2
4% CO2
-21 THC
Flow Rate
(4322)
560cm

harts·inc CHART NO. RN2-01-25-20M (4322)



Charts-Inc CHART NO. RN2-01-25-20M (4322)



JORDAN LABORATORIES, INC.
CHEMISTS AND ENGINEERS
CORPUS CHRISTI, TEXAS
MAY 15, 1991

CUBIX CORPORATION
9225 LOCKHART HWY.
AUSTIN, TEXAS 78747

REPORT OF ANALYSIS

SAMPLE IDENTIFICATION: SUN OIL COMPANY
FUEL OIL #2
5-1-91

HEAT OF COMBUSTION, BTU/LB ------------------------------- 19200

SULFUR, WT.% -- 0.13

LAB. NO. H29-1018

RESPECTFULLY SUBMITTED,

CARL F. CROWNOVER

TEL. 512-884-0371 PO BOX 2552 78403

JORDAN LABORATORIES, INC.
CHEMISTS AND ENGINEERS
CORPUS CHRISTI, TEXAS
MAY 15, 1991

CUBIX CORPORATION
9225 LOCKHART HWY.
AUSTIN, TEXAS 78747

REPORT OF ANALYSIS

SAMPLE IDENTIFICATION: SUN OIL COMPANY
FUEL OIL
5-2-91

HEAT OF COMBUSTION, BTU/LB ---------------------------------- 18900

SULFUR, WT.% --- 0.10

LAB. NO. H29-1019

RESPECTFULLY SUBMITTED,

CARL F. CROWNOVER

Caleb Brett

Caleb Brett U.S.A., Inc.

MAY 13, 1991 PA/91/2121-L

SUN OIL COMPANY
3144 PASSYUNK AVE.
PHILADELPHIA, PA. 19145

ATTN: MR. GEORGE KEEGAN

RE: "LAB ANALYSIS"
NO. 2 FUEL OIL
5/2/91

Dear Mr. Keegan:

We have pleasure in enclosing our results and invoice for the above referenced analysis.

We thank you for requesting our services and trust that all is in order.

Sincerely yours,

Geri-Ann Pavonarius
Lab Manager
CALEB BRETT USA, INC./PHILADELPHIA

cc: file

jc

Head Office: P.O. Box 12973, Houston, Texas 77217, Telephone: 713/941-3999, Telex: 795-441
East Coast: P.O. Box 190, Essington, Pennsylvania 19029, Telephone: 215/521-1725, Telex: 83-4325
West Coast: P.O. Box 6099, Signal Hill, California 90806, Telephone: 213/427-5481, Telex: 65-6314

Caleb Brett

Caleb Brett U.S.A., Inc.

OFFICE:	PHILADELPHIA	DATE:	5/1/91
To	SUN	YOUR REF:	
Sample of	FUEL OIL	OUR REF:	PA/91/2121-L
Drawn by	SUN	Lab Ref:	#2663
Representing	SAMPLE SUBMITTED FOR ANALYSIS ON 5/4/91.		

The above sample was examined and the following results obtained

REPORT OF ANALYSIS

API GRAVITY @ 60°F	D 287	31.6
SULFUR (% wt)	D 4294	0.17
ASH (% wt)	D 482	0.002
BTU's/lb.		19305
BTU's/gal.		139459
CARBON		87.91
HYDROGEN		12.29
OXYGEN		0.20
NITROGEN		0.12

Head Office: P.O. Box 12973, Houston, Texas 77217. Telephone: 713/941-3999. Telex: 795-441
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West Coast: P.O. Box 6099, Signal Hill, California 90806. Telephone: 213/427-5481. Telex: 65-6314
Gulf Coast: P.O. Box 12973, Houston, Texas 77217. Telephone: 713/946-2420. Telex: 77-5548

Form # C/B 049

BP

Caleb Brett

Caleb Brett U.S.A., Inc.

OFFICE:	PHILADELPHIA	**DATE:**	5/2/91
To	SUN OIL	**YOUR REF:**	
Sample of	FUEL OIL	**OUR REF:**	PA/91/2121-L
Drawn by	SUN	Lab Ref:	#2664
Representing	SAMPLE SUBMITTED FOR ANALYSIS ON 5/4/91.		

The above sample was examined and the following results obtained

REPORT OF ANALYSIS

API GRAVITY @ 60°F	D 287	31.3
SULFUR (% wt)	D 4294	0.16
ASH (% wt)	D 482	0.001
BTU's/lb.		19174
BTU's/gal.		138762
CARBON		87.78
HYDROGEN		12.50
OXYGEN		0.13
NITROGEN		0.007

Caleb Brett

Caleb Brett U.S.A., Inc.

APRIL 29, 1991 PA/91/2092-L

SUN REFINING
3144 PASSYUNK AVE.
PHILADELPHIA, PA. 19145

ATTN: MR. GEORGE KEEGAN

RE: "LAB ANALYSIS"
NO. 2 FUEL OIL
4/25/91

Dear Mr. Keegan:

We have pleasure in enclosing our results and invoice for the above referenced analysis.

We thank you for requesting our services and trust that all is in order.

Sincerely yours,

Geri-Ann Pavonarius

Geri-Ann Pavonarius
Lab Manager
CALEB BRETT USA, INC./PHILADELPHIA

cc: file

jc

Head Office: P.O. Box 12973, Houston, Texas 77217, Telephone: 713/941-3999, Telex: 795-441
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West Coast: P.O. Box 6099, Signal Hill, California 90806, Telephone: 213/427-5481, Telex: 65-6314

Caleb Brett

Caleb Brett U.S.A., Inc.

OFFICE:	PHILADELPHIA	**DATE:**	4/25/91
To	SUN	**YOUR REF:**	
Sample of	NO. 2 FUEL OIL	**OUR REF:**	PA/91/2092-L
Drawn by	SUN	Lab Ref:	#2469

Representing SAMPLE SUBMITTED FOR ANALYSIS ON 4/25/91.

The above sample was examined and the following results obtained

REPORT OF ANALYSIS

	ASH (% wt)	D 482	0.005
	GRAVITY, API @ 60°F	D 287	33.1
	SULFUR (% wt)	D 4294	0.20
	HEAT OF COMBUSTION, BTU/lb.	D 240	19313
	BTU/gal.	calc.	138242
*	CARBON (% wt)		87.43
*	HYDROGEN (% wt)		12.77
*	OXYGEN (% wt)		0.02
*	NITROGEN (% wt)		.008

* TESTS PERFORMED BY MICROANALYSIS.

HP

PARTICULATE MATTER EMISSION CALCULATIONS

Test Date: 5-1-91
Plant: Sun Oil Philadelphia, PA
Stack: Westinghouse 301-G Unit #2
Test Run #: PM-2

EXAMPLE CALCULATION

Dry Stack Flow (cfh, dry basis, standard conditions)

$$Qd = Qa \times 1059 \times \frac{Ps}{Ts} \times Fd$$

O2 F Factor Stoichiometric Flows

2.03×10^7 = NA ACFM X 1059 X $\frac{NA \text{ "Hg}}{NA \text{ °F} + 460}$ X NA %

Meter Volume (dry basis at standard conditions)

$$Vs = 17.65 \times Vm \times \frac{Pb + (\Delta Havg \times .07355)}{Tm + 460}$$

57.34 = 17.65 X 57.80 ft³ X $\frac{29.87 \text{ "Hg} + (1.02 \times .07355)}{64 \text{ °F} + 460}$

Particulate Matter Emission Rate (lbs/hr)

$$Ep\ (front) = \frac{Mf \times Qd}{Vs \times 454}$$

15.96 lb/hr = $\frac{0.02047 \text{ g} \times 2.03 \times 10^7 \text{ cfh}}{57.34 \text{ ft}^3 \times 454}$

$$Ep\ (back) = \frac{Mb \times Qd}{Vs \times 454}$$

1.01 lb/hr = $\frac{0.00130 \text{ g} \times 2.03 \times 10^7 \text{ cfh}}{57.34 \text{ ft}^3 \times 454}$

Ep (total) = Ep (front) + Ep (back)

16.97 lb/hr = 15.96 lb/hr + 1.01 lb/hr

16.97 lb/hr × (1/402.0 mmBtu/hr) = **0.04 lbs/mmBtu**

Method 5 Filter Weighing Data Sheet

Company: Sun Oil
Plant: Philadelphia, PA
Date:
Emission point:

Tare Weights

JK Mini Filters for Back half wieght

Date:	5/13				
Time:	11:15				
	Weight	Weight	Weight	Weight	Final
Filter #	#1 (g)	#2 (g)	#3 (g)	#4 (g)	Avg. Wt.
.2um 600	.0866	.0863	.0864		
.45um 100	.0800	.0799	.0800		
.8um 400	.0711	.0707	.0709		
.45um 200	.0805	.0801	.0801		
.2um 500	.0868	.0865	.0865		
.8um 300	.0725	.0721	.0723		
.8um A	.0720	.0721	.0720		
.2um B	.0872	.0870	.0873		
.45um C	.0837	.0838	.0834		

Final Weights

Description	Vol	Filter #	Weight #1 (g)	Weight #2 (g)	Weight #3 (g)	Weight #4 (g)	Final Avg. Wt.
		Date:					
		Time:					
Run 2	415mL	#300/.8um	.0727	.0727	.0729		
Run 2	415mL	#100/.45um	.0796	.0793	.0794		
Run 2	415mL	#500/.2um	.0864	.0865	.0864		
Run 5	325mL	#400/.8um	.0710	.0708	.0708		
Run 5	325mL	#200/.45um	.0800	.0799	.0800		
Run 5	325mL	#600/.2um	.0864	.0864	.0866		
A Blank	300mL	.8um	.0716	.0714	.0715		
B Blank	300mL	.2um	.0866	.0865	.0868		
C Blank	300mL	.45um	.0833	.0829	.0832		

Notes:

Method 5 Filter Weighing Data Sheet

Company: SUN oil
Plant: Philly PA
Date:
Emission point:

Tare Weights

JR

Date:					
Time:	10:00				
	Weight	Weight	Weight	Weight	Final
Filter #	#1 (g)	#2 (g)	#3 (g)	#4 (g)	Avg. Wt.
00019	3419	3421	3422		.3420
00004	3458	3460	3459		.3459
00003	.3431	.3430	3429		.3430
00021	3449	3448	3450		.3449
00020	3452	3430	3430		.3430
00018	3445	3443	3410		.3442
00060	3335	3335	3336		3335

Final Weights

Description	Date:	5-13-91	5-13-91			
	Time:	10:00	4:10			
Description		Weight	Weight	Weight	Weight	Final
	Filter #	#1 (g)	#2 (g)	#3 (g)	#4 (g)	Avg. Wt.
Run 5	00003	.3579	.3580	.3578		3579
Run 1	00004	.4157	.4160	.4160		4159
Run 2	00018	.3563	3563	.3563		3563
Run 3	00019	.3533	.3534	.3533		3533
Run 4	00020	[illegible]	.3564	.3564		3564
Run 6	00021	.3600	.3603	.3604		3602
Blank	00060	.3386	.3387	.3387		3387

.0149

Notes:

Method 5 Beaker Weighing Data Sheet

Company: Sun oil
Plant: Phila., Pa.
Date:
Emission point:

Tare Weights

JR

Date:	5-10-91				
Time:	11:15				
	Weight	Weight	Weight	Weight	Final
Beaker #	#1 (g)	#2 (g)	#3 (g)	#4 (g)	Avg. Wt.
1	100.4874	100.4877			
4	101.6691	101.6691			
8	102.3620	102.3620			
07	100.9360	100.9362			
B	103.1060	103.1065			
7	102.3230	102.3226			
A	100.7151	100.7151			

Final Weights

	Date:	5-13					
	Time:	9:00					
Vol.			Weight	Weight	Weight	Weight	Final
(ml)	Beaker #	Description:	#1 (g)	#2 (g)	#3 (g)	#4 (g)	Avg. Wt.
315	1	Run 6	100.4950	100.4951			
325	4	Run 3	101.6750	101.6750			
230	8	PM-1 front 1/2	102.3856	102.3858			
315	07	Run 5	100.9440	100.9440			
380	B	Run 4	103.1143	103.1146			
260	7	Run 2 Unit 2	102.3319	102.3322			
215	A	Blank Acetone	100.7157	100.7157			

PM-1

EPA Method 5 Stack Sampling Data Sheet

Plant Name: Sun Refining		Stack Height:	DGM#:
Date: 5-1		Stack Diameter:	DGMCF: .9921
Source: Unit 2		Stack moisture (% by volume)	Mol. Wt.
Technicians: JS, KJ, RJK		Atm. Pressure: 29.90	Static Pressure: -1.5
Probe size: 8'	Run#: 1 Box#: 2	K Factor: .68	Sample Time:
Nozzle Area: .00025	Filter #: 00004	PTCF:	No. of Sample Pts:
Time: Start: 17:25	Stop:	Posttest Leak Check: .01 cfm at 21" Hg	
Pretest Leak check: .01 cfm at 25 Hg		Meter Reading: Initial: 375.503	Final: 375.504

Impinger Number	1	2	3	4
Contents				
Initial Wt. (g)	648.9	647.9	489.9	702.6
Final Wt. (g)	679.5	655.9	491.2	714.9

2489.3
2541.5

Exhaust Gas Concentrations: CO2 (%): 3.00 O2 (%): 17.00

Point	Clock Time	DGM Reading	Δ P (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	17:25	314.4	2.2	1.97	-5	92	200	216	66	211
2	17:28.5	317.6	2.1	1.70	-5	92	206	215	58	213
3	17:32	320.9	2.1	1.48	-5	92	228	225	56	218
4	17:35.5	323.1	2.2	1.55	-5	92	229	217	56	221
5	17:39	325.9	1.75	1.2	-5	92	232	211	58	219
6	17:42.5	327.6	1.25	0.88	-4	92	230	203	60.1	224
7	17:52	329.9	1.80	1.34	-4	90	232	226	64	221
8	17:55.5	332.0	1.75	1.23	-4	92	244	227	61	234
9	17:59	333.7	1.40	.98	-4	92	231	[illegible]	63	[illegible]
10	18:02.5	336.8	1.30	1.05	-4	92	230	192	65	[illegible]
11	18:05.5	339.2	1.30	1.05	-4	92	231	791	66	[illegible]
12	18:09	342.3	1.20	.84	-4	92	232	221	67	[illegible]
Totals or Avgs.										

EPA Method 5 Stack Sampling Data Sheet

Point	Clock Time	DGM Reading	Δ P (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	18:15	345.6	1.65	1.16	-4	90	221	814	56	238
2	18:18.5	348.7	.75	.52	-3	90	222	813	56	237
3	18:21	351.2	.50	.35	-3	90	[illegible]	813	57	239
4	18:25.5	353.1	.75	.52	-3	90	[illegible]	811	58	238
5	18:22	355.6	1.0	.75	-3	90	224	812	59	240
6	18:32	357.8	1.0	.73	-3	910	222	782	59	240
1	18:37	361.0	2.9	2.1	-6	88	258	824	60	226
2	18:40	363.2	3.2	2.25	-6	88	265	825	60	229
3	18:44	365.2	1.5	1.11	-5	90	267	810	61	230
4	18:48	367.8	2.4	1.68	-5	90	266	812	62	232
5	18:50	369.7	2.6	1.83	-6	90	265	808	63	230
6	18:53.5	371.6	2.6	1.83	-6	90		805		
		373.2								
								810		
Totals or Avgs.										

Avg $\sqrt{\Delta P}$ = 1.30 MW = 28.69

DGF = .9578
Avg T_m = 91
Avg T_s = 810

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DGVc = 58.80 X .9921 = 58.34

Company Name

FIELD CHECK OF PERCENT ISOKINETIC

The following field check should be performed after the first sample and may be performed after subsequent samples if changes were made. None of the results from this page are used as input into the final data reduction.

