Department of Energy
Albuquerque Operations
Los Alamos Area Office
Los Alamos, New Mexico 87544

MAR 05 1987

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ED DIRECTOR'S OFFICE

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

RECEIVED

Mr. Michael Burkhart, Director
N.M. Environmental Improvement Division
P.O. Box 968
Santa Fe, NM 87504-0968

Dear Mr. Burkhart:

Enclosed is the Trial Burn Report for the Technical Area (TA) 50 Controlled Air Incinerator. This report addresses all trial burn requirements of the New Mexico Hazardous Waste Management Regulations (NMHWMR-2), specifically 302.E.2.b.(6) and includes information committed to by Laboratory personnel during the August 11, 1986 meeting with your staff.

After review and acceptance by the Division, appropriate steps will be taken to amend Appendix J, Resource Conservation and Recovery Act (RCRA)-TRIAL BURN PLAN in the Laboratory's RCRA Part B permit application. These amendments will reflect information obtained during the actual trial burn.

The trial burn that occurred on September 4-7, 1986 is an important milestone in the Laboratory's Part B hazardous waste permit process and is an integral part of the comprehensive plan for the management of wastes. During the trial burn run, as your staff is aware, much information was gathered and preliminary results were encouraging. As you will discover from the enclosed report, the Laboratory's trial burn run was successful with destruction and removal efficiencies exceeding those required by 40 CFR 264.343.

I certify that the trial burn has been carried out in accordance with the approved trial burn plan as modified by the exemptions noted in Sections 5.2 and 5.3 of the report. In addition, I certify the information contained in the report to be true and factual.

8351

If you have any questions, please call James Phoenix of my staff at 667-5288.

Sincerely,

Harold E. Valencia
Area Manager

6500A

Enclosures:
As stated

cc:
A. Davis, U.S. EPA, Dallas, TX
J. Highland, U.S. EPA, Dallas, TX, w/o enclosures

Report filed in book case, room N 2311.
CKC

RCRA TRIAL BURN
FINAL REPORT
for the
LOS ALAMOS
CONTROLLED AIR INCINERATOR

Submitted to
State of New Mexico
Environmental Improvement Division
Santa Fe, New Mexico

By
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO

March, 1987

VOLUME I
(Report, Appendices A through H)

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1.0 TEST OBJECTIVES

On September 4 through 7, 1986 the Los Alamos National Laboratory (LANL) conducted a trial burn directed toward obtaining a Resource Conservation and Recovery Act (RCRA) operating permit for the Los Alamos Controlled Air Incinerator (CAI).

The trial burn was conducted at four separate test conditions. Specially prepared liquid and solid simulated waste feed materials were incinerated at two secondary combustion chamber temperatures.

Testing and analysis were performed to:

1) Determine the destruction and removal efficiency (DRE) of principal organic hazardous constituents (POHC), carbon tetrachloride (CCl_4) and trichloroethylene (TCE), using a volatile organic sampling train (VOST);

2) Determine the particulate and gaseous chloride concentration in the stack effluent using an EPA Method-5 sampling train;

3) Monitor the carbon monoxide emissions during each trial burn run using an EPA Method 10 sampling train.

Clean Air Engineering, Inc. (CAE) of Palatine, Illinois was contracted to provide sampling activities. Controls for Environmental Pollution, Inc. (CEP) of Santa Fe, New Mexico was contracted to provide sample analysis. Sampling and analysis was in compliance with the requirements of the RCRA regulations for a Part B Permit for treatment and disposal of hazardous wastes.

The testing took place at the Los Alamos CAI in Los Alamos, New Mexico on September 4 through 7, 1986. Observing and coordinating the field testing were:

Regulatory Observers:	Phillip Schwindt-USEPA, Region VI G. Kelly Crossman-NMEID
Laboratory Management:	Ray Garde-LANL/HSE-7 Leon Borduin-LANL/HSE-7
Trial Burn Project Officer	Ralph Koenig-LANL/HSE-7
Quality Assurance Officer	John Vavruska-LANL/HSE-7
Lab Analysis Coordinator	Larry Fields-LANL/HSE-9
Sampling Coordinator	John Chapman-CAE, Inc.
Facility Operations Manager	David Hutchins-LANL/HSE-7
Facility Operators	TDF Staff-LANL/HSE-7

2.0 DESCRIPTION OF INSTALLATION

2.1 Facility

The LANL Controlled Air Incinerator (CAI) is a dual chamber, refractory lined incinerator. An atomizing nozzle introduces liquid wastes into the primary (lower) combustion chamber (PCC) where underfire air supports combustion at near stoichiometric conditions. Solid waste is batch fed into the primary chamber through a ram feeder and guillotine door mechanism.

Unburned volatile compounds and entrained particles exit the primary chamber through a connecting duct to the secondary (upper) combustion chamber (SCC). Excess air is introduced at this location to promote complete combustion.

The secondary chamber is designed to provide added residence time and supplemental heat where necessary to burn off volatile organics. Oxygen/combustibles analyzers at the outlet of each chamber monitor and control oxygen in chamber offgas. The excess air is controlled by the adjustment of underfire air flow in the primary chamber and the secondary air flow in the secondary chamber.

The offgas cleaning system consists of a quench tower, a high-energy variable throat venturi scrubber, a packed column absorber tower, a condenser, a mist eliminator, a reheater, a roughing filter and a series of two high-efficiency particulate air (HEPA) filter banks, a carbon adsorber and an induced-draft blower.

A more detailed description of the CAI and its associated equipment is included in Appendix J. of the Los Alamos National Laboratory Part B Application, entitled RCRA Trial Burn Plan for a Modular Incinerator at the Los Alamos National Laboratory in Los Alamos, New Mexico, and is included as Appendix I of this document.

2.2 Operating Conditions

Incinerator target operating conditions were as follows:

. Temperatures--	
Primary chamber-	***
Secondary chamber-	2000-2200 ^{o}F
Condenser outlet-	130 ^{o}F
Reheater outlet-	160 ^{o}F
. Pressures--	
Primary chamber-	-2 in. H_2O
Venturi pressure drop-	40-70 in. H_2O
Feed nozzle atomizing medium-	60 psig
. Flows--	
Venturi solution-	8 gpm
Absorber solution-	10 gpm
Steam bleed-	>15 lb/hr
. Other--	
Primary chamber O_2 -	4-9%
Secondary chamber O_2 -	4-9%
Scrub sump pH-	5

*** Primary chamber temperature is dependent on waste feed rate and excess O_2

Four operating conditions were chosen for the trial burn. Waste feed form (solid vs. liquid) and secondary combustion chamber temperature (2000 vs. 2200 ^{o}F) were the variables during these test conditions. Carbon tetrachloride (CCl_4) and trichloroethylene (TCE) were chosen to be the principal organic hazardous constituents (POHC) in the simulated waste feed. Conditions 1 and 2 were liquid feed at 2200 and 2000 ^{o}F, respectively. Conditions 3 and 4 were solid feed at 2200 and 2000 ^{o}F, respectively. Liquid feed rates ranged from 147 to 173 lb/hr. Solid feed rates ranged from 166 to 203 lb/hr.

More detailed information on actual operating conditions during the trial burn is contained in Appendix B of this report, as well as in Tables 1 through 8. Liquid and solid feed preparation, composition and feed rate data is presented in Appendix C of this report.

3.0 SUMMARY OF PROCEDURES

3.1 SAMPLING PROCEDURES

Methods

The sampling procedures followed requirements outlined in U.S Environmental Protection Agency (USEPA) Methods 1, 2, 3, 5 and 10. These methods are entitled:

- Method 1--"Sample and Velocity Traverse for Stationary Sources;"
- Method 2--"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube);"
- Method 3--"Gas Analysis for Carbon Dioxide, Oxygen; Excess Air and Dry Molecular Weight;"
- Method 5--"Determination of Particulate Emissions from Stationary Sources;"
- Method 10--"Determination of Carbon Monoxide Emissions from Stationary Sources."

These methods appear in detail in Title 40 of the Code of Federal Regulations (CFR), Part 60, Appendix A.

The metering equipment was designed and manufactured by the Research Appliance Co. and/or Nutech to meet U.S. EPA standards. All equipment was calibrated at the Clean Air Engineering, Inc. laboratory prior to shipment to the job site.

The sampling for POHC followed procedures outlined in "Protocol for the Collection and Analysis of Volatile POHC Using VOST," EPA-600/8-84-007, dated March 1984. This is a draft method that has not yet been promulgated by the U.S. EPA.

The VOST is shown in Fig. 1 of Appendix L. The EPA Method 5 sampling apparatus is shown in Fig. 2 of Appendix L. The EPA Method 10 apparatus is shown in Fig. 3 on page 6-3 of Appendix O.

Gaseous chlorine emissions were sampled by modifying the EPA Method 5 sample train to collect gaseous chloride in the impinger solution. This was done by substituting 0.1 N NaOH for H_2O in the first two impingers.

Sampling Locations

Particulate emissions sampling was performed in the duct just upstream of the CAI stack. The duct has two ports for performing sampling traverses, and four points were sampled per port. Three runs took place for each of the four test conditions. The sampling time per point was five minutes for a total sampling time of 80 minutes. The particulate emissions sampling locations are shown in Fig. 3 of Appendix L.

POHC sampling was performed downstream of the particulate emissions sampling at a single point in the duct. Six runs took place for each of the four test conditions. The total sampling time was 20 minutes for each run.

Carbon monoxide sampling was also performed downstream of the particulate emissions sampling at a single point in the duct. Three runs were performed coinciding with the particulate emissions sampling for each of the four test periods.

PROCEDURES

Principle Organic Hazardous Constituents

The volatile collection system consisted of condensers to cool the gas and two adsorbent traps in series. The first trap contained a section of TENAX followed by a section of charcoal.

Each set of two traps was exposed to approximately twenty liters of effluent gas over a twenty minute period. The traps were changed and the sampling repeated until six sets of traps were taken at each test condition.

Each trap was placed in its own transport tube and sealed by Clean Air Engineering, Inc. personnel for shipment to the analytical laboratory. Aqueous condensate was recovered at the end of each sampling condition. This sample was archived but not analyzed due to the insolubility of the POHC.

Particulate Emissions

The particulate emission rate was determined using procedures outlined in EPA Method 5. The particulate samples collected on glass fiber filters were analyzed gravimetrically. The probe and nozzles were washed with acetone. The wash was transferred to tared beakers and evaporated to dryness. This weight was also included in the analysis.

Carbon Monoxide Emissions

The carbon monoxide emission rate was determined using procedures outlined in EPA Method 10. A continuous gas sample was analyzed with a non-dispersive infrared (NDIR) analyzer.

A Flame Ionization Detector (FID) analyzer was also used to monitor CO and CO_2 levels in the CAI offgas and to provide a comparison of the accuracy of the FID versus NDIR method of CO measurement.

Carbon Dioxide and Oxygen Levels in Offgas

Levels of Carbon Dioxide and Oxygen in the stack exhaust were determined by ORSAT analysis performed in conjunction with the particulate sampling periods. In addition, an O_2/Combustibles analyzer monitored the levels of O_2 in combustion gases leaving the secondary combustion chamber (SCC).

Liquid and Aqueous Process Samples

Liquid and aqueous process samples were taken in accordance with the procedures and requirements set out in "Requirements and Specifications for Offgas Sampling," the Clean Air Engineering, Inc.'s Test Protocol, and with the CAI RCRA Trial Burn Run Plan (see Appendices K, L and N).

Solid Samples

Solid process samples were taken in accordance with the procedures and requirements set out in "Requirements and Specifications for Offgas Sampling," Clean Air Engineering, Inc.'s Test Protocol and with the CAI RCRA Trial Burn Run Plan (see Appendices K, L and N).

Sampling of the exposed activated carbon was amended to three samples taken at the end of conditions 2, 3 and 4. Initially, the sampling scheme was amended to taking one activated carbon sample following liquid and one sample following solids testing. In anticipation of possibly higher organic emissions during solids incineration, it was decided to take a sample after each of the solids testing conditions.

LANL contracted CEP laboratories to perform the POHC and other laboratory analyses. CAE delivered the samples directly to CEP in Santa Fe, New Mexico. The results are presented in Appendix A under Analytical Results.

3.2 ANALYTICAL PROCEDURES

Analysis for levels of CCl_4 and TCE in offgas samples was performed according to the procedures outlined in "Procedures for the Collection and Analysis of Volatile POHC Using VOST," EPA-600/8-84-007, March 1984. This is a draft method that has not yet been promulgated by the U.S. EPA.

Analyses of solid and liquid samples were performed in accordance with "Methods for Chemical Analysis of Water and Waste," EPA-600/4-79-020, March 1979.

ORGANIC ANALYSIS

VOST Sample Analysis

The two adsorbent cartridges taken for each sample period were thermally desorbed to volatilize the sample, which was then trapped on an analytical sorbent trap. This trap was in turn heated to 180°C and the effluent injected into a Gas Chromatograph/Mass Spectrometer (GC/MS) for analysis. The volatile POHCs are separated by temperature programmed gas chromatography and detected by low resolution mass spectrometry.

The GC/MS was tuned every 12/24 hour period to meet USEPA key abundance criteria for 4-Bromofluorobenzene (4-BFB) before any standards or samples were analyzed. 50.0 nanograms (ng) of 4-BFB was injected daily directly on column and analyzed. 50.0 ng of 4-BFB was also analyzed by adding to a blank TENAX sorbent cartridge and desorbing according to the procedures outlined in the VOST protocol. Percent recovery was calculated each day to monitor recovery. The average recovery was 77.3 percent for the period of sample analysis.

The internal standard calibration method was used to initially establish response factors and to establish the ability to generate acceptable accuracy. The standard deviation of both CCl_4 and TCE for their initial calibration response factors was 0.09. A USEPA quality assurance/ quality control sample of CCl_4 and TCE was spiked into TENAX and TENAX/charcoal by the flash vaporization technique. The results of both parameters were within 10 percent of the known value. Each day blanks were run to demonstrate that interferences from the analytical system were under control.

It was discovered that in some instances the sample concentration was outside the internal standard calibration curve. In these cases external standard techniques were employed with a minimum of three calibration standards analyzed, bracketing sample concentrations run that day.

Problems experienced in the analysis of VOST samples were with breakage of the sample cartridges and with quenching of the analytical detector. The VOST cartridges were originally supplied with Teflon filled ferrules. When tightened sufficiently to form a hermetic seal, uneven pressure was exerted by the ferrule on the glass surface, causing the VOST cartridge to fracture. Seal problems were also experienced with these ferrules during thermal desorption of the cartridges. Graphite ferrules, which are softer than teflon filled ferrules, seal with less tightening and retain a hermetic seal during thermal desorption, were used to correct this problem. However, three cartridges were received in broken condition, and others were broken from over tightening by the analysts attempting to form an airtight seal.

Analytical detector quenching occurs when a quantity of a particular mass fragment exceeds a preset value of signal counts for a mass selective detector. Once this preset value is exceeded the data gathering activity of the system is terminated. The analyst must them restart the equipment manually if any more data is to be acquired from the sample injection. This occurred in some instances during the analysis of VOST cartridges. Carbon tetrachloride was in high enough concentrations to cause detector quenching. Furthermore, CCl_4 was the first component of interest to elute from the gas chromatographic column, thus causing instrument shutdown and loss of data.

In cases for which one of the cartridges was broken or the analytical detector quenched, emission rates of POHC were reported as "greater than" values and DREs were not reported.

Aqueous Sample Analysis

All aqueous samples were analyzed by USEPA method 601. External calibration techniques were used with EPA traceable stock solutions at a minimum of three concentrations at the beginning of each 12/24 hour period. EPA Quality Control samples were run daily to monitor laboratory performance. Reagent water and system blanks were run on a frequency of 10 percent or daily to demonstrate system stability. Replicate standards were run on a frequency of 10 percent to monitor instrument precision and accuracy. Both percent standard deviation and average percent recovery were within method limits.

Liquid Samples

All feed stock and liquid mixtures were analyzed by USEPA method 8010. Calibration standards from USEPA traceable stock solutions at a minimum of three concentrations were analyzed daily for external standard calibration. System

blanks were run daily to demonstrate system control. EPA Quality Control samples were used initially to verify accuracy of standard concentrations. Percent standard deviation of USEPA Quality Control standards averaged 6.1 percent for CCl_4 and 8.0 percent for TCE. Replicate samples were analyzed at a frequency of 10 percent to monitor instrument precision. The percent standard deviation for twenty-six samples was 4.3 percent.

Initial results for percentage levels of CCl_4 and TCE in feed stocks and liquid mixture feed blends were off by as much as a factor of four. This can be attributed to dilution error in the samples by the analytical lab performing the analysis. Samples were diluted from one to ten thousand (1/10,000) and one to one hundred thousand (1/100,000) in order to stay within the working range of the gas chromatograph and analytical detector. Significant error can result with dilutions of this magnitude. Once the error was discovered, the samples were reanalyzed using smaller injection volumes and a less sensitive analytical detector, along with lower dilution rates.

Solid Samples

All solid samples were analyzed by USEPA method 8010, using thermal desorption and gas chromatography. See "Liquid Samples," above.

INORGANIC ANALYSIS

Liquids and Solids

Analysis for chlorides in liquid and solid samples was performed by Ion Chromatography in accordance with USEPA method 300.0.

Trace Metals

Levels of aluminum (Al) and iron (Fe) in EPA Method 5 particulate samples were determined using Atomic Adsorption Graphite Furnace analysis techniques in accordance with USEPA methods 202.2 and 236.2. Analysis for sodium (Na) was by Direct Aspiration Flame technique in accordance with USEPA method 273.1.

PHYSICAL PROPERTIES

Liquid Feed

Analyses of liquid feed samples for determination of physical properties and elemental composition were performed by Clean Air Engineering on archived sample splits. The

following methods/techniques were employed for the analyses:

Carbon, Hydrogen	ASTM 3178
Nitrogen	ASTM 3179
Sulfur	ASTM 3177
BTU/lb	ASTM 2015
Chlorine	ASTM 4208
Density	Weight/unit vol @ 20°C
%CCl_4	Gc/FID
%TCE	Gc/FID
%Fuel Oil	Gc/FID

Results of analysis for all samples are presented in the reports in Appendix A.

3.3 QUALITY CONTROL PROCEDURES

Sampling

All samples were taken either by, or under the direction and supervision of, the sampling contractor, Clean Air Engineering, Inc., in accordance with EPA methods and procedures and adhering to the provisions of the guidelines set forth in the documents appearing in Appendices I, J, K, L and N. Sample custody was the responsibility of the sampling contractor from the time of sample collection until the samples were delivered to the analytical laboratory. Chain of Custody forms, establishing independence of sample custody, are presented in Appendix F.

Analysis

Approximately 10 percent of the analyses performed for this study were evaluated by the insertion of Quality Control (QC) samples. Six different types of Audit QC samples were included in the sample batches collected by the Clean Air Engineering, Inc. sampling team and subsequently shipped to CEP in Santa Fe for analysis.

These QC samples were prepared by HSE-9 QA/QC at Los Alamos National Laboratory. The values of the spike levels of the QC samples were unknown to all of the principals involved, including the contract manager. The QC values were not divulged by HSE-9 QA/QC until all of the laboratory data from CEP of Santa Fe had been reported.

Most of the standards used in the preparation of these samples were supplied by Chem Services or SPEC labs. The later spiked VOST cartridges were prepared from standards that are traceable to the USEPA.

The six different types of QC samples that were prepared were:

a) Chloride ion in a water matrix;

b) Inorganic cations (FE, Al) in a water matrix;

c) CCl_4 and TCE in a soil matrix;

d) CCl_4 and TCE in a water matrix;

e) CCl_4 and TCE in a Fuel Oil matrix;

f) CCl_4 and TCE on VOST cartridges.

Results from analysis of chloride and inorganic (Fe & Al) containing QC samples spiked at various target levels showed

good recoveries, with an average percent recovery of 103% for chlorides and 119% for the inorganics. HSE-9 did not have an appropriate Na standard when these QC samples were spiked; therefore, a QC sample for Na was not submitted.

The average percent recovery for the liquid mixture feed containing QC sample was 87%. Two sets of organic in water QC samples were submitted. Average percent recoveries were 167% and 58% for CCl_4, and 56% and 126% for TCE in sets one and two, respectively.

Results for both sets of organic in soil QC samples were inconclusive. A discussion of these results is found in Appendix A.

VOST QC Samples

The original QA/QC protocol suggested that a surrogate chemical compound be added to approximately 10% of the VOST cartridges prior to their being analyzed, so that surrogate data could be used to calculate recovery as a measure of the accuracy of sample preparation and analysis. This scheme was not adhered to, however, because it was felt that artificially spiking these TENAX based cartridges with a surrogate compound dissolved in methanol might inadvertently alter the adsorption properties of the VOST cartridges. It is well known in the chemical literature that the adsorption of some types of compounds onto TENAX will desorb other compounds. Thus, it was decided to insert approximately 10% blind QC samples into the sample batches in lieu of using surrogate spikes. These QC samples were spiked with known concentrations of the two compounds of interest (CCl_4 and TCE). In addition, the EPA provided audit gas samples as another check on the accuracy of the VOST assays.

Three sets of VOST QC audit samples were submitted for analyses. In the first set, a 1000-to-1 dilution error spiked TCE in concentrations much higher than expected in offgas. Average recoveries for this set were 50% for CCl_4 and 5.5% for TCE. The second set was spiked more in range with concentrations actually seen in the offgas samples and showed much better recoveries, averaging 130% for CCl_4 and 127% for TCE. USEPA audit gases were used to spike the third set of VOST QC samples and average recoveries of 78.5% for CCl_4 and 98.6% for TCE resulted.

The EPA samples were gas phase and are therefore considerably more representative of a true stack gas sample than are the samples provided by the HSE-9 QA/QC laboratory. HSE-9's samples were liquid phase spikes which in no way represented real world conditions. This becomes even more clear when the QC results from the two spiking procedures are examined. The EPA gas phase audit samples are within a

few percent of the "True Value" while the liquid phase samples differ in some cases by much greater amounts.

Detailed results for the analysis of all audit samples are presented with a discussion in Appendix A.

4.0 RESULTS

The trial burn was comprised of four test conditions, two of liquid feed and two of solid feed, during which the primary variable was combustion chamber temperature. During conditions 1 and 2 (liquid feed), a total of 1269 lb of CCl_4 and 558 lb of TCE were fed to the incinerator. Total CCl_4 and TCE fed to the incinerator during conditions 3 and 4 (solid feed) was 964 lb and 442 lb, respectively. For the whole of the trial burn, a total of 2233 pounds of CCl_4 and 1000 pounds of TCE was fed to the incinerator.

Principal Organic Hazardous Constituents

Test conditions and results of analysis for the destruction and removal efficiency (DRE) of the principal organic hazardous constituents in the incinerator feed are presented in Tables 1 through 4 of this report.

Particulate Emissions

Test conditions and results of analysis for particulate emissions are presented in Tables 5 through 8 of this report.

Carbon Monoxide and Chloride Emissions

The test conditions and results of analysis for carbon monoxide and chloride emissions are presented along with the particulate emissions results in Tables 5 through 8 of this report.

Data required for the determination of POHC, HCl and particulate emission rates and DRE are located in Appendices A through E and in the Clean Air Engineering, Inc. report on the trial burn, Appendix O of this report.

4.1 SUMMARY OF TEST RESULTS

Destruction and Removal Efficiency (DRE) of POHCs

Destruction and Removal Efficiencies are based on the inlet mass flow rate calculated from waste feed material and the outlet measured mass flow rate.

A. Carbon Tetrachloride (CCl_4)

1) The DRE of CCl_4 during condition 1 exceeded 99.99% for VOST sample periods 1-2, 1-5 and 1-6. The DRE of CCl_4 for periods 1-1, 1-3 and 1-4 can only be expressed as "less than" values and are, therefore, not reported.

2) The DRE of CCl_4 during condition 2 exceeded 99.99% for VOST sample periods 2-1, 2-4, 2-5 and 2-6. The DRE of CCl_4 for periods 2-2 and 2-3 can only be expressed as "less than" values and are, therefore, not reported.

3) The DRE of CCl_4 during condition 3 exceeded 99.99% for all six VOST sample periods.

4) The DRE of CCl_4 during condition 4 exceeded 99.99% for all six VOST sample periods.

B. Trichloroethylene (TCE)

1) The DRE of TCE during condition 1 exceeded 99.9999% for VOST sample periods 1-2, 1-3 and 1-6. The DRE of TCE for periods 1-1, 1-4 and 1-5 can only be expressed as "less than" values and are, therefore, not reported.

2) The DRE of TCE during condition 2 exceeded 99.9999% for VOST sample periods 2-1, 2-4, 2-5 and 2-6. The DRE of TCE for periods 2-2 and 2-3 can only be expressed as "less than" values and are, therefore, not reported.

3) The DRE of TCE during condition 3 exceeded 99.9999% for VOST sample periods 3-5 and 3-6. The DRE of TCE for periods 3-1, 3-2, 3-3 and 3-4 was greater than 99.999% but did not achieve 99.9999%.

4) The DRE of TCE during condition 4 exceeded 99.9999% for five of the six VOST sample periods. The DRE of TCE for period 4-4 was 99.99985%.

Exhaust Stack Particulate Emissions

1) Particulate concentrations (corrected to 7% O_2) were no greater than 0.0110 gr/dscf for all three EPA Method-5 sample periods during condition 1.

2) Particulate concentrations (corrected to 7% O_2) were no greater than 0.0153 gr/dscf for all three EPA Method-5 sample periods during condition 2.

3) Particulate concentrations (corrected to 7% O_2) were no greater than 0.0237 gr/dscf for all three EPA Method-5 sample periods during condition 3.

4) Particulate concentrations (corrected to 7% O_2) were no greater than 0.0244 gr/dscf for all three EPA Method-5 sample periods during condition 4.

Chloride Removal Efficiency

1) The chloride removal efficiency during condition 1 was >99.998% for all three EPA Method-5 sample periods.

1) The chloride removal efficiency during condition 2 was >99.939% for all three EPA Method-5 sample periods.

1) The chloride removal efficiency during condition 3 was >99.623% for all three EPA Method-5 sample periods.

1) The chloride removal efficiency during condition 4 was >99.609% for all three EPA Method-5 sample periods.

Carbon Monoxide (CO) Concentration at the Stack

1) The CO concentration during condition 1 averaged 8 ppmv over the three EPA Method-5 sampling periods.

2) The CO concentration during condition 2 averaged 6 ppmv over the three EPA Method-5 sampling periods.

3) The CO concentration during condition 3 averaged 5 ppmv over EPA Method-5 sampling periods 2 and 3.

4) The CO concentration during condition 4 averaged 6 ppmv over the three EPA Method-5 sampling periods.

TABLE 1A
Summary of Results
Principle Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 4, 1986
Condition 1

Run No.	1-1	1-2	1-3
Start Time (Approx.)	1:10pm	2:00pm	2:43pm
<u>Organic Feed Rate</u>			
CCl_4, (lbm/hr)	65.91	74.80	74.80
TCE, (lbm/hr)	28.50	32.34	32.34
<u>Gas Conditions</u>			
Temperature, (^oF)	209	209	209
Moisture, (Volume %)	35.20	35.20	35.20
O_2, (Volume %)	9.2	9.2	9.2
CO_2, (Volume %)	8.6	8.6	8.6
Density, (lbm/ft^3)	0.0407	0.0407	0.0407
Excess Air, (%)	73.60	73.60	73.60
<u>Gas Flow Rates</u>			
Volume Basis			
acfm	1475	1475	1475
dscfm	586	586	586
Mass Basis			
lbm/hr	3604	3604	3604
<u>Organic Emissions</u>			
CCl_4, (ppbv)	[1]>1.88	65.09	56.14
CCl_4, (lbm/hr)	[1]>2.64E-5	9.13E-4	7.88E-4
TCE, (ppbv)	[1]***	1.81	<0.129
TCE, (lbm/hr)	[1]***	2.17E-5	<1.54E-6
<u>Destruction & Removal Efficiency</u>			
CCl_4, (%)	[1]***	99.99878	99.99895
TCE, (%)	[1]***	99·99993	>99.99999

[1] Analytical detector quenched-
results possibly underestimated.

TABLE 1B
Summary of Results
Principle Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 4, 1986
Condition 1

Run No.	1-4	1-5	1-6
Start Time (Approx.)	3:25pm	6:54pm	7:38pm
<u>Organic Feed Rate</u>			
CCl_4, (lbm/hr)	76.39	76.92	76.92
TCE, (lbm/hr)	33.04	33.30	33.30
<u>Gas Conditions</u>			
Temperature, (^oF)	209	213	213
Moisture, (Volume %)	35.20	36.52	36.52
O_2, (Volume %)	9.2	9.2	9.2
CO_2, (Volume %)	8.6	8.6	8.6
Density, (lbm/ft^3)	0.0407	0.0401	0.0401
Excess Air, (%)	73.60	73.60	73.60
<u>Gas Flow Rates</u>			
Volume Basis			
acfm	1475	1521	1521
dscfm	586	585	585
Mass Basis			
lbm/hr	3604	3654	3654
<u>Organic Emissions</u>			
CCl_4, (ppbv)	[1]>59.18	[1]>52.57	52.43
CCl_4, (lbm/hr)	[1]>8.30E-4	[1]>7.37E-4	7.35E-4
TCE, (ppbv)	[1]***	[1]***	1.588
TCE, (lbm/hr)	[1]***	[1]***	1.90E-5
<u>Destruction & Removal Efficiency</u>			
CCl_4, (%)	[1]***	[1]***	99.99904
TCE, (%)	[1]***	[1]***	99.99994

[1] Analytical detector quenched-
results possibly underestimated.

TABLE 2A
Summary of Results
Principle Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 5, 1986
Condition 2

Run No.	2-1	2-2	2-3
Start Time (Approx.)	9:50am	10:44am	12:16pm
<u>Organic Feed Rate</u>			
CCl_4, (lbm/hr)	78.63	78.63	77.84
TCE, (lbm/hr)	33.17	33.17	32.78
<u>Gas Conditions</u>			
Temperature, (^oF)	216	216	226
Moisture, (Volume %)	32.45	32.45	31.96
O_2, (Volume %)	10.4	10.4	10.4
CO_2, (Volume %)	8.0	8.0	8.0
Density, (lbm/ft^3)	0.0405	0.0405	0.0400
Excess Air, (%)	93.34	93.34	93.34
<u>Gas Flow Rates</u>			
Volume Basis			
acfm	1351	1351	1356
dscfm	550	550	548
Mass Basis			
lbm/hr	3283	3283	3255
<u>Organic Emissions</u>			
CCl_4, (ppbv)	0.62	[1]***	[2]***
CCl_4, (lbm/hr)	8.16E-6	[1]***	[2]***
TCE, (ppbv)	<0.115	[1]***	[2]>0.115
TCE, (lbm/hr)	<1.30E-6	[1]***	[2]>1.29E-6
<u>Destruction & Removal Efficiency</u>			
CCl_4, (%)	99.99999	[1]***	[2]***
TCE, (%)	>99.99999	[1]***	[2]***

[1] Analytical detector quenched-
[2] Sample broken by analytical laboratory-
results possibly underestimated.