1. Calculate nozzle volume at stack conditions (NVSC) given the following items obtained during the sample:

   a. Corrected dry gas volume, DGV 58.34 ft^3
   b. Aver. Stack Temp., TS 1270 °R
   c. Aver. Meter Temp., TM 551 °R
   d. Dry Gas Fraction, BDG .9578

$$NVSC = \frac{(DGV)\frac{(TS)}{(TM)}}{(BDG)} = \frac{(58.34)\frac{(1270)}{(551)}}{(.9578)} = \underline{140.39}\ ft^3$$

2. Calculate the average corrected stack velocity (V). First, sum the square roots of the Δp's obtained during the sample and divide by N, the number of Δp's, to obtain the average square root of Δp:

$$\text{Aver. } \sqrt{\Delta p} = \frac{\Sigma\sqrt{\Delta p}}{N} = \frac{(31.17)}{(24)} = \underline{1.30}\ in.^{1/2}$$

$$V = (85.48)\ (PTCF)\sqrt{\frac{TS}{\text{Mole Wt.} \times \text{Stack Press}}}\ \text{Aver. } \sqrt{\Delta p}$$

$$V = (85.48)\ (.84)\sqrt{\frac{(1270)}{(28.69)(29.87)}}\ (1.30) = \underline{113.63}\ ft/sec$$

Preliminary molecular weight may be used unless significant changes occurred in moisture fraction. Preliminary stack pressure may be used.

3. Calculate percent isokinetic given:

   a. Nozzle volume, NVSC 140.39 ft^3
   b. Nozzle area, AN .00025 ft^2
   c. Sample Time, TIM 5100 seconds
   d. Aver. Corrected Velocity, V 113.63 ft/sec

$$\%\ Iso. = \frac{(NVSC)(100\%)}{(AN)(TIM)(V)} = \frac{(140.39)\ (100\%)}{(.00025)(5100)(113.63)} = \underline{96.9}$$

Date ____________________

Signature ____________________

EPA Method 5 Stack Sampling Data Sheet

Plant Name: Sun Oil
Date: 5-2
Source: Unit 2
Technicians: JS, KJ, RJK
Probe size: 8' Run#: 2 Box#: 1
Nozzle Area: .000 25 Filter #: 00018
Time: Start: 9:40 Stop:
Pretest Leak check: .015 at 17"Hg

Stack Height: ~ 50' DGM#: 1529786
Stack Diameter: 14' DGMCF: .9921
Stack moisture (% by volume) Mol. Wt.
Atm. Pressure: 29.87 Static Pressure: -1.5
K Factor: .68 Sample Time: 82
PTCF: No. of Sample Pts: 24
Posttest Leak Check: .015 at 21"Hg
Meter Reading: Initial: 325.505 Final: 25.520

Impinger Number	1	2	3	4
Contents				
Initial Wt. (g)	625.8	618.8	477.0	711.8
Final Wt. (g)	648.8	628.8	477.8	723.1

2433.4
2478.5

Exhaust Gas Concentrations: CO2 (%): 3.14 O2 (%): 16.93

	Point	Clock Time	DGM Reading	Δ P (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
	1	9:40	374.7	2	1.41	-3	62	218	810	58	207
	2	9:43.5	377.1	1.1	.74	-3	66	226	804	58	227
	3	9:47	379.0	.95	.64	-3	66	229	804	59	231
	4	9:50.5	380.5	1.25	.85	-3	64	239	804	59	229
	5	9:54	382.1	1.40	.94	-3	64	246	802	60	227
	6	9:57.5	383.8	1.25	.85	-3	64	247	793	60	225
00	1	10:02	385.6	2.5	1.69	-3	65	270	810	51	236
3.5	2	10:11.5	388.3	1.55	1.01	-3	65	269	810	51	240
7	3	10:15	390.4	1.55	1.1	-3	65	268	811	52	238
10.5	4	10:18.5	392.2	1.75	1.18	-3	65	262	810	52	235
14	5	10:22	394.4	1.65	1.11	-3	66	258	809	53	234
17.5	6	10:25.5	396.2	1.45	.98	-3	66	255	803	53	230
21											
	Totals or Avgs.										

58

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EPA Method 5 Stack Sampling Data Sheet

Run 2 100%
Unit 2

Point	Clock Time	DGM Reading	Δ P (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	10:37	398.2	1.8	1.21	-3	66	258	814	58	236
2	10:40.5	401.4	1.6	1.1	-3	66	258	810	51	244
3	10:44	403.5	1.75	1.18	-3	66	273	813	51	241
4	10:47.5	405.4	2.2	1.49	-3	66	271	809	52	237
5	10:51	408.9	1.75	1.18	-3	66	265	805	52	235
6	10:54.5	410.9	1.50	1.01	-3	66	267	791	53	232
1	11:02	413.8	22	1.82	-3	66	258	814	54	229
2	11:05.5	417.5	1.5	1.01	-3	66	245	808	52	241
3	11:09	421.2	1.45	.98	-3	66	245	805	53	237
4	11:12.5	423.6	2.1	1.4	-3	66	238	801	54	232
5	11:16	426.7	1.9	1.28	-3	66	255	800	55	228
6	11:20.5	429.9	2.8	1.88	-3	66	242	794	56	225
	11:24	432.5								
						65		805		
		57.80 X .9921								
		57.34								
Totals or Avgs.										

432

DGF = .964
MW = 28.78
ΔH@ = 1.30

Testing by Cubix Corporation

EPA Method 5 Stack Sampling Data Sheet

100% Load

Plant Name: Sun Oil		Stack Height: ~50'	DGM#: 1529785
Date: 5-2-91		Stack Diameter: 14'	DGMCF: .9921
Source: Unit 2		Stack moisture (% by volume)	Mol. Wt.
Technicians: JS, KJ, KJK		Atm. Pressure: 29.72	Static Pressure: -1.5
Probe size: 8'	Run#: 3 Box#: 2	K Factor: .68	Sample Time: 82
Nozzle Area: .00125	Filter #: 00019	PTCF:	No. of Sample Pts: 24
Time: Start: 12:05	Stop:	Posttest Leak Check:	
Pretest Leak check: .012 at 21" Hg		Meter Reading: Initial:	Final:

Impinger Number	1	2	3	4
Contents	200 mls DI H2O	200 mls DI	Empty	SG
Initial Wt. (g)	671.8	697.3	491.2	815.9
Final Wt. (g)	704.1	703.4	491.8	826.4

2676.2
2725.7

Exhaust Gas Concentrations: CO_2 (%): 3.12 O_2 (%): 17.20

	Point	Clock Time	DGM Reading	ΔP (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
0.0	1	12:05	433.5	1.7	1.15	4	72	228	802	62	213
3.5	2	12:08.5	436.4	1.0	.67	3	74	228	802	56	236
7	3	12:14	438.1	.70	.55	3	74	236	805	51	242
10.5	4	12:17.5	440.3	1.0	.79	4	74	243	804	51	238
14	5	12:21	442.6	1.25	.85	4	74	251	804	52	235
17.5	6	12:24.5	444.9	1.35	.925	5	72	251	803	52	230
21											
	1	12:35	447.6	2.25	1.53	4	72	250	813	53	240
	2	12:38.5	450.5	1.45	0.99	4	71	252	804	54	238
	3	12:42	452.8	1.40	0.95	4	71	253	804	56	235
	4	12:45.5	454.9	2.25	1.53	5	70	253	802	58	231
	5	12:49	457.5	2.15	1.94	4	71	250	798	59	233
	6	12:52.5	460.0	2.60	1.77	5	71	246	790	60	230
	Totals or Avgs.										

EPA Method 5 Stack Sampling Data Sheet

Run 3
Unit 2

100%

Point	Clock Time	DGM Reading	Δ P (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	13:01	462.0	2	1.37	5	74	260	815	60	217
2	13:04.5	464.7	1.65	1.10	5	74	264	810	52	238
3	13:08	467.0	1.75	1.26	5	74	261	810	52	236
4	13:11.5	468.9	2.4	1.65	5	74	258	808	53	233
5	13:15	472.3	2.1	1.41	5	74	254	805	53	228
6	13:18.3	473.9	1.15	.79	5	74	255	798		
1	13:28	476.4	2.3	1.58	6	74	253	815	55	222
2	13:31.5	479.2	1.75	1.20	6	72	254	813	53	246
3	13:35	482.2	1.65	1.13	5	72	253	812	54	243
4	13:38.5	485.2	1.75	1.20	5	72	252	811	54	238
5	13:42	487.9	1.75	1.20	5	70	251	810	55	234
6.	13:45.5	489.8	1.25	.85	5	72	252	798	56	230
		491.9								
		58.40x.9921				72		806		
		57.94								
Totals or Avgs.										

76.5

491.5

DGF = .961
MW = 28.75
Avg √ΔP = 1.30

% 150 = 100.5

EPA Method 5 Stack Sampling Data Sheet

90% Load

Plant Name: Sun Refining + Marketing		Stack Height: 50'	DGM#: 1529785
Date: 5·2·91		Stack Diameter: 14'	DGMCF: .9921
Source: Unit 2		Stack moisture (% by volume)	Mol. Wt.
Technicians: [illegible]		Atm. Pressure: 29.92	Static Pressure: -1.5
Probe size: 8'	Run#: 4 Box#: 1	K Factor: .80	Sample Time: 84
Nozzle Area: .00025	Filter #: 00020	PTCF:	No. of Sample Pts: 24
Time: Start: 15:55	Stop:	Posttest Leak Check: .015 cfm at 21" Hg	
Pretest Leak check: .01 at 15" Hg		Meter Reading: Initial: 549.306	Final: 549.3075

Impinger Number	1	2	3	4	
Contents	200 Mls DI	200 Mls DI	Empty	SG	
Initial Wt. (g)	638.4	637.4	477.8	800.6	2554.2
Final Wt. (g)	660.0	646.3	478.8	810.8	2595.9

Exhaust Gas Concentrations: CO2 (%): 2.87 O2 (%): 17.20

Point	Clock Time	DGM Reading	ΔP (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	15:55	492.5	2.2	1.68	-3	74	200	770	62	202
2	15:58.5	494.7	1.70	1.36	-3	74	205	771	52	243
3	16:02	496.8	1.6	1.28	-3	75	231	774	42	238
4	16:05.5	498.4	1.6	1.28	-3	74	232	773	42	236
5	16:09	501.5	1.4	1.12	-3	74	226	771	43	233
6	16:12.5	503.4	1.25	1.01						
1	16:20	505.2	2	1.6	-3	70	271	770	48	222
2	16:23.5	507.6	1.65	1.32	-3	72	269	770	50	244
3	16:27	510.2	1.75	1.40	-3	75	256	770	50	243
4	16:30.5	512.8	2.3	1.84	-4	76	255	770	50	238
5	16:34	515.3	2.0	1.6	-4	76	248	765	52	234
6	16:37.5	518.4	1.20	.96	-3	76	250	740	53	230
Totals or Avgs.										

507

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O_2 17.20
CO_2 - 2.87

EPA Method 5 Stack Sampling Data Sheet

Box #1 Run #4
90% Load

Point	Clock Time	DGM Reading	Δ P (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	3:45	520.5	2.20	2.16	4	78	237	780	59	241
2	3:48.5	523.2	1.40	1.12	4	78	235	767	59	240
3	3:52	525.5	1.45	1.16	4	78	232	765	59	238
4	3:55.5	527.5	2.20	1.76	5	76	230	763	59	236
5	3:59	529.9	2.40	1.92	4	74	227	756	60	231
6	4:02.5	532.4	2.20	1.76	5	72	225	747	61	238
1	4:10.00	535.1	2.20	1.76	4	74	229	773	62	241
2	4:13.5	537.7	2.20	1.76	5	75	232	776	52	239
3	4:17	540.1	0.85	0.68	5	76	229	767	51	238
4	4:20.5	542.1	1.00	0.80	4	77	224	768	52	242
5	4:24	543.8	1.25	1.08	4	78	223	752	53	239
6	4:27.5	546.3	1.25	1.00	5	79	222	750	53	243
		549.0								
		56.50x.9921				76		766		
		56.05								
Totals or Avgs.										

Avg $\sqrt{\Delta P}$ = 1.31
DSF = .966
MW = 28.76

EPA Method 5 Stack Sampling Data Sheet

Plant Name: Sun
Date: 5-2-91
Source: Unit 2
Technicians: JS KJ RJK
Probe size: 8' Run#: 5 Box#: 3
Nozzle Area: .00025 Filter #: 00003
Time: Start: 17: Stop:
Pretest Leak check: .01 at 15" Hg

Stack Height: ~50
Stack Diameter: 14
Stack moisture (% by volume)
Atm. Pressure: 29.92
K Factor: .80
PTCF:
Posttest Leak Check:
Meter Reading: Initial: Final:

DGM#: 152979 J
DGMCF: .9121
Mol. Wt.
Static Pressure: -1.5
Sample Time: 84
No. of Sample Pts: 24

Impinger Number	1	2	3	4
Contents	200 ml DI	200 ml DI	Empty	Sb
Initial Wt. (g)	618.3	625.8	490.3	712.1
Final Wt. (g)	638.2	635.0	492.1	724.1

2446.5
2489.4

Exhaust Gas Concentrations: CO2 (%): 2.85 O2 (%): 17.28

Point	Clock Time	DGM Reading	ΔP (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	17:05	549.9	2.6	2.08	6	78	200	772	48	216
2	17:08.5	553.0	1.0	.81	5	78	244	766	48	239
3	17:12	555.2	1.0	.81	5	80	260	767	49	241
4	17:15.5	557.2	1.0	.81	5	78	268	767	50	236
5	17:19	559.4	1.35	1.08	5	78	272	767	50	232
6	17:22.5	561.6	1.25	1.0	5	78	270	752	51	229
1	17:32	563.9	2.4	1.92	6	78	246	749	48	226
2	17:35.5	567.0	3.1	2.48	7	76	241	770	49	242
3	17:39	570.6	1.5	1.2	6	76	265	760	50	245
4	17:42.5	572.8	2.2	1.76	6	76	262	750	51	241
5	17:46	574.3	2.6	2.1	6	76	253	753	52	237
6	17:49.5	576.5	2.0	1.6	6	78	247	750	53	236
		579.8								
Totals or Avgs.										

564.4
578

Testing by Cubix Corporation

CO_2 2.85
O_2 - 17.28

EPA Method 5 Stack Sampling Data Sheet

Run 5
Unit 2
90%

Point	Clock Time	DGM Reading	Δ P (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	18:00	578.9	1.55	1.56	5	78	250	770	47	232
2	18:03.5	582.3	2.1	1.68	5	78	251	769	47	249
3	18:07	584.6	1.75	1.40	5	78	254	761	48	246
4	18:10.5	587.2	2.1	1.68	6	78	254	757	48	242
5	18:14	590.9	1.5	1.2	5	78	254	745	48	239
6	18:17.5	593.0	1.1	0.88	5	78	253	742	50	237
1	18:25	594.8	2.0	1.6	6	79	258	770	51	242
2	18:28.5	597.1	1.85	1.48	5	82	258	768	51	238
3	18:32.0	599.6	1.45	1.16	5	82	257	761	53	233
4	18:35.5	601.7	1.65	1.32	6	82	258	762	53	237
5	18:39	603.9	1.70	1.36	6	82	259	767	54	240
6	18:42.5	606.2	1.25	1.00	6	83	257	753	55	237
	18:46.0	608.1								
		58.20X.9921				78		761		
		57.74								
Totals or Avgs.										

.94
.07

DGF = .967
MW = 28.76
avg $\sqrt{\Delta P}$ = 1.31

% 150 = 96

Testing by Cubix Corporation

EPA Method 5 Stack Sampling Data Sheet

Plant Name: Sun Oil
Date: 5-2-91
Source: Unit 2
Technicians: JS, KJ, RJK
Probe size: 8' Run#: 6 Box#: 2
Nozzle Area: .00075 Filter #: 00021
Time: Start: 19.20 Stop:
Pretest Leak check: .015 at 17" Hg

Stack Height: ~50
Stack Diameter: 14
Stack moisture (% by volume)
Atm. Pressure: 29.92
K Factor: .80
PTCF:
Posttest Leak Check: .01 at 17" Hg
Meter Reading: Initial: 669.302 Final: 669.303

DGM#: 1529795
DGMCF: .9971
Mol. Wt.
Static Pressure: -1.5
Sample Time: 54
No. of Sample Pts: 12

Impinger Number	1	2	3	4
Contents	200 DI	200 DI	Empty	SG
Initial Wt. (g)	673.5	697.8	491.7	826.4
Final Wt. (g)	691.0	709.6	495.2	836.8

2689.4
2732.6

Exhaust Gas Concentrations: CO2 (%): 2.85 O2 (%): 17.25

Point	Clock Time	DGM Reading	ΔP (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	19:20	609.1	2.1	1.68	4	82	200	768	48	223
2	19:23.5	612.0	2.1	1.68	4	82	204	769	48	246
3	19:27	615.6	1.90	1.52	4	82	236	767	48	244
4	19:30.5	617.9	1.75	1.40	4	84	245	765	49	242
5	19:34	620.4	1.50	1.20	4	84	269	765	49	241
6	19:37.5	622.9	1.25	1.0	4	86	267	750	50	236
1	19:40	624.6	1.75	1.40	4	86	263	780	51	252
2	19:43.5	627.6	2.8	2.8	4	86	260	766	51	252
3	19:47	629.8	1.75	1.4	4	86	265	762	52	250
4	19:50.5	632.8	2.4	1.92	6	86	266	758	53	246
5	19:54	635.8	2	1.6	5	86	267	755	54	245
6	19:57.5	638.3	2.1	1.68	5	86	266	754	56	241
		640.3								
Totals or Avgs.										

23.5

DGF = .966
MW = 28.77
Avg √ΔP = 1.36

EPA Method 5 Stack Sampling Data Sheet

O_2: 17.25
CO_2: 2.85

Run #6
Unit #2

Point	Clock Time	DGM Reading	Δ P (" H2O)	ΔH (" H2O)	Line Vac. ("Hg)	DGM Temp.(°F)	Hot Box Temp.(°F)	Stack Temp.(°F)	Last Imp. Temp.(°F)	Probe Temp.(°F)
1	20:00	640.3	3	2.46	7	86	265	766	58	237
2	20:13.5	642.3	3.2	2.57	7	88	264	764	49	248
3	20:17	646.1	1.5	1.2	6	88	26[illegible]	755	51	246
4	20:20.5	648.2	2.4	1.92	7	88	266	753	53	241
5	20:24	650.1	2.5	2.0	6	88	264	748	54	239
6	20:27.5	653.0	2.0	1.6				745		
1	20:35	655.5	2.0	1.6	-6	88	268	758	54	233
2	20:38.5	657.3	1.0	.80	-5	88	26[illegible]	756	54	251
3	20:42	659.7	1.15	.92	-5	88	268	758	55	249
4	20:45.5	663.6	1.25	1.00	-6	87	268	757	55	245
5	20:49	665.4	1.35	1.08	6	86	267	745	56	243
6	20:52.5	667.3	1.05	0.86	-5	86	266	725	57	245
	20:56	61.90								
		59.90 X .9921				86		757		
		59.43								
Totals or Avgs.										

% ISO = 93.7%

Testing by Cubix Corporation

Scott Specialty Gases a division of
Scott Environmental Technology Inc. 2600 CAJON BLVD., SAN BERNARDINO, CA 92405
TELEX: 510-100-8831 (ScotGas)
FAX: 714-887-0549
PHONE: 714-887-2571

Shipped From: Scott San Bernardino
Date Shipped 1/19/90
Our Project No: 4494
Your P.O. No: 89333
Page 1 of 1
Expiration Date: July 18, 1991

CUBIX CORP

CERTIFICATE OF ANALYSIS—EPA PROTOCOL GASES*

Certified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. ALM-11711 Cylinder Pressure 1900 PSIG Certified Accuracy ±1% % NBS Traceable

COMPONENTS	CERTIFIED CONC	REFERENCE STD: SRM/CRM NO.	REFERENCE STD: CYL. NO.	REFERENCE STD: CONC.	GAS ANALYZER: MAKE/MODEL/SERIAL NO.	GAS ANALYZER: LAST CAL. DATE	GAS ANALYZER: ANALYTICAL PRINCIPLE
Nitric Oxide	80.79ppm	1684	ALM-3640	97.28ppm	TECO 10AR/14853-150	11/10/89	Chemi-Luminensce
NOX	81.67ppm						

BALANCE GAS

ANALYZER READINGS: Z = Zero Gas T = Test Gas R = Reference Gas

Component Nitric Oxide
First Analysis Date 1/10/90 Units PPM

Z 0.00	R 97.30	T 80.93
R 97.36	Z 0.03	T 80.80
Z 0.00	T 80.70	R 97.00

Mean Test Assay 80.86ppm

Second Analysis Date 1/17/90 Units PPM

Z 0.00	R 97.32	T 80.78
R 97.30	Z 0.06	T 80.80
Z 0.04	T 80.88	R 97.30

Mean Test Assay 80.79ppm

Component ______
Date ______ Units ______

Z	R	T
R	Z	T
Z	T	R

Mean Test Assay ______

Date ______ Units ______

Z	R	T
R	Z	T
Z	T	R

Mean Test Assay ______

Component ______
Date ______ Units ______

Z	R	T
R	Z	T
Z	T	R

Mean Test Assay ______

Date ______ Units ______

Z	R	T
R	Z	T
Z	T	R

Mean Test Assay ______

Chronology: Date ______
Assay ______

Analyst Lee Oldham

Approved By: [signature]

TELEX: 510-100-8831 (ScotGas)
FAX: 714-887-0549
PHONE: 714-887-2571

Scott Specialty Gases a division of

Scott Environmental Technology Inc. 2600 CAJON BLVD., SAN BERNARDINO, CA 92405

Shipped From: Scott San Bernardino
Date Shipped 1/19/90
Our Project No: 4494
Your P.O. No: 89333
Page 1 of 1
Expiration Date: July 18, 1991

CUBIX CORP

CERTIFICATE OF ANALYSIS—EPA PROTOCOL GASES*

Certified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. ALM-11708 Cylinder Pressure 1900 PSIG Certified Accuracy ±1% % NBS Traceable

COMPONENTS	CERTIFIED CONC	REFERENCE STD SRM/CRM NO.	REFERENCE STD CYL. NO.	REFERENCE STD CONC.	GAS ANALYZER MAKE/MODEL/SERIAL NO.	GAS ANALYZER LAST CAL. DATE	GAS ANALYZER ANALYTICAL PRINCIPLE
Nitric Oxide	40.78ppm	1684	ALM-3640	97.28ppm	TECO 10AR/14853-150	11/10/89	Chemi-Luminenscent
NOX	41.03ppm						

BALANCE GAS

ANALYZER READINGS: Z = Zero Gas T = Test Gas R = Reference Gas

Component Nitric Oxide
First Analysis Date 1/10/90 Units PPM

Z	0.00	R	97.27	T	40.90
R	97.29	Z	0.04	T	40.94
Z	0.00	T	40.98	R	97.44

Mean Test Assay 40.91ppm

Second Analysis Date 1/17/90 Units PPM

Z	0.00	R	97.23	T	40.74
R	97.20	Z	0.01	T	40.73
Z	0.00	T	40.77	R	97.18

Mean Test Assay 40.78ppm

Component ______
Date ______ Units ______

Z		R		T	
R		Z		T	
Z		T		R	

Mean Test Assay ______

Date ______ Units ______

Z		R		T	
R		Z		T	
Z		T		R	

Mean Test Assay ______

Component ______
Date ______ Units ______

Z		R		T	
R		Z		T	
Z		T		R	

Mean Test Assay ______

Date ______ Units ______

Z		R		T	
R		Z		T	
Z		T		R	

Mean Test Assay ______

Chronology: Date ______
Assay ______

Analyst Lee Oldham

Approved By: [signature]

Scott Specialty Gases

Electronics Group

a division of
Scott Environmental Technology, Inc.

3714 LAPAS DRIVE, HOUSTON, TEXAS 77023, (713) 644-4820, FAX (713) 644-0244

CUBIX CORP.
P.O. BOX 5083
AUSTIN, TEXAS 78763
ATTN: MARC McDANIEL

Date: JULY 12, 1989
Our Project No.: 718349
Your P.O. No.: 89093 REPLACEMENT (3)

Gentlemen:

Thank you for choosing Scott for your Specialty Gas needs. The analyses for the gases ordered, as reported by our laboratory, are listed below. Results are in volume percent, unless otherwise indicated.

ANALYTICAL REPORT

Cyl No. ALM003284 Analytical Accuracy ±1%

Component MOL%	Concentration
CARBON MONOXIDE	15.3 PPM
METHANE	20.8 PPM
NITROGEN	BALANCE

Cyl No. Analytical Accuracy

Component	Concentration

Cyl No. Analytical Accuracy

Component	Concentration

Cyl No. Analytical Accuracy

Component	Concentration

Analyst

Approved By

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the company without extra cost.

Scott Specialty Gases

Electronics Group

a division of
Scott Environmental Technology, Inc.

3714 LAPAS DRIVE, HOUSTON, TEXAS 77023, (713) 644-4820, FAX (713) 644-0244

CUBIX CORPORATION
M. MCDANIEL
P.O. BOX 5083
AUSTIN, TX. 78763

Date: MARCH 20, 1991
Our Project No.: 0410319
Your P.O. No.: 91013

Gentlemen:
Thank you for choosing Scott for your Specialty Gas needs. The analyses for the gases ordered, as reported by our laboratory, are listed below. Results are in volume percent, unless otherwise indicated.

ANALYTICAL REPORT

Cyl No. AAL8641 Analytical Accuracy ±1%

Component MOL%	Concentration
CARBON DIOXIDE	3.99% ±0.02% Abs
OXYGEN	18.21% ±0.02% Abs
NITROGEN	BALANCE

Cyl No. ______ Analytical Accuracy ______

Component	Concentration

Analyst Jerri A. Hyde

Approved By [signature]

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the company without extra cost.

Scott Specialty Gases

Electronics Group

a division of
Scott Environmental Technology, Inc.

3714 LAPAS DRIVE, HOUSTON, TEXAS 77023, (713) 644-4820, FAX (713) 644-0244

CUBIX CORPORATION
P.O. BOX 5083
AUSTIN, TX. 78763

Date: FEBRUARY 8, 1991
Our Project No.: 04-09400
Your P.O. No.: 91013

Gentlemen:
Thank you for choosing Scott for your Specialty Gas needs. The analyses for the gases ordered, as reported by our laboratory, are listed below. Results are in volume percent, unless otherwise indicated.

ANALYTICAL REPORT

Cyl No. AAL17794 — Analytical Accuracy ±1%

Component	Concentration
CARBON DIOXIDE	11.99%±0.02% Abs
OXYGEN	8.0% ±0.02%Abs
NITROGEN	BALANCE
EXP: 2/1/92	

Cyl No. AAL1713 — Analytical Accuracy ±1%

Component	Concentration
CARBON DIOXIDE	4.00%±0.02%Abs
OXYGEN	18.00%±0.02%Ab
NITROGEN	BALANCE
EXP: 2/1/92	

Analyst *John Sempa*

Approved By [signature]

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the company without extra cost.

Scott Specialty Gases

a division of
Scott Environmental Technology, Inc.

Electronics Group

3714 LAPAS DRIVE, HOUSTON, TEXAS 77023, (713) 644-4820, FAX (713) 644-0244

CUBIX CORPORATION
P.O. BOX 5083
AUSTIN, TX. 78763
MARC McDANIEL

Date: OCTOBER 3, 1989
Our Project No.: 0400803
Your P.O. No.: 89-204

Gentlemen:
Thank you for choosing Scott for your Specialty Gas needs. The analyses for the gases ordered, as reported by our laboratory, are listed below. Results are in volume percent, unless otherwise indicated.

ANALYTICAL REPORT

Cyl No. AAL5279 Analytical Accuracy ±1%

Component	Concentration
CARBON MONOXIDE	151 PPM
METHANE	79.4 PPM
NITROGEN	BALANCE

Cyl No. ______ Analytical Accuracy ______

Component	Concentration

Cyl No. ______ Analytical Accuracy ______

Component	Concentration

Cyl No. ______ Analytical Accuracy ______

Component	Concentration

Analyst [signature]

Approved By [signature]

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the company without extra cost.

Scott Specialty Gases
Electronics Group

a division of
Scott Environmental Technology, Inc.

3714 LAPAS DRIVE, HOUSTON, TEXAS 77023, (713) 644-4820, FAX (713) 644-0244

CUBIX CORPORATION
1713 FORT VIEW ROAD
AUSTIN, TEXAS 78704

Date: JANUARY 10, 1991
Our Project No.: 0408730
Your P.O. No.: 90347

Gentlemen:
Thank you for choosing Scott for your Specialty Gas needs. The analyses for the gases ordered, as reported by our laboratory, are listed below. Results are in volume percent, unless otherwise indicated.

ANALYTICAL REPORT

Cyl No. ALM006263 Analytical Accuracy ±2%

Component	Concentration
CARBON MONOXIDE	39.8 PPM
METHANE	40.0 PPM
NITROGEN	BALANCE
Exp: 1/92	

Cyl No. ______ Analytical Accuracy ______

Component	Concentration

Cyl No. ______ Analytical Accuracy ______

Component	Concentration

Cyl No. ______ Analytical Accuracy ______

Component	Concentration

Analyst ______

Approved By ______

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the company without extra cost.