TABLE 2B
Summary of Results
Principle Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 5, 1986
Condition 2

Run No.	2-4	2-5	2-6
Start Time (Approx.)	1:02pm	2:48pm	3:27pm
<u>Organic Feed Rate</u>			
CCl_4, (lbm/hr)	77.84	78.37	78.37
TCE, (lbm/hr)	32.78	33.04	33.04
<u>Gas Conditions</u>			
Temperature, (^oF)	226	229	229
Moisture, (Volume %)	31.96	31.99	31.99
O_2, (Volume %)	10.4	10.4	10.4
CO_2, (Volume %)	8.0	8.0	8.0
Density, (lbm/ft^3)	0.0400	0.0398	0.0398
Excess Air, (%)	93.34	93.34	93.34
<u>Gas Flow Rates</u>			
Volume Basis			
acfm	1356	1345	1345
dscfm	548	541	541
Mass Basis			
lbm/hr	3255	3214	3214
<u>Organic Emissions</u>			
CCl_4, (ppbv)	11.98	44.99	62.91
CCl_4, (lbm/hr)	1.57E-4	5.83E-4	8.15E-4
TCE, (ppbv)	1.93	1.32	1.43
TCE, (lbm/hr)	2.17E-5	1.46E-5	1.58E-5
<u>Destruction & Removal Efficiency</u>			
CCl_4, (%)	99.99979	99.99925	99.99896
TCE, (%)	99.99993	99.99996	99.99996

TABLE 3A
Summary of Results
Principle Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 6, 1986
Condition 3

Run No.	3-1	3-2	3-3
Start Time (Approx.)	10:36am	11:17am	5:09pm
Organic Feed Rate			
CCl_4, (lbm/hr)	49.30	49.30	55.77
TCE, (lbm/hr)	24.19	24.19	27.22
Gas Conditions			
Temperature, (^oF)	225	225	216
Moisture, (Volume %)	35.40	35.40	39.47
O_2, (Volume %)	10.1	10.0	10.2
CO_2, (Volume %)	8.0	7.6	7.6
Density, (lbm/ft^3)	0.0396	0.0396	0.0392
Excess Air, (%)	87.66	87.66	85.08
Gas Flow Rates			
Volume Basis			
acfm	1543	1543	1654
dscfm	596	596	604
Mass Basis			
lbm/hr	3669	3669	3888
Organic Emissions			
CCl_4, (ppbv)	22.05	22.46	57.68
CCl_4, (lbm/hr)	3.15E-4	3.20E-4	8.34E-4
TCE, (ppbv)	2.75	2.77	14.80
TCE, (lbm/hr)	3.35E-5	3.38E-5	1.83E-4
Destruction & Removal Efficiency			
CCl_4, (%)	99.99937	99.99935	99.99851
TCE, (%)	99.99986	99.99986	99.99933

TABLE 3B
Summary of Results
Principle Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 6, 1986
Condition 3

Run No.	3-4	3-5	3-6
Start Time (Approx.)	5:56pm	7:24pm	7:57pm
<u>Organic Feed Rate</u>			
CCl_4, (lbm/hr)	55.77	54.05	54.05
TCE, (lbm/hr)	27.22	26.17	26.17
<u>Gas Conditions</u>			
Temperature, (^oF)	216	210	210
Moisture, (Volume %)	39.47	27.36	27.36
O_2, (Volume %)	10.0	10.2	10.2
CO_2, (Volume %)	7.6	7.6	7.6
Density, (lbm/ft^3)	0.0392	0.0418	0.0418
Excess Air, (%)	85.08	88.69	88.69
<u>Gas Flow Rates</u>			
Volume Basis			
acfm	1654	1565	1565
dscfm	604	692	692
Mass Basis			
lbm/hr	3888	3922	3922
<u>Organic Emissions</u>			
CCl_4, (ppbv)	46.01	2.41	29.14
CCl_4, (lbm/hr)	6.65E-4	4.00E-5	4.83E-4
TCE, (ppbv)	6.59	0.066	0.091
TCE, (lbm/hr)	8.14E-5	9.30E-7	1.29E-6
<u>Destruction & Removal Efficiency</u>			
CCl_4, (%)	99.99881	99.99992	99.9991
TCE, (%)	99.99969	99.99999	99.99999

TABLE 4A
Summary of Results
Principle Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 7, 1986
Condition 4

Run No.	4-1	4-2	4-3
Start Time (Approx.)	1:49pm	2:30pm	3:53pm
<u>Organic Feed Rate</u>			
CCl_4, (lbm/hr)	57.36	57.36	58.68
TCE, (lbm/hr)	28.28	28.28	28.41
<u>Gas Conditions</u>			
Temperature, (^oF)	213	213	211
Moisture, (Volume %)	25.37	25.37	25.59
O_2, (Volume %)	12.3	12.3	11.0
CO_2, (Volume %)	5.9	5.9	7.0
Density, (lbm/ft^3)	0.0419	0.0419	0.0421
Excess Air, (%)	132.33	132.33	103.31
<u>Gas Flow Rates</u>			
Volume Basis			
acfm	1468	1468	1538
dscfm	666	666	698
Mass Basis			
lbm/hr	3685	3685	3886
<u>Organic Emissions</u>			
CCl_4, (ppbv)	54.73	5.96	27.23
CCl_4, (lbm/hr)	8.73E-4	9.50E-5	4.55E-4
TCE, (ppbv)	0.595	<0.118	0.441
TCE, (lbm/hr)	8.10E-6	<1.61E-6	6.31E-6
<u>Destruction & Removal Efficiency</u>			
CCl_4, (%)	99.99848	99.99983	99.99922
TCE, (%)	99.99997	>99.99999	99.99998

TABLE 4B
Summary of Results
Principle Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 7, 1986
Condition 4

Run No.	4-4	4-5	4-6
Start Time (Approx.)	4:38pm	6:09pm	6:46pm
<u>Organic Feed Rate</u>			
CCl_4, (lbm/hr)	58.68	61.59	61.59
TCE, (lbm/hr)	28.41	30.13	30.13
<u>Gas Conditions</u>			
Temperature, (^oF)	211	202	202
Moisture, (Volume %)	25.59	26.07	26.07
O_2, (Volume %)	11.0	10.2	10.2
CO_2, (Volume %)	7.0	8.0	8.0
Density, (lbm/ft^3)	0.0421	0.0427	0.0427
Excess Air, (%)	103.31	89.51	89.51
<u>Gas Flow Rates</u>			
Volume Basis			
acfm	1538	1536	1536
dscfm	698	701	701
Mass Basis			
lbm/hr	3886	3933	3933
<u>Organic Emissions</u>			
CCl_4, (ppbv)	61.56	59.11	49.36
CCl_4, (lbm/hr)	1.03E-3	9.93E-4	8.29E-4
TCE, (ppbv)	2.910	1.808	1.368
TCE, (lbm/hr)	4.16E-5	2.59E-5	1.96E-5
<u>Destruction & Removal Efficiency</u>			
CCl_4, (%)	99.99824	99.99839	99.99865
TCE, (%)	99.99985	99.99991	99.99993

TABLE 5
Summary of Results
Particulate, CO and HCl Emissions
(EPA Method 5)
September 4, 1986
Condition 1

Run No.	1-1	1-2	1-3
Start Time (Approx.)	1:10pm	6:52pm	9:25pm
Organic Feed Rate			
CCl_4, (lbm/hr)	70.36	76.92	76.92
TCE, (lbm/hr)	30.42	33.30	33.30
Total Chloride (as HCl), (lbm/hr)	92.01	100.63	100.63
Gas Conditions			
Temperature, (^oF)	209	213	212
Moisture, (Volume %)	35.20	36.52	36.60
O_2, (Volume %)	9.2	9.2	9.2
CO_2, (Volume %)	8.6	8.6	8.6
Density, (lbm/ft^3)	0.0407	0.0401	0.0401
Excess Air, (%)	73.60	73.60	73.60
Gas Flow Rates			
Volume Basis			
acfm	1475	1521	1467
dscfm	586	585	565
Mass Basis			
lbm/hr	3605	3654	3528
Particulate Emissions			
gr/dscf	0.0093	0.0056	0.0087
gr/dscf (corr. to 7% O_2)	0.0110	0.0066	0.0103
lbm/hr	0.0466	0.0280	0.0422
Carbon Monoxide Emissions			
ppmv	5	6	7
ppmv (corr. to 12% CO_2)	7	8	17
ppmv (corr. to 50% Excess Air)	6	7	14
lbm/hr	0.013	0.015	0.030
Chloride Emissions (as HCl)			
ppmv	<0.485	<0.489	<0.477
lbm/hr	<0.0016	<0.0016	<0.0015
Chloride Removal Efficiency (%)	>99.998	>99.998	>99.998
Percent Isokinetic (%)	103.91	104.11	104.94

TABLE 6
Summary of Results
Particulate, CO and HCl Emissions
(EPA Method 5)
September 5, 1986
Condition 2

Run No.	2-1	2-2	2-3
Start Time (Approx.)	9:50am	12:20pm	2:40pm
Organic Feed Rate			
CCl_4, (lbm/hr)	78.63	77.84	78.37
TCE, (lbm/hr)	33.17	32.78	33.04
Total Chloride (as HCl), (lbm/hr)	102.14	101.08	101.78
Gas Conditions			
Temperature, (^oF)	216	226	229
Moisture, (Volume %)	32.45	31.96	31.99
O_2, (Volume %)	10.4	10.4	10.4
CO_2, (Volume %)	8.0	8.0	8.0
Density, (lbm/ft^3)	0.0405	0.0400	0.0398
Excess Air, (%)	93.34	93.34	93.34
Gas Flow Rates			
Volume Basis			
acfm	1351	1356	1345
dscfm	550	548	541
Mass Basis			
lbm/hr	3283	3255	3214
Particulate Emissions			
gr/dscf	0.0104	0.0086	0.0116
gr/dscf (corr. to 7% O_2)	0.0137	0.0114	0.0153
lbm/hr	0.0488	0.0405	0.0537
Carbon Monoxide Emissions			
ppmv	5	6	7
ppmv (corr. to 12% CO_2)	8	9	11
ppmv (corr. to 50% Excess Air)	6	8	9
lbm/hr	0.012	0.014	0.017
Chloride Emissions (as HCl)			
ppmv	<0.447	19.76	137.5
lbm/hr	<0.0014	0.0614	0.422
Chloride Removal Efficiency (%)	>99.998	99.939	99.585
Percent Isokinetic (%)	98.60	102.24	101.27

TABLE 7
Summary of Results
Particulate, CO and HCl Emissions
(EPA Method 5)
September 6, 1986
Condition 3

Run No.	3-1	3-2	3-3
Start Time (Approx.)	10:35am	5:07pm	7:27pm
Organic Feed Rate			
CCl_4, (lbm/hr)	49.30	55.77	54.05
TCE, (lbm/hr)	24.19	27.22	26.17
Total Chloride (as HCl), (lbm/hr)	67.01	75.52	72.88
Gas Conditions			
Temperature, (^oF)	225	216	210
Moisture, (Volume %)	35.40	39.47	27.36
O_2, (Volume %)	10.1	10.0	10.2
CO_2, (Volume %)	8.0	7.6	7.6
Density, (lbm/ft^3)	0.0396	0.0392	0.0418
Excess Air, (%)	87.66	85.08	88.69
Gas Flow Rates			
Volume Basis			
acfm	1543	1654	1565
dscfm	596	604	692
Mass Basis			
lbm/hr	3669	3888	3922
Particulate Emissions			
gr/dscf	0.0120	0.0165	0.0183
gr/dscf (corr. to 7% O_2)	0.0154	0.0210	0.0237
lbm/hr	0.0611	0.0852	0.1086
Carbon Monoxide Emissions			
ppmv	[3]	5	5
ppmv (corr. to 12% CO_2)		8	8
ppmv (corr. to 50% Excess Air)		6	6
lbm/hr		0.013	0.015
Chloride Emissions (as HCl)			
ppmv	74.68	33.00	50.40
lbm/hr	0.253	0.113	0.198
Chloride Removal Efficiency (%)	99.623	99.850	99.728
Percent Isokinetic (%)	104.74	105.65	97.96

[3] Data out of range of the upper limit.

TABLE 8
Summary of Results
Particulate, CO and HCl Emissions
(EPA Method 5)
September 7, 1986
Condition 4

Run No.	4-1	4-2	4-3
Start Time (Approx.)	1:50pm	3:57pm	7:10pm
Organic Feed Rate			
CCl_4, (lbm/hr)	57.36	58.68	61.59
TCE, (lbm/hr)	28.28	28.41	30.13
Total Chloride (as HCl), (lbm/hr)	77.93	79.25	83.36
Gas Conditions			
Temperature, (^oF)	213	211	202
Moisture, (Volume %)	25.37	25.59	26.07
O_2, (Volume %)	12.3	11.0	10.2
CO_2, (Volume %)	5.9	7.0	8.0
Density, (lbm/ft^3)	0.0419	0.0421	0.0427
Excess Air, (%)	132.33	103.31	89.51
Gas Flow Rates			
Volume Basis			
acfm	1468	1538	1536
dscfm	666	698	701
Mass Basis			
lbm/hr	3685	3886	3933
Particulate Emissions			
gr/dscf	0.0055	<0.0001	0.0188
gr/dscf (corr. to 7% O_2)	0.0089	<0.0001	0.0244
lbm/hr	0.0315	<0.001	0.1132
Carbon Monoxide Emissions			
ppmv	5	5	7
ppmv (corr. to 12% CO_2)	10	9	11
ppmv (corr. to 50% Excess Air)	8	7	9
lbm/hr	0.015	0.015	0.021
Chloride Emissions (as HCl)			
ppmv	13.0	71.2	82.0
lbm/hr	0.049	0.282	0.326
Chloride Removal Efficiency (%)	99.937	99.644	99.609
Percent Isokinetic (%)	96.30	101.63	103.11

5.0 DISCUSSION

5.1 RESULTS

Destruction and Removal of Carbon Tetrachloride

During analysis of VOST cartridges from condition 1, results from periods 2, 3 and 6 yielded DREs in excess of 99.99%. The samples obtained during runs 1, 4 and 5 quenched the flame in the analytical detector. Emissions for these periods were reported as "greater than" values in the analytical report. Due to this, DREs calculated for these periods can only be reported as "less than" values, and their validity is subject to question. Hence, they are not reported.

During analysis of VOST cartridges from condition 2, analysis of samples from periods 1, 4, 5 and 6 yielded DREs in excess of 99.99%. The sample obtained from run 2 quenched the flame in the analytical detector. The sample container used from run 3 was broken at the analytical laboratory and the sample was lost. Because of this, DREs for these two periods are not reported.

All samples taken during conditions 3 and 4 were analyzed without problems and DREs for CCl_4 calculated for these conditions exceeded 99.99% in all cases.

Destruction and Removal Efficiency of Trichloroethylene

For condition 1, only the analytical results from runs 2, 3 and 6 were used to calculate DREs. DREs for TCE exceeded 99.9999% for these periods. The samples obtained from runs 1, 4 and 5 quenched the flame in the analytical detector.

For condition 2, only the analytical results from runs 1, 4, 5 and 6 were used to calculate DREs. DREs for TCE exceeded 99.9999% for these periods. The sample obtained from run 2 quenched the flame in the analytical detector and the sample from run 3 was broken and could not be analyzed.

Results were obtained from the analysis of all the samples from condition 3. DREs of TCE exceeded 99.9999% for runs 5 and 6. DREs for runs 1, 2, 3 and 4 fell near, but below, 99.9999%.

Results were obtained from the analysis of all the samples from condition 4. The only run for which the DRE of TCE did not exceed 99.9999% was period 4.

Problems with DRE of TCE During Condition 3

In comparing differences in the CAI process behavior during conditions 3 and 4 to determine why DRE performance standards were not met in runs 1-4 of condition 3, the following observations can be made:

a) Primary chamber temperatures averaged ca. 1675°F for day 3 and 1460°F for day 4;

b) Secondary chamber temperatures were steady at 2200°F for day 3 and 2000°F for day 4.

c) The percentage of O_2 in the secondary chamber offgas averaged ca. 7% on day 3 and 10% on day 4.

The lower temperatures in the primary combustion chamber during condition 4 might have served to allow smoother, less energetic volatilization of the organics in the solid feed matrix than was the case in condition 3. In addition, the lower temperatures in both primary and secondary chambers would have allowed a longer residence time for more complete destruction of the TCE.

A higher percentage of excess air during condition 4, and hence a higher SCC O_2 level, would also be expected to produce a favorable shift towards complete combustion of the solids.

Process conditions during run 4 of condition 4 did not differ significantly from those of the other periods during that day, when DRE performance standards of >99.9999% were met. No explanation presents itself for this anomaly.

Particulate Emissions at the Stack

The EPA Method 5 sample train was modified by replacing the water in the impingers with 0.1 N sodium hydroxide to enhance the collection of chlorides from the gas stream. For this reason, the condensed moisture was measured gravimetrically and not volumetrically.

The first and last traverse points were adjusted to 1 inch away from the duct wall. The volume of gas metered during run 1, condition 1, was adjusted down by 0.12 ft^3 because of a leak check run on the sample train between points 1-1 and 1-2.

Carbon Monoxide Concentrations at the Stack

During conditions 1, 2 and 4, the CO concentrations averaged 10 ppmv when corrected to 12% CO_2 in the stack gas. During run 1, condition 3, the CO concentration exceeded the upper

limit of the detector and chart recorder. This corresponded to, and was a result of, an inadvertent reduction in the amount of steam injection into the primary chamber during this period (see Appendix B). The chart recorder system was calibrated so that the upper limit was approximately 500 ppmv CO. Following renewal of steam injection, the CO concentration dropped to an average of about 10 ppmv when corrected to 12% CO_2 during runs 2 and 3. During run 2, two peaks were noted. At actual stack conditions, the first peak of 70 ppmv occured at 5:16 pm and the second peak of 63 ppmv occured at 5:29 pm.

These results were determined by continuous gas sample analysis employing the NDIR and procedures outlined in EPA Method 10. Problems in the operation and calibration of the FID instrument made its results somewhat suspect and no assessment of comparative accuracy of the two instruments or methods is possible at this time.

Gaseous Chloride Emissions

During condition 1, gaseous chloride concentrations were below the detectable limit of 0.5 ppmv. During condition 2, gaseous chloride concentrations rose from <0.5 ppmv during run 1 to 137 ppmv during run 3.

During condition 3, gaseous chloride concentrations averaged 53 ppmv over the three runs. During condition 4, gaseous chloride concentrations went from 13 ppmv during run 1 to 82 ppmv during run 3.

The scrubber discharge liquid (process sump) pH during the trial burn varied between values of 1.4 to 12.6. Mean pH during sampling periods ranged from 2.6 to 8.8. The average pH over the total of all trial burn sample periods was 4.7. In all cases, gaseous chloride emissions were well below 4 lb/hr and scrubber HCl removal efficiency exceeded 99%.

5.2 EXCEPTIONS TO THE TRIAL BURN PLAN (Appendix I)

The following are exceptions to the Trial Burn Plan, Appendix J of the Los Alamos Part B Application of November 1986, Revision 1.0, of October 1985 (Appendix I in this report):

a) Page 7, Table 1--Automatic feed cutoff parameters have been changed to include Minumum SCC temperature, Maximum CO concentration, Minimum SCC O_2 (%), Minimum scrub solution pH, and Maximum combustion gas velocity. Minimum and maximum values for automatic feed cutoff parameters have been adjusted as discussed in section 7, "Proposed Permit Conditions."

Minimum Primary Combustion Chamber temperature varies with the feed rate and excess O_2 and should not be a feed cutoff parameter. Minimum and maximum HEPA filter pressure drop are nuclear safety concerns and it is therefore not appropriate to address this parameter in chemical operations. HEPA filters must be certified through DOP testing (see Appendix G) by an independent auditing organization at LANL before the CAI is allowed to operate; therefore, permit restrictions on HEPA filter pressure drop would be unnecessary and redundant.

b) Page 10, #7--CO monitoring was performed with a Horiba NDIR analyzer using EPA Method 10 technique. The offgas sample point was at the duct prior to the stack (point #10 of Fig. 5, page 17) rather than between the reheater and HEPA filter banks.

c) Page 19, i.--Problems with the FID analyzer did not allow confirmation of ORSAT stack gas analysis.

d) Page 33, #3--Twelve EPA Method 5 sampling runs were made, 3 replicates for each of the four test conditions. A total of 24 VOST sampling runs were made, 6 replicates for each test condition.

e) Page 34, Table 5--CCl_4 and TCE accounted for about 65% by weight of the liquid feed. Ash content was approx. 0.25 % by weight.

f) Page 35, Table 6--Pel-E-Cel, a commercial cellulosic absorbent made from corncob, was substituted for sawdust.

g) Page 36, Table 7 & page 39, #2--Sampling run duration was 80 minutes for EPA Method 5 and 20 minutes for VOST.

h) Page 39, #3--Actual consumption of test wastes totaled 2233 lb of CCl_4 and 1000 lb of TCE for all four test conditions.

i) Page 40, Table 9--The actual test schedule took four days, each day corresponding to a new test condition.

5.3 EXCEPTIONS TO THE QUALITY ASSURANCE PLAN (Appendix J)

The following exceptions were noted to the Quality Assurance Project Plan for a Controlled Air Incinerator Trial Burn of March 1986:

a) Section 3.0--Final combustion temperature in conditions 1 and 3 was 2200 ^{o}F. TCE was added as a POHC in the feed mixtures.

b) Table 6-1.--Scrubber discharge liquid samples were taken at the beginning, middle and end of each EPA Method 5 run and composited. Since POHC and HCl emission rates were integrated over their entire sample periods, it was felt that the scrubber discharge liquid samples should be a composite of samples taken over the total sample period, and thus be as representative of the average value as possible.

c) Section 11.0--As discussed in section 3.3 of this report, no surrogate spiking of VOST cartridges before analysis was performed. In accordance with section 12.0 of the Quality Assurance Plan (Appendix J), in place of replicate analyses of composited samples, replicate standard reference materials were submitted for analysis to monitor instrument precision and accuracy.

5.4 Demonstration of Waste Feed Cutoff System

On February 20, 1987 a system checkout of waste stream shutdown circuits was performed by TDF personnel. The control circuits tested were for low SCC temperature, low SCC O_2 concentration, low process liquid pH, and high offgas CO concentration. Simulated out-of-compliance operating conditions were generated by substituting a variable current source as input to control circuits, in place of actual thermocouples/transducers. Current sources were then varied to simulate a change in value of the system parameter of interest, causing a trip in the corresponding control relay. When current levels varied outside the setpoint value, the waste liquid shutoff valve serving the liquid burner was observed to close. Coil voltage for the timer in the solid waste feeding circuit was observed to drop from 117 VAC to 0.0 VAC, dropping out the timer and serving to interrupt the solid waste feeding system.

Detailed documentation of the waste feed cutoff system checkout is included in Appendix B.

6.0 SOURCES OF FUGITIVE EMISSIONS

The Treatment Development Facility (TDF) ventilation control zones and filtered exhaust systems, designed initially for plutonium confinement and modified for fission/activation product and hazardous materials processing, are also effective in confining and containing fugitive emmissions from volatile liquid processing operations.

There are two primary sources of possible fugitive emissions of volatile compounds in the TDF process area: 1) the liquid feed preparation room, and 2) the Controlled Air Incinerator itself.

Ventilation Zone Concept

The process areas on the first floor of the TDF are divided into three ventilation zones, with the non-process areas designated as a fourth zone. The zones are separated from each other by physical barriers and pressure gradients to minimize the possibility of the spread of contaminants. Progressing from Zone 4, ambient atmosphere, each succeeding zone is held at an increasingly greater negative pressure as the probability of the existence of contaminants increases. Zone 3 is defined as the process area entrances and consists of the change rooms, Health Physics area, halls, control room, the shipping and receiving area, and the equipment egress bay. These areas are held at negative air pressures with respect to the ambient atmospheric pressures of Zone 4.

Zone 2 is defined as the areas surrounding the process equipment, vessels, and tanks. Air is supplied to the Zone 2 incinerator area via single HEPA filters from the main air supply system and from the Zone 3 shipping/receiving area. In-leakage occurs at the doors separating the two areas to provide confinement and mitigate any flow of contamination to the Zone 3 areas. Air is supplied to the liquid feed preparation Zone 2 area from the surrounding Zone 3 process Bay 2 via a transfer plenum containing a powered louver connected to the fire protection system.

Zone 1 is defined as the interiors of the process equipment, vessels, and tanks. The incinerator and its associated offgas cleanup systems are exhausted through the process HEPA filters and activated carbon bed. The air from the liquid feed preparation room and the barrel exhaust hood is exhausted via double HEPA filters and an activated carbon filter to the main facility stack (SE-1). The feed mix/blend tank vents are fed directly into this exhaust plenum.

Air from the Bay 1 incinerator Zone 2 and Zone 3 areas is also exhausted via SE-1 after double HEPA filtration. Air

from the Bay 2 Zone 3 process area is double HEPA filtered and exhausted via facility stack SE-2.

Liquid Feed Preparation Room

During periods in which volatile chemical compounds are stored in the liquid feed preparation room, a 200 SCFM exhaust blower is in operation to supplement the normal negative zone pressure gradient. During liquid transfer and feeding operations, and any time when there is an increased possibility of airborne vapors present, a 1000 SCFM exhaust blower is also in operation to ensure capture of fugitive vapors and their exhaust through the room HEPA and carbon bed filters.

Controlled Air Incinerator

During actual incinerator operation, the process induced draft blower holds the primary and secondary chambers of the CAI at a negative pressure (approximately -2 in. WC) with respect to the surrounding Zone 2. Should a process upset result in a pressurization of the combustion chambers for more than a five second period, a controlled shutdown of the process will occur, stopping waste feed. The shutdown delay is necessary to allow for momentary "puffing" of the CAI chamber pressure during periods following the initial batch feeding of solid materials. This behavior is to be expected during solids feeding and more rigorous restrictions would result in unnecessary process shutdowns.

7.0 PROPOSED PERMIT CONDITIONS

Based on the foregoing Trial Burn Results, the following operating conditions and parameters have been shown to achieve or exceed the performance standards of 40 CFR 264.343 and are recommended as conditions for permitted operation of the Los Alamos Controlled Air Incinerator when burning RCRA hazardous wastes (see Table 9):

7.1 PROPOSED SOLID WASTE PERMIT CONDITIONS

a) Maximum Allowable CO Emissions

The maximum allowable CO concentration in the CAI offgas in ppmv should be 10 times the percent CO_2 concentration. Above this level, the automatic waste feed cutoff will be actuated, timed to suspend waste feed should the CO levels not decrease below this limit within a five (5) minute period. Should CO emissions exceed 500 ppm at any time, waste feed will be automatically stopped without timed delay. This is consistent with the shutoff requirements during PCB incineration at Los Alamos.

Based on trial burn CO_2 levels, the maximum CO concentration would thus be allowed to vary up to a maximum of 90 ppm. Although average CO emissions during the trial burn were much less than these levels, CO "spikes" typically occur during normal incinerator operation. If permitted conditions restrict CO concentrations to the lower levels seen in the trial burn, normal operation can be expected to result in frequent and unnecessary controlled shutdowns of the CAI.

Because the accuracy of the FID could not be certified for CO detection during the trial burn, Los Alamos agrees to employ an NDIR type analyzer for determination of CO concentrations in incinerator offgas when burning RCRA wastes. We intend, however, to gather comparative NDIR and FID data to determine the relative effectiveness of the FID as a process monitoring instrument. Should results appear favorable, substitution of the FID will be submitted for review to the NMEID.

b) Maximum Thermal Duty

The maximum thermal input to the primary chamber of the CAI while achieving performance standards during the trial burn was 1.51 MM BTU/hr. This is the total of waste and auxiliary feeds to the incinerator, and should be the maximum thermal duty permitted for the

Table 9. Recommended Permit Conditions

Parameter	Type of RCRA Permit Solid	Liquid	Explanation
Max. CO in Offgas (ppm)	90/500	90/500	Timed/Immediate (Feed Cutoff)
Max. PCC Thermal Input (MM BTU/hr)	1.51	1.51	
Temperature (oF):			
Primary Chamber	NPC	NPC	
Secondary Chamber	1950-2050	1950-2050	(Feed Cutoff)
Max. Combustion Gas Flow (lb/hr)	3654	3933	(Feed Cutoff)
Minimum O_2 in SCC (%)	7.5	6.0	(Feed Cutoff)
Minumum Scrubber pH	1.0	1.0	(Feed Cutoff)
Venturi Pressure Drop (in. WC)	NPC	NPC	
Waste Feed:			
Appendix VIII Constituents	CCl_4 & Lower	CCl_4 & Lower	
Minimum BTU/lb	NPC	8418	
Waste Feed Rate (lb/hr)	NPC	NPC	
Maximum Organic Chlorine (lb/hr)	81.1	99.4	Total for liquid solid & aqueous
Max. Ash Content (wt%)	NPC	<0.3	Total for liquid and aqueous
Max. Viscosity (SSU)	---	200	
Max. Natural Gas in Primary Chamber (MM BTU/hr)	NPC	NPC	
Water Injection Rate	NPC	NPC	

NPC=Not a Permit Condition

CAI during RCRA hazardous waste incineration. Hazardous wastes containing more incinerable Appendix VIII Constituents than CCl_4 should be allowed to be fed to the CAI in greater amounts than CCl_4, provided that the total thermal input does not exceed the maximum permitted thermal duty and any other restrictions on waste composition are satisfied.

c) Combustion Chamber Temperature

Based on trial burn results, it is recommended that an operating range of 1950-2050 ^{o}F be set for the Secondary Combustion Chamber temperature. Since Primary Combustion Chamber temperature is dependent on feed rate and excess O_2, no permit restriction should be set for this parameter.

d) Combustion Gas Flowrate

The maximum stack gas flowrate established while achieving performance standards during solids incineration was 3933 lb/hr (65.55 lb/min). It is recommended that this be set as the upper limit for permitted operation.

e) Minimum Scrubber pH

Chloride removal efficiencies in the offgas were unaffected by swings in the pH of the process scrubber liquid, which varied from a pH of 1.0 to 10.3 (by analysis). Building sump pH levels were controlled at all times between a pH of 3 and 6.5. Thus, the CAI demonstrated effective control of system waste water pH and gaseous chloride removal efficiency. Based on these results the minimum scrubber liquid pH allowed should be 1.0.

f) Venturi Pressure Drop

Venturi pressure drop should not be specified as a permit condition for particulate control due to the presence of the HEPA filtration system. See discussion in Appendix G.

g) Appendix VIII Constituents

Since the DREs for CCl_4 in the solids trial burn tests 3 & 4 exceeded 99.99%, the permit should allow incineration of all wastes containing CCl_4 and any Appendix VIII Constituents lower than CCl4 on the EPA Ranking of Incinerability List. Since DREs for TCE in solids trial burn 4 were shown to exceed 99.9999%, all F027 compounds lower than CCl4 on the EPA Ranking of Incinerability List should also be allowed when

operating at those same conditions. Thus, all Appendix VIII Constituents at levels above 1000 ppm, with the exception of $CFCl_3$, $CHBr_3$, and CF_2Cl_2, should be allowed. Discussion in Section D-5b(2)(d)(2) of the trial burn plan supports this position.

h) Minimum Heating Value

Per the discussion in Section D-5b(2)(f) of the trial burn plan, since the CAI has auxiliary fuel firing capability in both chambers, no permit requirement should be made which specifies a minimum solids, sludge or slurry heating value. The maximum heat value allowed would be such that the sum total of all feed streams would not exceed the maximum thermal duty of the primary chamber.

i) Solid Waste Feed Rate

The only permit conditions related to the solid waste feed rate should be the maximum allowable primary chamber thermal duty and the primary and secondary chamber temperatures. As long as these permit conditions are met, organic solid wastes should be destroyed at the DRE levels specified in the RCRA regulations.

j) Liquid Waste Feed Rate

As stated in the 1983 Guidance Manual for Hazardous Incinerator Permits, EPA-PB85-100577, on page 4-6, wastes more easily incinerated than CCl_4 should be permitted at rates up to the maximum thermal duty of the primary chamber.

k) Water Feed Rate

Per the discussion on page 46 of the Trial Burn Plan, both RCRA solid and liquid permits should allow the injection into the primary chamber of contaminated water for incineration. Justification is the successful demonstration of flameless oxidation of CCl_4 in the solids trial burn tests. Contaminated water means a liquid containing no less than 90 weight percent of water in which the organic contaminant, if any, is CCl_4 or falls below CCl_4 on the EPA Ranking of Incinerability List.

l) Maximum Organic Chlorine Content of Waste

The permit should allow the maximum organic chlorine feed rate shown by the trial burn results to occur while achieving HCl removal greater than 99%, i.e.- 99.34 lb/hr (102.14 lb/hr as HCl). Since the source of

HCl is irrelevant to the performance of the CAI's air pollution control equipment, either all solid or all liquid or any combination of solid and liquid feed should be allowed.

m) Maximum Ash Content of Waste

There should be no ash content permit condition for incineration of solids in the CAI. Since particulate emission rates were well below the maximum allowed in all periods of the trial burn, this testing should be considered an acceptable particulate test for all solid wastes and sludges.

n) Physical Form of Wastes

The physical form given in the RCRA solid hazardous waste permit should specify solids, sludges, and slurries.

o) Natural Gas Feed Rate

The only permit limit on natural gas feed rate should be the maximum thermal duty. This will allow the substitution of easily incinerated wastes (higher waste heat value) for auxiliary fuel as long as specified operating conditions are maintained. This situation is discussed on page 4-6 of the 1983 Guidance Manual for Hazardous Waste Incinerator Permits, EPA-PB84-100577.

7.2 PROPOSED LIQUID WASTE PERMIT CONDITIONS

a) Maximum Allowable CO Emissions

See previous discussion for solid wastes, Section 7.1.a.

b) Maximum Thermal Duty

The incineration of any combination of liquid, aqueous, and solid/sludge wastes with a total thermal duty equal to the maximum permitted duty (see previous discussion in Section 7.1.b) should be permitted.

c) Combustion Chamber Temperature

Based on trial burn results, it is recommended that an operating range of 1950-2050 ^{o}F be set for the Secondary Combustion Chamber temperature. Since Primary Combustion Chamber temperature is dependent on feed rate and excess O_2, no permit restriction should be set for this parameter.

d) Combustion Gas Flowrate

The maximum stack gas flowrate established while achieving performance standards during liquids incineration was 3654 lb/hr (60.90 lb/min). It is recommended that this be set as the upper limit for permitted operation.

e) Minimum Scrubber pH

See discussion under Solid Wastes Permit Conditions, Section 7.1.e.

f) Venturi Pressure Drop

Venturi pressure drop should not be specified as a permit condition for particulate control due to the presence of the HEPA filtration system. See discussion in Appendix G.

g) Appendix VIII Constituents

Since the liquid feed for trial burn tests 1 and 2 contained CCl_4, the permit should allow incineration of CCl_4 and all wastes containing any Appendix VIII Constituents lower than CCl4 on the EPA Ranking of Incinerability List. Since DREs for TCE in solids trial burn 4 were shown to exceed 99.9999%, all F027 compounds lower than CCl4 on the EPA Ranking of Incinerability List should also be allowed when operating at those same conditions. Thus, all Appendix VIII Constituents at levels above 1000 ppm, with the exception of $CFCl_3$, $CHBr_3$, and CF_2Cl_2, should be allowed. Discussion in Section D-5b(2)(d)(2) of the trial burn plan supports this position.

h) Minimum Heating Value

A minimum heating value of 8418 BTU/lb, based on trial burn liquid feed analyses, should be set as a liquid feed permit condition. Results of analyses of trial burn liquid feed mixtures are presented in Appendix A.

i) Liquid Waste Feed Rate

As stated in the 1983 Guidance Manual on page 4-6, wastes more easily incinerated than CCl_4 and higher than the minimum heat value should be permitted at rates up to the maximum thermal duty of the primary chamber.

j) Water Feed Rate

Per the discussion on page 46 of the Trial Burn Plan (Appendix I), both RCRA solid and liquid permits should allow the injection into the primary chamber of contaminated water for incineration. Justification is the successful demonstration of flameless oxidation of CCl_4 in the solids trial burn tests. Contaminated water means a liquid containing no less than 90 weight percent of water in which the organic contaminant, if any, is CCl_4 or falls below CCl_4 on the EPA Ranking of Incinerability List.

k) Maximum Organic Chlorine Content of Waste

The permit should allow the maximum organic chlorine feed rate shown by the trial burn results to occur while achieving HCl removal greater than 99%, i.e.- 99.34 lb/hr (102.14 lb/hr as HCl). Since the source of HCl is irrelevant to the performance of the CAI's air pollution control equipment, either all solid or all liquid or any combination of solid and liquid feed should be allowed.

l) Maximum Ash Content of Waste

The maximum permitted liquid waste ash content should be that demonstrated during the trial burn, <0.3 weight percent of the feed. Results of analyses of trial burn liquid feed mixtures are presented in Appendix A.

m) Maximum Liquid Feed Viscosity

The CAI employs a National Air Oil Burner Co. model S.A.R. No. O atomizing oil burner for injection of liquid feed into the primary chamber. This burner will accommodate many grades of oils, tars, pitches and asphalts up to a viscosity of 150-200 Saybolt Seconds Universal (see Appendix H). Therefore, the maximum viscosity of liquid waste feed to the CAI allowed shall be no greater than 200 SSU.

n) Physical Form of Wastes

The physical form given in the RCRA liquid hazardous waste permit should specify liquid organic and aqueous wastes.

o) Natural Gas Feed Rate

The only permit limit on natural gas feed rate should be the maximum thermal duty. This will allow the substitution of easily incinerated wastes (higher waste heat value) for auxiliary fuel as long as specified

operating conditions are maintained. This situation is discussed on page 4-6 of the 1983 Guidance Manual.