Instrumental Analysis
Quality Assurance Data

Date : 4/30/91
Plant: Sun Oil Philadelphia Refinery
Technician: RJK

NOx Analyzer: NO2 to NO Converter Efficiency Test

	NOx Concentration (ppm)	% Decrease from Initial Concentration	NO Concentration (ppm)
Initial Concentration	37.8	0	37.8
10 minute Concentration	37.9	-0.1	35
20 minute Concentration	38	-0.2	34
30 minute Concentration	38	-0.2	32.1
Full Scale	100		

Sample System Bias Check

Parameter	Calibration Gas Concentration (ppm)	Full Scale Span (ppm)	Direct Calibration Response (ppm)	Sample System Response (ppm)	Sample System Bias (% of Span)
NOx	81.67	100	81.7	81.3	0.4

Sample System Leak Check

Run #	in. of mercury Intial	in. of mercury Final
C-1	21	21
C-13	19	19

Quality Assurance Worksheet:

	CERTIFIED GAS INPUT		INITIAL CALIBRATION & LINEARITY CHECK		TEST RUN C-1	ZERO and SPAN CALIBRATION CHECK		TEST RUN C-2	ZERO and SPAN CALIBRATION CHECK		TEST RUN C-3	ZERO and SPAN CALIBRATION CHECK	
	Concentration (% or ppm)	Target (% Chart)	Initial (% Chart)	Difference (% Chart)		Final (% Chart)	Drift (% Chart)		Final (% Chart)	Drift (% Chart)		Final (% Chart)	Drift (% Chart)
NOx					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	2.0	2.0	0.0	32.5	1.9	-0.1	32.5	2.1	0.1	32.8	2.2	0.2
low	41.0	43.0	43.3	0.3	% Chart			% Chart			% Chart		
high	81.7	83.7	83.8	0.1	34.5	83.8	0.1	34.5	83.8	0.1	34.8	83.4	-0.3
full scale	100.0				100.0			100.0			100.0		
CO					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	5.0	5.0	0.0	35.0	5.0	0.0	34.0	5.0	0.0	34.0	5.0	0.0
low	15.3	12.7	12.7	0.0	% Chart			% Chart			% Chart		
high	151.0	80.5	80.5	0.0	22.5	80.8	0.3	22.0	80.8	0.3	22.0	80.4	-0.1
full scale	200.0				200.0			200.0			200.0		
O2					Avg.%			Avg.%			Avg.%		
zero	0.0	10.0	10.0	-10.0	18.00	9.9	-0.1	18.05	9.9	-0.1	18.05	10.0	0.0
low	8.0	42.0	42.3	0.3	% Chart			% Chart			% Chart		
high	18.2	82.8	82.9	0.1	82.0	82.8	0.0	82.2	82.4	-0.4	82.2	82.5	-0.3
full scale	25.0				25.0			25.0			25.0		
CO2					Avg.%			Avg.%			Avg.%		
zero	0.0	2.0	2.0	0.0	2.22	2.0	0.0	2.09	2.1	0.1	2.10	2.0	0.0
low	4.0	28.6	28.5	-0.1	% Chart	28.8	0.2	% Chart	28.5	-0.1	% Chart	28.3	-0.3
high	12.0	81.9	82.2	0.3	15.0			15.9			16.0		
full scale	15.0				15.0			15.0			15.0		
THC					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	10.0	10.0	0.0	2.5	9.2	-0.8	3.0	10.0	0.0	1.8	10.0	0.0
low	20.8	51.6	51.3	-0.3	% Chart	51.3	-0.3	% Chart	51.5	-0.1	% Chart	51.5	-0.1
high	40.0	90.0	91.0	1.0	15.0			16.0			13.6		
full scale	50				50			50			50		

Quality Assurance Worksheet:

	CERTIFIED GAS INPUT		INITIAL CALIBRATION & LINEARITY CHECK		TEST RUN	ZERO and SPAN CALIBRATION CHECK		TEST RUN	ZERO and SPAN CALIBRATION CHECK		TEST RUN	ZERO and SPAN CALIBRATION CHECK	
	Concentration (% or ppm)	Target (% Chart)	Initial (% Chart)	Difference (% Chart)	C-4	Final (% Chart)	Drift (% Chart)	C-5	Final (% Chart)	Drift (% Chart)	C-6	Final (% Chart)	Drift (% Chart)
NOx					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	2.0	2.0	0.0	38.1	1.7	-0.3	38.7	2.0	0.0	39.5	2.0	0.0
low	41.0	43.0	43.3	0.3	% Chart			% Chart			% Chart		
high	81.7	83.7	83.8	0.1	40.1	83.4	-0.3	40.7	83.2	-0.5	41.5	83.8	0.1
full scale	100.0				100.0			100.0	100		100.0		
CO					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	5.0	5.0	0.0	32.0	4.9	-0.1	32.4	5.0	0.0	33.0	5.0	0.0
low	15.3	12.7	12.7	0.0	% Chart			% Chart			% Chart		
high	151.0	80.5	80.5	0.0	21.0	80.1	-0.4	21.2	79.5	-1.0	21.5	80.8	0.3
full scale	200.0				200.0			200.0			200.0		
O2					Avg.%			Avg.%			Avg.%		
zero	0.0	10.0	10.0	-10.0	17.70	9.8	-0.2	17.62	10.2	0.2	17.62	10.0	0.0
low	8.0	42.0	42.3	0.3	% Chart			% Chart			% Chart		
high	18.2	82.8	82.9	0.1	80.8	82.6	-0.2	80.5	82.7	-0.1	80.5	82.7	-0.1
full scale	25.0				25.0			25.0			25.0		
CO2					Avg.%			Avg.%			Avg.%		
zero	0.0	2.0	2.0	0.0	2.43	2.0	0.0	2.44	2.0	0.0	2.48	2.0	0.0
low	4.0	28.6	28.5	-0.1	% Chart	28.5	-0.1	% Chart	28.3	-0.3	% Chart	28.7	0.1
high	12.0	81.9	82.2	0.3	18.2			18.3			18.5		
full scale	15.0				15.0			15.0			15.0		
THC					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	10.0	10.0	0.0	1.8	10.0	0.0	2.3	10.3	0.3	2.5	10.0	0.0
low	20.8	51.6	51.3	-0.3	% Chart	50.8	-0.8	% Chart	50.8	-0.8	% Chart	51.2	-0.4
high	40.0	90.0	91.0	1.0	13.6			14.5			15.0		
full scale	50				50			50			50		

Quality Assurance Worksheet:

	CERTIFIED GAS INPUT		INITIAL CALIBRATION & LINEARITY CHECK		TEST RUN C-7	ZERO and SPAN CALIBRATION CHECK		TEST RUN C-8	ZERO and SPAN CALIBRATION CHECK		TEST RUN C-9	ZERO and SPAN CALIBRATION CHECK	
	Concentration (% or ppm)	Target (% Chart)	Initial (% Chart)	Difference (% Chart)		Final (% Chart)	Drift (% Chart)		Final (% Chart)	Drift (% Chart)		Final (% Chart)	Drift (% Chart)
NOx					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	2.0	2.0	0.0	43.8	2.0	0.0	44.5	2.0	0.0	45.2	2.0	0.0
low	41.0	43.0	43.3	0.3	% Chart			% Chart			% Chart		
high	81.7	83.7	83.8	0.1	45.8	83.8	0.1	46.5	83.8	0.1	47.2	83.8	0.1
full scale	100.0				100.0			100.0			100.0		
CO					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	5.0	5.0	0.0	29.0	4.9	-0.1	29.0	5.0	0.0	27.0	5.0	0.0
low	15.3	12.7	12.7	0.0	% Chart			% Chart			% Chart		
high	151.0	80.5	80.5	0.0	19.5	80.6	0.1	19.5	80.9	0.4	18.5	80.5	0.0
full scale	200.0				200.0			200.0			200.0		
O2					Avg.%			Avg.%			Avg.%		
zero	0.0	10.0	10.0	-10.0	17.25	10.1	0.1	17.23	10.0	0.0	17.25	10.0	0.0
low	8.0	42.0	42.3	0.3	% Chart			% Chart			% Chart		
high	18.2	82.8	82.9	0.1	79.0	82.3	-0.5	78.9	82.2	-0.6	79.0	82.6	-0.2
full scale	25.0				25.0			25.0			25.0		
CO2					Avg.%			Avg.%			Avg.%		
zero	0.0	2.0	2.0	0.0	2.78	2.0	0.0	2.81	2.0	0.0	2.79	2.0	0.0
low	4.0	28.6	28.5	-0.1	% Chart	28.6	0.0	% Chart	28.7	0.1	% Chart	28.6	0.0
high	12.0	81.9	82.2	0.3	20.5			20.7			20.6		
full scale	15.0				15.0			15.0			15.0		
THC					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	10.0	10.0	0.0	2.5	10.0	0.0	2.0	10.0	0.0	2.0	10.0	0.0
low	20.8	51.6	51.3	-0.3	% Chart	51.8	0.2	% Chart	51.3	-0.3	% Chart	51.5	-0.1
high	40.0	90.0	91.0	1.0	15.0			14.0			14.0		
full scale	50				50			50			50		

Quality Assurance Worksheet:

	CERTIFIED GAS INPUT		INITIAL CALIBRATION & LINEARITY CHECK		TEST RUN	ZERO and SPAN CALIBRATION CHECK		TEST RUN	ZERO and SPAN CALIBRATION CHECK		TEST RUN	ZERO and SPAN CALIBRATION CHECK	
	Concentration (% or ppm)	Target (% Chart)	Initial (% Chart)	Difference (% Chart)	C-10	Final (% Chart)	Drift (% Chart)	C-11	Final (% Chart)	Drift (% Chart)	C-12	Final (% Chart)	Drift (% Chart)
NOx					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	2.0	2.0	0.0	47.0	2.0	0.0	47.0	2.0	0.0	47.5	2.0	0.0
low	41.0	43.0	43.3	0.3	% Chart			% Chart			% Chart		
high	81.7	83.7	83.8	0.1	49.0	83.7	0.0	49.0	83.7	0.0	49.5	83.9	0.2
full scale	100.0				100.0			100.0			100.0		
CO					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	5.0	5.0	0.0	26.0	5.0	0.0	26.0	5.0	0.0	25.2	5.0	0.0
low	15.3	12.7	12.7	0.0	% Chart			% Chart			% Chart		
high	151.0	80.5	80.5	0.0	18.0	80.6	0.1	18.0	80.3	-0.2	17.6	80.3	-0.2
full scale	200.0				200.0			200.0			200.0		
O2					Avg.%			Avg.%			Avg.%		
zero	0.0	10.0	10.0	-10.0	17.00	10.1	0.1	17.00	9.9	-0.1	16.95	10.0	0.0
low	8.0	42.0	42.3	0.3	% Chart			% Chart			% Chart		
high	18.2	82.8	82.9	0.1	78.0	82.8	0.0	78.0	82.5	-0.3	77.8	8.0	-74.8
full scale	25.0				25.0			25.0			25.0		
CO2					Avg.%			Avg.%			Avg.%		
zero	0.0	2.0	2.0	0.0	3.00	2.0	0.0	3.00	2.0	0.0	3.00	2.0	0.0
low	4.0	28.6	28.5	-0.1	% Chart	28.6	0.0	% Chart	28.6	0.0	% Chart	28.6	0.0
high	12.0	81.9	82.2	0.3	22.0			22.0			22.0		
full scale	15.0				15.0			15.0			15.0		
THC					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	10.0	10.0	0.0	2.3	9.9	-0.1	2.0	10.5	0.5	2.0	10.0	0.0
low	20.8	51.6	51.3	-0.3	% Chart	51.5	-0.1	% Chart	51.5	-0.1	% Chart	51.8	0.2
high	40.0	90.0	91.0	1.0	14.5			14.0			14.0		
full scale	50				50			50			50		

Quality Assurance Worksheet:

	CERTIFIED GAS INPUT		INITIAL CALIBRATION & LINEARITY CHECK		TEST RUN C-13	ZERO and SPAN CALIBRATION CHECK		TEST RUN C-14	ZERO and SPAN CALIBRATION CHECK		TEST RUN C-15	ZERO and SPAN CALIBRATION CHECK	
	Concentration (% or ppm)	Target (% Chart)	Initial (% Chart)	Difference (% Chart)		Final (% Chart)	Drift (% Chart)		Final (% Chart)	Drift (% Chart)		Final (% Chart)	Drift (% Chart)
NOx					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	2.0	2.0	0.0	36.2	2.0	0.0	43.0	1.9	-0.1	48.5	1.8	-0.2
low	41.0	43.0	43.3	0.3	% Chart			% Chart			% Chart		
high	81.7	83.7	83.8	0.1	38.2	83.5	-0.2	45.0	83.5	-0.2	50.5	83.0	-0.7
full scale	100.0				100.0			100.0			100.0		
CO					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	5.0	5.0	0.0	36.0	5.0	0.0	32.0	5.0	0.0	29.0	5.0	0.0
low	15.3	12.7	12.7	0.0	% Chart			% Chart			% Chart		
high	151.0	80.5	80.5	0.0	23.0	80.9	0.4	21.0	80.5	0.0	19.5	80.5	0.0
full scale	200.0				200.0			200.0			200.0		
O2					Avg.%			Avg.%			Avg.%		
zero	0.0	10.0	10.0	-10.0	18.00	10.0	0.0	17.45	9.2	-0.8	17.13	9.9	-0.1
low	8.0	42.0	42.3	0.3	% Chart			% Chart			% Chart		
high	18.2	82.8	82.9	0.1	82.0	82.8	0.0	79.8	83.0	0.2	78.5	82.8	0.0
full scale	25.0				25.0			25.0			25.0		
CO2					Avg.%			Avg.%			Avg.%		
zero	0.0	2.0	2.0	0.0	2.15	2.0	0.0	2.67	2.0	0.0	2.90	2.0	0.0
low	4.0	28.6	28.5	-0.1	% Chart	28.6	0.0	% Chart	28.6	0.0	% Chart	28.6	0.0
high	12.0	81.9	82.2	0.3	16.3			19.8			21.3		
full scale	15.0				15.0			15.0			15.0		
THC					Avg. ppm			Avg. ppm			Avg. ppm		
zero	0.0	10.0	10.0	0.0	2.0	10.3	0.3	1.0	9.6	-0.4	1.5	11.0	1.0
low	20.8	51.6	51.3	-0.3	% Chart	51.5	-0.1	% Chart	51.8	0.2	% Chart	51.4	-0.2
high	40.0	90.0	91.0	1.0	14.0			12.0			13.0		
full scale	50				50			50			50		

Quality Assurance Worksheet:

	CERTIFIED GAS INPUT		INITIAL CALIBRATION & LINEARITY CHECK		TEST RUN C-16	ZERO and SPAN CALIBRATION CHECK	
	Concentration (% or ppm)	Target (% Chart)	Initial (% Chart)	Difference (% Chart)		Final (% Chart)	Drift (% Chart)
NOx					Avg. ppm		
zero	0.0	2.0	2.0	0.0	50.0	1.8	-0.2
low	41.0	43.0	43.3	0.3	% Chart		
high	81.7	83.7	83.8	0.1	52.0	83.8	0.1
full scale	100.0				100.0		
CO					Avg. ppm		
zero	0.0	5.0	5.0	0.0	28.0	5.0	0.0
low	15.3	12.7	12.7	0.0	% Chart		
high	151.0	80.5	80.5	0.0	19.0	51.5	-29.0
full scale	200.0				200.0		
O2					Avg.%		
zero	0.0	10.0	10.0	-10.0	16.95	9.5	-0.5
low	8.0	42.0	42.3	0.3	% Chart		
high	18.2	82.8	82.9	0.1	77.8	82.8	0.0
full scale	25.0				25.0		
CO2					Avg.%		
zero	0.0	2.0	2.0	0.0	3.09	2.0	0.0
low	4.0	28.6	28.5	-0.1	% Chart	28.8	0.2
high	12.0	81.9	82.2	0.3	22.6		
full scale	15.0				15.0		
THC					Avg. ppm		
zero	0.0	10.0	10.0	0.0	1.5	11.0	1.0
low	20.8	51.6	51.3	-0.3	% Chart	51.5	-0.1
high	40.0	90.0	91.0	1.0	13.0		
full scale	50				50		

NOZZLE INSPECTION AND MEASUREMENT DATA SHEET

Company Name Sun Oil Date Sampled 5-1-91 Nozzle Number 7

Presample Inspection

I hereby certify that the above referenced nozzle appears to be round, sharp-edged, free of nicks and dents and is judged acceptable for use at this time.

Last Previously Measured Nozzle Area .00025 ft^2

signature [signature]

Date Measured 8-91

date 5-1-91

Postsample Measurement

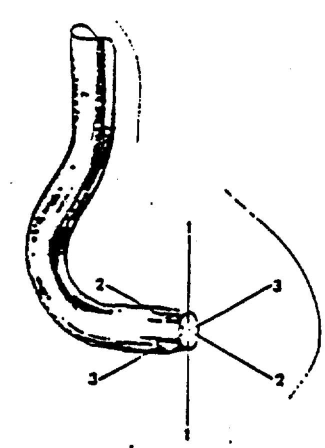
Measure three diameters as shown; measurement is in inches; record below; perform calculations. *

1. .2118 2. .2119 3. .2120

Average Diameter .2119

$$\text{Area} = \frac{\pi D^2}{4 \times 144} = .00025 \ ft^2$$

This area shall be used in data reduction.



[signature]
signature

date 5-17-91

* Maximum allowable difference between largest diameter and smallest diameter is 0.004 inches

Nov 80 JHK

Magnehelic Gauge Calibration Worksheet

Date: 1/15/91
Magnehelic Gauge(s): 10303C093, 80911BW162, 00319AM145
Meter Box Number: NUTECH 1529795
Reference Gauge: INCLINED MANOMETER 5837
Technician: JPS

Reference Pressures (in. H20)	Magnehelic Gauge Response (inches H20) Gauge Number			% Difference Gauge Number		
	10303C093	80911BW162	00319AM145	10303C093	80911BW162	00319AM145
0.11	0.11	0.11	-	0.00	0.00	-
0.50	0.50	0.50	0.50	0.00	0.00	-
0.99	-	0.95	0.99	-	0.00	3.80
1.50	-	1.50	1.55	-	1.33	0.00
2.00	-	1.95	2.10	-	2.50	5.00
4.00	-	-	4.05	-	-	1.25
	-	-	-	-	-	-
	-	-	-	-	-	-

M-5 Thermometer Calibration

February 16, 1989

Thermometer	NBS	Hot Box	Last Imp.	DGM
Temp. Range	(0-51°C)	(50-500°F)	(25-125°F)	(0-140°F)
Ambient Air	75.5°F (24.2°C)	73°F	73°F	75°F
Ice Bath	35°F (1.7°C)	NR	36°F	35.5°F
Hot Water	119.7°F (48.7°C)	117°F	118.5°F	120°F

The Texas Air Control Board

Certifies That

JOHN P.SURVIS

Has completed a course conducted by The Texas Air Control Board and has met the requirements for evaluating visible emissions.

TEXAS AIR CONTROL BOARD

March 15, 1991
Date Certified

September 13, 1991
This Certificate Expires

Phillip J. Clark 3/15/91
Certifying Officer Date

ALTIMETER CERTIFICATION

TRAILER # 1

CERTIFICATION TAG

ITEM NAME Altimeter

PART NUMBER A8/A-10-4

SERIAL NUMBER 184997

MANUFACTURER Aeroonic

WORK ORDER NUMBER 21816

IF ITEM IS TESTED ONLY, FILL OUT BELOW

THIS ITEM HAS BEEN FUNCTIONAL TESTED AND FOUND TO BE AIRWORTHY

BY ______________________ DATE ____________

CENTURY INSTRUMENT CORPORATION
4440 SOUTHEAST BOULEVARD
WICHITA, KS 67210
CERTIFICATED REPAIR STATION NO. 364-84

ALTIMETER CORRECTION CARD

S/N 184947 Date 7/20/87

ALT READING	ADD ALGEB.	ALT READING	ADD ALGEB.
-1000	-10	16000	-20
0	+10	18000	-45
500	-20	20000	-50
1000	0	25000	
1500	-20	30000	
2000	-10	35000	
3000	+5	40000	
4000	-15	45000	
6000	-10	50000	
8000	-20	H 50%	
10000	-25	H 40%	
12000	+5	ZERO	
14000	+15		

FOR REPAIR STATION NO. 364-84

Thermo Electron Corporation

Richard A. Curran
Regional Sales Manager

Environmental Instruments Division
108 South Street
Hopkinton, Massachusetts 01748
(617) 435-5321

INTERFERENCE RESPONSE TEST

DATE OF TEST JAN 18, 1980

ANALYZER TYPE 10AR RANGE 0-25PPM SERIAL NO. 10AR-014B-80

TEST GAS TYPE	CONCENTRATION PPM	ANALYZER OUTPUT RESPONSE	% OF SPAN
CO	500	< .1 PPM	<.1%
CO_2	201	< .1 PPM	< .1%
CO_2	10%	< .1 PPM	<.1%
O_2	20.9%	<.1 PPM	<.1%

Continous Emission Analyzer Interference Response Tests

Date: 7/8/88
Technician: KRB / MM

Analyzer Type: Thermo Enviromental
Analyzer Model: Model 48 Gas Filter Correlation Analyzer
Serial Number: 48-23576-210
Analyzer Test Range: 0-20 ppmv

Test Gas		Analyzer Response		Response Ratio
Type Gas	Concentration	Concentration ppmv	% of Range	
Air	CO Free	0.0	N/A	
CO_2/O_2	4%/18%	0.0	↓	0.000
CO_2/O_2	12%/8%	-0.2	↓	-0.017/-0.025
CO_2/O_2	21%/3%	-0.3	↓	-0.014/-0.100
Air	Dry	0.4	↓	CO Impurity?
NOx	176 ppmv	0.4	↓	0.002
NOx	3030 ppmv	0.4	↓	0.0001
SO_2	401 ppmv	-0.2	↓	0.0005
Propane	240 ppmv	0.4	↓	0.002

(Response ratios for CO_2/O_2 rows: ppmv/%; for NOx, SO_2, Propane rows: ppmv/ppmv)

all interferences are negligable

Response Time Data Sheet

Date: 3/14/89

Plant: Austin Office

Technician: MM/DC

Sample Manifold Press.: 6 psi

Sample Line Length: 140 ft.

Pump Model No.: 6-3 Dia-pump

Analyzer:	NOx Analyzer	Oxygen Analyzer
Model:	TECO 10AR	Teledyne 320 AX
Range:	0 - 1000 ppm	0 - 25 %
Span Gas:	900 ppm NO_x	Air = 20.9% O_2
Upscale Response	.65 min	.72 min
	.60	.75
	.60	.80
Average	.61 min	.76 min
Downscale Response	.65 min	.96 min
	.65	.90
	.65	.85
Average	.65 min	.88 min

Comments:

3/8" Sample line

Igloo Condenser

SYMBOLS AND CONSTANTS USED IN EMISSION CALCULATIONS

Constants

68°F = standard temperature = 528°R = 20°C = 293°K

29.92 inches Hg = standard absolute pressure

7.785×10^{-8} lbs/SCF of NO per ppm by volume

11.94×10^{-8} lbs/SCF of NO_2 per ppm by volume

7.263×10^{-8} lbs/SCF of CO per ppm by volume

4.150×10^{-8} lbs/SCF of THC as methane per ppm by volume

1.659×10^{-7} lbs/SCF of SO_2 per ppm by volume

1.339 liters/grams H_2O at 68°F and 29.92 inches Hg

$$6{,}885.6 \text{ ft/min} \bullet \sqrt{\frac{(\text{lb/lb-m})(\text{in.Hg})}{(°\text{K})(\text{in.}H_2O)}}$$

1.7 ppm CO/% CO_2 (CO analyzer interference response factor)

17.040×10^3 = mg of H_2S per equivalent

454 = grams per pound (g/lb)

7.061×10^{-5} lbs SO_2 per milliequivalent

0.07355 = inches Hg per inch H_2O

$$499.4 = \frac{28.3 \text{ l}}{\text{ft}^3} \times \frac{528°\text{R}}{29.92 \text{ in.Hg}}$$

$$9.793 = \frac{293°\text{K}}{29.92 \text{ in.Hg}}$$

Symbols

A = stack area (ft^3)

C_{CO} = concentration of CO (ppm_v)

C_{CO_2} = concentration of CO_2 (ppm_v)

C_{H_2S} = concentration of H_2S (mg/DSCM or ppm_v)

C_{NO} = concentration of NO (ppm_v)

C_{NO_2} = concentration of NO_2 (ppm_v)

C_{SO_2} = concentration of SO_2 (lbs/DSCF or ppm_v)

C_{THC} = concentration of THC as methane (ppm_v)

E_{CO} = CO emissions (lbs/hr)

E_{H_2S} = H_2S emissions (lbs/hr)

E_{NO} = NO emissions (lbs/hr)

E_{NO_2} = NO_2 emissions (lbs/hr)

E_{NO_x} = emissions of NO and NO_2 expressed as NO_2

E_{part} = emission rate of particulate matter (lbs/hr)

E_{SO_2} = SO_2 emissions (lbs/hr)

E_{THC} = emissions of THC as methane (lbs/hr)

F_d = dry fraction (% volume)

F_w = wet fraction (% volume)

K_d = DGM correction factor (unitless)

K_p = pitot tube factor (unitless)

Symbols, continued

MWC = total weight gain (grams H_2O)

MW = molecular weight of stack gas (lbs/lb-mole)

M_f = dry weight gain of probe wash and filter, front half/grams)

M_b = dry weight gain of impinger catch, back half/grams)

N_t = normality of titrant

P_b = barometric pressure (inches Hg)

P_g = static stack pressure (inches H_2O)

P_m = DGM absolute pressure (inches Hg)

P_s = absolute stack pressure (inches Hg)

Q_a = volumetric flow at stack conditions (ACFM)

Q_d = volumetric flow (SCFH, dry basis)

t_s = stack temperature (°C or °F)

T_s = absolute stack temperature (°K or °R)

T_m = average meter temperature (°C or °F)

V_{net} = volume as read directly from dry gas meter (liters or ft^3)

V_m = dry gas meter volume corrected for meter correction factor (liters or ft^3)

V_L = volume (liters or ft^3)

V_s = volume sampled, corrected to standard conditions

V = velocity (ft/min)

Symbols, continued

V_t = volume of titrant to endpoint

V_a = sample aliquot volume

V_{tb} = volume of titrant to blank endpoint

Circular Stack Sampling Traverse Point Layout
(EPA Method 1)

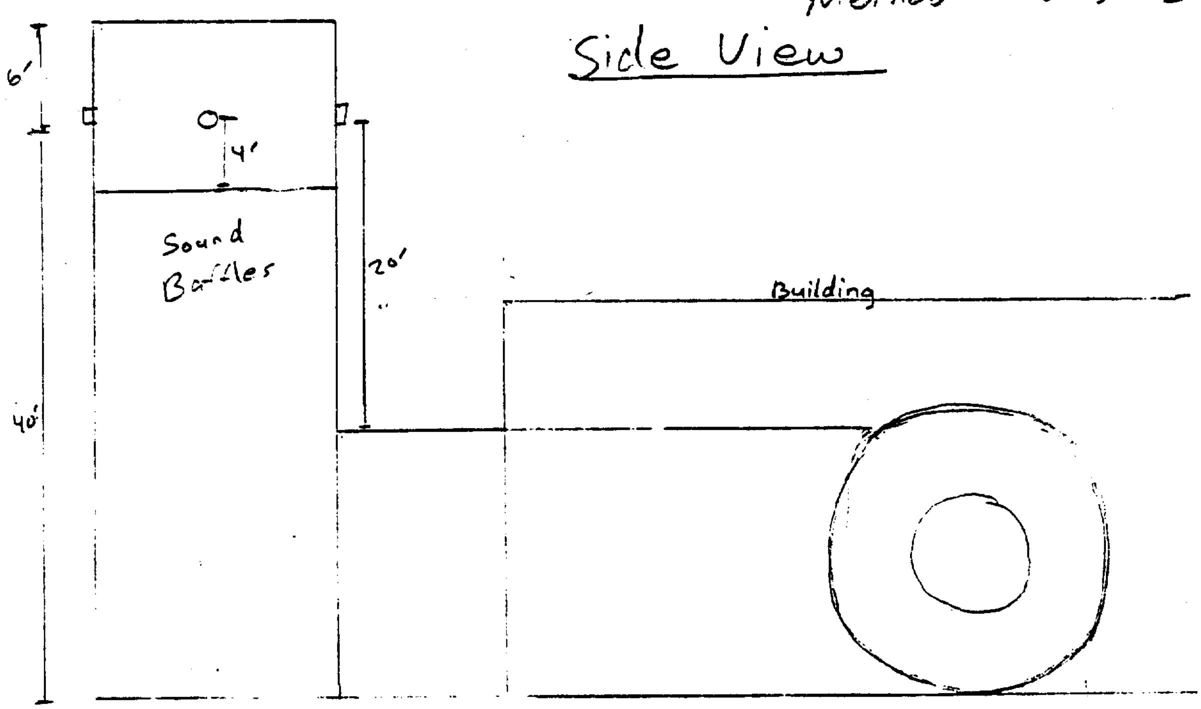
Date: 4-30-91
Plant: Sun Oil Philly
Source: Westinghouse 301 G
Technician(s) KT, JS

Ser. # 17A1744-1 + 2
(Testing on unit # 2)

Port + Stack ID: 173.0 in.
Port Extension 5.0 in.
Stack ID: 168.0 in.
Stack Area 153.9 ft²
Total Req'd Traverse Pts. 48
No. of Traverse Pts. 24 /diam.
No. of Traverse Pts. 12 /port

Stack Diagram (Side View showing major unit components, dimensions and nearest upstream & downstream flow disturbances)

Method 1-4 sheet



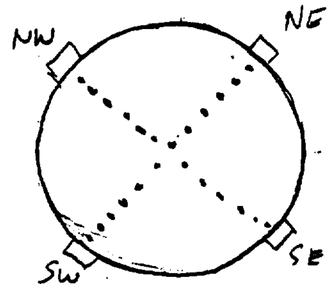
Traverse Point Number	Length Factor (% of diameter) Number of traverse pts./diameter 4	6	8	12	12/port	Distance from Reference Point (inches)
1	6.7	4.4	3.2	2.1	1.1	1.8 + 5.0 = 6.8
2	25.0	14.6	10.5	8.2	3.2	5.4 + 5.0 = 10.4
3	75.0	29.6	19.4	11.8	5.5	9.2 + 5.0 = 14.2
4	93.3	70.4	32.3	17.7	7.9	13.3 + 5.0 = 18.3
5		85.4	67.7	25.0	10.5	17.6 + 5.0 = 22.6
6		95.6	80.6	35.6	13.2	22.2 + 5.0 = 27.2
7			89.5	64.4	16.1	27.0 + 5.0 = 32.0
8			96.8	75.0	19.4	32.6 + 5.0 = 37.6
9				82.3	23.0	38.6 + 5.0 = 43.6
10				88.2	27.2	45.7 + 5.0 = 50.7
11				93.3	32.3	54.3 + 5.0 = 59.3
12				97.9	39.8	66.9 + 5.0 = 71.9

Circular Stack Sampling Traverse Point Layout
(EPA Method 1) Method 5 TP. Layout

Date: 4-30-91	Port + Stack ID: 173.0 in.
Plant: Sun Oil Philadelphia PA	Port Extension 5.0 in.
Source: Westinghouse 301-6 #2	Stack ID: 168.0 in.
Technician(s) KJ, JS	Stack Area 153.9 ft²
	Total Req'd Traverse Pts. 24
	No. of Traverse Pts. 12 /diam.
	No. of Traverse Pts. 6 /port

Stack Diagram (Side View showing major unit components, dimensions and nearest upstream & downstream flow disturbances)

TOP View



Side View (see O_2 Traverse Point Layout)

Traverse Point Number	Length Factor (% of diameter) Number of traverse pts./diameter 4	6	8	12	Distance from Reference Point (inches)
1	6.7	4.4	3.2	2.1	3.5 + 5.0 = 8.5
2	25.0	14.6	10.5	8.2	13.8 + 5.0 = 18.8
3	75.0	29.6	19.4	11.8	19.8 + 5.0 = 24.8
4	93.3	70.4	32.3	17.7	29.9 + 5.0 = 34.9
5		85.4	67.7	25.0	42.0 + 5.0 = 47.0
6		95.6	80.6	35.6	59.8 + 5.0 = 64.8
7			89.5	64.4	
8			96.8	75.0	
9				82.3	
10				88.2	
11				93.3	
12				97.9	