7.3 WASTE ANALYSIS

In accordance with the Los Alamos Part B Application Waste Characterization and Analysis Plan (Vol 1A, Section 3.0), all waste materials to be incinerated in the CAI will be analyzed for heating value, organic chlorine and ash content. Wastes whose origin and history cannot be determined will also be analyzed for selected parameters such as ignitability, reactivity, pH, EP toxicity, and elemental composition.

7.4 OPERATIONAL INSPECTIONS

Operational inspections of the CAI and process area which are required under RCRA regulations will be conducted in accordance with 40 CFR 264.347(b) and with Section 6 of the Los Alamos Part B Permit Application of November 1986, "Procedures to Prevent Hazards."

7.5 EMERGENCY WASTE FEED CUT-OFF TESTING

Since the CAI is not routinely operating, the emergency waste feed cut-off system will be tested before startup of the CAI during permitted operation while burning RCRA wastes, but not necessarily on a monthly basis.

RCRA TRIAL BURN REPORT: APPENDIX

APPENDIX A. ANALYTICAL RESULTS

1) ANALYSIS FOR POHCs & CHLORIDE IN INCINERATOR FEED

i) Carbon Tetrachloride (CCl_4) Feedstock
ii) Trichloroethylene (TCE) Feedstock
iii) Liquid Mixture Feed (LMF)
iv) Fuel Oil Feed (FOF)
v) Alumagel (ALGL)
vi) Pel-e-cel (PEL)
vii) Caustic Solution (CS)

Analytical Report

Date: 12/01/86

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Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
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Tel. (505)-667-5889

Source of Samples: ----> Burn Test

Sample Sheet # 5425

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96591	46%CT	56235	CCl4	40	%	4
86.12412	LA-1-V-1-CCL4	56235	CCl4	100	%	5
86.12413	LA-1-V-1-TCE	79016	TCE	97	%	5
86.12414	LA-1-V-1-L.M.F.	56235	CCl4	32	%	2
		79016	TCE	16	%	1
		CL	Chloride	1	MG/L	.5
		SOLIDS,DIS	Disolved Solids	12350	MG/L	1235
86.12415	LA-1-V-2-L.M.F.	56235	CCl4	43	%	2
		79016	TCE	21	%	1
		CL	Chloride	8	MG/L	.5
		SOLIDS,DIS	Disolved Solids	5460	MG/L	546
86.12416	LA-1-V-3-L.M.F.	56235	CCl4	40	%	2
		79016	TCE	20	%	1
		CL	Chloride	3	MG/L	.5
		SOLIDS,DIS	Disolved Solids	2630	MG/L	263
86.12417	LA-2-V-1-L.M.F.	56235	CCl4	30	%	3
		79016	TCE	16	%	1
		CL	Chloride	5	MG/L	.5
		SOLIDS,DIS	Disolved Solids	6600	MG/L	660
86.12418	LA-2-V-2-L.M.F.	56235	CCl4	41	%	2
		79016	TCE	20	%	1
		CL	Chloride	3	MG/L	.5
		SOLIDS,DIS	Disolved Solids	5010	MG/L	501
86.12419	LA-2-V-3-L.M.F.	56235	CCl4	46	%	3
		79016	TCE	18	%	1
		CL	Chloride	4	MG/L	.5
		SOLIDS,DIS	Disolved Solids	10550	MG/L	1055

Date: 12/1/86
Approved, Contracting

mag 12-1-86
Date: 12/1/86
Approved, Quality Control

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Source of Samples: ----> Burn Test

Sample Sheet # 5422

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96584	24ug/gCT,32 TCE	56235	CCl4	< 5	UG/L	2
		79016	TCE	< 5	UG/L	2
00.96585	33ug/gCT,25 TCE	56235	CCl4	< 5	UG/L	2
		79016	TCE	< 5	UG/L	2
00.96589	32ug/L CT,40TCE	56235	CCl4	25	UG/L	3
		79016	TCE	34	UG/L	4
00.96590	32ug/L CT,40TCE	56235	CCl4	21	UG/L	3
		79016	TCE	47	UG/L	5
00.96773	20ng/gCT20510TC	56235	CCl4	.1	UG/KG	.1
		79016	TCE	7.8	UG/KG	1
00.96774	38ng/gCT38494TE	56235	CCl4	.1	UG/KG	.1
		79016	TCE	.05	UG/KG	.1
00.96775	20ng/mlCT20280T	56235	CCl4	44	UG/L	4
		79016	TCE	8050	UG/L	805
00.96776	60ng/mlCT60840T	56235	CCl4	69	UG/L	7
		79016	TCE	44000	UG/L	4400
86.10192	LA-1-V-1-F.O.F.	56235	CCl4	< 1	MG/L	1
		79016	TCE	< 1	MG/L	1
		CL	Chloride	< 1.000	MG/L	1.000
86.10193	LA-2-M5-1-ALGL	56235	CCl4	27	UG/KG	3
		79016	TCE	1	UG/KG	1
		CL	Chloride	38.000	UG/G	2.000
86.10194	LA-1-M5-1-ALGL	56235	CCl4	510	UG/KG	51
		79016	TCE	628	UG/KG	63
		CL	Chloride	54.000	UG/G	2.000
86.10195	LA-3,4-V-123PEL	56235	CCl4	82	UG/KG	8
		79016	TCE	70	UG/KG	7
		CL	Chloride	2,610.000	UG/G	130.000
86.10196	LA-3-V-3-I.A.	56235	CCl4	168	UG/KG	16
		79016	TCE	150	UG/KG	15
		CL	Chloride	8,750.000	UG/G	435.000
		PH	pH	9.900	PH UNITS	0.200
86.10197	LA-4-M5-123-I.A	56235	CCl4	2000	UG/KG	200
		79016	TCE	600	UG/KG	60
		CL	Chloride	26,700.000	UG/G	1,335.000
		PH	pH	8.900	PH UNITS	0.200
86.10198	LA-1-V-1-HEPA	56235	CCl4	38	UG/KG	4
		79016	TCE	< 1	UG/KG	1

		CL	Chloride		9.000	UG/G	1.000
		PH	pH		8.300	PH UNITS	0.200
86.10199	LA-4-V-3-HEPA4	56235	CCl4	150		UG/KG	15
		79016	TCE	10		UG/KG	1
		CL	Chloride		87,700.000	UG/G	4,335.000
		PH	pH		5.900	PH UNITS	0.200

Date: 12/1/86

Approved, Contracting

Date: 12/1/86

Approved, Quality Control

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Source of Samples: ----> Burn Test

Sample Sheet # 5423

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96767	80.8 ppm	CL	Chloride	83.000	MG/L	1.000
86.10186	LA-1-V-1-C.S.	CL	Chloride	1,050.000	MG/L	1.000
86.10187	LA-2-V-1-C.S.	CL	Chloride	1,050.000	MG/L	1.000
86.10188	LA-2-V-3-C.S.	CL	Chloride	1,375.000	MG/L	1.000
86.10189	LA-3-V-1-C.S.	CL	Chloride	950.000	MG/L	1.000
[illegible].10190	LA-3-V-2-C.S.	CL	Chloride	1,300.000	MG/L	1.000
[illegible].10191	LA-4-V-123-C.S.	CL	Chloride	1,350.000	MG/L	1.000

Date: 12/1/86
Approved, Contracting

Date: 12/1/86
Approved, Quality Control

APPENDIX A. ANALYTICAL RESULTS

2) ANALYSIS FOR POHCs & CHLORIDE IN EFFLUENTS

i) Offgas (VOST-T,TC & M5-IMP)
ii) Scrubber Discharge Liquid (SDL)
iii) Activated Charcoal (ACF & ACU)
iv) Makeup Water (MW)
v) Incinerator Ash (IA)
vi) HEPA Filters (HEPA & HEPA4)

Analytical Report

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Source of Samples: ----> Burn Test

Sample Sheet # 5379

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96586	4800ngCT,280TCE	56235	CCl4	2900	NG	299
		79016	TCE	240	NG	24
00.96587	220ngCT,4500TCE	56235	CCl4	330	NG	33
		79016	TCE	4800	NG	488
00.96588	800ngCT,1100TCE	56235	CCl4	1440	NG	144
		79016	TCE	2100	NG	210
.96770	20ngCT,20280TCE	56235	CCl4	8	NG	1
		79016	TCE	1150	NG	115
00.96771	10ngCT,10140TCE	56235	CCl4	5.6	NG	1
		79016	TCE	499	NG	50
00.96772	40ngCT,40560TCE	56235	CCl4	Broken	NG	
		79016	TCE		NG	
86.12449	1-V-1-T,TC	56235	CCl4	> 188	NG	19
		79016	TCE	Det Quenched	NG	
86.12450	1-V-2-T,TC	56235	CCl4	6780	NG	678
		79016	TCE	161	NG	16
86.12451	1-V-3-T,TC	56235	CCl4	5110	NG	511
		79016	TCE	< 10	NG	1
86.12452	1-V-4-T,TC	56235	CCl4	> 5760	NG	576
		79016	TCE	Det Quenched	NG	
86.12453	1-V-5-T,TC	56235	CCl4	> 5410	NG	541
		79016	TCE	Det Quenched	NG	
86.12454	1-V-6-T,TC	56235	CCl4	5410	NG	541
		79016	TCE	140	NG	14
86.12455	1-V-(1-6)-T,TC	56235	CCl4	< 10	NG	1
		79016	TCE	3	NG	1
86.12456	2-V-1-T,TC	56235	CCl4	63	NG	6
		79016	TCE	< 10	NG	1
86.12457	2-V-2-T,TC	56235	CCl4	Det Quenched	NG	
		79016	TCE		NG	
86.12458	2-V-3-T,TC	56235	CCl4	Broken	NG	
		79016	TCE	< 10	NG	1
.12459	2-V-4-T,TC	56235	CCl4	1190	NG	119
		79016	TCE	164	NG	16
86.12460	2-V-5-T,TC	56235	CCl4	4580	NG	458
		79016	TCE	115	NG	12
86.12461	2-V-6-T,TC	56235	CCl4	5660	NG	566
		79016	TCE	110	NG	12

86.12462	2-V-(1-6)-T,TC	56235	CCl4		8	NG	1
		79016	TCE	<	10	NG	1
86.12463	3-V-1-T,TC	56235	CCl4		2170	NG	217
		79016	TCE		231	NG	23
86.12464	3-V-2-T,TC	56235	CCl4		2230	NG	223
		79016	TCE		235	NG	23
86.12465	3-V-3-T,TC	56235	CCl4		5660	NG	566
		79016	TCE		1240	NG	124
86.12466	3-V-4-T,TC	56235	CCl4		4440	NG	444
		79016	TCE		543	NG	54
86.12467	3-V-5-T,TC	56235	CCl4		258	NG	26
		79016	TCE		6	NG	1
86.12468	3-V-6-T,TC	56235	CCl4		2993	NG	300
		79016	TCE		8	NG	1
86.12469	3-V-(1-6)-T,TC	56235	CCl4	<	10	NG	1
		79016	TCE	<	10	NG	1
86.12470	4-V-1-T,TC	56235	CCl4		5600	NG	560
		79016	TCE		52	NG	5
86.12471	4-V-2-T,TC	56235	CCl4		590	NG	59
		79016	TCE	<	10	NG	1
86.12472	4-V-3-T,TC	56235	CCl4		2600	NG	260
		79016	TCE		36	NG	4
86.12473	4-V-4-T,TC	56235	CCl4		5200	NG	520
		79016	TCE		210	NG	21
86.12474	4-V-5-T,TC	56235	CCl4		6200	NG	620
		79016	TCE		162	NG	16
86.12475	4-V-6-T,TC	56235	CCl4		4900	NG	490
		79016	TCE		116	NG	12
86.12476	4-V-(1-6)-T,TC	56235	CCl4	<	10	NG	1
		79016	TCE	<	10	NG	1
86.12477	(1-4)-V-1-T,TCA	56235	CCl4	<	10	NG	1
		79016	TCE		502	NG	50
86.12478	(1-4)-V-2-T,TCA	56235	CCl4	<	10	NG	1
		79016	TCE		605	NG	61
86.12479	(1-4)-V-3-T,TCA	56235	CCl4	<	10	NG	1
		79016	TCE		614	NG	61
86.12480	(1-4)-V-4-T,TCA	56235	CCl4		615	NG	62
		79016	TCE	<	10	NG	1
86.12481	(1-4)-V-5-T,TCA	56235	CCl4			NG	
		79016	TCE		Broken	NG	
86.12482	(1-4)-V-6-T,TCA	56235	CCl4		730	NG	73
		79016	TCE	<	10	NG	1
86.12483	(1-4)V-ALL-T,TC	56235	CCl4	<	10	NG	1
		79016	TCE	<	10	NG	1

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Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ----> Burn Test

Sample Sheet # 5377

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result		Units	Uncertainty +/-
00.96768	25.9 ppm	CL	Chloride		27.000	MG/L	1.000
00.96769	12.9 ppm	CL	Chloride		13.000	MG/L	1.000
86.12420	PA1234M5123IMPB	CL	Chloride	<	1.000	MG/L	1.000
86.12421	LA-1-M5-1-IMP	CL	Chloride	<	1.000	MG/L	1.000
86.12422	LA-1-M5-2-IMP	CL	Chloride	<	1.000	MG/L	1.000
86.12423	LA-1-M5-3-IMP	CL	Chloride	<	1.000	MG/L	1.000
86.12424	LA-2-M5-1-IMP	CL	Chloride	<	1.000	MG/L	1.000
86.12425	LA-2-M5-2-IMP	CL	Chloride		48.000	MG/L	1.000
86.12426	LA-2-M5-3-IMP	CL	Chloride		325.000	MG/L	1.000
86.12427	LA-3-M5-1-IMP	CL	Chloride		168.000	MG/L	1.000
86.12428	LA-3-M5-2-IMP	CL	Chloride		72.000	MG/L	1.000
86.12429	LA-3-M5-3-IMP	CL	Chloride		148.000	MG/L	1.000
86.12430	LA-4-M5-1-IMP	CL	Chloride		42.000	MG/L	1.000
86.12431	LA-4-M5-2-IMP	CL	Chloride		220.000	MG/L	1.000
86.12432	LA-4-M5-3-IMP	CL	Chloride		270.000	MG/L	1.000

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MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ----> Burn Test

Sample Sheet # 5424

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
86.12400	LA-1-V-1-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.14	UG/L	.1
		CL	Chloride	14,000.000	MG/L	700.000
		PH	pH	10.300	PH UNITS	0.200
86.12401	LA-1-V-2-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	18,000.000	MG/L	900.000
		PH	pH	2.900	PH UNITS	0.200
86.12402	LA-1-V-3-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.21	UG/L	.1
		CL	Chloride	26,000.000	MG/L	1,300.000
		PH	pH	2.400	PH UNITS	0.200
86.12403	LA-2-V-1-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	13,000.000	MG/L	650.000
		PH	pH	2.200	PH UNITS	0.200
86.12404	LA-2-V-2-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.57	UG/L	.1
		CL	Chloride	25,000.000	MG/L	1,250.000
		PH	pH	1.800	PH UNITS	0.200
86.12405	LA-2-V-3-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.18	UG/L	.1
		CL	Chloride	28,000.000	MG/L	1,400.000
		PH	pH	1.600	PH UNITS	0.200
86.12406	LA-3-V-1-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.43	UG/L	.1
		CL	Chloride	20,000.000	MG/L	1,000.000
		PH	pH	1.000	PH UNITS	0.200
86.12407	LA-3-V-2-S.D.L.	56235	CCl4	.14	UG/L	.1
		79016	TCE	.64	UG/L	.1
		CL	Chloride	9,000.000	MG/L	450.000
		PH	pH	3.500	PH UNITS	0.200
86.12408	LA-3-V-3-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.59	UG/L	.1
		CL	Chloride	19,000.000	MG/L	950.000
		PH	pH	4.100	PH UNITS	0.200
86.12409	LA-4-V-1-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.43	UG/L	.1

		CL	Chloride		12,000.000	MG/L		600.000
		PH	pH		2.000	PH UNITS		0.200
86.12410	LA-4-V-2-S.D.L.	56235	CCl4	<	.12	UG/L	.1	
		79016	TCE		.57	UG/L	.1	
		CL	Chloride		18,000.000	MG/L		900.000
		PH	pH		207.000	PH UNITS		0.200
86.12411	LA-4-V-3-S.D.L.	56235	CCl4	<	.12	UG/L	.1	
		79016	TCE		.35	UG/L	.1	
		CL	Chloride		22,000.000	MG/L		550.000
		PH	pH		1.900	PH UNITS		0.200

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Analytical Report

Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ----> Burn Test

Sample Sheet # 5378

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96764	6.4 ppm	CL	Chloride	7.000	MG/L	1.000
00.96765	3.2 ppm	CL	Chloride	3.600	MG/L	1.000
00.96766	12.9 ppm	CL	Chloride	14.500	MG/L	1.000
86.12433	LA-1-V-A.C.(F)	56235	CCl4	990	UG/KG	99
		79016	TCE	< 1	UG/KG	1
		CL	Chloride	2,300.000	UG/G	1.000
		PH	pH	9.900	PH UNITS	0.200
86.12434	LA-12V123-AC(U)	56235	CCl4	< 1	UG/KG	1
		79016	TCE	35	UG/KG	4
		CL	Chloride	9,780.000	UG/G	1.000
		PH	pH	5.700	PH UNITS	0.200
86.12435	LA-3-V-3-AC.(U)	56235	CCl4	1100	UG/KG	110
		79016	TCE	58	UG/KG	6
		CL	Chloride	30,100.000	UG/G	1.000
		PH	pH	6.000	PH UNITS	0.200
86.12436	LA-4-V-123-AC(U	56235	CCl4	620	UG/KG	62
		79016	TCE	110	UG/KG	11
		CL	Chloride	12,550.000	UG/G	1.000
		PH	pH	4.900	PH UNITS	0.200
86.12437	LA-1-V-1-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12438	LA-1-V-2-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12439	LA-1-V-3-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12440	LA-2-V-1-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12441	LA-2-V-2-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12442	LA-2-V-3-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12443	LA-3-V-1-M.W.	56235	CCl4	< .1	UG/L	.1

		79016	TCE	<	.12		UG/L	.1	
		CL	Chloride			3.000	MG/L		1.000
86.12444	LA-3-V-2-M.W.	56235	CCl4	<	.1		UG/L	.1	
		79016	TCE	<	.12		UG/L	.1	
		CL	Chloride			3.000	MG/L		1.000
86.12445	LA-3-V-3-M.W.	56235	CCl4	<	.1		UG/L	.1	
		79016	TCE	<	.12		UG/L	.1	
		CL	Chloride			3.000	MG/L		1.000
86.12446	LA-4-V-1-M.W.	56235	CCl4		.2		UG/L	.1	
		79016	TCE		.13		UG/L	.1	
		CL	Chloride			3.000	MG/L		1.000
86.12447	LA-4-V-2-M.W.	56235	CCl4		.2		UG/L	.1	
		79016	TCE		.13		UG/L	.1	
		CL	Chloride			3.000	MG/L		1.000
86.12448	LA-4-V-3-M.W.	56235	CCl4		.2		UG/L	.1	
		79016	TCE	<	.12		UG/L	.1	
		CL	Chloride			3.000	MG/L		1.000

Date: 12/1/86

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Date: 12/01/86

: John Vavruska
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From: Larry R. Field
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Tel. (505)-667-5889

Source of Samples: ----> Burn Test

Sample Sheet # 5422

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96584	24ug/gCT,32 TCE	56235	CCl4	< 5	UG/L	2
		79016	TCE	< 5	UG/L	2
00.96585	33ug/gCT,25 TCE	56235	CCl4	< 5	UG/L	2
		79016	TCE	< 5	UG/L	2
00.96589	32ug/L CT,40TCE	56235	CCl4	25	UG/L	3
		79016	TCE	34	UG/L	4
00.96590	32ug/L CT,40TCE	56235	CCl4	21	UG/L	3
		79016	TCE	47	UG/L	5
00.96773	20ng/gCT20510TC	56235	CCl4	.1	UG/KG	.1
		79016	TCE	7.8	UG/KG	1
00.96774	38ng/gCT38494TE	56235	CCl4	.1	UG/KG	.1
		79016	TCE	.05	UG/KG	.1
00.96775	20ng/mlCT20280T	56235	CCl4	44	UG/L	4
		79016	TCE	8050	UG/L	805
00.96776	60ng/mlCT60840T	56235	CCl4	69	UG/L	7
		79016	TCE	44000	UG/L	4400
86.10192	LA-1-V-1-F.O.F.	56235	CCl4	< 1	MG/L	1
		79016	TCE	< 1	MG/L	1
		CL	Chloride	< 1.000	MG/L	1.000
86.10193	LA-2-M5-1-ALGL	56235	CCl4	27	UG/KG	3
		79016	TCE	1	UG/KG	1
		CL	Chloride	38.000	UG/G	2.000
86.10194	LA-1-M5-1-ALGL	56235	CCl4	510	UG/KG	51
		79016	TCE	628	UG/KG	63
		CL	Chloride	54.000	UG/G	2.000
86.10195	LA-3,4-V-123PEL	56235	CCl4	82	UG/KG	8
		79016	TCE	70	UG/KG	7
		CL	Chloride	2,610.000	UG/G	130.000
86.10196	LA-3-V-3-I.A.	56235	CCl4	168	UG/KG	16
		79016	TCE	150	UG/KG	15
		CL	Chloride	8,750.000	UG/G	435.000
		PH	pH	9.900	PH UNITS	0.200
6.10197	LA-4-M5-123-I.A	56235	CCl4	2000	UG/KG	200
		79016	TCE	600	UG/KG	60
		CL	Chloride	26,700.000	UG/G	1,335.000
		PH	pH	8.900	PH UNITS	0.200
86.10198	LA-1-V-1-HEPA	56235	CCl4	38	UG/KG	4
		79016	TCE	< 1	UG/KG	1

		CL	Chloride		9.000	UG/G	1.000
		PH	pH		8.300	PH UNITS	0.200
86.10199	LA-4-V-3-HEPA4	56235	CCl4	150		UG/KG	15
		79016	TCE	10		UG/KG	1
		CL	Chloride		87,700.000	UG/G	4,335.000
		PH	pH		5.900	PH UNITS	0.200

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APPENDIX A. ANALYTICAL RESULTS

3) ANALYSIS OF PARTICULATE IN OFFGAS

Analytical Report

Date: 12/01/86

: John Vavruska
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Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ----> Burn Test

Sample Sheet # 5421

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
86.10161	LANL-1-M5-1	AL	Al	5.300	MG/L	0.100
		FE	Fe	3.200	MG/L	0.100
		NA	Na	2.500	MG/L	0.100
86.10162	LANL-1-M5-2	AL	Al	6.700	MG/L	0.100
		FE	Fe	5.000	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
.10163	LANL-1-M5-3	AL	Al	5.700	MG/L	0.100
		FE	Fe	2.500	MG/L	0.100
		NA	Na	2.100	MG/L	0.100
86.10164	LANL-2-M5-1	AL	Al	2.300	MG/L	0.100
		NA	Na	2.100	MG/L	0.100
86.10165	LANL-2-M5-2	AL	Al	3.500	MG/L	0.100
		FE	Fe	7.600	MG/L	0.100
		NA	Na	2.000	MG/L	0.100
86.10166	LANL-2-M5-3	AL	Al	3.600	MG/L	0.100
		FE	Fe	22.200	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
86.10167	LANL-3-M5-1	AL	Al	3.400	MG/L	0.100
		FE	Fe	26.200	MG/L	0.100
		NA	Na	2.200	MG/L	0.100
86.10168	LANL-3-M5-2	AL	Al	3.700	MG/L	0.100
		FE	Fe	31.100	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
86.10169	LANL-3-M5-3	AL	Al	3.100	MG/L	0.100
		FE	Fe	51.200	MG/L	0.100
		NA	Na	2.300	MG/L	0.100
86.10170	LANL-4-M5-1	AL	Al	4.100	MG/L	0.100
		FE	Fe	18.400	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
86.10171	LANL-4-M5-2	AL	Al	3.300	MG/L	0.100
		FE	Fe	29.300	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
.10172	LANL-4-M5-3	AL	Al	5.400	MG/L	0.100
		FE	Fe	65.600	MG/L	0.100
		NA	Na	2.200	MG/L	0.100
86.10173	BLANK	AL	Al	8.100	MG/L	0.100
		FE	Fe	0.600	MG/L	0.100
		NA	Na	1.700	MG/L	0.100

86.12484	Fe= 0.099 mg/L	AL	Al	<	0.100	MG/L	0.100
		FE	Fe		0.120	MG/L	0.100
		NA	Na		6.900	MG/L	0.100
86.12485	Fe=.08Al=.45mgL	AL	Al		0.500	MG/L	0.100
		FE	Fe		0.100	MG/L	0.100
		NA	Na		0.100	MG/L	0.100

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APPENDIX A. ANALYTICAL RESULTS

4) ANALYSIS FOR HEAT CONTENT, ASH, DENSITY, ELEMENTAL & MATRIX CONSTITUENTS

i) Fuel Oil (FOF)
ii) Liquid Mixture Blend (LMF)

ANALYSIS FOR HEAT CONTENT, ASH, DENSITY, ELEMENTAL & MATRIX CONSTITUENTS

Note: Data contained in this section was unavailable at the time of submission of the the Raw Data report to the New Mexico Environmental Improvement Division.

UNIVERSITY OF CALIFORNIA
CAE Project No: 3770

Analysis of Liquid Waste Feed Samples

	Fuel Oil	Waste Feed					
	1-V-1 F.O.F	1-V-1 L.M.F	1-V-2 L.M.F	1-V-3 L.M.F	2-V-1 L.M.F	2-V-2 L.M.F	2-V-3 L.M.F
Btu	19028	8418	8569	8675	8512	8586	8522
% C	87.97	33.97	34.73	33.89	34.42	35.58	34.41
% H	11.94	5.03	4.31	4.87	4.85	4.17	4.66
% N	0.11	0.08	0.12	0.07	0.07	0.17	0.11
% O	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
% S	0.37	0.13	0.09	0.05	0.14	0.08	0.09
% Cl	0.92	60.59	60.50	60.90	60.31	59.73	60.50
% Asn	<0.1	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Density	0.85396	1.20545	1.20485	1.19982	1.20082	1.20781	1.2001
% CCl_4		42.29	50.09	48.85	49.06	48.27	49.15
% TCE		19.90	18.26	20.62	19.64	19.23	19.62
% Fuel Oil		30.82	31.64	30.53	31.31	32.50	31.22

	ASTM Method
Carbon, Hydrogen	3178
Nitrogen	3179
Sulfur	3177
Btu	2015 - with modification to contain volatile vapors
Chlorine	4208
Density	weight/unit val @ 20°C
% CCl_4	Gc/FID
% TCE	Gc/FID
% Fuel oil	Gc/FID

APPENDIX A. ANALYTICAL RESULTS

5) ANALYSIS FOR O_2, CO_2, & CO IN OFFGAS

i) ORSAT Analysis
ii) O_2/Combustibles Strip Chart
iii) CO Emission Strip Chart

i) ORSAT Analysis

ORSAT READINGS

Job: Los Alamos National Laboratories

Controlled Air Incinerators

Date: 9/7/86

Test No.: LANL-4-MS-1, LANL-4-MS-2, LANL-4-MS-3

Time	% CO_2		% O_2		% CO	
LANL-4-MS-1 Bag 1	5.8		18.2	12.4 Silica Gel Gain		11.6
Bag 1	5.8		18.2	12.4 H_2O	gain	242.6
Bag 2	6.0		18.2	12.2		
Bag 2	6.0		18.2	12.2		
LANL-4-MS-2 Bag 1	7.0		18.3	~~12~~ 11.3		
Bag 1	7.0		17.8	11.1 silica	Gel	13.8
Bag 1	7.0		18.1	11.1 H_2O	gain	210.9
Bag 2	7.0		18.0	11.0		
Bag 2	7.0		18.2	11.0		
LANL-4-MS-3 Bag 1	8.0		18.2	10.2	silica gel	18.4
Bag 1	8.0		18.2	10.2	H_2O gain	279
~~Bag 2~~	~~6.4~~		~~18.6~~	~~12.2~~		
~~Bag 2~~	~~6.~~		~~18.4~~	~~12.2~~		
~~Bag 2~~	~~6.2~~		~~18.4~~	~~12.2~~		
Average						

Bag 2 not fully purged.

Engineering, Inc.

ORSAT READINGS

Job: Los Alamos National Laboratories - Controlled Date: 9-4-86

Air Incinerator - Stack

Test No.: LANL-1-M5-1 (Condition 1 Run 1)
LANL-1-M5-2 (Condition 1 Run 2)
LANL-1-M5-3 (Condition 1 Run 3)

Time	% CO_2		% O_2		% CO	
LANL-1-M5-1 Bag 1	8.7		17.8	9.1		
Bag 1	8.6		17.8	9.2		
Bag 2	8.6		17.8	9.2		
Bag 2	8.6		17.8	9.2		
			12.6		96	
LANL-1-M5-2 Bag 1	8.6		17.8	9.2		
Bag 1	8.6		17.8	9.2		
Bag 2	8.6		17.7	9.1		
Bag 2	8.6		17.7	9.1		
LANL-1-M5-3 Bag 1	8.7		17.8	9.1		
Bag 1	8.6		17.8	9.2		
Bag 2	8.6		17.8	9.2		
Bag 2	8.6		17.8	9.2		
Average						

Engineering, Inc.

ORSAT READINGS

Job: Los Alamos National Laboratories - Controlled Air Incinerator - Stack

Date: 9-5-86

Test No.: LANL-2-MS-1, LANL-2-MS-2, LANL-2-MS-3

Time	% CO_2		% O_2		% CO	
LANL-2-MS-1 Bag 1	8.0		18.4	10.4		
Bag 1	8.0		18.4	10.4		
Bag 2	8.0		18.4	10.4		
Bag 2	8.0		18.4	10.4		
	silica gel gain - 8.8 g		impinger water gain - 295 ml			
LANL-2-MS-2 Bag 1	8.0		18.4	10.4		
Bag 1	8.0		18.4	10.4		
Bag 2	8.0		18.4	10.4		
Bag 2	8.0		18.4	10.4		
	silicagel gain - 11.0		impinger H_2O gain - 296			
LANL-2-MS-3 Bag 1	8.0		18.4	10.4		
Bag 1	8.0		18.4	10.4		
Bag 2						
Bag 2						
	silica gel gain - 13.6		impinger H_2O gain - 287			
Average						

Engineering, Inc.

ORSAT READINGS

Job: Los Alamos National Laboratories - Controlled Air Incinerator - Stack samples

Date: 9/6/86

Test No.: LANL-3-MS-1, LANL-3-MS-2, LANL-3-MS-3

Time	% CO_2		% O_2		% CO	
LANL-3-MS-1 Bag 1	8.0		18.1	10.1		
Bag 1	8.0		18.1	10.1		
Bag 2	8.0		18.1	10.1		
Bag 2	8.0		18.1	10.1		
	silica gel gain - 18		imp. H_2O gain - 381			
LANL-3-MS-2 Bag 1	7.6		17.6	10.0	silica gel gain - 18.4	
Bag 1	7.6		17.6	10.0	impinger H_2O gain - 416.7	
Bag 2	~~7~~.6		~~16.7~~	10.0		
Bag 2	7.~~8~~0		17.6	10.0		
LANL-3-MS-3 Bag 1	7.6		17.8	10.2	silica gel gain - 17.9	
Bag 1	~~7.16~~ 7.6		17.8	10.2	impinger H_2O gain - 280	
Bag 2	7.6		17.8	10.2		
Bag 2	7.6		17.8	10.2		
Average						

Engineering, Inc.

LANL-1-M5-1-ORSAT-MOISTURE

BAG 1			BAG 2		
CO_2+O_2	O_2	CO_2	CO_2+O_2	O_2	CO_2
17.8	9.1	8.7	17.8	9.2	8.6
17.8	9.2	8.6	17.8	9.2	8.6

Silica Gel gain - 12.6g. Impinger Water gain - 296 ml.