Sun Oil Corporation
Cogen Philadelphia, PA
Westinghouse 301-G

Date	4/30/91	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91
Unit #	#2	#2	#2	#2	#2	#2	#2	#2
Test Number	**C-1**	**C-2**	**C-3**	**C-4**	**C-5**	**C-6**	**C-7**	**C-8**
Start Time	1648	815	901	948	1034	1116	1201	1246
Stop Time	1839	847	933	1020	1106	1150	1233	1318
Turbine Operation								
Power (MW)	18.3	17.9	17.7	21.83	21.75	21.75	24.8	24.8
Power Turbine Speed (rpm)	3600	3600	3600	3600	3600	3600	3600	3600
Exhaust Temp. (TTXC-°F)	684	656	663	724	733	735	792	795
Compressor Discharge (psig)	73.5	72.5	72.5	73.8	74.0	74.0	75.5	75.0
Reference CPD (psia)	86	86	86	86	86	86	86	86
Fuel Flow (gal./min)	38	37.4	37.2	42	42.5	42.2	45.75	46.25
Fuel Flow (lbs/hr)	16142	15888	15803	17842	18054	17927	19435	19647
Heat Input (MMBtu/hr)	311.8	306.8	305.2	344.6	348.7	346.2	375.3	379.4
H2O Flow (lbs/hr)	4843	4766	4741	5352	5416	5378	5830	5894
H2O Flow (gal/min)	9.804	9.649	9.598	10.836	10.965	10.888	11.804	11.933
H2O-to-fuel Ratio (lb/lb)	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
Fuel Specific Gravity	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Fuel Heating Value (Btu/lb)	19313	19313	19313	19313	19313	19313	19313	19313
Ambient Conditions								
Barometer (in. Hg)	29.88	29.9	29.9	29.9	29.9	29.90	29.90	29.90
Temperature (°F dry)	77	70	70	76	75	78	80	81
Temperature (°F wet)	69	58	58	61	61	62	62	63
Humidity (lbs/lb of air)	**0.0131**	**0.0074**	**0.0074**	**0.0078**	**0.0078**	**0.0080**	**0.0075**	**0.0079**
Measured Emissions								
NOx (ppmv)	32.5	32.5	32.6	38.1	38.7	39.5	43.6	44.5
NOx (ppm @ 15% O2)	66.1	67.3	67.9	70.2	69.6	71.1	70.8	71.5
NOx (ppm @15% O2, Humidity)	75.1	68.6	69.2	72.2	71.6	73.3	72.4	73.7
NOx (ppm @15% O2, ISO Day)	70.4	66.0	66.6	67.8	67.1	68.3	66.5	67.8
CO (ppmv)	35.0	34.0	34.0	32.0	32.4	33.0	29.0	29.1
O2 (%)	18.00	18.05	18.05	17.70	17.62	17.62	17.23	17.23
CO2 (%)	2.22	2.09	2.10	2.43	2.44	2.46	2.73	2.81
THC (ppmv)	2.5	3.0	1.6	1.8	2.3	2.5	2.5	2.0
Stack Flow Rates (SCFH)								
O2 Stoichiometry	2.07E+07	2.07E+07	2.06E+07	2.07E+07	2.05E+07	2.03E+07	1.98E+07	1.99E+07
Pitot Tube								
Fuel Fo Factor	1.31	1.36	1.36	1.32	1.34	1.32	1.31	1.31
Mass Emissions								
NOx (lbs/hr)	80.39	80.51	80.81	94.39	94.65	95.93	103.63	105.66
NOx (lb/MMBtu)	0.25	0.26	0.26	0.27	0.27	0.28	0.28	0.28
CO (lbs/hr)	52.64	51.21	50.94	48.21	48.16	48.73	41.72	41.95
THC (lbs/hr as methane)	2.15	2.58	1.54	1.55	1.91	2.11	2.06	1.55

Sun Oil Corporation

Cogen Philadelphia, PA

Westinghouse 501-D

Date	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91	5/1/91
Unit #	#2	#2	#2	#2	#1	#1	#1	#1
Test Number	**C-9**	**C-10**	**C-11**	**C-12**	**C-13**	**C-14**	**C-15**	**C-16**
Start Time	1331	1438	1521	1610	1657	1809	1856	1947
Stop Time	1403	1511	1555	1643	1729	1841	1928	2019
Turbine Operation								
Power (MW)	24.8	26.25	26.7	26.9	17	22.5	25.2	28
Power Turbine Speed (rpm)	3600	3600	3600	3600	3600	3600	3600	3600
Exhaust Temp (TTXC-°F)	805	836	835	837	667	743	787	818
Compressor Discharge (psig)	74.8	75.6	75.8	75.5	71.0	71.0	74.0	78.0
Reference CPD (psia)	86	86	86	86	86	86	86	86
Fuel Flow (gal/min)	46.1	49.03	49.1	49	37	43	47	50
Fuel Flow (lbs/hr)	19583	20828	20858	20815	15718	18266	19966	21240
Heat Input (MMBtu/hr)	378.2	402.3	402.8	402.0	303.6	352.8	385.6	410.2
H2O Flow (lbs/hr)	5875	6248	6257	6245	4715	5480	5990	6372
H2O Flow (gal/min)	11.894	12.650	12.668	12.642	9.546	11.094	12.126	12.900
H2O-to-fuel Ratio (lb/lb)	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
Fuel Specific Gravity	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Fuel Heating Value (Btu/lb)	19313	19313	19313	19313	19313	19313	19313	19313
Ambient Conditions								
Barometer (in. Hg)	29.90	29.90	29.90	29.90	29.90	29.90	29.90	29.90
Temperature (°F dry)	82	82	83	84	84	79	78	77
Temperature (°F wet)	62	62	63	63	63	61	60	60
Humidity (lbs/lb of air)	**0.0070**	**0.0070**	**0.0075**	**0.0072**	**0.0072**	**0.0071**	**0.0067**	**0.0069**
Measured Emissions								
NOx (ppmv)	45.2	47.0	47.0	47.5	36.2	43.0	46.6	50.0
NOx (ppm @ 15% O2)	73.1	71.1	71.1	70.9	73.6	73.5	75.9	74.7
NOx (ppm @15% O2, Humidity)	74.1	72.1	72.5	72.2	74.9	74.6	75.4	75.5
NOx (ppm @15% O2, ISO Day)	67.3	65.7	66.1	65.6	69.8	70.6	71.5	69.1
CO (ppmv)	27.0	25.0	25.0	25.2	36.0	32.0	29.0	28.0
O2 (%)	17.25	17.00	17.00	16.95	18.00	17.45	17.13	16.95
CO2 (%)	2.79	3.00	3.00	3.00	2.15	2.67	2.90	3.09
THC (ppmv)	2.0	2.3	2.0	2.0	2.0	1.0	1.5	1.5
Stack Flow Rates (SCFH)								
O2 Stoichiometry	2.00E+07	1.99E+07	1.99E+07	1.96E+07	2.02E+07	1.97E+07	1.97E+07	2.00E+07
Pitot Tube								
Fuel Fo Factor	1.31	1.30	1.30	1.32	1.35	1.29	1.30	1.28
Mass Emissions								
NOx (lbs/hr)	107.76	111.53	111.69	111.23	87.18	101.17	114.13	119.47
NOx (lb/MMBtu)	0.28	0.28	0.28	0.28	0.29	0.29	0.30	0.29
CO (lbs/hr)	39.14	37.52	37.57	35.88	52.72	45.78	41.50	40.66
THC (lbs/hr as methane)	1.65	1.90	1.65	1.63	1.67	0.82	1.23	1.25

Parameter	units					
Date		5/1/91				
Time		3:35	4:05	4:20	4:35	4:50
Run	#	60%	60%	60%	60%	60%
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	37	37	37.	37.	37
Fuel Header	PSIG	960	960	960	960	960
Temp	deg F	84	84	84	84	84
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		9.86	9.86	10.0	10.0	10.0
DEHA	ppb	>450	> 450	450	450	450
Temp	deg F	90	91	91	91	91
Flow	gpm	12.9	12.9	12.9	12.9	12.9
Combustor						
Pressure	psig	71	71	71	71	71
avg outlet	deg F	1269	1286	1282	1285	1284
spread	deg F	83	78	85	98	97
max / min	deg F	1302/1219	1325/1247	1320/1245	1322/1234	1322/·233
avg stack	deg F	665	668	668	670	669
max / min	deg F	665/648	678/661	678/661	679/661	678/661
Meg Watts	MW	17.	17.	17	17	17
Humidity	%	38	33	33	33	33
Amb Temp	deg F	82.9	83	83	83	83
Bar Press	mmHG	29.85↓	29.83↓	29.83↓	29.83	29.83

Parameter	units					
Date		5/1/91	→			
Time		5:05	5:20	5:35	5:50	6:05
Run	#	60%	→			75%
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	37	37	37	37	43
Fuel Header	PSIG	960	960	960	960	960
Temp	deg F	84	84	84	84	84
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.0	10.0	→		
DEHA	ppb	450	450	→		
Temp	deg F	91	91	90	90	89
Flow	gpm	12.9	12.9	12.9	12.9	15.6
Combustor						
Pressure	psig	71	71	71	71	71
avg outlet	deg F	1279.7	1283.6	1281.5	1282	1409
spread	deg F	73	81	82	86	104
max / min	deg F	1315/1242	1324/1243	1320/1239	1320/1234	1453/1349
avg stack	deg F	665	669	666	666	744
max / min	deg F	676/660	679/662	676/660	676/659	752/730
Meg Watts	MW	17.	17.	17.	17.	22.5
Humidity	%	28	28	28	28	34
Amb Temp	deg F	81.9	81.9	81.9	81.9	81
Bar Press	mmHG	29.8↓	29.8↓	29.8↓	29.8↓	29.78↓

Parameter	units					
Date		5/1/91				
Time		6:20	6:35	6:50	7:05	7:20
Run	#	75%				
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	43	43	43	47	47
Fuel Header	PSIG	960	960	960	960	960
Temp	deg F	84	84	84	84.5	84.5
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.0	10.0	10.0	10.0	10.0
DEHA	ppb	>450	>450	>450	450	450
Temp	deg F	91	91	91	79	78
Flow	gpm	15.6	15.6	15.6	17.6	17.6
Combustor						
Pressure	psig	71	71	73	74	74
avg outlet	deg F	1411	1415	1433	1500	1501
spread	deg F	89	65	128	101	100
max / min	deg F	1454/1365	1442/1377	1540/1412	1537/1436	1536/1435
avg stack	deg F	743.5	743	782	787.5	787
max / min	deg F	752/729	751/729	794/767	799/772	794/772
Meg Watts	MW	22.5	22.5	25.2	25.2	25.2
Humidity	%	34	34	34	34	34
Amb Temp	deg F	80.1	80.1	80.1	79	79
Bar Press	mmHG	29.87↓	29.87↓	29.87↓	29.77↓	29.77

Parameter	units					
Date		5/1/91				
Time	P.M.	7:35	7:50	8:05	8:20	
Run	#	75%	100%	100%		
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	43	50	50		
Fuel Header	PSIG	960	960	960		
Temp	deg F	85	84	84		
Sulfur % wt	%				DONE TESTING	
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1		
Water						
ph		10.0	→	→		
DEHA	ppb	>450	→	→		
Temp	deg F	76	75	74		
Flow	gpm	18.3	18.6	18.8		
Combustor						
Pressure	psig	78	78	78		
avg outlet	deg F	1532	1548	1547		
spread	deg F	113	115	121		
max / min	deg F	1581/1468	1598/1483	1598/1477		
avg stack	deg F	820	818	817		
max / min	deg F	830/805	827/813	826/804		
Meg Watts	MW	27	28	28		
Humidity	%	34	34	34%		
Amb Temp	deg F	78	77	76		
Bar Press	mmHG	29.77✓	2977✓	29.77✓		

Parameter	units					
Date	4/30/91	4/30/91	4/30/91	4/30/91	4/30/91	4/30/91
Time	4:55	4:55 P.M.	5:10 P.M.	5:25 P.M.	5:40 P.M.	5:55 P.M.
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	38.	38.	38.	38.	38.
Fuel Header	PSIG	955	955	955	955	955
Temp	deg F	84	84	84	84	84
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.24	10.24	10.24	10.24	10.24
DEHA	ppb	>450	>450	>450	>450	>450
Temp	deg F	83	83	83	83	83
Flow	gpm	13.1	13.1	13.2	13.2	13.2
Combustor						
Pressure	psig	73.5	73.5	74	74	73.5
avg outlet	deg F	1280	1280	1282	1284	1282
spread	deg F	120	126	116	120	119
max / min	deg F	1340/1220	1344/1218	1337/1221	1341/1221	1342/1223
avg stack	deg F	682	685	684	684	685
max / min	deg F	692/672	694/673	694/673	694/673	694/673
Meg Watts	MW	18.	18.1	18.4	18.5	18.5
Humidity	%	64	64	64	64	64
Amb Temp	deg F	77	78	78	78	78
Bar Press	mmHG	29.93↓	29.93↓	29.93↓	29.93↓	29.93↓

Parameter	units					
Date		4/30/91	4/30/91	4/30/91		
Time		6:10 P.M.	6:25 P.M.	6:40 P.M.		
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	38.	38.1	38.		
Fuel Header	PSIG	955	955	955		
Temp	deg F	84	84	84		
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1		
Water						
ph		10.24	10.24	10.24		
DEHA	ppb	> 450	> 450	> 450		
Temp	deg F	82	82	82		
Flow	gpm	13.2	13.2	13.2		
Combustor						
Pressure	psig	73.5	73.5	73.5		
avg outlet	deg F	1280	1277	1279		
spread	deg F	118	107	113		
max / min	deg F	1339/1221	1327/1220	1332/1219		
avg stack	deg F	683	684	683		
max / min	deg F	693/672	693/672	692/671		
Meg Watts	MW	18.5	18.5	18.4		
Humidity	%	64	64	64		
Amb Temp	deg F	78	78	78		
Bar Press	mmHG	29.91 ↓	29.91 ↓	29.91 ↓		

Parameter	units					
Date		5/1/91	5/1/91 →			
Time		08:05 A.M.	08:20	08:35	08:50	09:05
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	37.3	37.4	37.3	37.2	37.2
Fuel Header	PSIG	955	955	955	955	955
Temp	deg F	79	79	77	77	77
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.24	10.24	10.24	9.86 →	
DEHA	ppb	>450	>450	>450	>450 →	
Temp	deg F	69	69	69	69	69
Flow	gpm	12.9	13.1	13.1	13.0	12.9
Combustor						
Pressure	psig	72.5	72.5	72.5	72.5	72.5
avg outlet	deg F	1240	1250	1254	1256	1252
spread	deg F	115	117	118	117	113
max / min	deg F	1291/1176	1297/1180	1300/1182	1305/1188	1303/1190
avg stack	deg F	653	655.5	656	661.5	663
max / min	deg F	663/642	665/645	666/645	671/651	672/651
Meg Watts	MW	17.7	17.9	17.9	17.9	17.7
Humidity	%	67	67	46	46	46
Amb Temp	deg F	71	72	72	74	75
Bar Press	mmHG	29.95↑	29.95↑	29.96↑	29.96↑	29.96↑

Parameter	units					
Date		5/1/91 →		→		
Time		09:20	09:35	09:50	10:05	10:20
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	37.4	37.3	42.1	42.05	42.10
Fuel Header	PSIG	955	955	955	955	955
Temp	deg F	78	78	80	80	80
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		9.86 →	→	→	→	
DEHA	ppb	>450 →	→	→	→	
Temp	deg F	69	69	71	72	78.5
Flow	gpm	13.1	13.1	15.0	15.08	15.05
Combustor						
Pressure	psig	72.5	72.5	74.	73.5	74
avg outlet	deg F	1254	1252	1366	1369	1372
spread	deg F	113	112	125	133	131
max / min	deg F	1304/1191	1302/1190	1419/1294	1427/1294	1426/1295
avg stack	deg F	664.5	665	722.5	726.7	731
max / min	deg F	674/653	673/653	735/712	739/716	743/721
Meg Watts	MW	17.9	17.9	21.75	21.9	21.7
Humidity	%	48	48	48	48	48
Amb Temp	deg F	75	76	76	77	78
Bar Press	mmHG	29.96 —	29.96 —	29.96 —	29.96 —	29.96

High - Lo

POINT #1

Parameter	units					
Date		5/1/91				
Time		10:35	10:50	11:05	11:20	11:35
Run	#					
FUEL						
Heat of Combustion	Btu/#					
	/gal					
API gravity	@ 60					
Flow	GPM	42.5	42.5	42.0	42.2	42.2
Fuel Header	PSIG	955	955	955	955	955
Temp	deg F	80	80	80.5	81	81
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		9.86	9.86	9.86	→	→
DEHA	ppb	>450	→	→	→	→
Temp	deg F	80	80	80	81	81
Flow	gpm	15.0	15.0	15.0	15.0	15.0
Combustor						
Pressure	psig	74	74	74	74	74
avg outlet	deg F	1371	1370	1374	1373	1374
spread	deg F	126	134	126	125	131
max / min	deg F	1428/1302	1430/1296	1428/1302	1430/1305	1437/1306
avg stack	deg F	740	733	734.7	734.5	736.7
max / min	deg F	774/722	746/723	747/724	746/725	749/727
Meg Watts	MW	21.8	21.75	21.75	21.75	21.75
Humidity	%	48	48	46	46	46
Amb Temp TC2	deg F	79	79	79	79	80
Bar Press	mmHG	29.96	29.96	29.96	29.96	29.96