LANL-1-M5-2-ORSAT-MOISTURE

BAG 1			BAG 2		
CO_2+O_2	O_2	CO_2	CO_2+O_2	O_2	CO_2
17.8	9.2	8.6	17.7	9.1	8.6
17.8	9.2	8.6	17.7	9.1	8.6

Silica Gel gain - 14.0g Impinger Water Gain - 395

LANL-1-M5-3-ORSAT-MOISTURE

BAG 1			BAG 2		
CO_2+O_2	O_2	CO_2	CO_2+O_2	O_2	CO_2
17.8	9.1	8.7	17.8	9.2	8.6
17.8	9.2	8.6	17.8	9.2	8.6

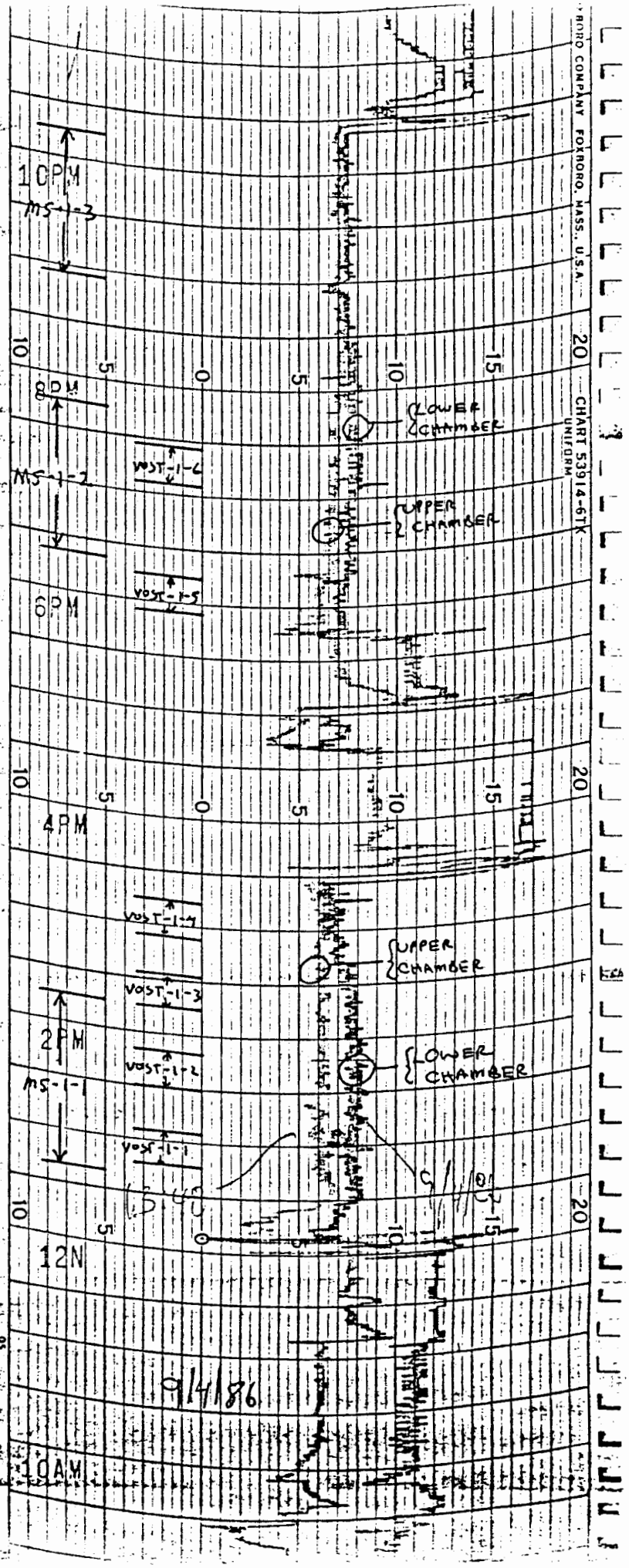
Silica Gel Gain - 14.0 Impinger Water Gain - 385

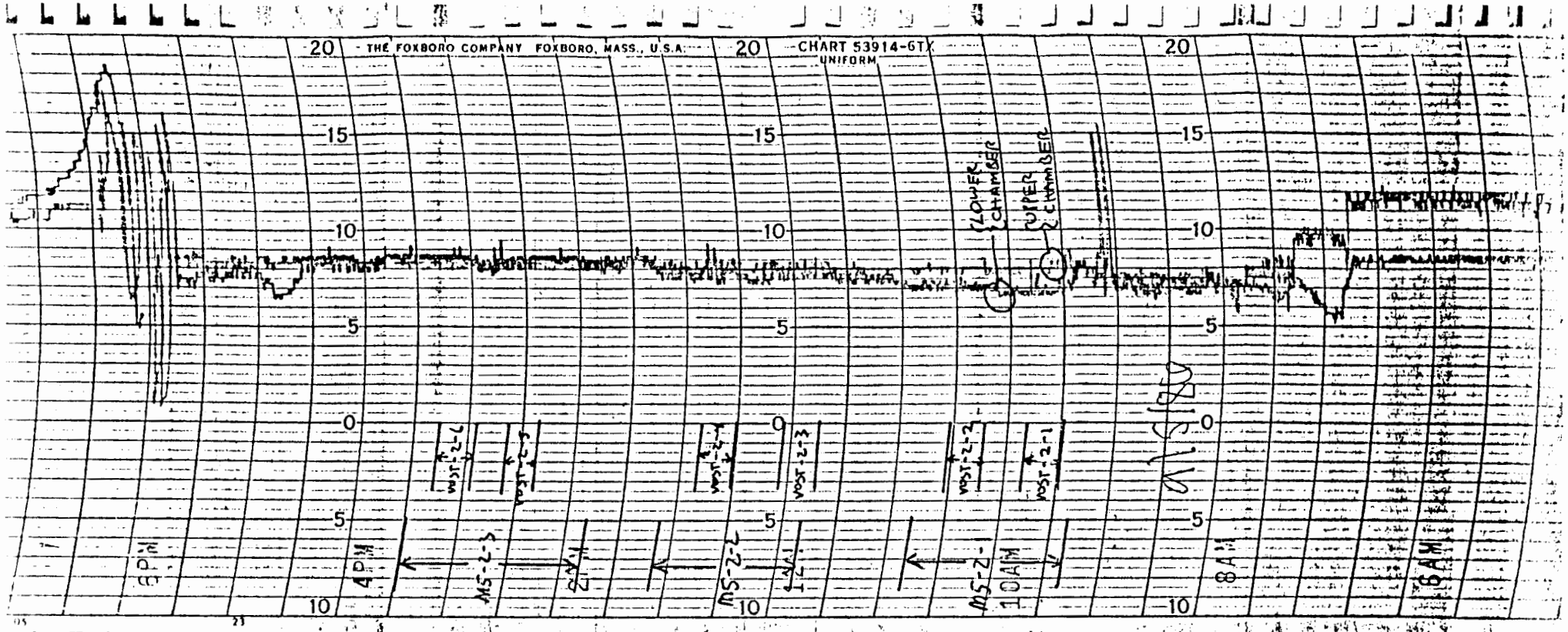
ii) O_2/Combustibles Strip Chart

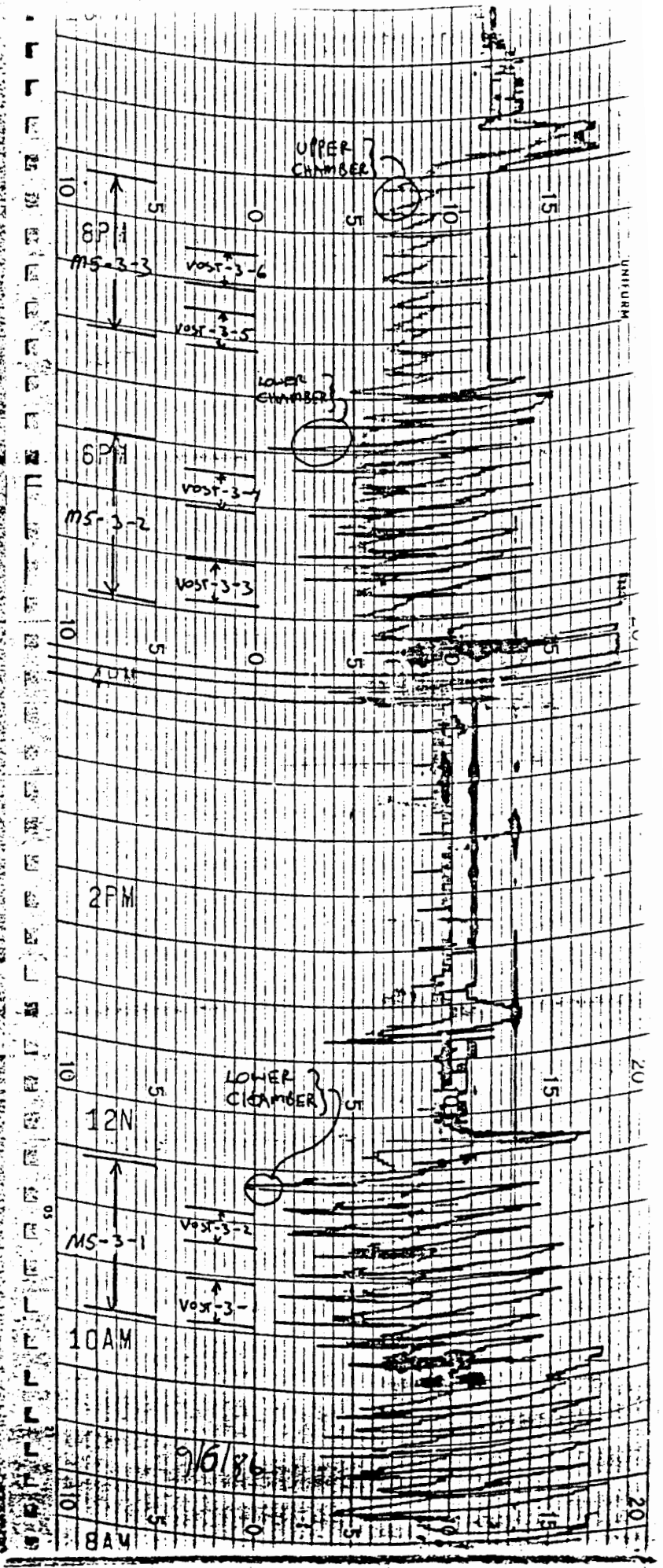
Incinerator O_2/comb. *

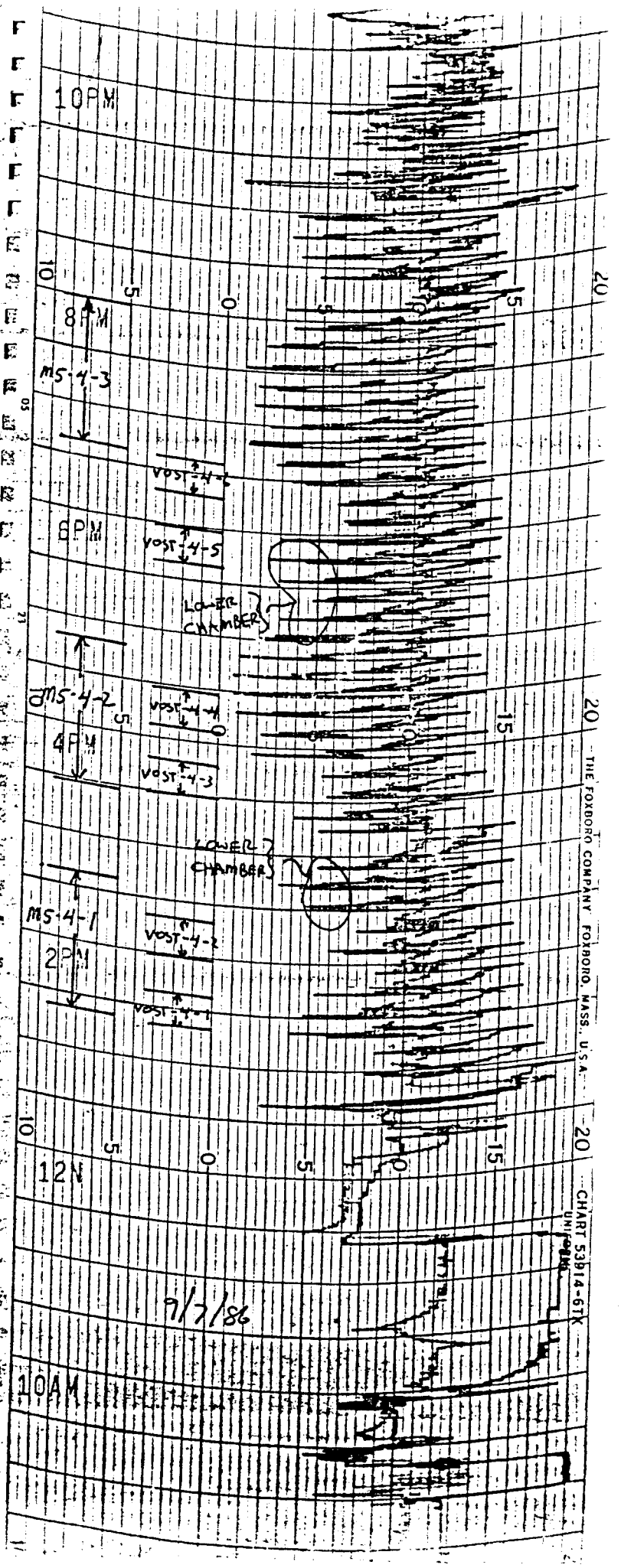
(Lower chamber is darker trace)

* Values above "0" are percent (%) excess oxygen (O_2)




THE FOXBORO COMPANY FOXBORO, MASS., U.S.A.
CHART 53914-6TX
UNIFORM
20
15
10
5
0
5
10
6PM
4PM
2PM
12N
10AM
8AM
6AM
MS-2-3
MS-2-2
MS-2-1
WST-2-4
WST-2-5
WST-2-1
WST-2-2
WST-2-3
LOWER CHAMBER
UPPER CHAMBER


UPPER CHAMBER
8PM
MS-3-3
VOST-3-6
VOST-3-5
LOWER CHAMBER
6PM
VOST-3-4
MS-3-2
VOST-3-3
2PM
LOWER CHAMBER
12N
VOST-3-2
MS-3-1
VOST-3-
10AM
9/6/86
8AM
UNIFORM


10PM
8PM
MS-4-3
VOST-4-6
6PM
VOST-4-5
LOWER CHAMBERS
MS-4-2
VOST-4-4
4PM
VOST-4-3
LOWER CHAMBERS
MS-4-1
VOST-4-2
2PM
VOST-4-1
12N
9/7/86
10AM
THE FOXBORO COMPANY FOXBORO, MASS., U.S.A.
CHART 53914-6TK

iii) CO Emission Strip Chart

CLEAN AIR ENGINEERING, INC
November 21, 1986

CARBON MONOXIDE EMISSIONS

UNIVERSITY OF CALIFORNIA
LOS ALAMOS NATIONAL LABORATORY

Purchase Order No: 2-LFD-1415F-1
CAE Project No: 3770

UNIVERSITY OF CALIFORNIA
CAE Project No: 3770

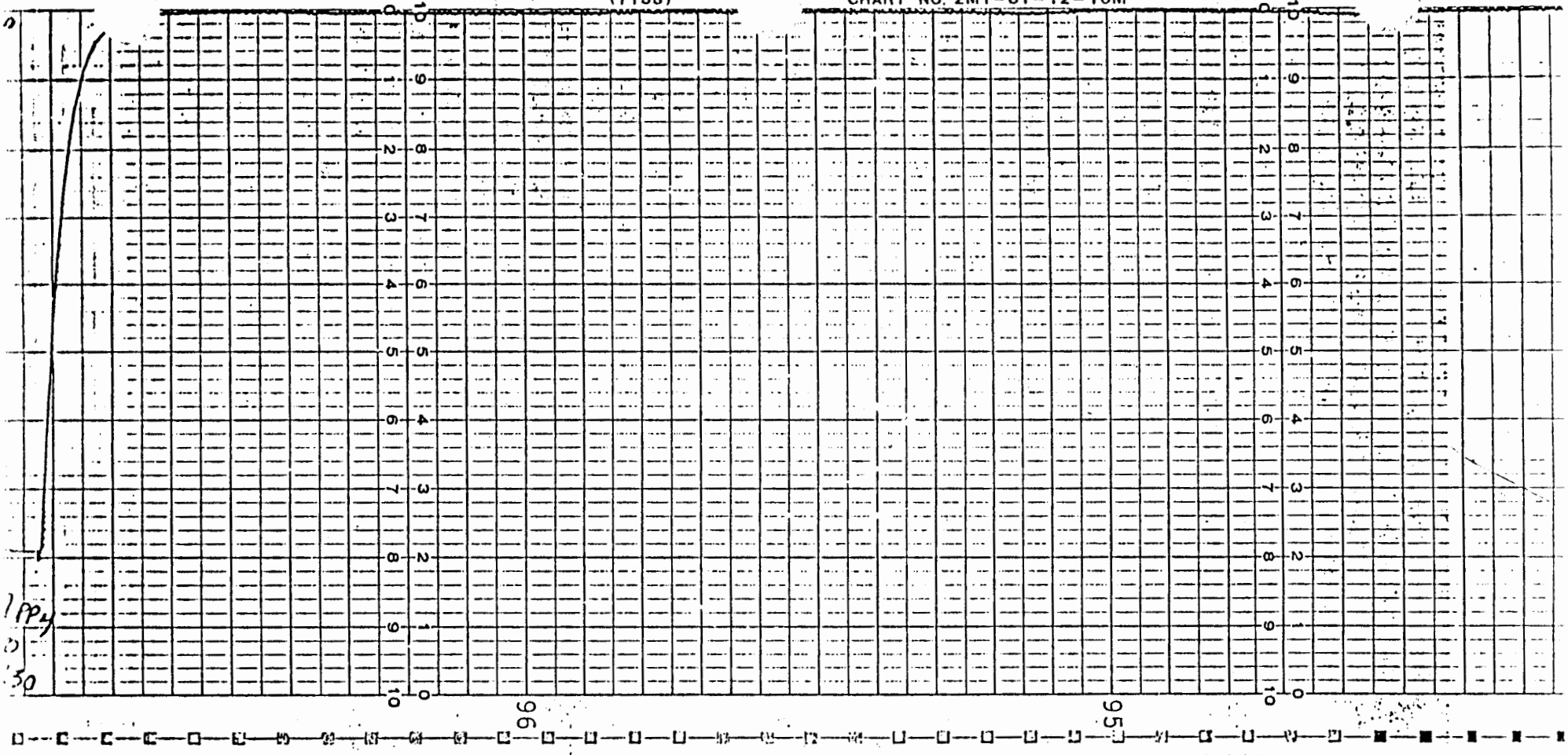
Summary of Results
Carbon Monoxide Concentrations
(as ppmv, dry basis)

Run	1	2	3
Condition 1 Sept. 4, 1986	5	6	12
Condition 2 Sept. 5, 1986	5	6	7
Condition 3 Sept. 6, 1986	*	5**	5
Condition 4 Sept. 7, 1986	5	5	7

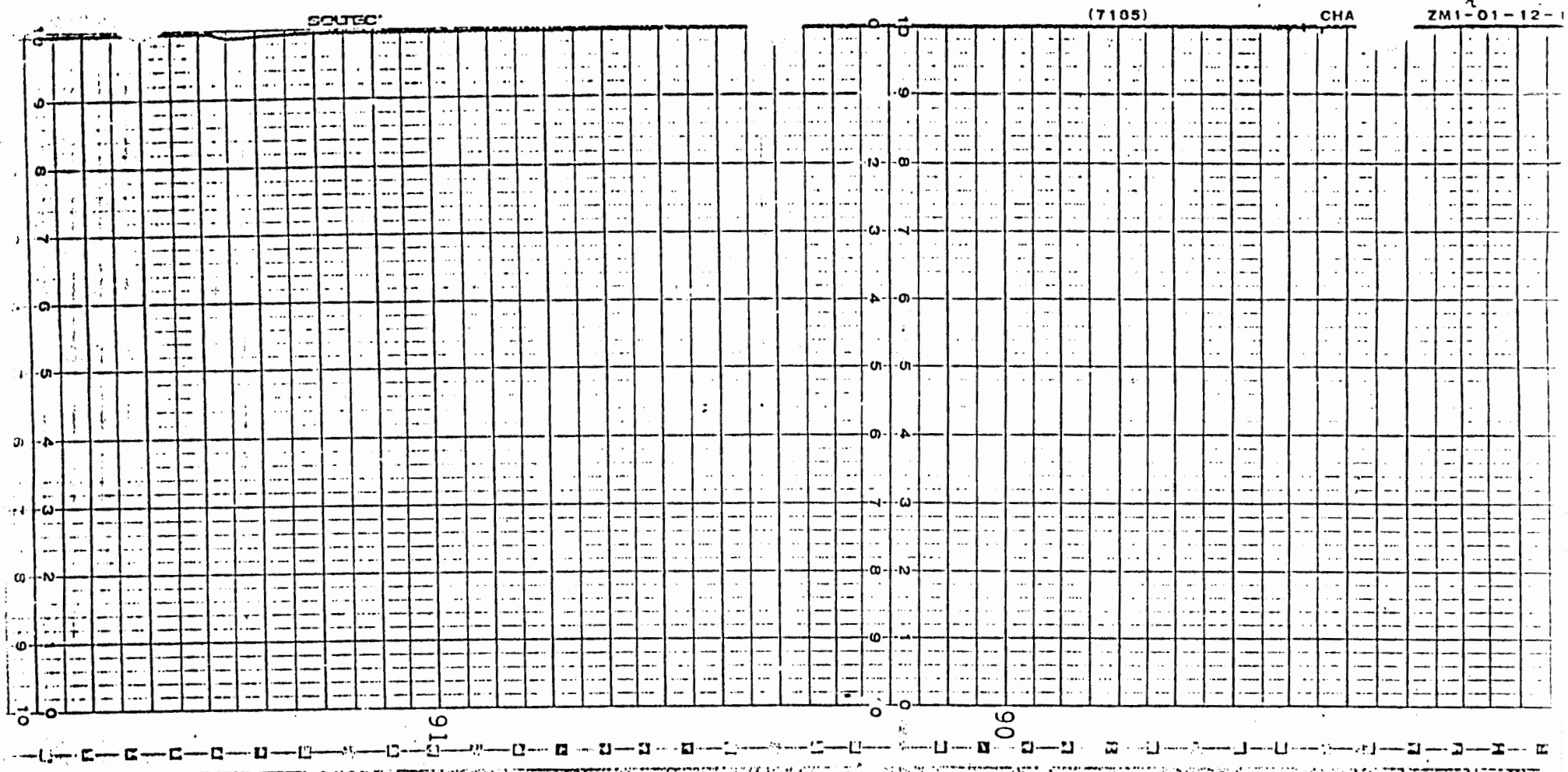
*-Data out of range of chart recorder
**-Two peaks noted at 70 and 63 ppm during middle of run

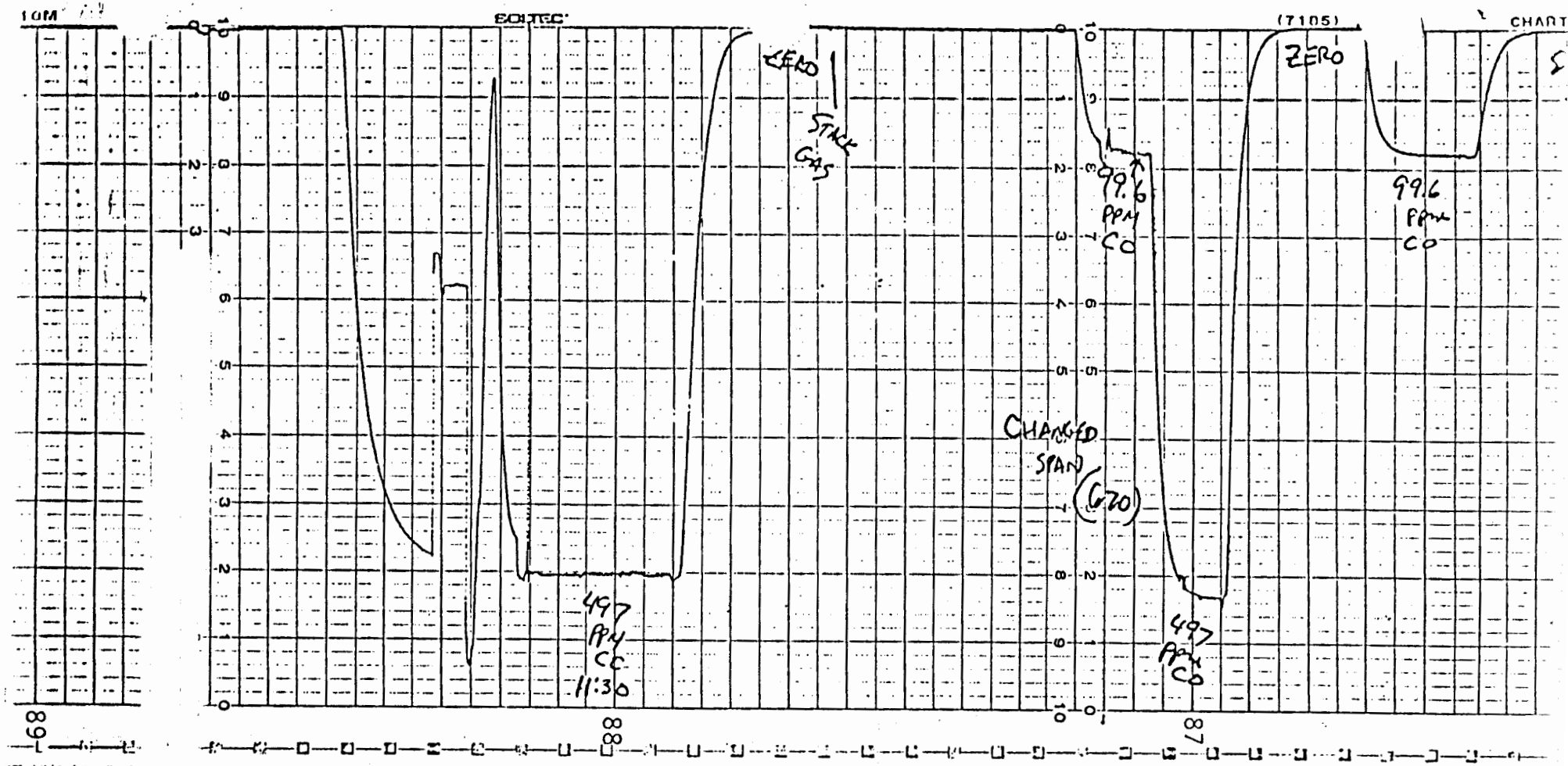
SOLTEC
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10
10. ZM1-01-1 10M
98
CI
(7105)
99
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10
SOLTEC PRODUCTS
CHART NO. ZM1-01-12-10M

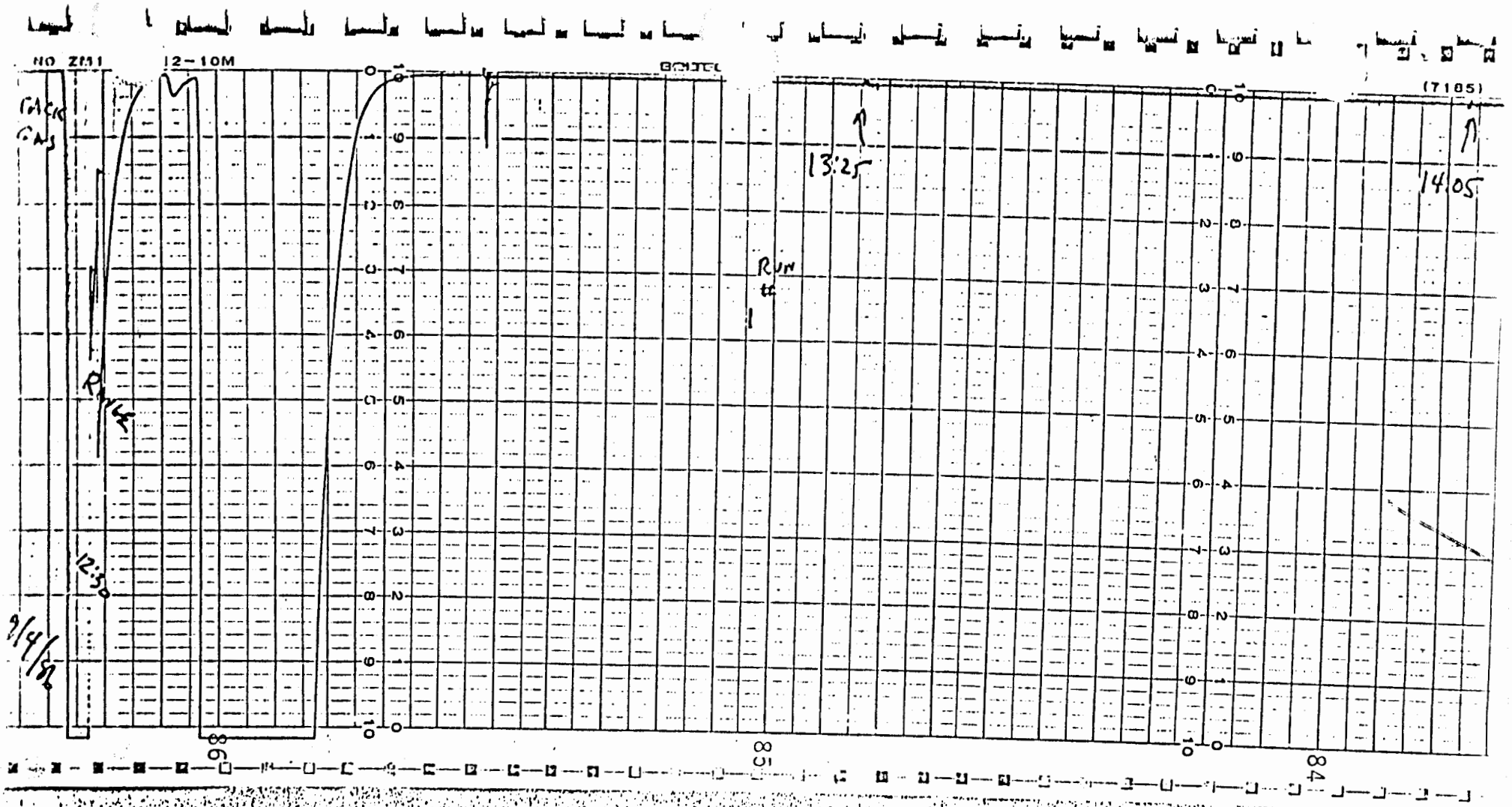
(7186) CHART NO. ZM1-01-12-10M

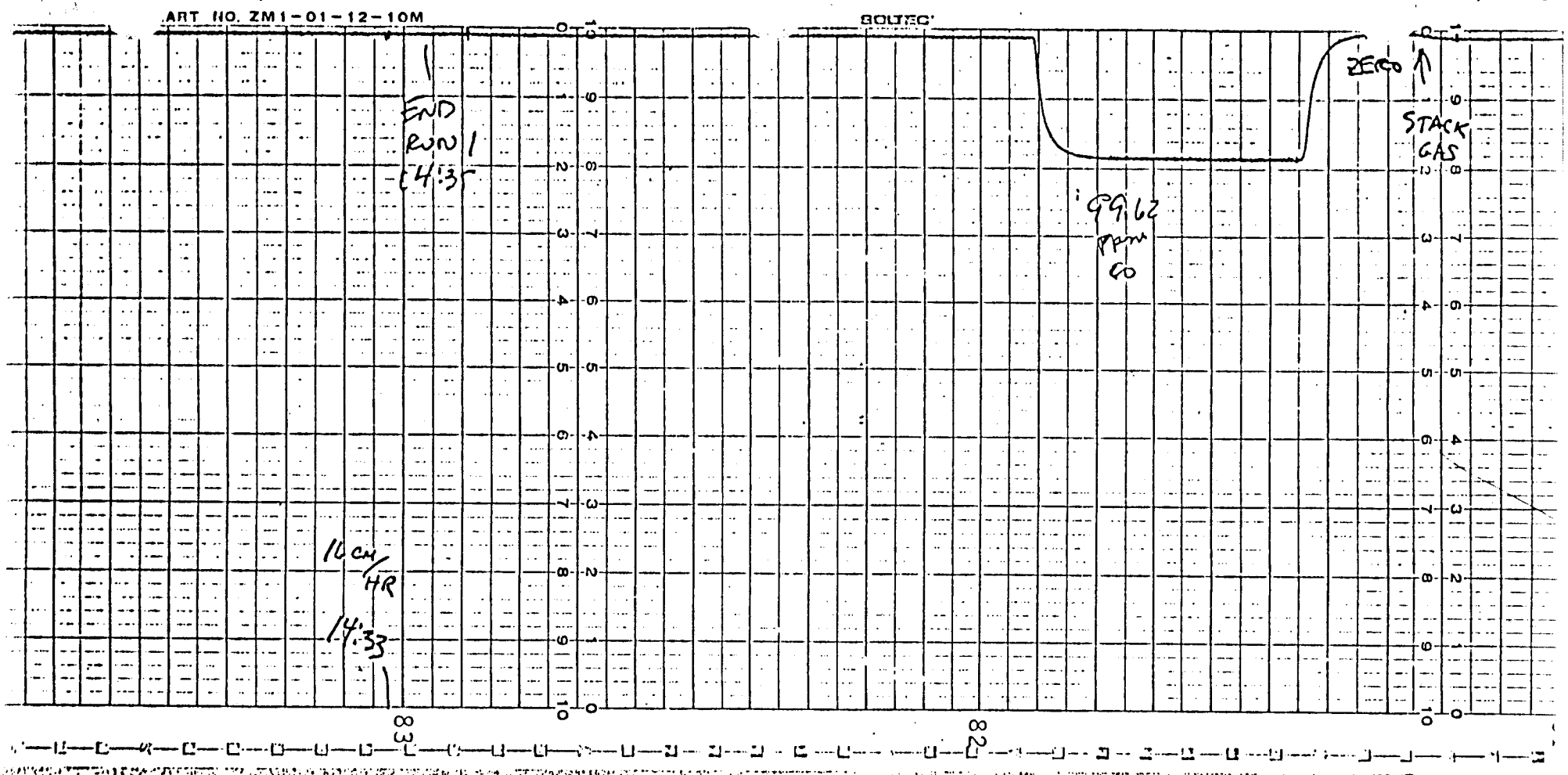


(7105)
CHART NO. ZM1-01-12-
94
93
92


SCUTEC
(7105)
CHA
ZM1-01-12-
91
90


10M
SOLTEC
(7105)
CHART
ZERO
STACK GAS
99.6 PPM CO
CHANGED SPAN (G20)
497 PPM CO 11:30
497 PPM CO
ZERO
99.6 PPM CO
89
88
87


NO ZM1
12-10M
(7185)
13:25
14:05
12:50
9/4/82
86
85
84


ART NO. ZM1-01-12-10M
SOLTEC
END
RUN 1
14:35
10 CM/HR
14:33
99.62
ppm
CO
ZERO
STACK
GAS
83
82

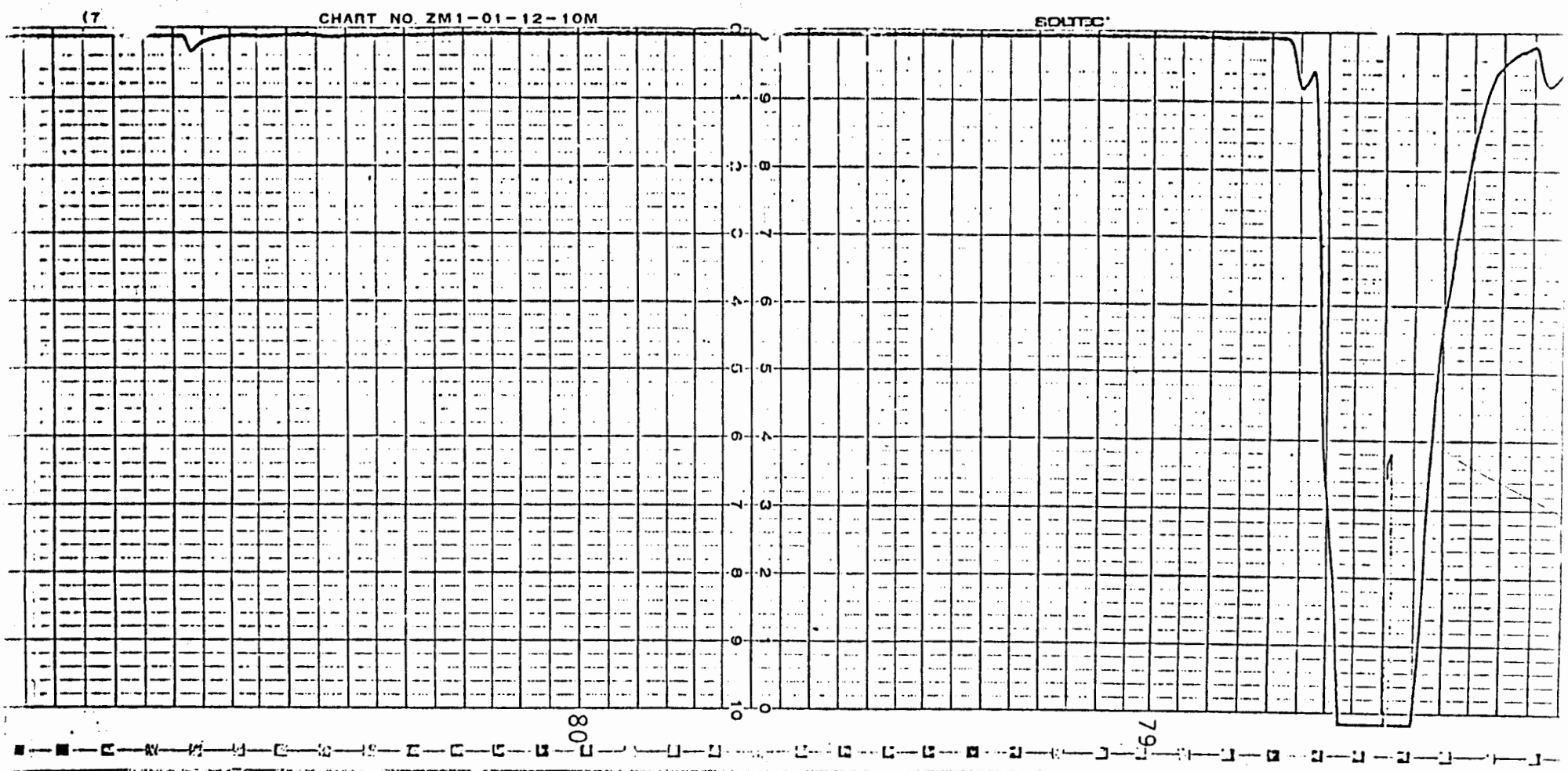
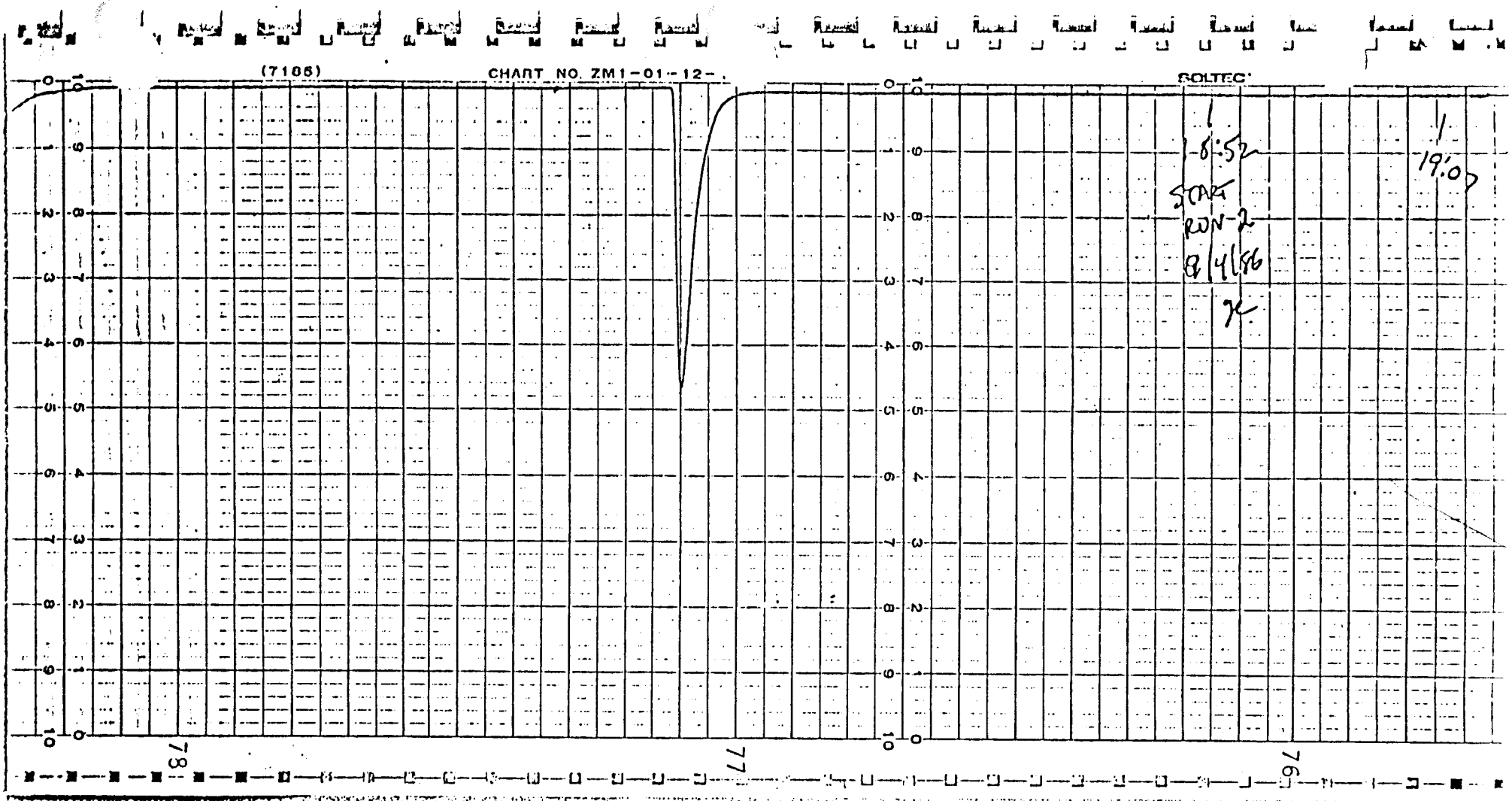
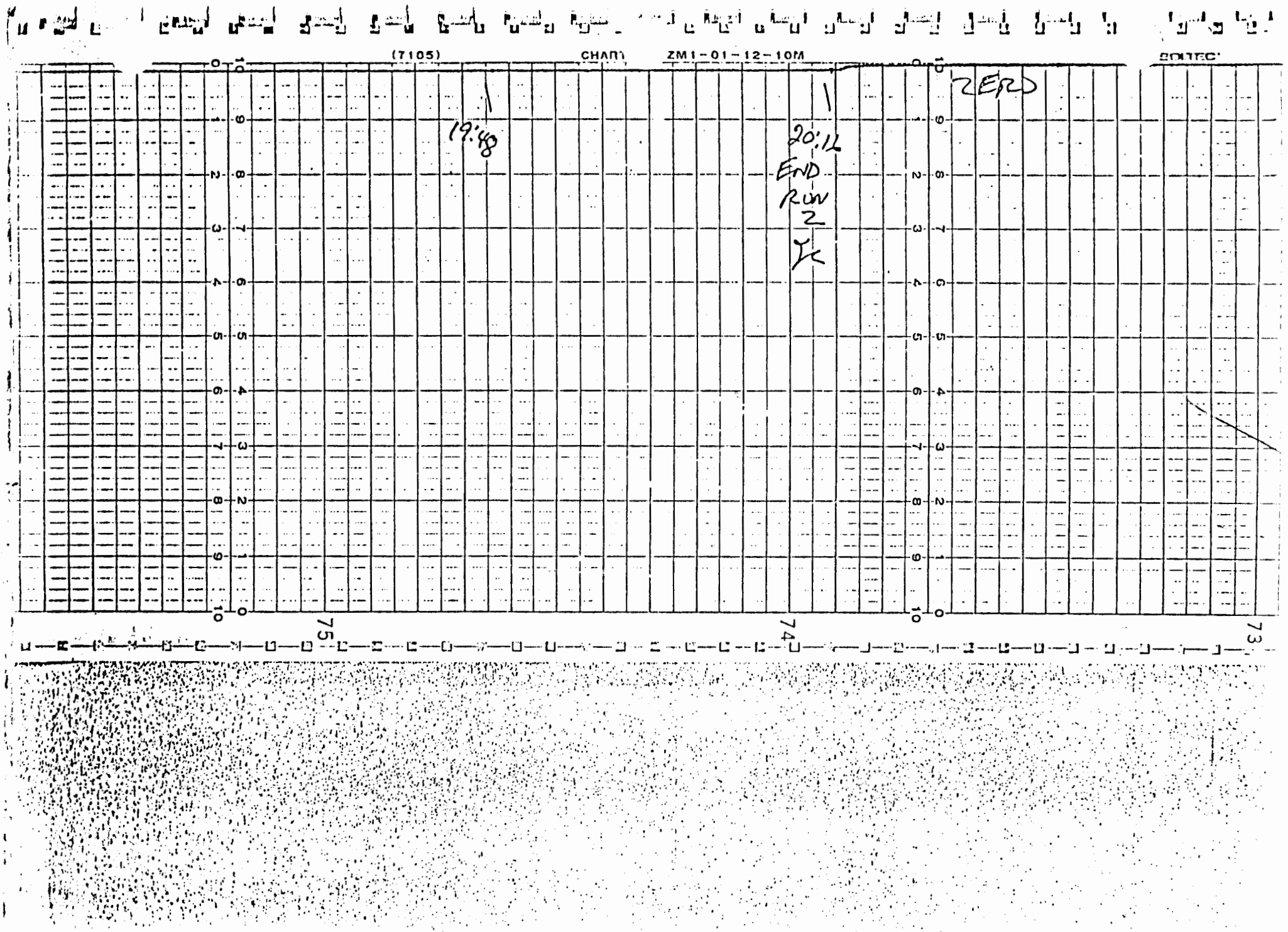
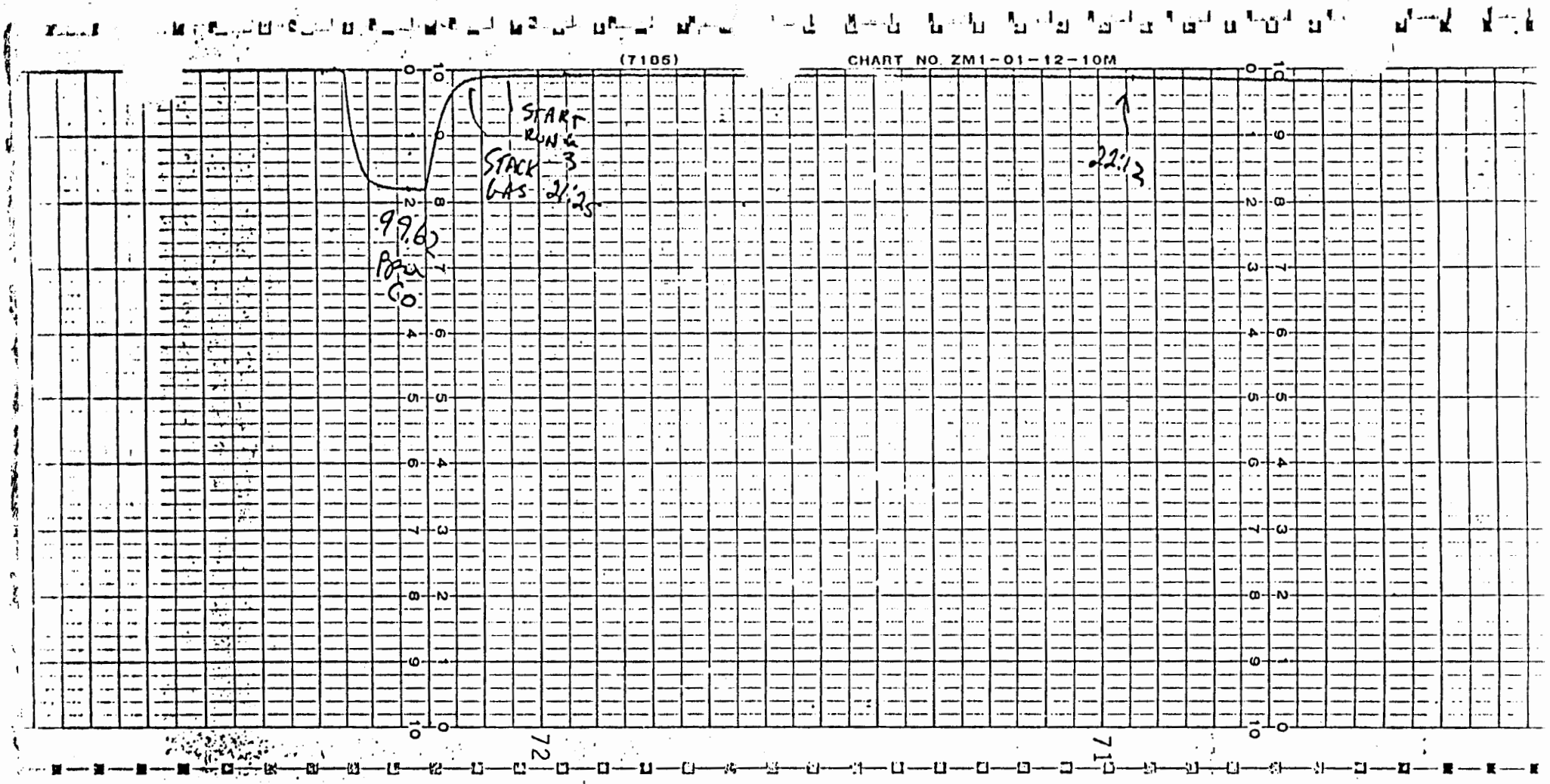
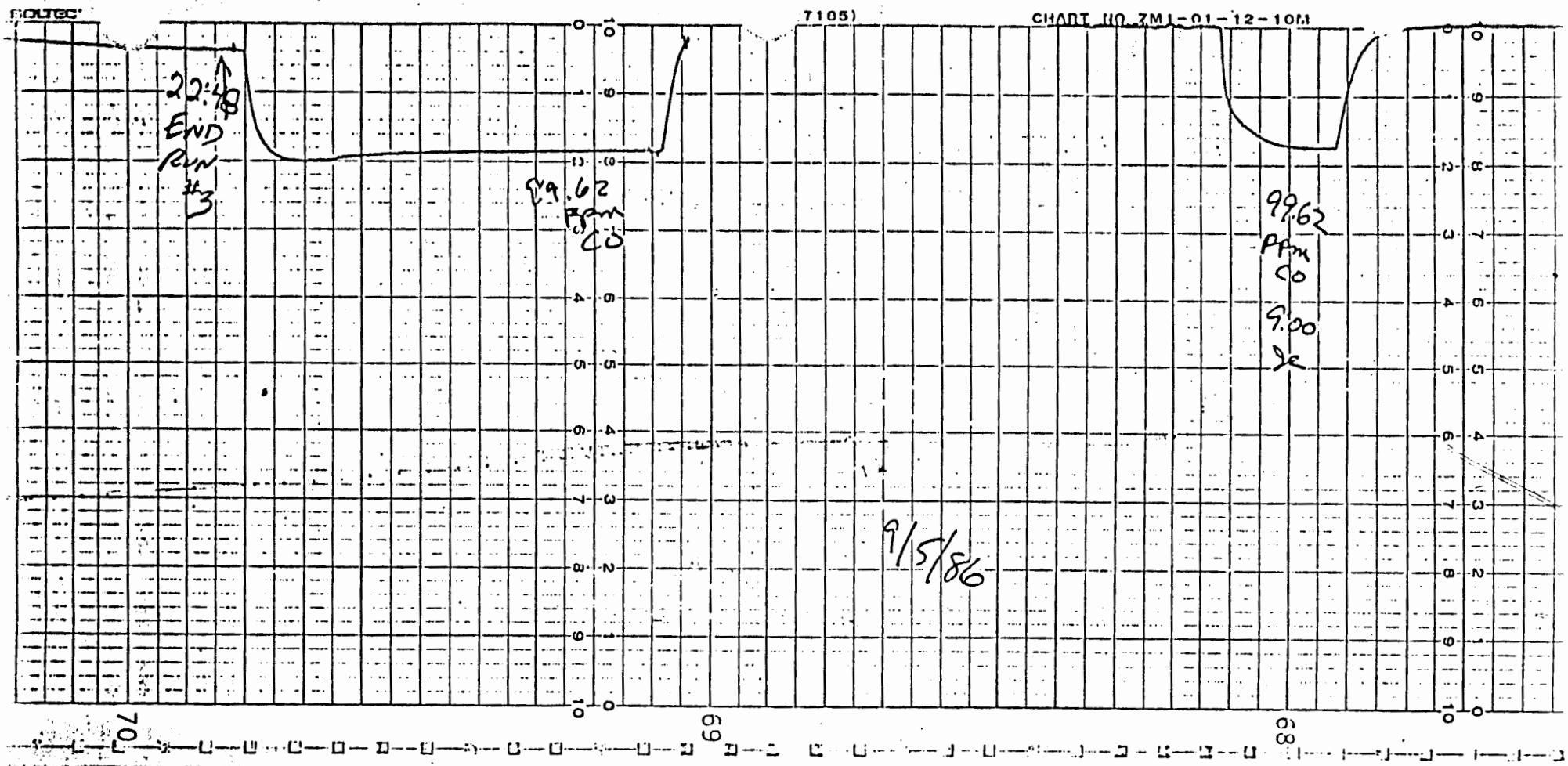