Parameter	units					
Date		5/1/91 →				
Time		11:50	12:45PM	12:20	12:35	12:50
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	42.2	45.5	46.	46.5	46.5
Fuel Header	PSIG	955	960	960	960	960
Temp	deg F	83	83	83	84	83.5
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		9.86 →	→	→	→	→
DEHA	ppb	>450 →	→	→	→	→
Temp	deg F	83	83	83	86	86
Flow	gpm	15.0	16.2	16.5	17.0	16.8
Combustor						
Pressure	psig	74	75.5	75.5	75	75
avg outlet	deg F	1377	1440	1474	1473	1473
spread	deg F	128	96	115	133	131
max / min	deg F	1436/1308	1470/1374	1540/1425	1539/1396	1538/1395
avg stack	deg F	739.	796	787	788	788.
max / min	deg F	750/726	801/788	798/784	801/786	801/786
Meg Watts	MW	21.8	24.9	24.8	24.8	24.3
Humidity	%	46	48	48	48	48
Amb Temp	deg F	81	81	81	82	82
Bar Press	mmHG	29.96	29.95	29.95	29.95	29.95

Parameter	units					
Date	-	5/1/91	→	→	→	→
Time		1:05	1:20	1:35	1:50	2:05
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	46.	46.2	46.1	46.1	46.1
Fuel Header	PSIG	960	960	960	960	960
Temp	deg F	84	84	84	84	84
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		9.86 →	→	→	→	→
DEHA	ppb	>450 →	→	→	→	→
Temp	deg F	86	86	86	89	89
Flow	gpm	16.7	16.9	16.8	17.0	17.2
Combustor						
Pressure	psig	75.	74.	74.5	75	75
avg outlet	deg F	1470	1482	1486	1478	1477
spread	deg F	142	150	154	132	132
max / min	deg F	1542/1400	1555/1405	1564/1407	1540/1408	1540/1408
avg stack	deg F	802	799	805	771	771
max / min	deg F	809/794	812/797	813/800	807/791	806/791
Meg Watts	MW	24.8	24.9	24.8	24.8	24.8
Humidity	%	48	39	39	33	33
Amb Temp	deg F	85	86	86	84	84
Bar Press	mmHG	29.95	29.94↓	29.94↓	29.89↓	29.94↓

Parameter	units					
Date		5/1/91				
Time		2:20	2:35	2:50	3:05	3:20
Run	#					
FUEL						
Heat of	Btu/#	increasing to full power				
Combustion	/gal					
API gravity	@ 60					
Flow	GPM		49.1	48.9	49.	49.2
Fuel Header	PSIG		960	960	960	960
Temp	deg F		85	86	86	86
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb		.3/1	.3/1	.3/1	.3/
Water						
ph			4.86 →	→	→	→
DEHA	ppb		>450 →	→	→	→
Temp	deg F		89.5	90	90	90
Flow	gpm		18.5	18.2	18.2	18.2
Combustor						
Pressure	psig		76	75.5	75.5	76
avg outlet	deg F		1541	1541	1540	1539
spread	deg F		164	165	164	165
max / min	deg F		1623/1459	1627/1462	1626/1462	1624/1459
avg stack	deg F		834	838	837	835
max / min	deg F		841/830	847/831	846/830	838/833
Meg Watts	MW		26	26.5	26.5	26.5
Humidity	%		33	33	38	38
Amb Temp	deg F		84	85	85	85
Bar Press	mmHG		29.89 ↓	29.89 ↓	29.85 ↓	29.85 ↓

34
29
47

Parameter	units					
Date		5/1/91				
Time		3:35	3:50	4:05	4:20	4:35
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	49.	49.	49.	49.	49.
Fuel Header	PSIG	960	960	960	960	960
Temp	deg F	86	86	86	86	87
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		9.86 →	→	→	10. →	→
DEHA	ppb	>450 →	→	→	>450 →	→
Temp	deg F	90	91	91	91	91
Flow	gpm	18.2	18.2	18.2	18.2	18.2
Combustor						
Pressure	psig	75.5	75.5	75.5	75.5	75.5
avg outlet	deg F	1531	1539	1535	1535	1533
spread	deg F	104	112	139	147	169
max / min	deg F	1555/1451	1560/1448	1605/1466	1622/1475	1619/1450
avg stack	deg F	835	831	838.5	837.2	837.2
max / min	deg F	839/834	845/829	849/830	847/829	847/829
Meg Watts	MW	26.9	26.9	27.	26.9	26.9
Humidity	%	38	38	33	33	33
Amb Temp	deg F	85	85	85	84	83
Bar Press	mmHG	29.85↓	29.85↓	29.83↓	29.83↓	29.83↓

Parameter	units					
Date		5/1/91				
Time		4:50	5:05	5:20	5:35	5:50
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	49.	48.8	49.2	49.1	49.
Fuel Header	PSIG	960	960	960	960	960
Temp	deg F	87	87	87	87	86
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.0	10.0 →	→	→	→
DEHA	ppb	>450 →	→	→	→	→
Temp	deg F	91	91	91	90	90
Flow	gpm	18.2	18.2	18.2	18.2	18.2
Combustor						
Pressure	psig	75.5	75.5	75.5	75.5	76.5
avg outlet	deg F	1534	1533	1535	1534	1535
spread	deg F	169	174	169	171	175
max / min	deg F	1621/1452	1622/1448	1619/1450	1623/1451	1619/1444
avg stack	deg F	837.5	835.3	836.1	837.1	837.7
max / min	deg F	848/830	842/828	844/830	848/828	849/830
Meg Watts	MW	26.9	27.	26.9	27.	27.
Humidity	%	33	28	28	28	28
Amb Temp	deg F	83	85	82	82	82
Bar Press	mmHG	29.83↓	29.8↓	29.8↓	29.8↓	29.8↓

32
29
24
15

Parameter	units					
Date		5/1/91				
Time		6:05	6:20	6:35	6:50	7:05
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	49.2	49.1	49.3	49.3	49.7
Fuel Header	PSIG	960	960	960	960	960
Temp	deg F	86	86	86	86	86
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.0 →	→	→	→	
DEHA	ppb	>450 →	→	→	→	
Temp	deg F	89	88	88	82	79
Flow	gpm	18.2	18.2	18.2	18.4	18.5
Combustor						
Pressure	psig	76.5	76.5	76.5	76.5	76.5
avg outlet	deg F	1532	1532	1534	1537	1485
spread	deg F	165	170	168	164	143
max / min	deg F	1623/1458	1613/1443	1621/1444	1628/1464	1560/1417
avg stack	deg F	835	836.4	836.1	832.5	828
max / min	deg F	847/827	847/827	850/828	845/824	840/820
Meg Watts	MW	27.1	27.	27.	27.2	23
Humidity	%	34 →	→	→	→	34%
Amb Temp	deg F	81	81	81	81	79
Bar Press	mmHG	29.78↓ →	→	→	→	29.77↓

TESTING DONE 19:05

Parameter	units					
Date		5/2/91	→			→
Time		10:00A.M.	10:30	11:00	11:30	12 Noon
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	52.2	52.	52.	52.	52.
Fuel Header	PSIG	955	950	950	950	950
Temp	deg F	80	80	80	80	80
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.02	→			→
DEHA	ppb	>450	→			→
Temp	deg F	63	69	70	70	70
Flow	gpm	20.5	20.	20.	19.6	20.
Combustor						
Pressure	psig	80.	80.	80.	80.	80.
avg outlet	deg F	1555.2	1554.5	1557.5	1562.7	1557.6
spread	deg F	169	171	168	180	181
max / min	deg F	1633/1464	1635/1464	1636/1468	1642/1462	1638/1457
avg stack	deg F	817.5	819.3	817.7	818.5	818
max / min	deg F	823/812	824/813	824/811	824/813	824/811
Meg Watts	MW	29.5	29.5	29.5	29.5	29.5
Humidity	%	52 →		42 →		40
Amb Temp	deg F	64	65	66	66	66
Bar Press	mmHG	29.91 →		29.89 →		29.88↓

Parameter	units					
Date		5/2/91	→			
Time		12:30 P.M.	1:00	1:30	2:00	2:30
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	51.8	51.7	51.8	51.5	51.6
Fuel Header	PSIG	950	950	950	950	950
Temp	deg F	79.5	79.5	79.5	79.5	79.5
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.02 →	→	→	→	
DEHA	ppb	>450 →	→	→	→	
Temp	deg F	70	70	70	70	70
Flow	gpm	19.7	19.6	19.6	19.6	19.6
Combustor						
Pressure	psig	79.5	79.5	79.5	79.5	79.5
avg outlet	deg F	1547.2	1552.2	1552.5	1551.9	1546.7
spread	deg F	186	174	179	185	167
max / min	deg F	1637/1451	1634/1460	1638/1459	1641/1456	1626/1459
avg stack	deg F	818.7	819.7	818.7	820.	819
max / min	deg F	824/813	826/813	825/812	825/814	824/13
Meg Watts	MW	29.2	29.2	29.4	29.2	29.2
Humidity	%	40	40 →		37 →	
Amb Temp	deg F	67	67	67	67	67
Bar Press	mmHG	29.88↓	29.88↓ →		29.86↓ →	

Parameter	units					
Date		5/2/91	→			→
Time		3:00 P.m.	3:30	4:00	4:30	5:00
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	48.1	48.2	48.2	48.2	48.2
Fuel Header	PSIG	950	950	950	950	955
Temp	deg F	79.5	79.5	79.5	79.5	80
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.02 →		→	→	10.02
DEHA	ppb	>450 →		→	→	>450
Temp	deg F	70	70	70	70	71
Flow	gpm	18.0	18.2	17.9	17.9	17.9
Combustor						
Pressure	psig	78.	78	78	78	78
avg outlet	deg F	1468.4	1446.7	1467.1	1466.7	1466.
spread	deg F	167	173	166	163	158
max / min	deg F	1546/1379	1528/1355	1548/1382	1550/1387	1546/1388
avg stack	deg F	781.7	779.7	779.7	780	777
max / min	deg F	787/777	787/773	786/775	787/774	783/771
Meg Watts	MW	26.5	26.5	26.5	26.5	26.5
Humidity	%	31 →		29%	29	29
Amb Temp	deg F	68	69	68	68	68
Bar Press	mmHG	29.84 →		29.83↓	29.83↓	29.83↓

Parameter	units					
Date		5/2/91	→			→
Time		5:30pm	6:00	6:30	7:00	7:30
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	48.1	47.9	48.1	48.1	48.1
Fuel Header	PSIG	955	953	953	952	952
Temp	deg F	79.5	79.	79.	79	79
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1	.3/1	.3/1
Water						
ph		10.02	→	→	→	→
DEHA	ppb	>450	→	→	→	→
Temp	deg F	70	70	70	70	69
Flow	gpm	17.9	17.9	18.1	18.1	18.1
Combustor						
Pressure	psig	78	78	78	78	78
avg outlet	deg F	1462.7	1462.8	1461.3	1456	1456
spread	deg F	167	154	157	162	167
max / min	deg F	1543/1376	1542/1388	1541/1384	1538/1376	1538/1371
avg stack	deg F	776.7	774.2	774.7	773	772
max / min	deg F	783/773	781/768	781/768	779/767	778/765
Meg Watts	MW	26.5	26.5	26.6	26.5	26.5
Humidity	%	29	29 →		29	29
Amb Temp	deg F	68	67	66	66	64
Bar Press	mmHG	29.83↓	29.86↑ →		29.85↓	29.85↓

Parameter	units					
Date		5/2/91	→	→		
Time		8:00 P.M.	8:30 P.M.	9:00 P.M.		
Run	#					
FUEL						
Heat of	Btu/#					
Combustion	/gal					
API gravity	@ 60					
Flow	GPM	48.1	48.1	48.1		
Fuel Header	PSIG	952	950	950		
Temp	deg F	78	78	78		
Sulfur % wt	%					
N2	ppm					
Water/Fuel	lb/lb	.3/1	.3/1	.3/1		
Water						
ph		10.02 →	→	→		
DEHA	ppb	>450 →	→	→		
Temp	deg F	68	67	66		
Flow	gpm	17.9	17.7	17.7		
Combustor						
Pressure	psig	78	78.5	79		
avg outlet	deg F	1454	1449	1448		
spread	deg F	163	159	160		
max / min	deg F	1530/1367	1525/1366	1526/1366		
avg stack	deg F	770	767	766		
max / min	deg F	776/764	773/760	772/760		
Meg Watts	MW	26.5	26.5	26.5		
Humidity	%	31	31	39		
Amb Temp	deg F	64	64	63		
Bar Press	mmHG	29.84↓	29.84↓	29.87↑		

Correction Factors for Various Parameters vs. Compressor Inlet Temperature
Fig. A1-5