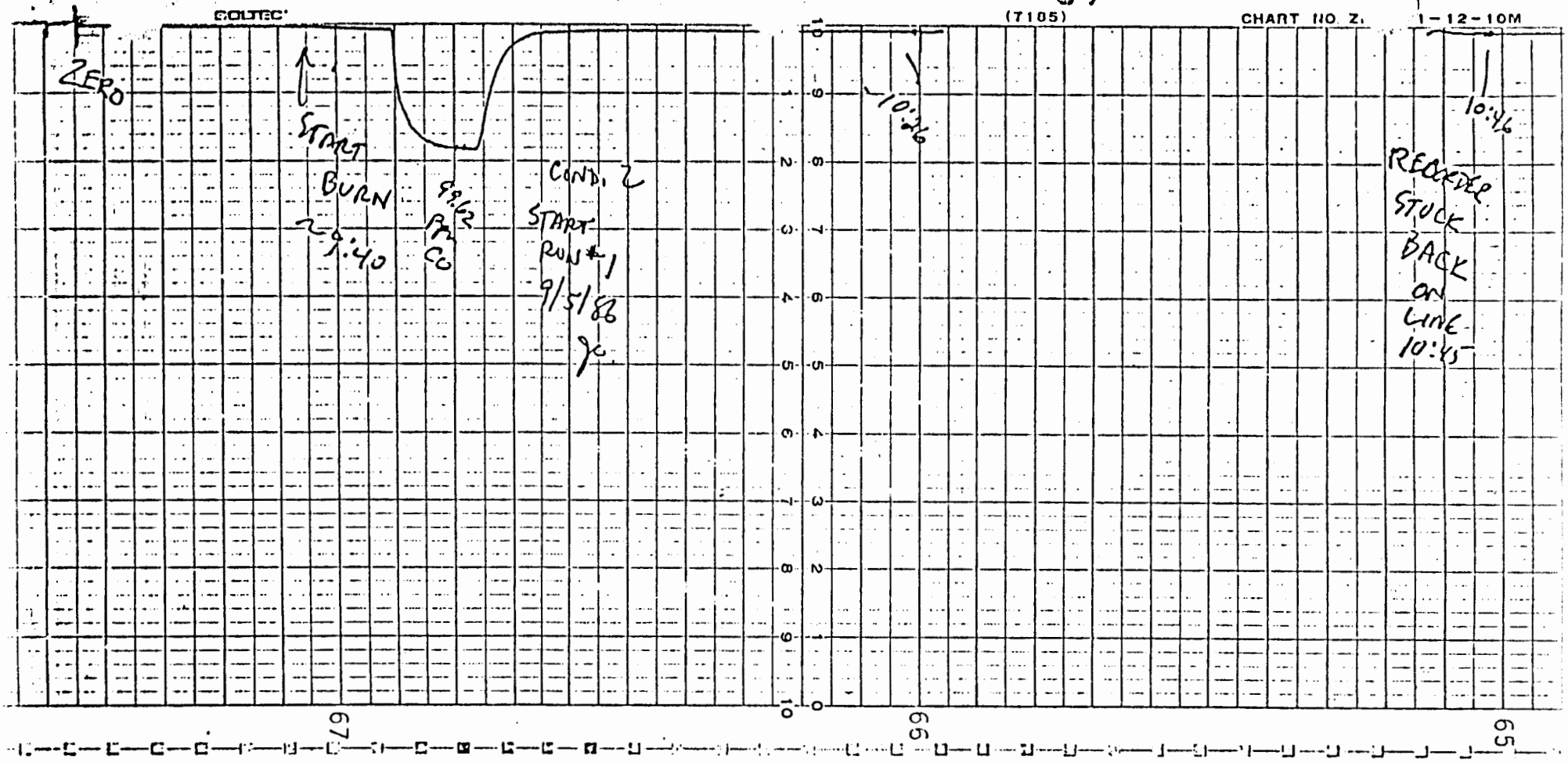
CHART NO. ZM1-01-12-10M
SOLTEC
80
79

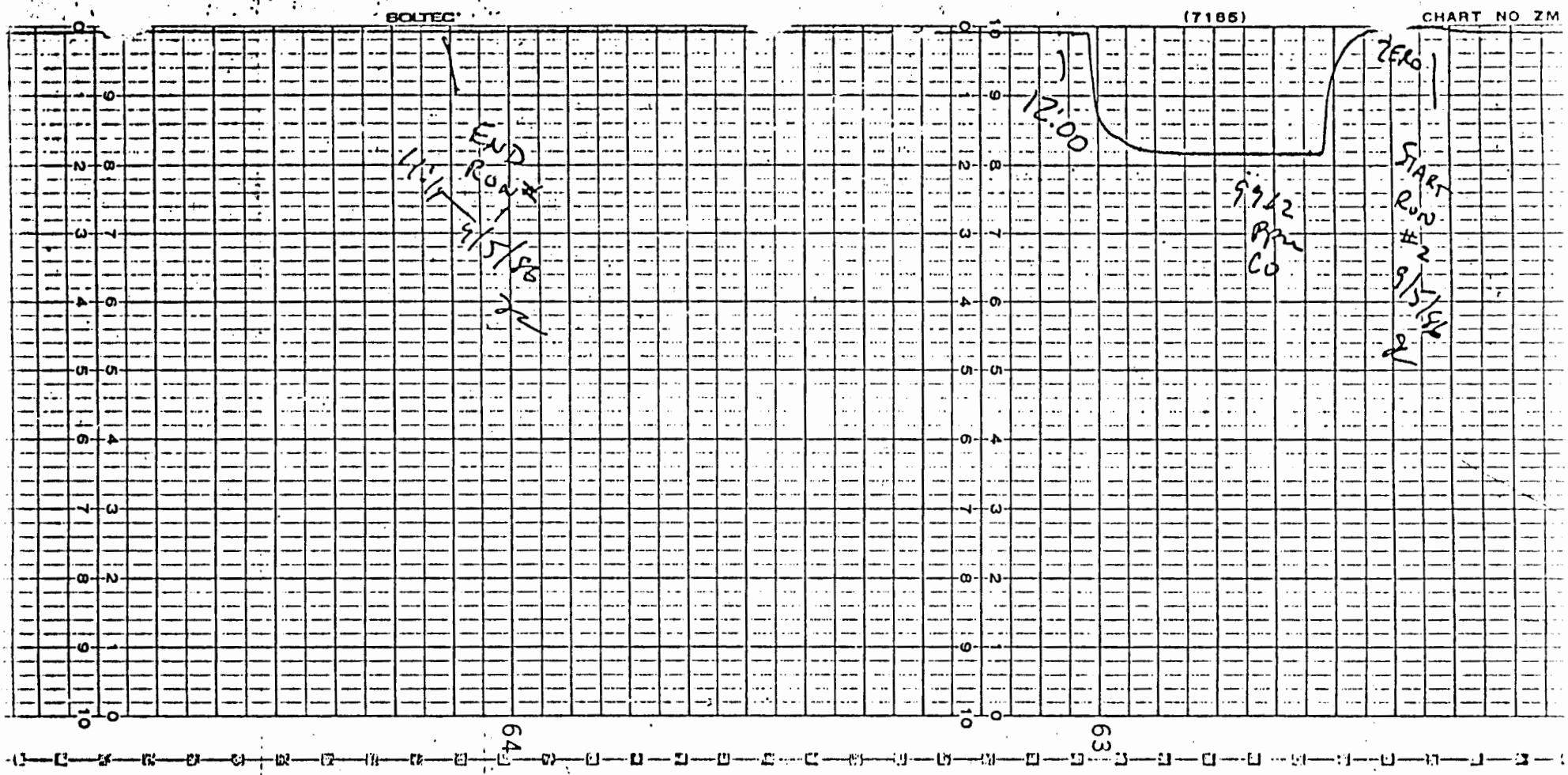

(7166)
CHART NO. ZM1-01-12-
SOLTEC
18:52
START
RUN 2
8/4/86
JK
19:07
78
77
76

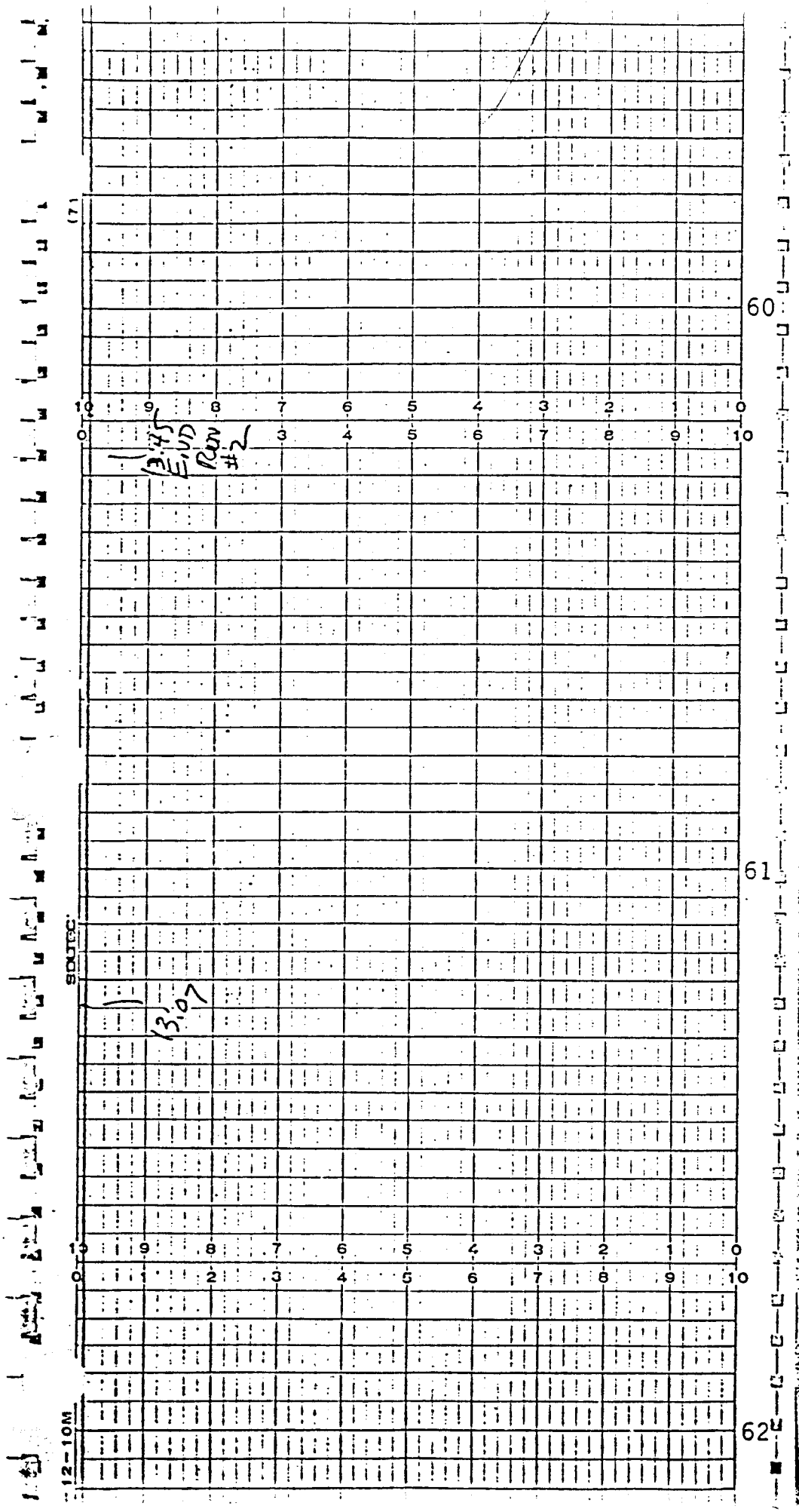

(7105)
CHART
ZM1-01-12-10M
ZERO
19:48
20:12
END
RUN
2
75
74
73

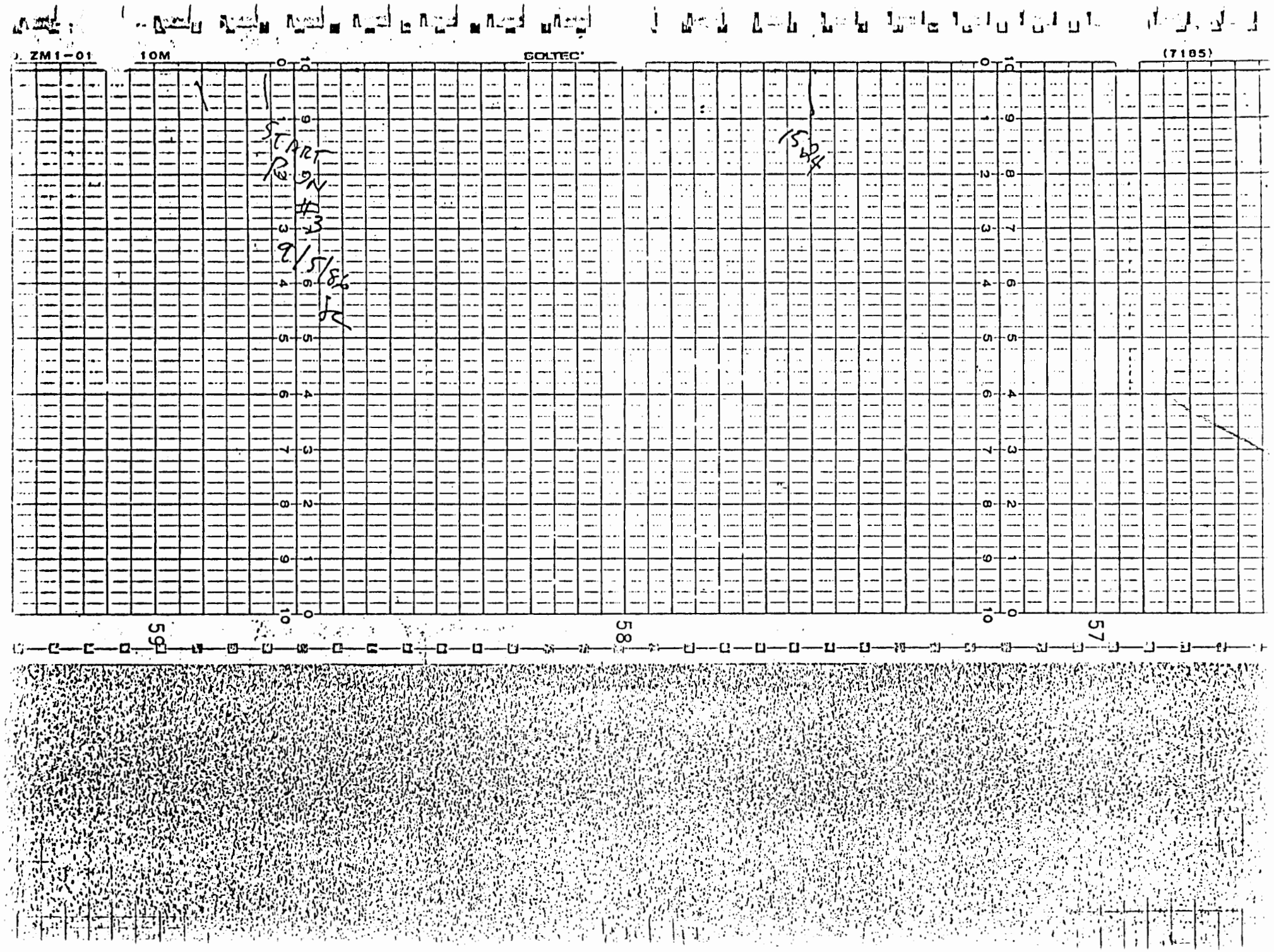

(7106)
CHART NO. ZM1-01-12-10M
START RUN 3
STACK GAS 21.25
99.6
22.13
72
71

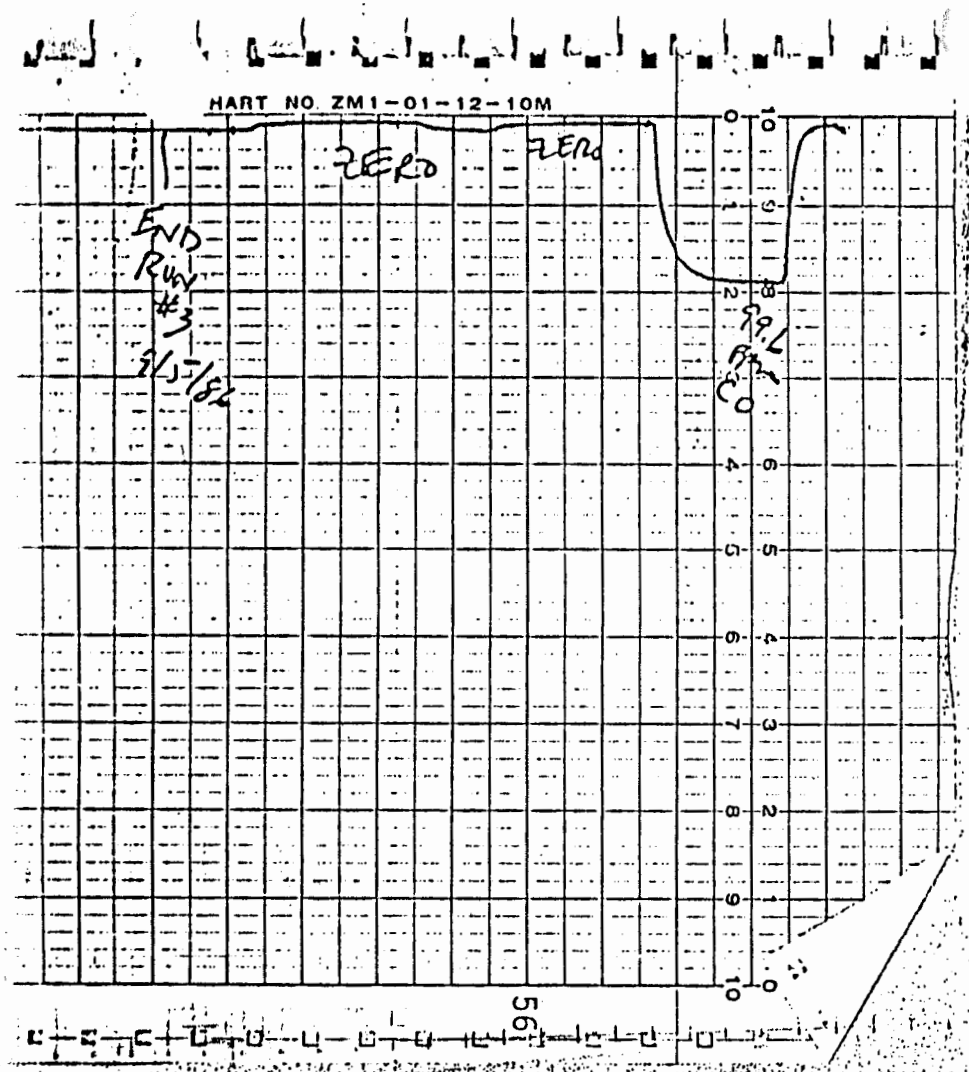

SOLTEC
7105)
CHART NO. ZM1-01-12-10M
22:48
END
RUN
#3
99.62
ppm
CO
99.62
ppm
CO
9:00
9/5/86
70
69
68

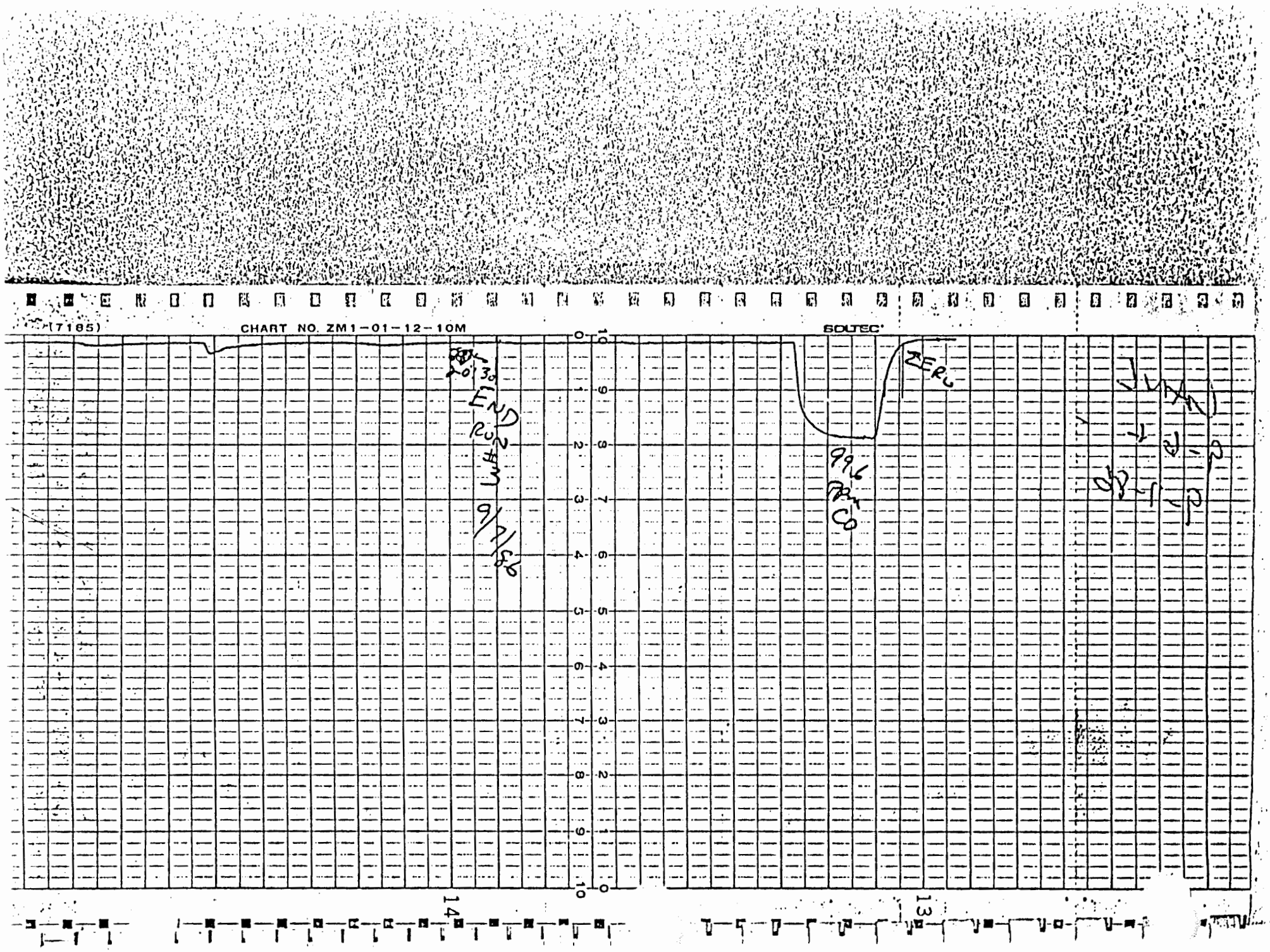

COLTEC
(7105)
CHART NO. Z.
1-12-10M
ZERO
START BURN ~9:40
9:42 P_2 CO
COND. 2 START RUN #1 9/5/88 JC
10:26
10:46
REACTOR STUCK BACK ON LINE 10:45
67
66
65


BOLTEC
(7165)
CHART NO ZM
END RUN #
11:15
9/5/86
12:00
9 1/2 BBL CO
ZERO
START RUN #2
9/5/86
64
63


60
61
62
13.45
E.U.D
Run
#2
13.07
SOLTEC
12-10M


ZM1-01
10M
GOLTEC
(7185)
START
RE-RUN
#3
9/5/86
56
58
57


HART NO. ZM1-01-12-10M
ZERO
ZERO
END
RUN
#3
7/15/82
29.7
BTU
CO
0
1
2
3
4
5
6
7
8
9
10
10
9
8
7
6
5
4
3
2
1
0


(7185)
CHART NO. ZM1-01-12-10M
SOLTEC
END RUN #3
9/7/86
ZERO
996 PPM CO
14
13

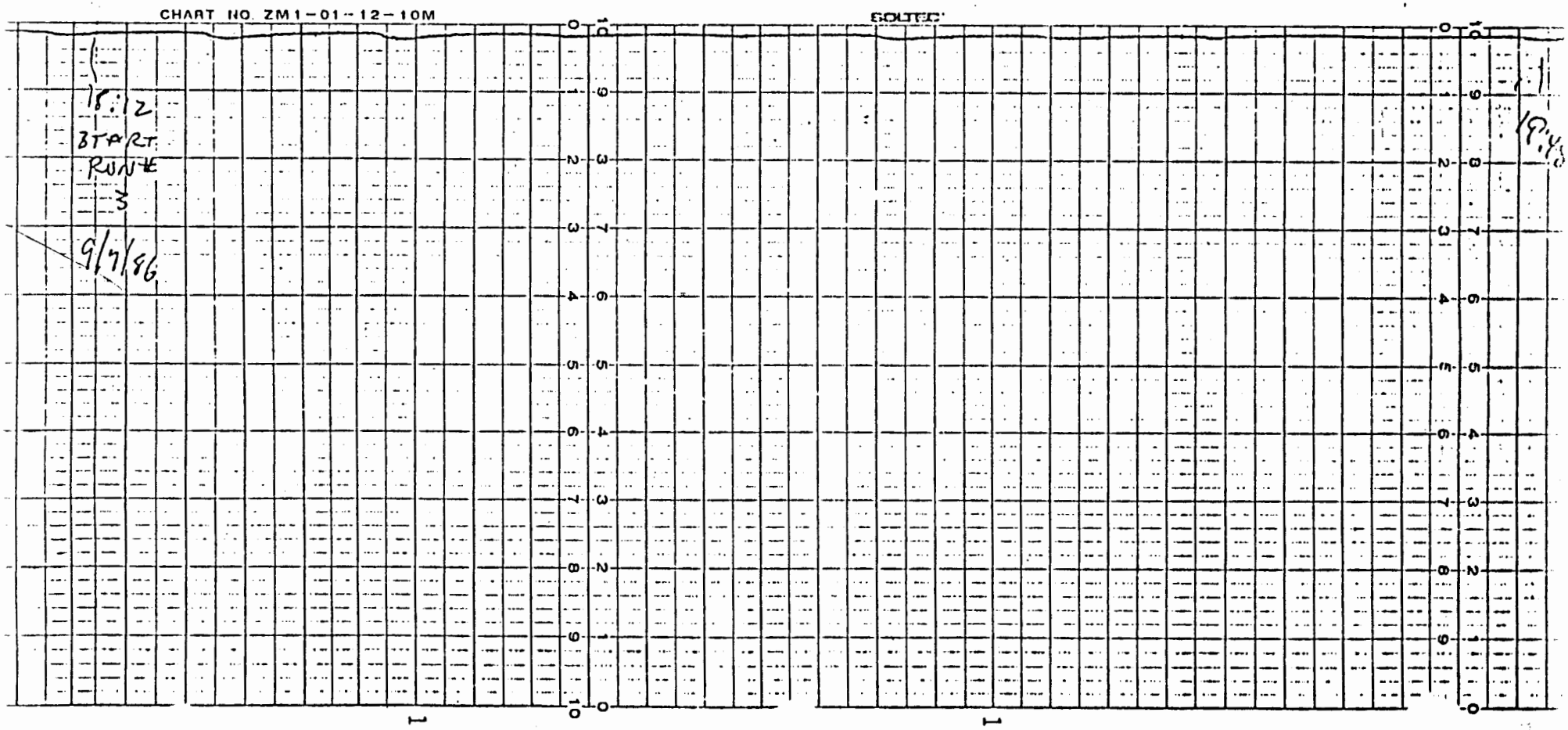
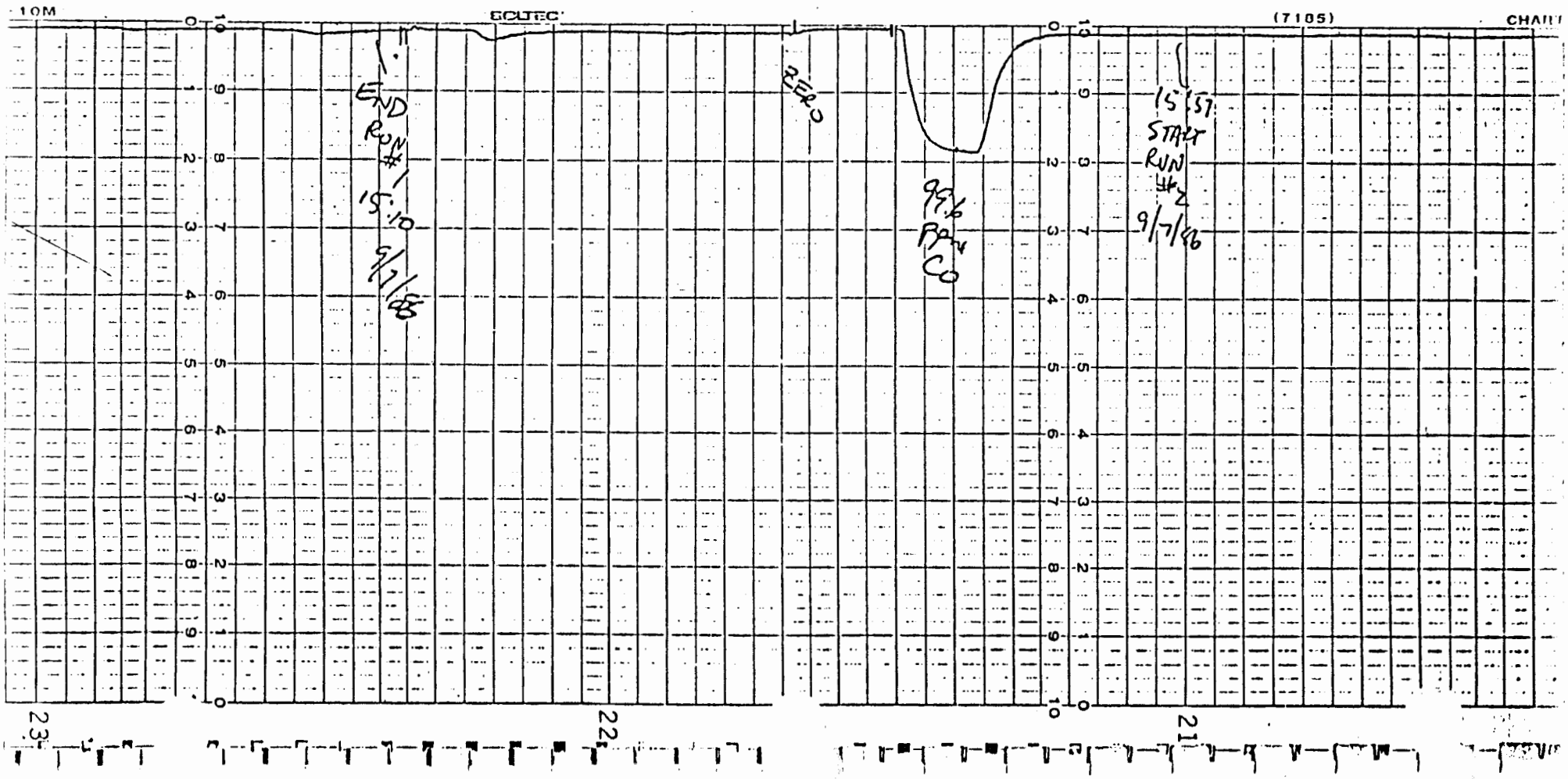
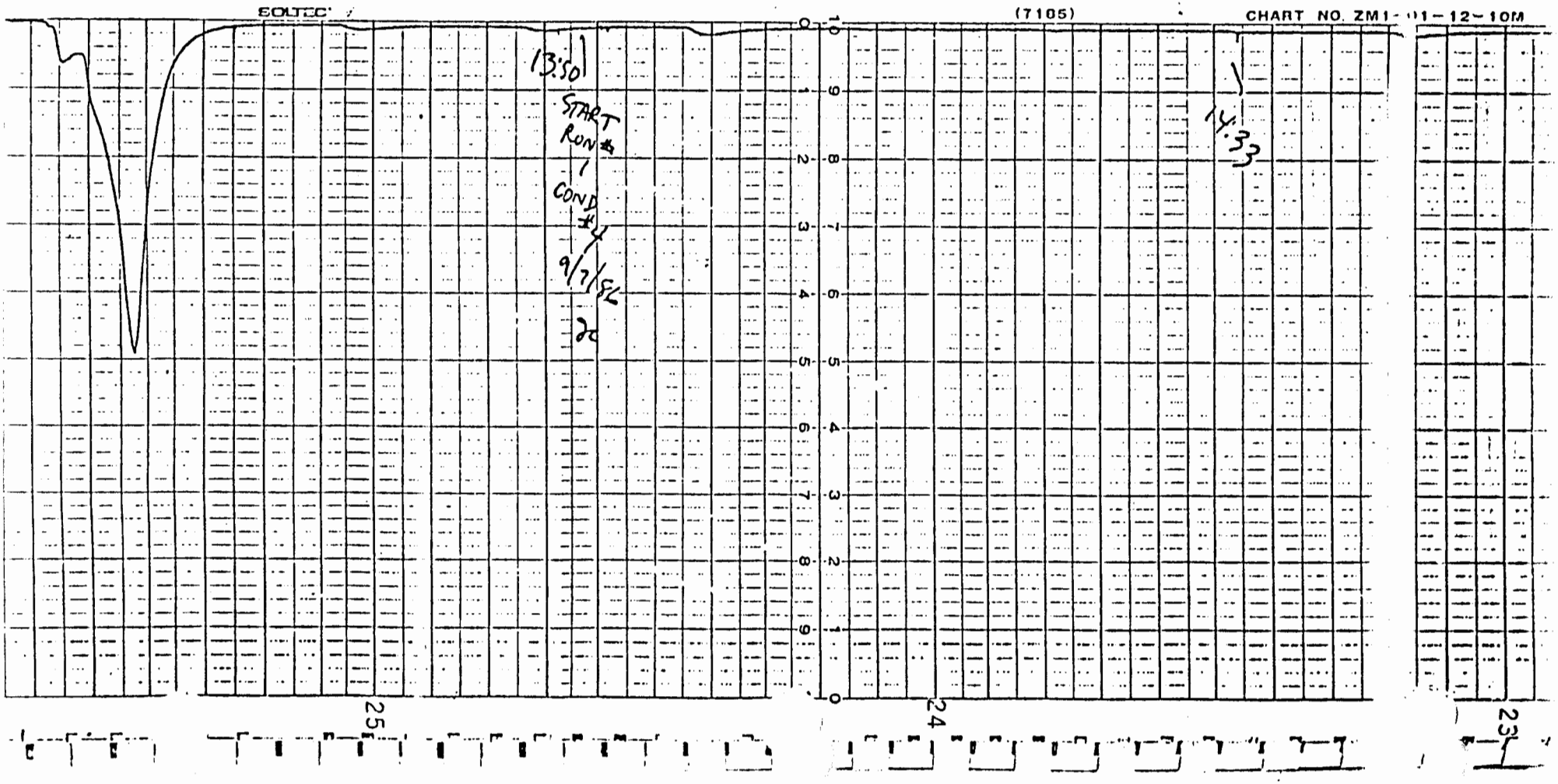


CHART NO. ZM1-01-12-10M
18:12
START
RUN #
3
9/7/86
18:4

SOLTEC
NO ZM1-01-12-10M
(7105)
18
Run #2
8/7/87
17:18
16:44

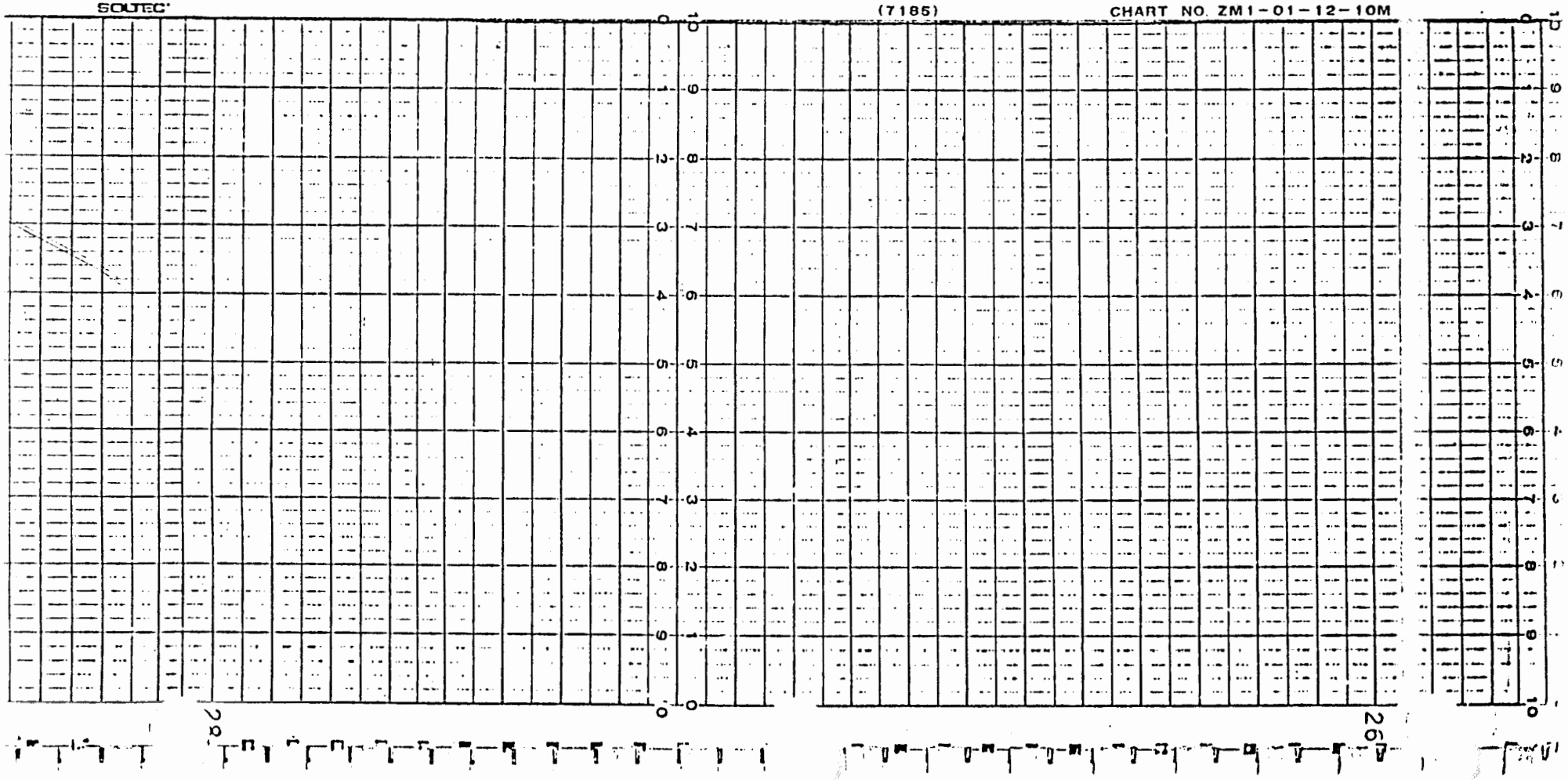

10M
ECLTEC
(7105)
CHART
END
RUN #1
15:10
9/7/86
ZERO
99%
RP_4
CO
15:57
START
RUN
#2
9/7/86
23
22
21


SOLTEC
(7105)
CHART NO. ZM1-01-12-10M
13:50
START
RUN #
1
COND
#4
9/7/86
20
14:33
25
24
23

SOLTEC

(7185)

CHART NO. ZM1-01-12-10M



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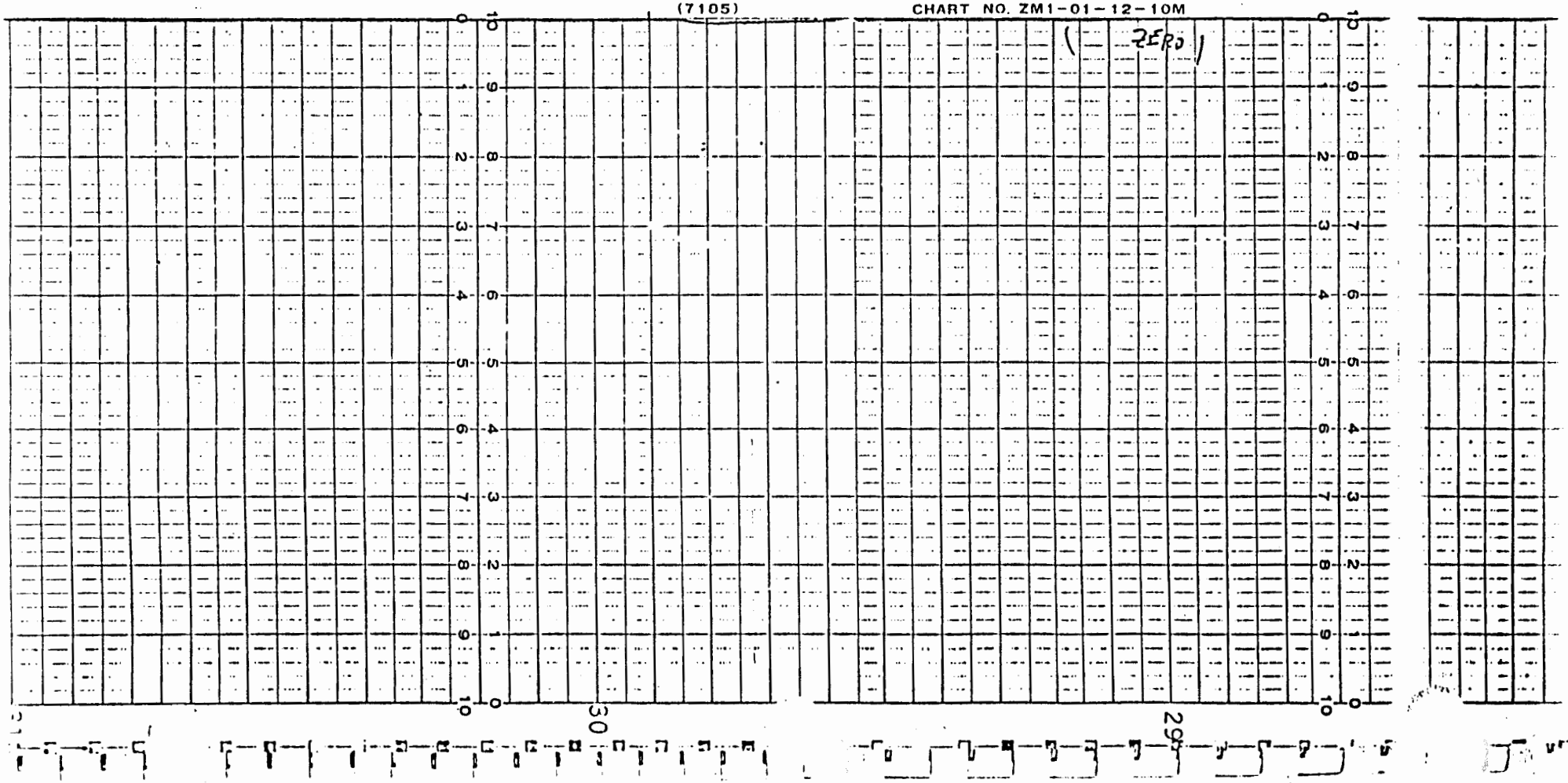
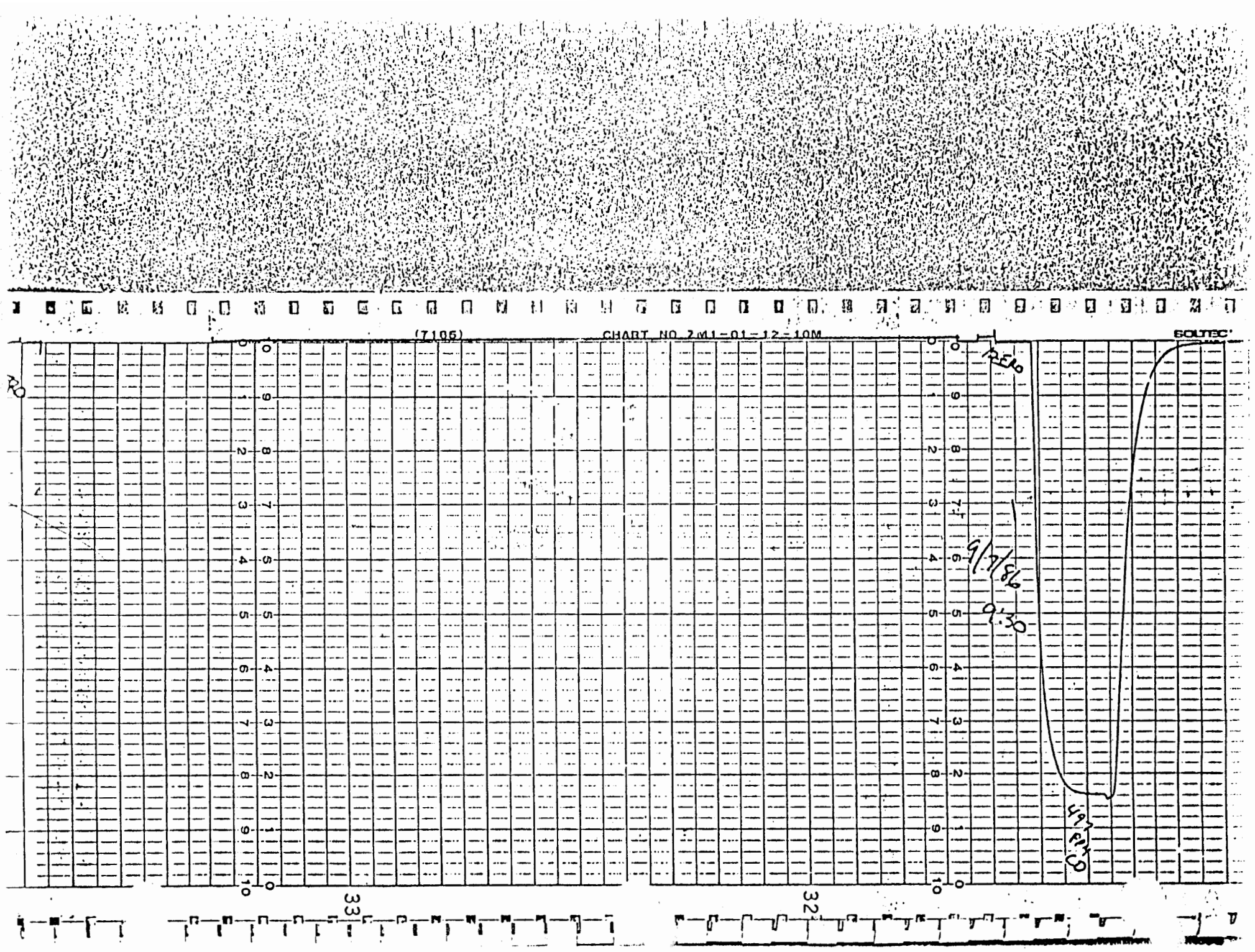
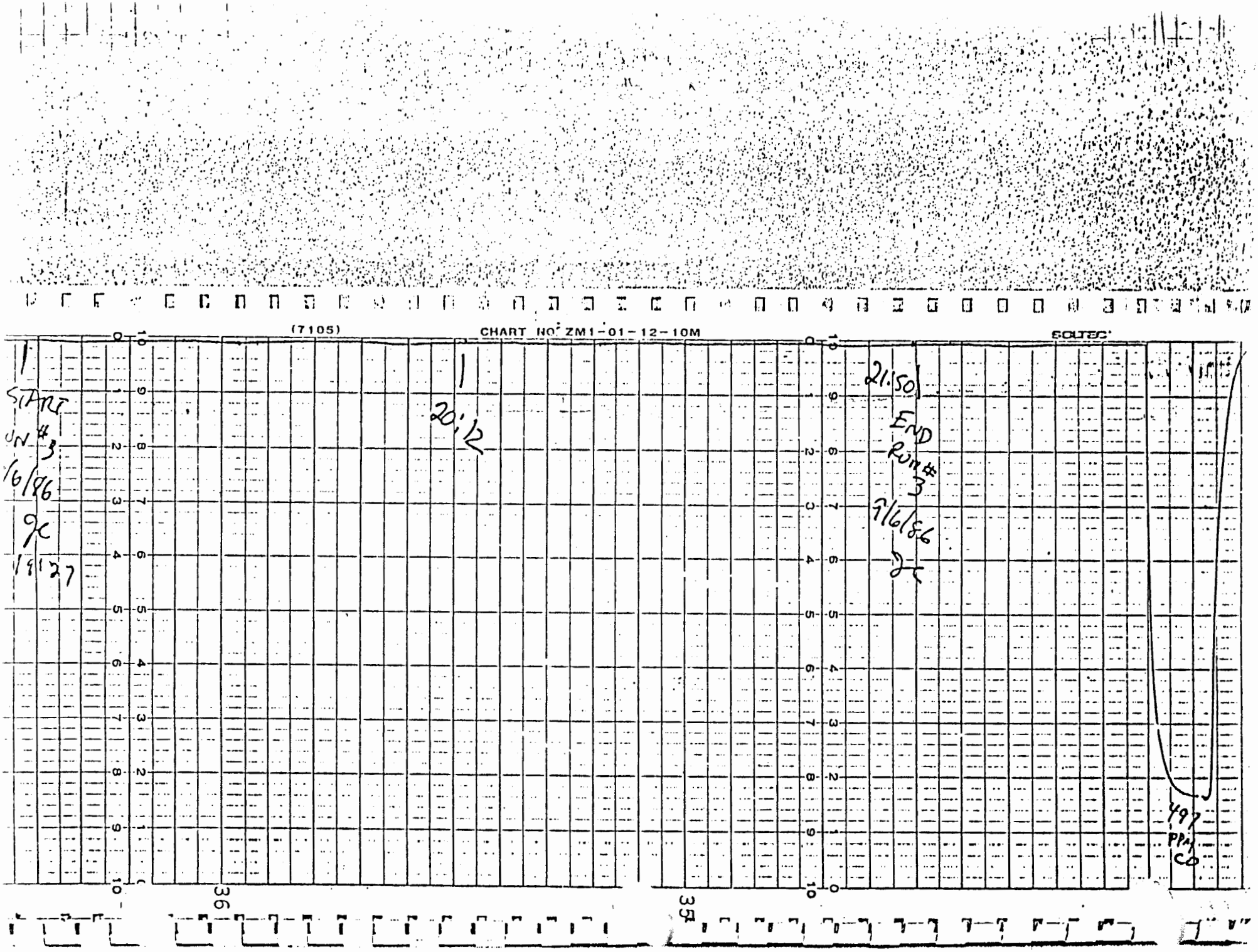
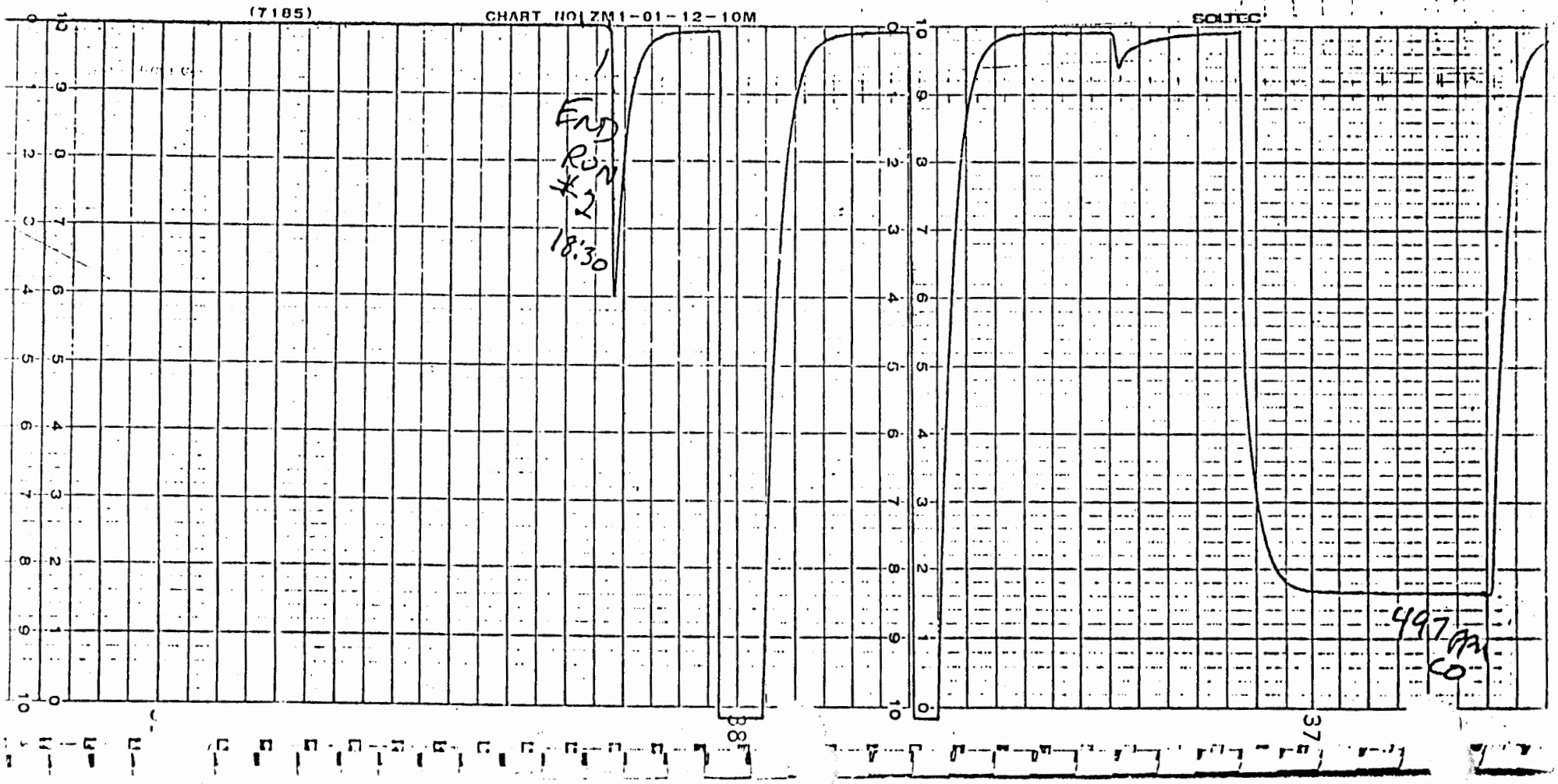
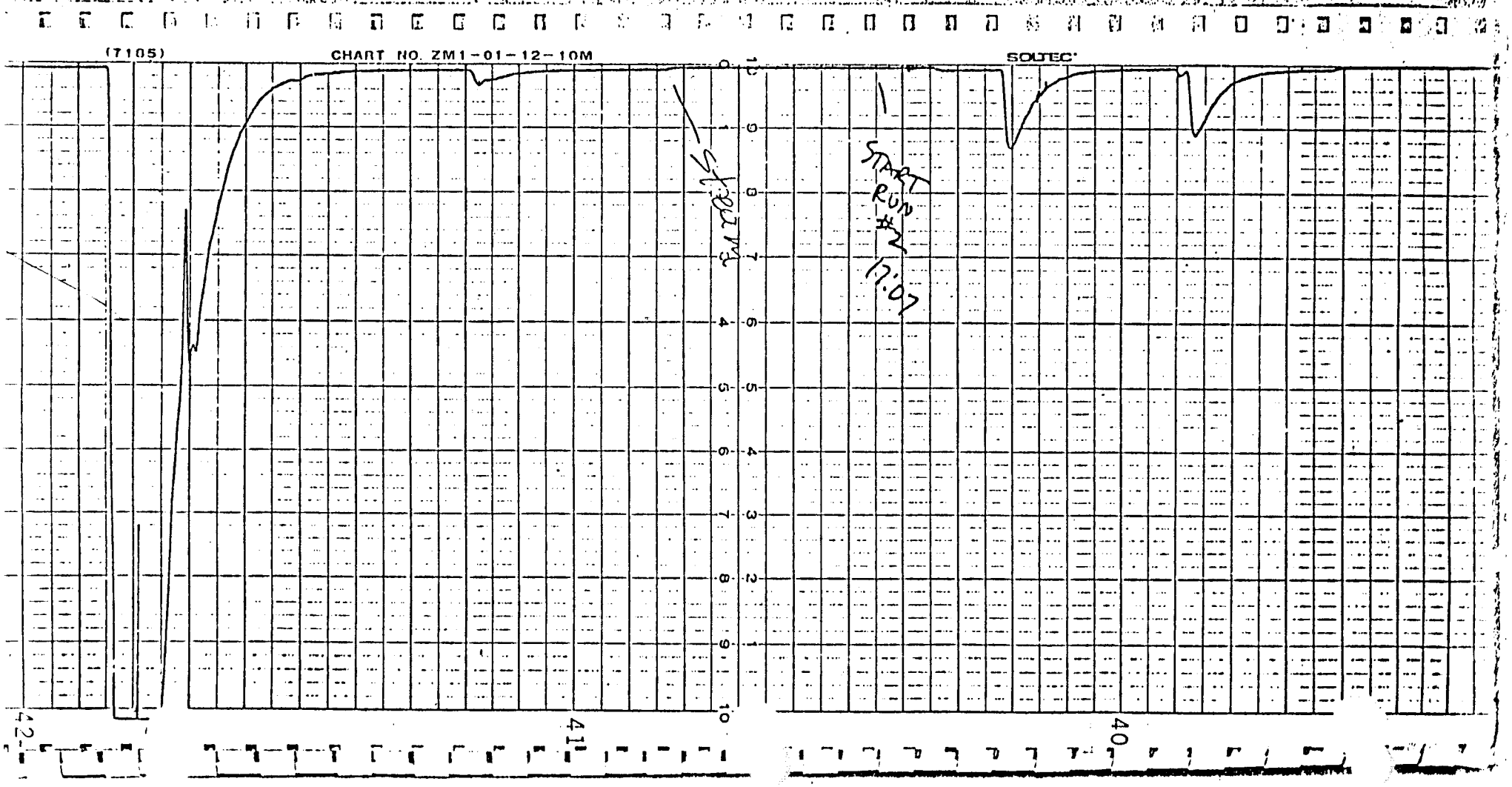
(ZERO)



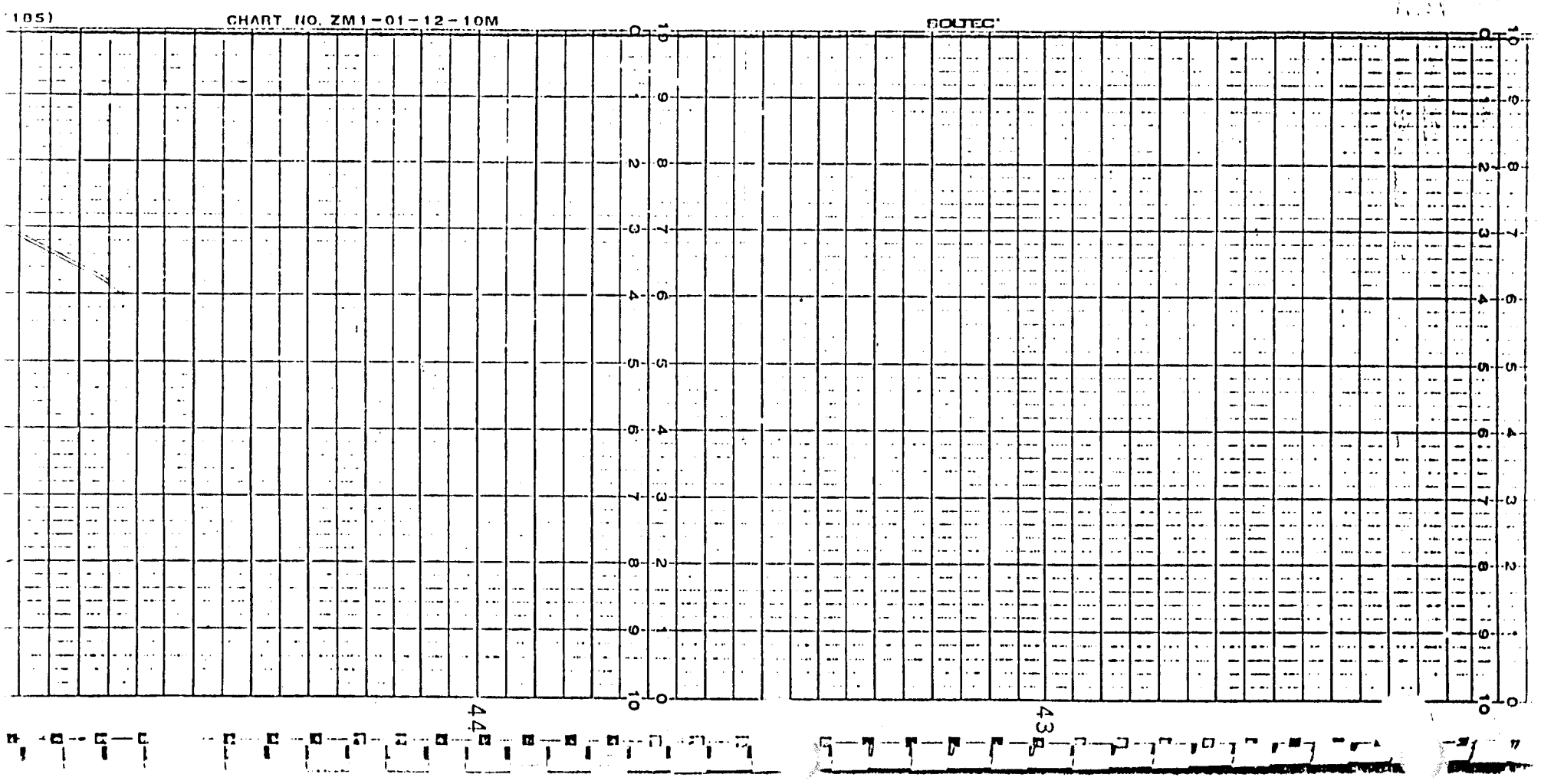

(7106)
CHART NO. 2M1-01-12-10M
SOLTEC
PREP
9/7/86
9:30
49 PSIG

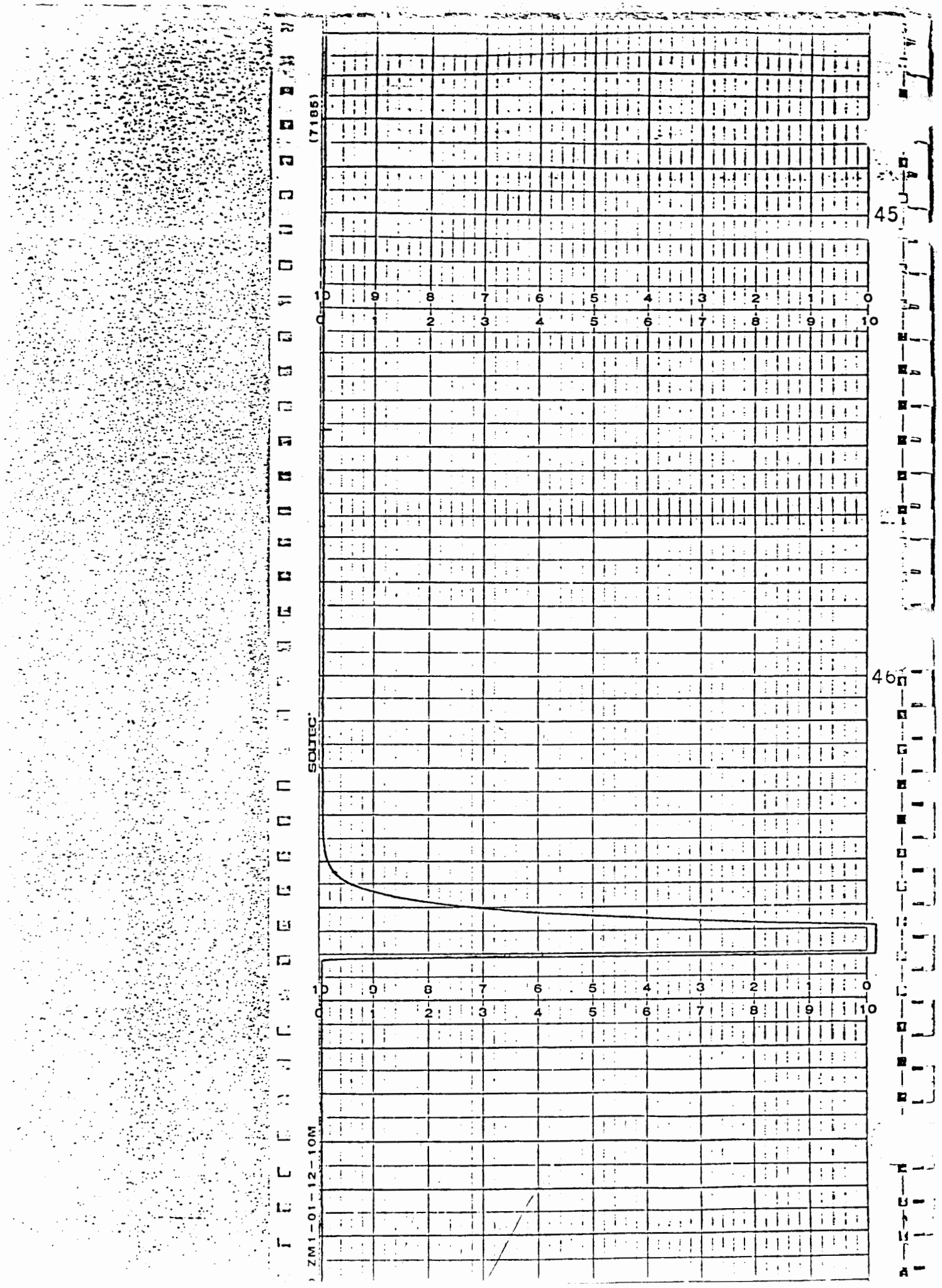

(7105)
CHART NO. ZM1-01-12-10M
SOLTEC
START
RUN #3
9/6/86
JC
19:27
20:12
21:50
END
Run #3
9/6/86
JC
497
PPM
CO
36
35

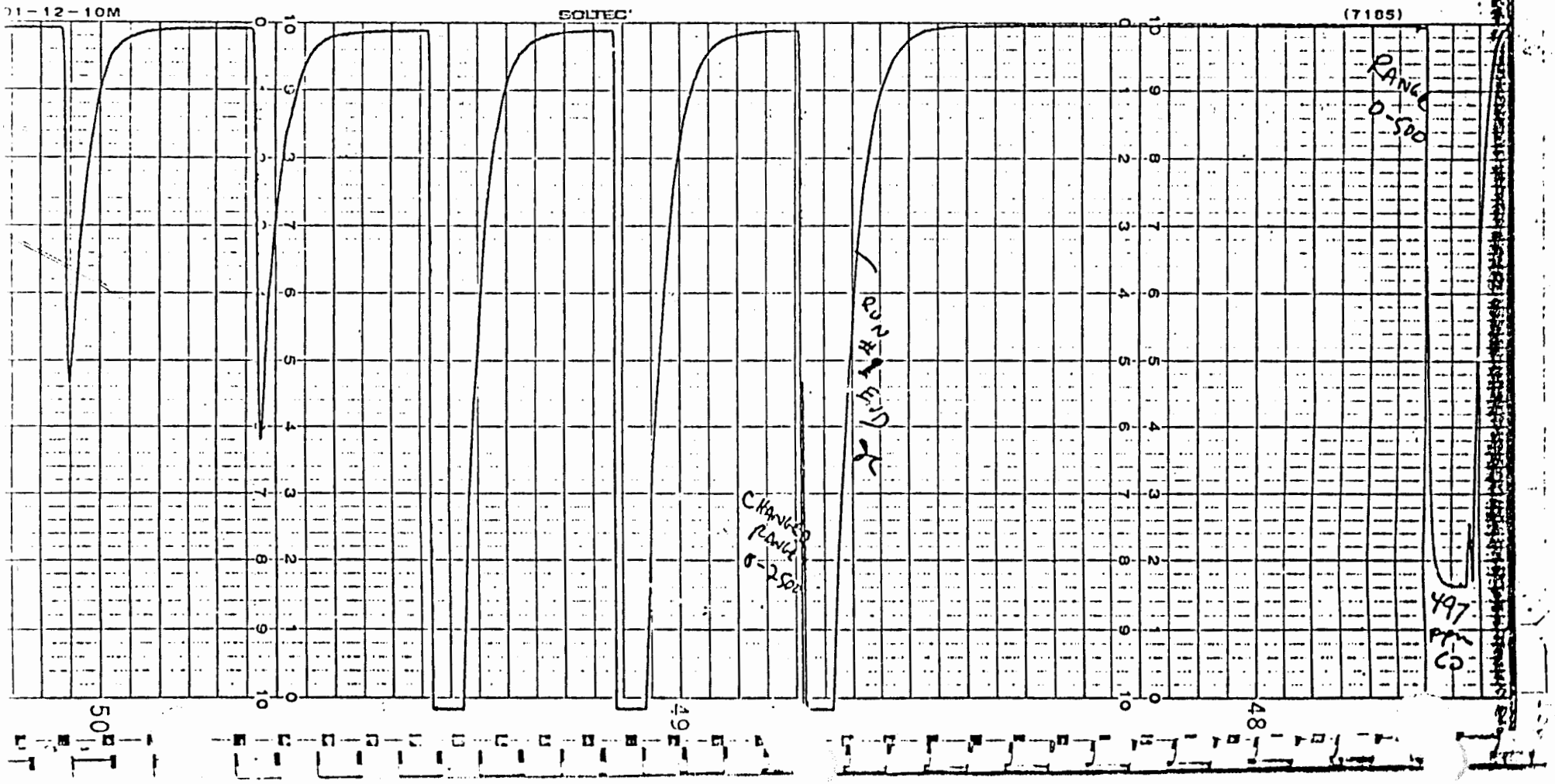

(7185)
CHART NO. ZM1-01-12-10M
SOLTEC
END RUN #2 18:30
497 ppm CO

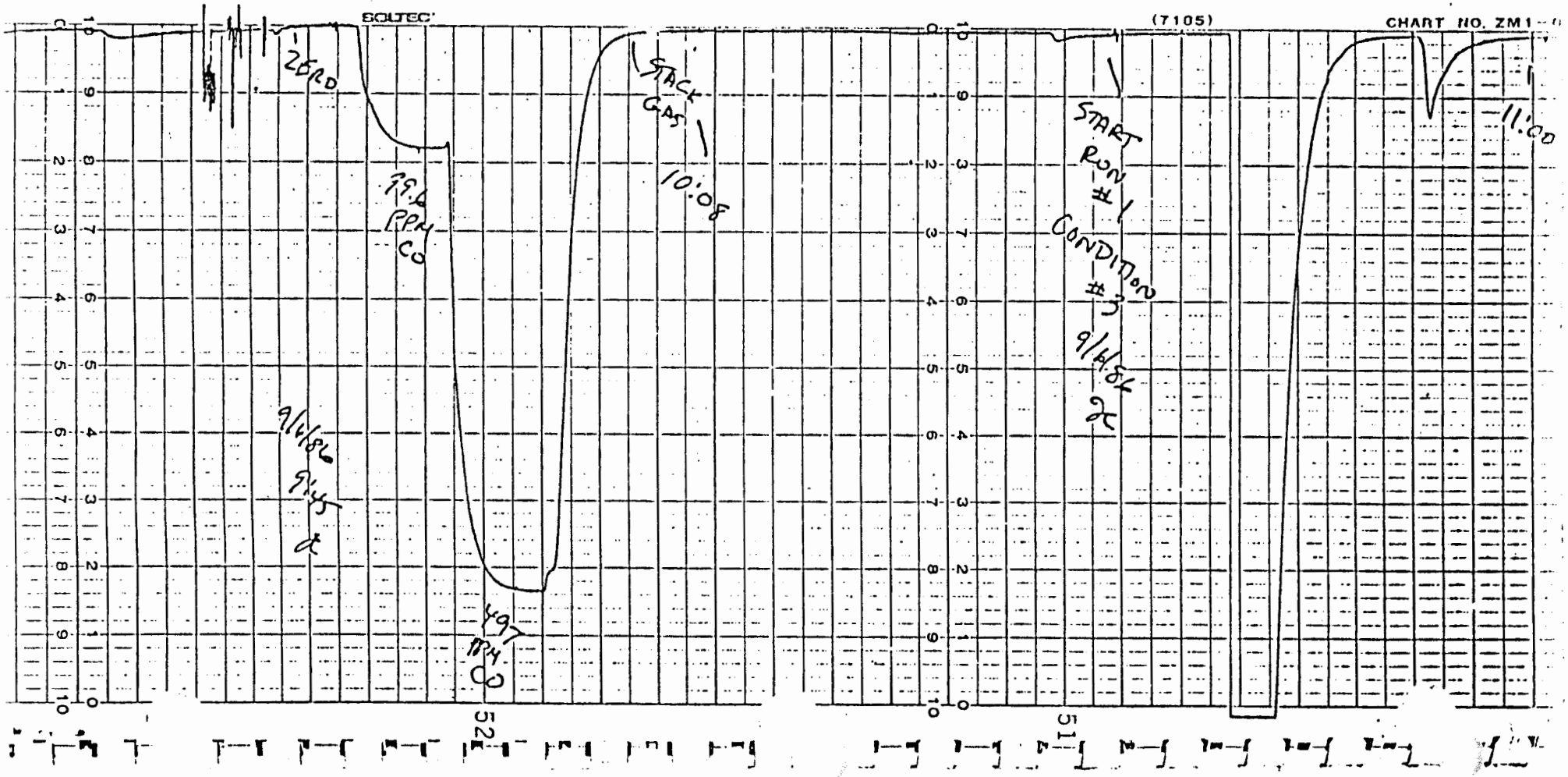

(7105)
CHART NO. ZM1-01-12-10M
SOLTEC
START RUN #2 12:07
42
41
40

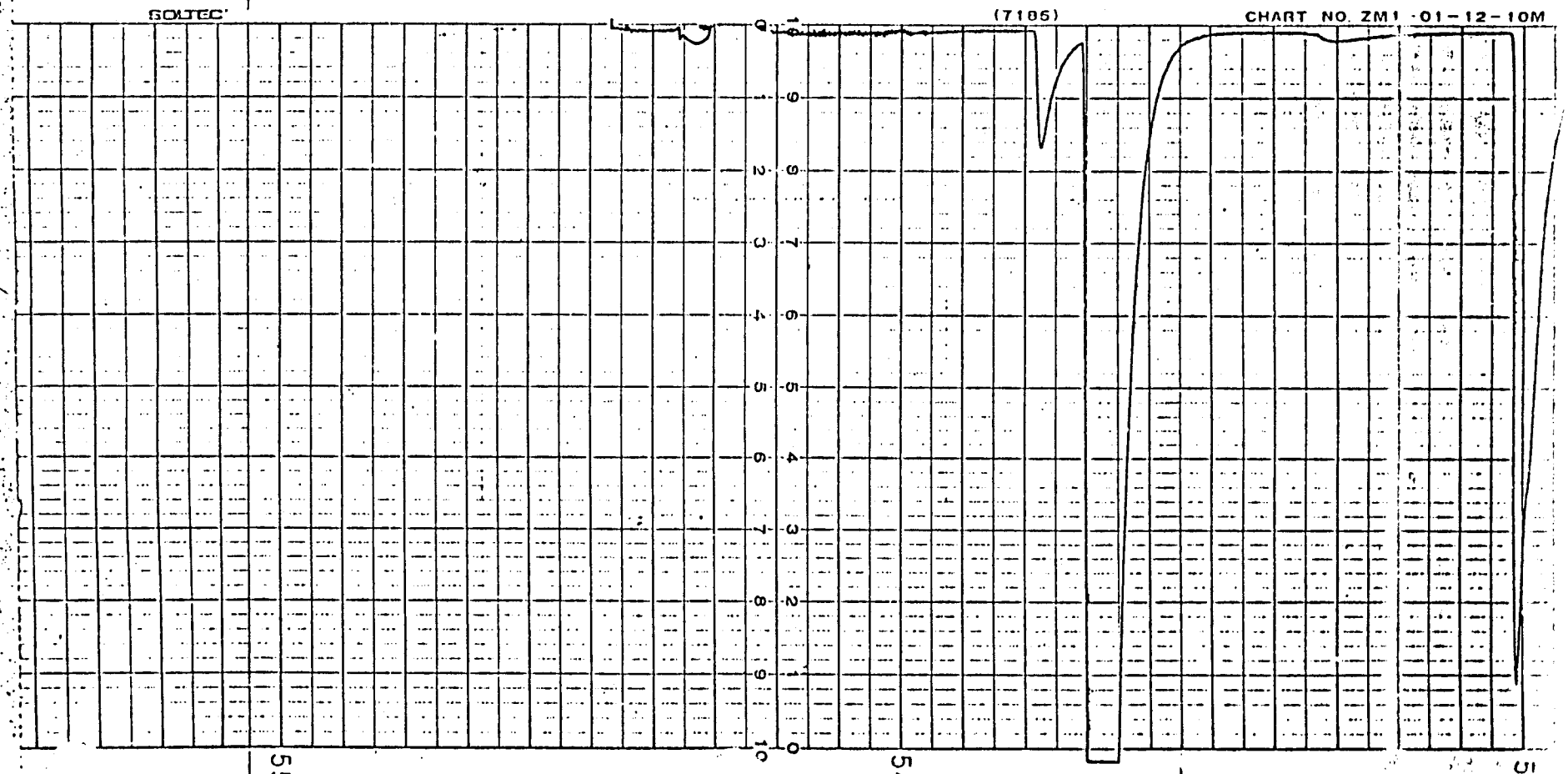
(105) CHART NO. ZM1-01-12-10M




(7185)
SOLTEC
ZM1-01-12-10M
45
46
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10


01-12-10M
SOLTEC
(7105)
RANGE 0-500
497 PPM CO
CHANGED RANGE 0-250
50
49
48


SOLTEC
(7105)
CHART NO. ZM1
ZERO
9/4/86
9:45
22
99.6
PPM
CO
497
PPM
CO
STACK
GAS
10:08
START
RUN #1
CONDITION
#3
9/4/86
22
11:00
52
51


SOLTEC
(7185)
CHART NO. ZM1 -01-12-10M
55
54
53

APPENDIX A. ANALYTICAL RESULTS

6) QC AUDIT SAMPLE RESULTS

i) HSE-9 QA Report
ii) EPA Audit Gas

i) HSE-9 QA Report

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

memorandum

TO: Lee C. Borduin, HSE 7, E517 DATE: November 26, 1986

FROM: Larry R. Field, HSE-9, Contracting MAIL STOP/TELEPHONE: K484/4086

SYMBOL: HSE-9/86-555

SUBJECT: Quality Assurance of Burn Test Analyses Performed By CEP (Santa Fe).

The results obtained from the Quality Control Samples submitted to CEP are given below. In addition a summary of analytical events is included at the end of this memorandum.

Chloride Analyses:

Sample Number	Analytical Result Units (ppm)	QC Result	% Recovery
00.96767	83.	81.	98.
00.96764	7.	6.4	91.
00.96765	3.6	3.2	113.
00.96766	14.5	12.9	112.
00.96768	27.	25.9	104.
00.96769	13.	12.9	100.

The average percent recovery for the chloride containing QC spiked samples was 103 % .

Inorganic Analyses (Na, Fe, & Al):

Sample Number	Analytical Result Units (mg/L)	QC Result	% Recovery
86.12484(Fe)	0.12	0.099	121.
86.12485(Fe)	0.1	0.08	125.
86.12485(Al)	0.5	0.45	111.

The average percent recovery for the Inorganic (Fe & Al) containing QC spiked samples was 119 % . Sodium (Na) was not in the QC sample.

Analyses of Liquid Mixture Feed:

Sample Number	Analytical Result Units (%)	QC Result	% Recovery
00.96591(CCl_4)	40.	46.	87.

The average percent recovery for the Liquid Feed Mixture containing QC spiked sample was 87 % .

Analyses of Volatile Organics in Soils:

Sample Number	Analytical Result Units (ug/kg)	QC Result	% Recovery
First Set			
00.96773(TCE)	7.8	20510.	0.03
00.96773(CCl_4)	0.1	20.	0.5
00.96774(TCE)	0.05	38494.	0.00
00.96774(CCl_4)	0.1	38.	0.2
Second Set			
00.96584(TCE)	ND	32.0	0.0
00.96584(CCl_4)	ND	24.3	0.0
00.96585(TCE)	ND	24.8	0.0
00.96585(CCl_4)	ND	32.7	0.0

The average percent recovery for the First Set of Volatile Organics in Soil containing QC spiked samples was 0.1 % .