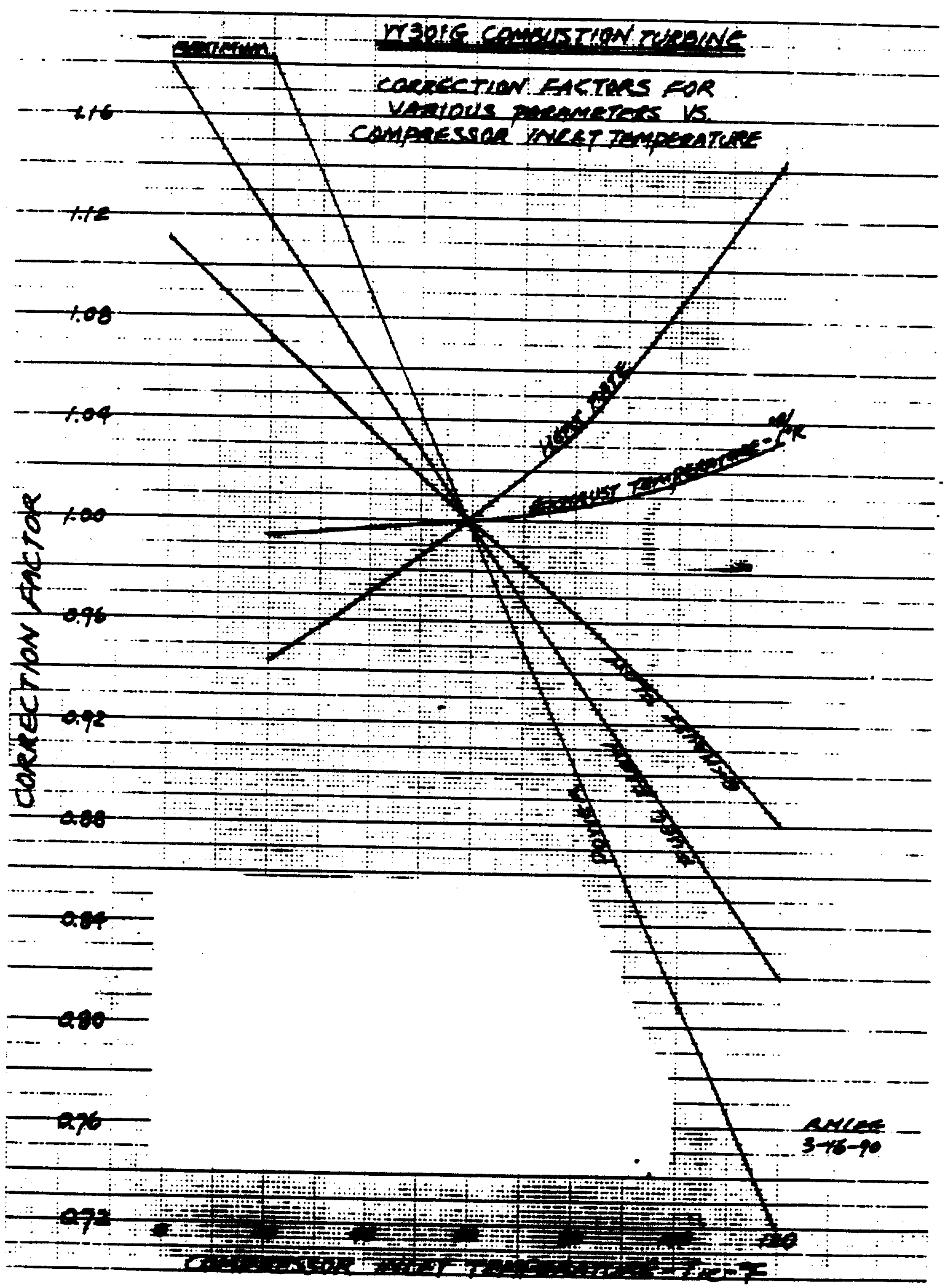


Table D5. TYPICAL PHYSICAL PROPERTIES OF FUEL OILS

Pacific standard No.		PS No. 100		PS No. 200	PS No. 300	PS No. 400
Grade		1	2	3	5	6
Common name		Kerosine	Distillate	Straight-run fuel oil	Low-crack fuel oil	Heavy-crack fuel oil
Typical analysis	Carbon (C)	84.7%		85.8%	87.5%	88.3%
	Hydrogen (H)	15.3%		12.1%	10.2%	9.5%
	Sulfur (S)[d]	0.02%		1.2%	1.1%	1.2%
	Water (H_2O)	-		-	0.05%	0.05%
	Other	-		0.9%	1.1%	1.0%
	(°Be)	41.8°		26.2°	16.5°	8.9°
	lb/gal	6.83		7.50	8	8.33
	Sp gr 60°/60°	0.82		0.90	0.96	1
	Approximate Btu/gal	136,000		142,000	146,000	152,000
	Approximate Btu/lb	19,910		18,950	18,250	18,000
		1	2			
Specifications	Max viscosity	-	-	45 sec (100°F)[b]	40 sec (122°F)[c]	300 sec (122°F)[c]
	Flash point) Min	110°F	125°F	150°F	150°F	150°F
	Flash point) Max	165°F[a]	190°F[a]	200°F[a]	-	-
	Max water and sediment	0.05%	0.05%	0.1%	1.0%	2.0%
	Max 10% point	420°F	440°F	460°F	-	-
	Max 90% point	-	620°F	675°F	-	-
	Max endpoint	600°F	-	-	-	-

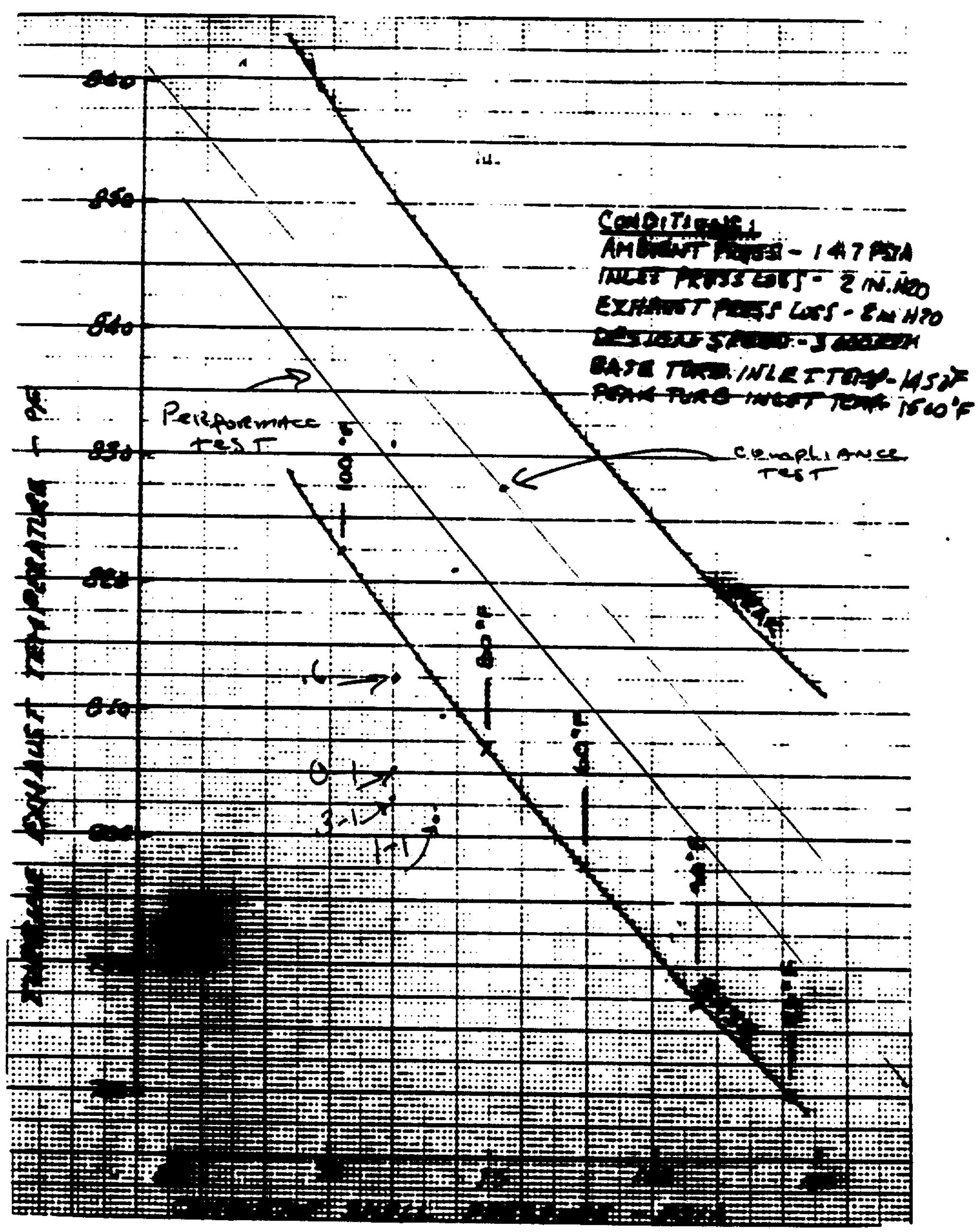
[a]Or legal maximum.
[b]Saybolt Universal.
[c]Saybolt Furol.
[d]Sulfur contents are only typical and will vary in different locales.

9220 DSCF/mmBTU

Fuel type	F_o range
Coal:	
Anthracite and lignite	1.016–1.130
Bituminous	1.083–1.230
Oil:	
Distillate	1.260–1.413
Residual	1.210–1.370
Gas:	
Natural	1.600–1.836
Propane	1.434–1.586
Butane	1.405–1.553
Wood	1.000–1.120
Wood bark	1.003–1.130

W301G GAS TURBINE INIT
Control Curve
Exhaust Temperature vs Combustor Shell Pressure
Fig. A1-1

This is not an authorized control curve as it was developed from an unidentified plot (Appendix 4, Fig. A4-5) for a W301G with 14.7 psia ambient press., 2"H_2O inlet loss (IL), 12"H_2O exhaust loss (EL), 3600 rpm, and 1450°F turbine inlet temp. An algorithm of 7°F/10"H_2O E.L was used to correct to 2"E.L. The exhaust temperature at 2"EL is 7°F lower than that for 12"EL.



SPECIAL INFORMATION
Ratings, Capacities, and Operating Data

GAS TURBINE

Simple Cycle, Single Shaft
Model W-301 G . . . . Serial No. 17A1744-1 & 2
Capacity at 80°F; 14.17 psia
Rated Power . . . . 27,000 KW Base
29,000 KW Peak
Gas Turbine Shaft Speed . . . . . 3600 rpm

Maximum Turbine Inlet Temperature
as Calculated by Heat Balance . . . . 1450°F Base Load
1500°F Peak Load
(See also "Temperature Considerations")

Fuel - Start and Run on Gas/Liquid Fuel
(Automatic Transfer)

Starting Unit - (Waukesha Diesel Model No. L1616DS1U)
760 HP @ 2200 Crankshaft RPM
Fitted with Twin Disc Torque Converter
Series 11500 MS 540 HD

MAIN LUBE OIL PUMP - Direct Driven Centrifugal Type

Mounted at the exhaust end of the gas turbine rotor.
Capacity . . . . 500 gpm at 125 psig
Speed . . . . 3600 rpm

PRIMARY AUXILIARY LUBE OIL PUMP

Motor Driven . . . . 25 HP, 60 cycle, 440 volt
Capacity . . . . 300 gpm at 218 ft. head
Speed . . . . 3500 rpm

SECONDARY AUXILIARY LUBE OIL PUMP

Motor Driven . . . . 3 HP, 125 Vdc
Capacity . . . . 150 gpm at 42 ft. head
Speed . . . . 1750 rpm

VISIBLE EMISSION OBSERVATION FORM

No.

COMPANY NAME: Sun Refining & Marketing

STREET ADDRESS: 3144 Passyunk Ave

CITY: Philadelphia **STATE:** PA **ZIP:** 19145

PHONE (KEY CONTACT): 215-339-2296 **SOURCE ID NUMBER:**

PROCESS EQUIPMENT: Westinghouse Turbine unit 2 **OPERATING MODE:** 100%

CONTROL EQUIPMENT: H2O Injection **OPERATING MODE:** .3

DESCRIBE EMISSION POINT: Short Rusty White stack, North of control room 1 section higher than other stacks

HEIGHT ABOVE GROUND LEVEL: ~50'

HEIGHT RELATIVE TO OBSERVER: Start ~50' End ~50'

DISTANCE FROM OBSERVER: Start ~75' End ~75'

DIRECTION FROM OBSERVER: Start N End N

DESCRIBE EMISSIONS: Start light looping plume End light looping plume

EMISSION COLOR: Start Gray End Gray

IF WATER DROPLET PLUME: Attached ☐ Detached ☐

POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED: Start 2' above stack End 2' above stack

DESCRIBE PLUME BACKGROUND: Start Clouds End Clouds

BACKGROUND COLOR: Start White End White

SKY CONDITIONS: Start 70% OC End 70% OC

WIND SPEED: Start 15-20 End 15-20

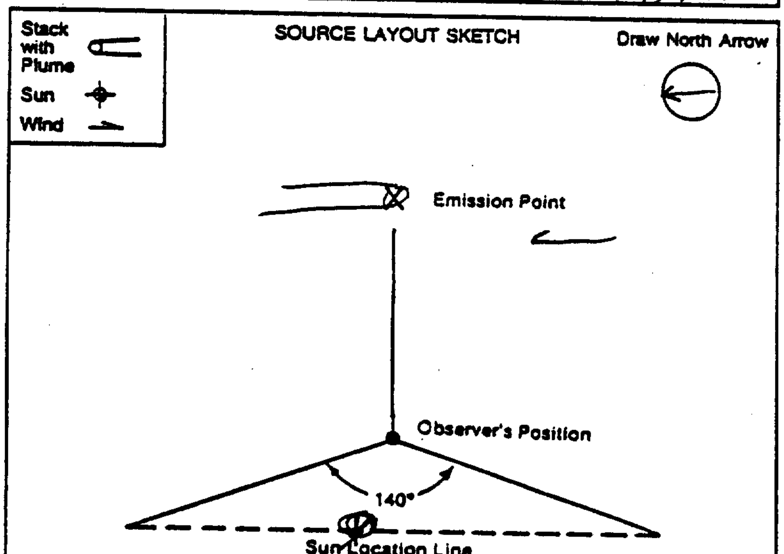
WIND DIRECTION: Start W End W

AMBIENT TEMP: Start 67 End 67

WET BULB TEMP: 54

RH, percent: 37%

SOURCE LAYOUT SKETCH — Draw North Arrow



ADDITIONAL INFORMATION:

OBSERVATION DATE: 5-2-91 **START TIME:** 14:21 **END TIME:** 14:27

MIN \ SEC	0	15	30	45	COMMENTS
1	10	10	10	10	
2	10	10	10	10	
3	10	10	10	10	
4	10	10	10	10	
5	10	10	10	10	
6	10	10	10	10	
7					
8					
9					
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19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

OBSERVER'S NAME (PRINT): John P Survis

OBSERVER'S SIGNATURE: John P Survis **DATE:** 5-2-91

ORGANIZATION: Cubix Corporation

CERTIFIED BY: Texas Air Control Board **DATE:** 3-15-91

CONTINUED ON VEO FORM NUMBER:

VISIBLE EMISSION OBSERVATION FORM

No.

COMPANY NAME
Sun Refining + Marketing

STREET ADDRESS
3144 Passyunk Ave

CITY Philadelphia
STATE PA
ZIP 19145

SOURCE ID NUMBER

PHONE (KEY CONTACT)
215-339-2296

PROCESS EQUIPMENT
Westinghouse Turbine Unit 1
OPERATG MODE 106

CONTROL EQUIPMENT
H2O Injection
OPERATG MODE .3

DESCRIBE EMISSION POINT
Short rusty white stack south of control room

HEIGHT ABOVE GROUND LEVEL ~50'
HEIGHT RELATIVE TO OBSERVER Start ~45' ~45'

DISTANCE FROM OBSERVER Start 100' End 100'
DIRECTION FROM OBSERVER Start SE SE

DESCRIBE EMISSIONS Start light looping plume End light plume

EMISSION COLOR Start Lt Green End Lt Grn

IF WATER DROPLET PLUME Attached ☐ Detached ☐

POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED Start 2' above stack End

DESCRIBE PLUME BACKGROUND Start Sky End Sky

BACKGROUND COLOR Start Blue End Blue

SKY CONDITIONS Start 0% cl.

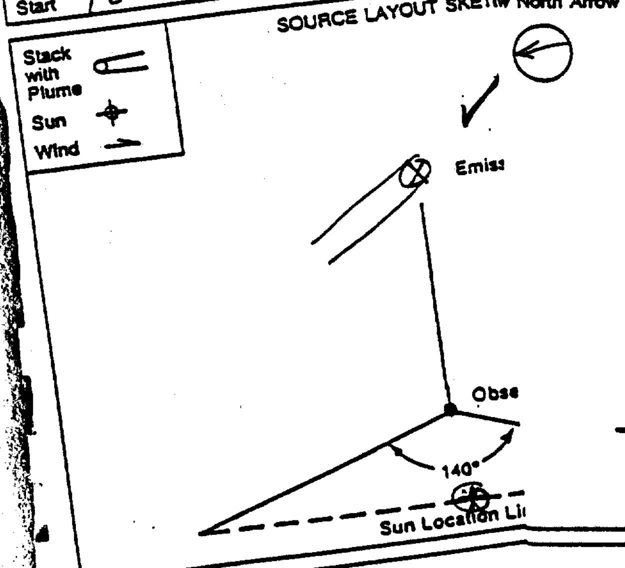
WIND SPEED Start 10-15 End 10-15

WIND DIRECTION Start SE SE

AMBIENT TEMP Start 78 End 77

WET BULB TEMP, percent 60 107%

SOURCE LAYOUT SKETCH Draw North Arrow



ADDITIONAL INFORMATION

OBSERVATION DATE 5-1-91
START TIME 19:20
END TIME 19:26

MIN \ SEC	0	15	30	45	COMMENTS
1	5	5	5	5	
2	5	5	5	5	
3	5	5	5	5	
4	5	5	5	5	
5	5	5	5	5	
6	5	5	5	5	
7					
8					
9					
10					
11					
12					
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26					
27					
28					
29					
30					

OBSERVER'S NAME (PRINT) John F Surris

OBSERVER'S SIGNATURE John F Surris
DATE 5-1-91

ORGANIZATION Cubix Corporation

CERTIFIED BY Texas Air Control Board
DATE 3-15-91

CONTINUED ON VEO FORM NUMBER