The average percent recovery for the Second Set of Volatile Organics in Soil containing QC spiked samples was 0.0 % .

ND is not detected.

Analyses of Volatile Organics in Water:

Sample Number	Analytical Result Units (ug/L)	QC Result	% Recovery
First Set			
00.96775(TCE)	8050.	20280.	39.
00.96775(CCl_4)	44.	20.	220.
00.96776(TCE)	44000.	60840.	72.
00.96776(CCl_4)	69.	60.	115.
Second Set			
00.96589(TCE)	34.	32.	106.
00.96589(CCl_4)	25.	40.	63.
00.96590(TCE)	47.	32.	146.
00.96590(CCl_4)	21.	40.	53.

The average percent recovery for the First Set of Volatile Organics in Water containing QC spiked samples was 56. % for TCE and 167 % for CCl_4 .

The average percent recovery for the Second Set of Volatile Organics in Water containing QC spiked samples was 126. % for TCE and 58 % for CCl_4 .

Vost Cartridge Analyses:

Sample Number	Analytical Result Units (ng)	QC Result	% Recovery
First Set			
00.96770(TCE)	1150.	20280.	6.
00.96770(CCl_4)	8.	20.	40.
00.96771(TCE)	499.	10140.	5.
00.96771(CCl_4)	6.	10.	60.
00.96772(TCE)	NR	40560.	--
00.96772(CCl_4)	NR	40.	--

Second Set

00.96586(TCE)	240.	280.	86.
00.96586(CCl_4)	2900.	4800.	60.
00.96787(TCE)	4800.	4500.	106.
00.96787(CCl_4)	330.	220.	150.
00.96588(TCE)	2100.	1100.	190.
00.96588(CCl_4)	1440.	800.	180.

The average percent recovery for the First Set of Vost Cartridges containing QC spiked samples was 5.5 % for TCE and 50 % for CCl_4 .

The average percent recovery for the Second Set of Vost Cartridges containing QC spiked samples was 127. % for TCE and 130 % for CCl_4 .

NR is not reported.

Summary of Analytical Events:

Approximately 10 % of the analyses performed for this study were evaluated by the insertion of Quality Control Samples. The results obtained from the analyses of these samples are listed above.

Good analytical recoveries were achieved from the determinations of Chloride and the atomic species (Fe, Al, and Na) in spiked QC samples. However, such was not the case for the organic analyses of TCE and CCl_4 in various matrices i.e., air, water, and soil.

Inspection of the analytical data obtained from, and auditing of the analytical procedures used by, the contract analytical laboratory (CEP of Santa Fe) pointed out two distinct flaws. One was in the spiking of the QC samples themselves and the other was in the analytical technique used by CEP to analyze the liquid feed mixtures.

1.) The problem with the spiked QC samples was that the TCE was spiked at a 1000 fold excess of what it should be. The behavior of large amounts of these volatile organic materials on sorption media such as soils and Tenax is unknown and may account for the low recoveries observed for the first set of analyses. Thus, it was decided to resubmit additional QC samples to CEP for analyses, that contained organic materials spiked at levels more-in-line with what was found in the majority of the other samples. The recoveries on second set were better for the vost cartridges, but were erratic for the water samples.

2.)The improper analytical technique used by CEP for the analyses of the Liquid Feed mixtures was GC-ECD. The reason for this being improper is that calibration curves for the ECD are extremely non-linear at the high levels found in the samples we submitted. GC-FID on the other hand is the appropriate analytical technique for these analyses. Thus, it was decided to resubmit for analyses, all of the samples previously analyzed by GC-ECD along with new QC samples. The results obtained for the QC samples for the old vs new method are found in tabular form in this memorandum as First Set = old method(GC-ECD) and Second Set = new method(GC-FID). The average recoveries for these are listed at the bottom of each table.

It should be noted here that the poor recoveries observed for the soil samples, may result from dramatic differences in altitude between the sampling site and analytical laboratory. Further, the soil used to make these QC samples is not truly representative of the ash samples for which they were intended, so the low recoveries may not be an indication of the reliability of data obtained from the ash samples. Then again, it may.

cy: Peggy Gautier, QA/QC.

ii) EPA Audit Gas Sample Analysis Results

December 23, 1986
HSE-7A-86-77
E517
(505) 667-7391

Ms. Cynthia Sokol
Research Triangle Institute
Building #6
P. O. Box 12194
Research Triangle Park, NC 27709

Dear Ms. Sokol:

Pursuant to a request by R.K.M. Jayanty, enclosed you will find an Analytical Report presenting results of analyses for Carbon Tetrachloride and Trichloroethylene on VOST samples taken during a RCRA Trial Burn at this location on September 4-7, 1986. These analyses were performed by the analytical firm of Controls for Environmental Pollution, Inc. of Santa Fe, New Mexico. Included in this report are analytical results on audit gases (Ref. #'s: AAL #11924 and AAL #12421) obtained through your office. These results are outlined in yellow on the second page of the report.

Also enclosed is a copy of a cover letter received from R.K.M. Jayanty concerning shipment and handling of the aforementioned audit gas cylinders. Please note that in this letter audit gas AAL #12421 is identified as 1,1,1-Trichloroethane, whereas the secondary POHC in our feed mixture was Trichloroethylene. Therefore, all VOST sample analyses were conducted to quantify the presence of Trichloroethylene (along with Carbon Tetrachloride) and NOT 1,1,1-Trichloroethane.

I hope these results meet with your approval. If you should have any questions, please call me at (505) 667-7391.

Sincerely yours,

David A. Hutchins
Group HSE-7
Chemical Waste Operations
Los Alamos National Laboratory

DAH:mec

Enclosures: a/s

Cy: R. Garde, HSE-7, MS E518
L. C. Borduin, HSE-7, MS E517
CRM-4, MS A150
HSE-7 Files, MS E517

RESEARCH TRIANGLE INSTITUTE

Center for Environmental Measurements

February 11, 1987

Mr. David A. Hutchins
Los Alamos National Laboratory
P. O. Box 1663
Mailstop E 517
Los Alamos, New Mexico 87545

Dear Mr. Hutchins:

Please find attached the Revised Audit Results for audit numbers 91 and 92, reflecting the corrected values of the test runs for carbon tetrachloride and trichloroethylene.

If you have any questions, please contact me (919) 541-6483.

Sincerely,

R.K.M. Jayanty
Project Leader

RKMJ/sr/91,92

cc: Darryl von Lehmden, EMSL/EPA
Robert Lampe, EMSL/EPA
Florence Richardson, EPA/Washington
Ralph Koenig, LANL
Mark Sides, Region VI, EPA

Post Office Box 12194 Research Triangle Park, North Carolina 27709 Telephone: 919 541-6000

FIELD AUDIT REPORT/NUMBER 91-Revised

PART A - To be filled out by organization supplying audit cylinders (RTI)

1. Organization supplying audit sample(s) and shipping address

Research Triangle Institute
P.O. Box 12194
Cornwallis Road
Research Triangle Park, N.C. 27709

2. Individual requesting Audit, organization, and phone number

Mark Sides, Region VI EPA, Dallas, TX (214) 767-8944

3. Audit supervisor, organization, and phone number

R.K.M. Jayanty, Research Triangle Institute, (919) 541-6483

4. Shipping instructions - Name, Address, Attention

Ralph Koenig, T.A. 50, Bldg. 37, SM-30 Bikini Rd., Los Alamos National Laboratory, Los Alamos, NM 87545

5. Shipping date for cylinder August 22, 1986

6. Guaranteed arrival date for cylinder by Overnite Trans. Co.

7. Audit cylinder(s) status/constituent concentration

A.	Cylinder number	AAL 11924
B.	Cylinder pressure, psig	1800
C.	Cylinder construction	Aluminum
D.	Audit Balance Gas	Nitrogen
E.	Date of Last Analysis	4/86
F.	Audit Gas(es), ppb	
	Carbon tetrachloride	16.9 ± 0.5
	Chloroform	23.2 ± 0.5
	Perchloroethylene	78 ± 1.9
	Benzene	52.6 ± 1.7
	Vinyl chloride	31.8 ± 1.0

cc: Darryl von Lehmden, EMSL/EPA
Robert Lampe, EMSL/EPA
Florence Richardson, EPA/Washington
Mark Sides, Region VI, EPA

FIELD AUDIT REPORT/NUMBER 91-Revised

PART B - To be filled out by audit supervisor

1. Organic chemical manufacturing process Hazardous Waste Trial Burn
2. Name of individual/organization being audited Ralph Koenig, Los Alamos National Laboratory
3. Location of audit Los Alamos National Laboratory, Los Alamos New Mexico 87545
4. Use of audit material Ascertain accuracy of VOST sampling and GC/MS analysis procedures.
5. Audit Results

A. Cylinder number AAL 11924
B. Pressure before audit, psig 1800
C. Pressure after audit, psig 1500
D. Audit date: 9/7/86

Compound	Auditee Conc. (ppb) 1	2	3	Average	RTI Concentration
Carbon tetrachloride	12.32	*	14.20	13.26	16.9 ± 0.5
Chloroform				N/A	23.2 ± 0.5
Perchloroethylene				N/A	78 ± 1.9
Benzene				N/A	52.6 ± 1.7
Vinyl chloride				N/A	31.8 ± 1.0

E. Audit Accuracy*

Carbon tetrachloride	-22
Chloroform	N/A
Perchloroethylene	N/A
Benzene	N/A
Vinyl chloride	N/A

$$* \text{ Percent accuracy} = \frac{\text{Auditee Conc.} - \text{RTI Conc.}}{\text{RTI Conc.}} \times 100$$

6. Problems (if any) This revised report replaces Δ91.

FIELD AUDIT REPORT/NUMBER 92-Revised

PART A - To be filled out by organization supplying audit cylinders (RTI)

1. Organization supplying audit sample(s) and shipping address

Research Triangle Institute
P.O. Box 12194
Cornwallis Road
Research Triangle Park, N.C. 27709

2. Individual requesting Audit, organization, and phone number

Mark Sides, Region VI EPA, Dallas, TX (214) 767-8944

3. Audit supervisor, organization, and phone number

R.K.M. Jayanty, Research Triangle Institute, (919) 541-6483

4. Shipping instructions - Name, Address, Attention

Ralph Koenig, T.A. 50, Bldg. 37, SM-30 Bikini Rd. Los Alamos National Laboratory, Los Alamos, NM 87545

5. Shipping date for cylinder: August 22, 1986

6. Guaranteed arrival date for cylinder: by Overnite Trans. Co.

7. Audit cylinder(s) status/constituent concentration

A.	Cylinder number	AAL 12421
B.	Cylinder pressure, psig	1400
C.	Cylinder construction	Aluminum
D.	Audit Balance Gas	Nitrogen
E.	Date of Last Analysis	6/86
F.	Audit Gas(es) PPB	
	Acetonitrile	14.9 ± 1.0
	Methyl Ethyl Ketone	18.1 ± 1.0
	Trichloroethylene	13.2 ± 0.7
	1,2-Dichloroethane	16.7 ± 0.9
	Trichlorofluoromethane	15.9 ± 0.5
	Bromomethane (7/85)	15.0 ± 0.6
	Dichlorodifluoromethane	15.5 ± 0.6
	1,2-Dibromoethane	16.2 ± 0.7
	1,1,1-Trichloroethane	16.3 ± 0.9

cc: Darryl von Lehmden, EMSL/EPA
Robert Lampe, EMSL/EPA
Florence Richardson, EPA/Washington
Mark Sides, Region VI, EPA

FIELD AUDIT REPORT/NUMBER 92

PART B - To be filled out by audit supervisor

1. Organic chemical manufacturing process Hazardous Waste Trial Burn.
2. Name of individual/organization being audited Ralph Koenig, Los Alamos National Laboratory
3. Location of audit Los Alamos National Laboratory New Mexico 87545
4. Use of audit material Ascertain accuracy of VOST sampling and GC/MS analysis procedure.

5. Audit Results

A. Cylinder number AAL 12421
B. Pressure before audit, psig 1400
C. Pressure after audit, psig 1350
D. Audit date: 9/7/86

Compound	Auditee Conc. (ppb) 1	2	3	Avg.	RTI Concentration
Acetonitrile				N/A	14.9 ± 1.0
Methyl Ethyl Ketone				N/A	18.1 ± 1.0
Trichloroethylene	12.25	12.95	13.82	13.01	13.2 ± 0.7
1,2-Dichloroethane				N/A	16.7 ± 0.9
Trichlorofluoromethane				N/A	15.9 ± 0.5
Bromomethane				N/A	15.0 ± 0.6
Dichlorodifluoromethane				N/A	15.5 ± 0.6
1,2-Dibromoethane				N/A	16.2 ± 0.7
1,1,1-Trichloroethane				N/A	16.3 ± 0.9

E. Audit Accuracy*

Acetonitrile	N/A	Bromomethane	N/A
Methyl Ethyl Ketone	N/A	Dichlorodifluoromethane	N/A
Trichloroethylene	-1	1,2-Dibromoethane	N/A
1,2-Dichloroethane	N/A	1,1,1-Trichloroethane	N/A
Trichlorofluoromethane	N/A		

$$* \text{ Percent accuracy} = \frac{\text{Auditee Conc.} - \text{RTI Conc.}}{\text{RTI Conc.}} \times 100$$

6. Problems (if any) This revised report replaces Δ92.

COMPARISON OF VOST QC AUDIT ANALYSES

Sample Number	Analytical Result (ng)	QC Result	% Recovery
First Set			
00.96770 (TCE)	1150	20280	6
00.96770 (CCl_4)	8	20	40
00.96771 (TCE)	499	10140	5
00.96771 (CCl_4)	6	10	60
00.96772 (TCE)	NR	40560	--
00.96772 (CCl_4)	NR	40	--
		Average: TCE	5.5
		CCl_4	50
Second Set			
00.96586 (TCE)	240	280	86
00.96586 (CCl_4)	2900	4800	60
00.96587 (TCE)	4800	4500	106
00.96587 (CCl_4)	330	220	150
00.96588 (TCE)	2100	1100	190
00.96588 (CCl_4)	1440	800	180
		Average: TCE	127
		CCl_4	130

Sample Number	Analytical Result (ng)	Analytical Conc. (ppb)	EPA QC Value (ppb)	% Recovery
EPA Audit Gases				
86.12477 (TCE)	502	12.25	13.2	93
86.12477 (CCl_4)	<10	---	0	---
86.12478 (TCE)	605	12.95	13.2	98
86.12478 (CCl_4)	<10	---	0	---
86.12479 (TCE)	614	13.82	13.2	105
86.12479 (CCl_4)	<10	---	0	---
86.12480 (TCE)	<10	---	0	---
86.12480 (CCl_4)	615	12.32	16.9	73
86.12481 (TCE)	NR	---	0	---
86.12481 (CCl_4)	NR	---	16.9	---
86.12482 (TCE)	<10	---	0	---
86.12482 (CCl_4)	730	14.20	16.9	84
			Average: TCE	99
			CCl_4	78

APPENDIX B. INCINERATOR OPERATING CONDITIONS

1) Operating Parameters

INCINERATOR OPERATING CONDITIONS

Parameter	RUN # 1-1	1-2	1-3	1-4	1-5	1-6
Waste Feed Rate, (lb_m/hr)	147	166.8	166.8	170.4	171.6	171.6
Waste Heat Content (Calculated-BTU/lb)	8418	8418	8418	8418	8569	8569
PCC Fuel Gas (SCFM) (@ 960 BTU/SCF)	.5	.5	.5	.5	.5	.5
PCC Thermal Input (MM BTU/hr)	1.266	1.433	1.433	1.463	1.499	1.499
Upper Combustion Chamber temp., (^oF)	2200	2200	2200	2200	2200	2200
Lower Combustion Chamber temp., (^oF)	1850	1900	1925	1950	1850	1925
Offgas Flow (acfm)	1475	1475	1475	1475	1521	1521
Stack Gas Temp. (^oF)	209	209	209	209	213	213
Mean Scrub Soln. pH	4.8	4.4	4.6	5.1	8.8	3.8
Bldg. Sump pH	3.2	4.8	5.5	5.9	6.3	6.2
Venturi Pressure Drop (in WC)	45	45	45	45	42	38
Chloride Feed Rate (as HCl, lb/hr)	86.21	97.82	97.82	99.93	100.6	100.6
Chloride Emissions (lb/hr)	<.0016	<.0016	<.0016	<.0016	<.0016	<.0016
Scrubber Efficiency (%)	99.99	99.99	99.99	99.99	99.99	99.99
SCC O_2 Level (%) (Strip Chart)	6.0	6.2	6.2	6.2	6.0	6.8
CO Emissions (ppmv @ 12% O_2)	7	7	7	7	8	8
Ash in Feed (%)	<.3	<.3	<.3	<.3	<.3	<.3
Particulate Out (gr/dscf @ 7% O^2)	.011	.011	.011	.011	.0066	.0066

INCINERATOR OPERATING CONDITIONS

Parameter	RUN # 2-1	2-2	2-3	2-4	2-5	2-6
Waste Feed Rate, (lb_m/hr)	173.4	173.4	171.6	171.6	172.8	172.8
Waste Heat Content (Calculated-BTU/lb)	8512	8512	8586	8586	8522	8522
PCC Fuel Gas (SCFM) (@ 960 BTU/SCF)	.5	.5	.5	.5	.5	.5
PCC Thermal Input (MM BTU/hr)	1.505	1.505	1.502	1.502	1.501	1.501
Upper Combustion Chamber temp., (^oF)	2000	2000	2000	2000	2000	2000
Lower Combustion Chamber temp., (^oF)	1875	1910	1950	1975	2000	2010
Offgas Flow (acfm)	1351	1351	1356	1356	1345	1345
Stack Gas Temp. (^oF)	216	216	226	226	229	229
Mean Scrub Soln. pH	5.1	4.8	4.8	5.0	3.6	2.6
Bldg. Sump pH	4.7	5.7	6.2	6.4	6.4	6.5
Venturi Pressure Drop (in WC)	38	38	38	38	39	39
Chloride Feed Rate (as HCl, lb/hr)	102.14	102.14	101.08	101.08	101.8	101.8
Chloride Emissions (lb/hr)	<.0014	<.0014	.0616	.0616	.4220	.4220
Scrubber Efficiency (%)	99.99	99.99	99.94	99.94	99.59	99.59
SCC O_2 Level (%) (Strip Chart)	8.0	8.0	8.0	8.0	8.2	8.2
CO Emissions (ppmv @ 12% O_2)	8	8	9	9	11	11
Ash in Feed (%)	<.3	<.3	<.3	<.3	<.3	<.3
Particulate Out (gr/dscf @ 7% O^2)	.0137	.0137	.0114	.0114	.0153	.0153

INCINERATOR OPERATING CONDITIONS

Parameter	RUN # 3-1	3-2	3-3	3-4	3-5	3-6
Waste Feed Rate, (lb_m/hr)	165.6	165.6	186.6	186.6	177.6	177.6
Waste Heat Content (Calculated-BTU/lb)	4874	4874	4874	4874	4874	4874
PCC Fuel Gas (SCFM) (@ 960 BTU/SCF)	1.0	1.0	1.0	1.0	1.0	1.0
PCC Thermal Input (MM BTU/hr)	.8647	.8647	.9671	.9671	.9232	.9232
Upper Combustion Chamber temp., (^oF)	2200	2200	2200	2200	2200	2200
Lower Combustion Chamber temp., (^oF)	1690	1720	1640	1675	1675	1650
Offgas Flow (acfm)	1544	1544	1655	1655	1567	1567
Stack Gas Temp. (^oF)	225	225	216	216	210	210
Mean Scrub Soln. pH	1.7	1.7	4.2	5.4	4.1	3.9
Bldg. Sump pH	6.4	6.5	6.0	6.1	6.4	6.4
Venturi Pressure Drop (in WC)	39	39	39	39	39	39
Chloride Feed Rate (as HCl, lb/hr)	67.01	67.01	75.52	75.52	72.88	72.88
Chloride Emissions (lb/hr)	.2525	.2525	.1130	.1130	.1978	.1978
Scrubber Efficiency (%)	99.62	99.62	99.85	99.85	99.73	99.73
SCC O_2 Level (%) (Strip Chart)	~7.0	~7.0	~6.5	~6.0	~7.5	~8.0
CO Emissions (ppmv @ 12% O_2)	***	***	8	8	8	8
Ash in Feed (%)	---	---	---	---	---	---
Particulate Out (gr/dscf @ 7% O^2)	.0154	.0154	.0210	.0210	.0237	.0237

INCINERATOR OPERATING CONDITIONS

Parameter	RUN # 4-1	4-2	4-3	4-4	4-5	4-6
Waste Feed Rate, (lb_m/hr)	190.2	190.2	193.8	193.8	203.4	203.4
Waste Heat Content (Calculated-BTU/lb)	4874	4874	4874	4874	4874	4874
PCC Fuel Gas (SCFM) (@ 960 BTU/SCF)	1.0	1.0	1.0	1.0	1.0	1.0
PCC Thermal Input (MM BTU/hr)	.9846	.9846	1.002	1.002	1.049	1.049
Upper Combustion Chamber temp., (^oF)	2000	2000	2000	2000	2000	2000
Lower Combustion Chamber temp., (^oF)	1350	1325	1425	1525	1575	1575
Offgas Flow (acfm)	1469	1469	1540	1540	1537	1537
Stack Gas Temp. (^oF)	213	213	211	211	202	202
Scrub Soln. pH	6.2	6.2	5.8	6.2	4.6	5.7
Bldg. Sump pH	5.5	5.8	6.2	6.3	6.4	6.5
Venturi Pressure Drop (in WC)	39	39	39	39	39	39
Chloride Feed Rate (as HCl, lb/hr)	77.93	77.93	79.25	79.25	83.36	83.36
Chloride Emissions (lb/hr)	.0491	.0491	.2819	.2819	.3260	.3260
Scrubber Efficiency (%)	99.94	99.94	99.64	99.64	99.61	99.61
SCC O_2 Level (%) (Strip Chart)	~11.0	~10.5	~10.0	~10.0	~9.5	~10.0
CO Emissions (ppmv @ 12% O_2)	10	10	9	9	11	11
Ash in Feed (%)	---	---	---	---	---	---
Particulate Out (gr/dscf @ 7% O^2)	.0089	.0089	.0136	.0136	.0244	.0244

APPENDIX B. INCINERATOR OPERATING CONDITIONS

2) Flowrate & Temperature Data

FLOWRATE & TEMPERATURE DATA

PARAMETER	SAMPLE PERIOD 1-1	1-2	1-3	1-4	1-5	1-6
Baro. P (in Hg)	23.19	23.19	23.19	23.19	23.08	23.08
HEPA OG (scfm)	903	903	903	903	922	922
Cond. Tout (F)	156	155	156	155	157	157
Cond. Pout (psia)	9.580	9.580	9.580	9.580	9.653	9.800
P_{H2O} @ Tcond. (psia)	4.307	4.205	4.307	4.205	4.413	4.413
Secondary Air (scfm)	15	15	15	15	15	17
Underfire Air (scfm)	20	20	20	20	20	20
Upper B. Air (scfm)	93	86	83	81	97	87
Lower B. Air (scfm)	7	7	7	7	7	7
Liquid B. Air (lb/m)	14.2	14.0	14.0	14.0	16.0	16.0
Liquid B. Air (scfm)	190	188	188	188	215	215
Upper B. Fuel (scfm)	23	22.3	23	21.7	25	25.5
Lower B. Fuel (scfm)	.5	.5	.5	.5	.5	.5
Total Steam (lb/hr)	106	105	104	103	107	105
Secondary Temp. (F)	2200	2200	2200	2200	2200	2200
Primary Temp. (F)	1825	1900	1930	1950	1850	1925
Waste Feed (lb/min)	2.45	2.78	2.78	2.84	2.86	2.86
% CCl4	44.84	44.84	44.84	44.84	44.84	44.84
% TCE	19.39	19.39	19.39	19.39	19.39	19.39
#2 Fuel oil (%)	34.93	34.93	34.93	34.93	34.93	34.93
CCl_4 Feed (lb/hr)	65.91	74.80	74.80	76.39	76.92	76.92
TCE Feed (lb/hr)	28.50	32.34	32.34	33.04	33.30	33.30
#2 Fuel Oil (lb/hr)	51.35	58.26	58.26	59.52	59.94	59.94
Ave. CO (ppm)	5	5	5	5	6	6
Ave. CO_2 (%)	8.6	8.6	8.6	8.6	8.6	8.6

FLOWRATE & TEMPERATURE DATA

PARAMETER	SAMPLE PERIOD 2-1	2-2	2-3	2-4	2-5	2-6
Baro. P (in Hg)	23.05	23.05	23.05	23.05	23.05	23.05
HEPA OG (scfm)	814	814	805	805	795	795
Cond. Tout (F)	151	153	153	152	152	152
Cond. Pout (psia)	9.784	9.784	9.790	9.790	9.757	9.757
P_{H2O} @ Tcond. (psia)	3.813	4.005	4.005	3.907	3.907	3.907
Secondary Air (scfm)	17	15	16	18	19	18
Underfire Air (scfm)	20	20	20	21	20	20
Upper B. Air (scfm)	47	44	39	37	35	35
Lower B. Air (scfm)	8	8	8	8	8	8
Liquid B. Air (lb/m)	16.4	16.4	16.2	16.2	16.2	16.2
Liquid B. Air (scfm)	220	220	217	217	217	217
Upper B. Fuel (scfm)	7.8	7.2	6.5	6.0	6.0	5.8
Lower B. Fuel (scfm)	.5	.5	.5	.5	.5	.5
Total Steam (lb/hr)	105	104	101	100	99	98
Secondary Temp. (F)	2000	2000	2000	2000	2000	2000
Primary Temp. (F)	1875	1910	1950	1975	2000	2010
Waste Feed (lb/min)	2.89	2.89	2.86	2.86	2.88	2.88
% CCl4	45.35	45.35	45.35	45.35	45.35	45.35
% TCE	19.12	19.12	19.12	19.12	19.12	19.12
#2 Fuel Oil (%)	34.69	34.69	34.69	34.69	34.69	34.69
CCl_4 Feed (lb/hr)	78.63	78.63	77.84	77.84	78.37	78.37
TCE Feed (lb/hr)	33.17	33.17	32.78	32.78	33.04	33.04
#2 Fuel Oil (lb/hr)	60.15	60.15	59.53	59.53	59.94	59.94
Ave. CO (ppm)	5	5	6	6	7	7
Ave. CO_2 (%)	8.0	8.0	8.0	8.0	8.0	8.0

FLOWRATE & TEMPERATURE DATA

PARAMETER	SAMPLE PERIOD 3-1	3-2	3-3	3-4	3-5	3-6
Baro. P (in Hg)	23.15	23.15	23.05	23.05	23.05	23.05
HEPA OG (scfm)	923	923	998	998	953	953
Cond. Tout (F)	154	155	160	160	142	140
Cond. Pout (psia)	9.775	9.775	9.726	9.726	9.726	9.726
P_{H2O} @ Tcond. (psia)	4.103	4.205	4.741	4.741	3.041	2.889
Secondary Air (scfm)	142	140	116	100	150	146
Underfire Air (scfm)	45	45	47	47	47	44
Upper B. Air (scfm)	157	152	156	147	171	175
Lower B. Air (scfm)	7	7	20	20	7	53
Liquid B. Air (lb/m)	0	0	0	0	0	0
Liquid B. Air (scfm)	0	0	0	0	0	0
Upper B. Fuel (scfm)	14	13	12.8	12.3	14.5	13.4
Lower B. Fuel (scfm)	1	1	1	1	1	1
Total Steam (lb/hr)	4	4	99	99	99	99
Secondary Temp. (F)	2200	2200	2200	2200	2200	2200
Primary Temp. (F)	1690	1720	1640	1675	1675	1650
Waste Feed (lb/min)	2.76	2.76	3.11	3.11	2.96	2.96
% CCl4	29.85	29.85	29.91	29.91	30.40	30.40
% TCE	14.62	14.62	14.56	14.56	14.68	14.68
#2 Fuel Oil (%)	0	0	0	0	0	0
CCl_4 Feed (lb/hr)	49.30	49.30	55.77	55.77	54.05	54.05
TCE Feed (lb/hr)	24.19	24.19	27.22	27.22	26.17	26.17
#2 Fuel Oil (lb/hr)	0	0	0	0	0	0
Ave. CO (ppm)	--	--	5	5	5	5
Ave. CO_2 (%)	8.0	8.0	7.6	7.6	7.6	7.6

FLOWRATE & TEMPERATURE DATA

PARAMETER	SAMPLE PERIOD 4-1	4-2	4-3	4-4	4-5	4-6
Baro. P (in Hg)	23.13	23.13	23.13	23.13	23.10	23.10
HEPA OG (scfm)	892	892	938	938	948	948
Cond. Tout (F)	139	138	138	138	138	137
Cond. Pout (psia)	9.731	9.731	9.731	9.731	9.721	9.721
P_{H2O} @ Tcond. (psia)	2.817	2.744	2.744	2.744	2.744	2.674
Secondary Air (scfm)	145	143	145	141	142	143
Underfire Air (scfm)	51	51	50	50	50	50
Upper B. Air (scfm)	134	137	132	132	132	133
Lower B. Air (scfm)	7	7	7	7	7	7
Liquid B. Air (lb/m)	0	0	0	0	0	0
Liquid B. Air (scfm)	0	0	0	0	0	0
Upper B. Fuel (scfm)	20	20	19.7	19.3	19.5	19.7
Lower B. Fuel (scfm)	1	1	1	1	1	1
Total Steam (lb/hr)	99	99	99	99	99	99
Secondary Temp. (F)	2000	2000	2000	2000	2000	2000
Primary Temp. (F)	1350	1325	1425	1525	1575	1575
Waste Feed (lb/min)	3.17	3.17	3.23	3.23	3.39	3.39
% CCl4	31.14	30.14	30.25	30.25	30.25	30.25
% TCE	14.90	14.90	14.68	14.68	14.79	14.79
#2 Fuel Oil (%)	0	0	0	0	0	0
CCl_4 Feed (lb/hr)	57.36	57.36	58.68	58.68	61.59	61.59
TCE Feed (lb/hr)	28.28	28.28	28.41	28.41	30.13	30.13
#2 Fuel Oil (lb/hr)	0	0	0	0	0	0
Ave. CO (ppm)	5	5	5	5	7	7
Ave. CO_2 (%)	5.9	5.9	7.0	7.0	8.0	8.0

APPENDIX B. INCINERATOR OPERATING CONDITIONS

3) Log Book & Manual Data Sheets

9/4/86 12:00 Bryan Analyzer calibration OK with CAE CO standard for comparison. CO_2 readings are highly suspect but CO readings appear good.

12:40 JSV Begin liquid feed, batch #1

10:04 JSV Stop feed to burner, totalizer = 520.0 lb

10:17 JSV Begin feed again after changing HEPAs.
Initially couldn't get feedpump pressure so took out ball check on pump check, cleaned it, put together. Pump works now.

18:20 CLJ Changed #1 Vapor Bank
18:30 DLM & WD " " " Bypass filter.

21:20 RP Began particulate run #3 totalizer = 1022.0 lbs.

22:50 WD. SAMPLING COMPLETE BURNER FEED TOTALIZER 1254.8 LBS

22:56 CHL Turned off Liquid Feed, Started Gas feed to liquid burner, will leave Steam atomizing medium on at ~50 psi

Reducing chamber temperatures, vent fan, A.P., etc. for idling mode.

9/5/86

0730 JSV Liquid feed totalizer = 1272.2 lb.

.30 JSV Prepared batch #2 liquid feed in tank
Composition: 277.2 lb TCE
638.4 lb CCl_4
488.2 lb Fuel Oil
3.5 lb Alumagel
This batch was added to ~5-10 gal of batch #1 in tank as heel from yesterday. Total volume of feed today = 150 gallons.

0939 Begin liquid feed – batch #2 Totalizer = 0.0

1000 Ops Detected with CO/CO_2 calibration. TTC & NMHC readings high on bargraph mode.

* install timer in Caustic Low Level Alarms

1400
1820
1840
9/6/86
1230
1310
1430
9/7/86
0245
1312
CHL Notified to
2039
9/8/86
CHL

:0 [illegible] Calibration complete. THC's [illegible] readings off-scale [illegible] CO [illegible] OK, [illegible]

00 DAA Prepared new tank of Caustic Solution

JSV Remont of batch #2, Totalizer = 1383.4 lbs

340 JSV Flushed out feed tank with two 2 gal cans of fuel oil, purged feed line with this

6/86

1230 CH. Changed Hepa - #1 Bank. (Bypass open ~3/4 hr)

310 PAP Discharge line on caustic pump burst.

430 PAP Replaced discharge line on caustic pump

4/86 CHL Switched Liquid Process Filters, Changed filters in East Tkg.

CHL Mixed a batch of Caustic

0245 CHL Changed HEPA #1 Bank. (Bypass open for

Did some clean-up on blow boxes - liq filter etc -

JSV Fed box in sideways (90°) to normal box orientation on conveyor. Box cleared ~~[illegible]~~ north edge of guillotine doorway by just <1 inch.

Earlier, ~~[illegible]~~ first box fed today jammed between room and doorway, hence, the reason for trying the new box orientation.

CHL

[illegible] to Corbin - Brought 8 rolls 2" Masking Tape from Trailer -

2039 Sampling finished -

2/8/86

CHL 0082 Lighted boiler burner

0005 Started Shutdown -

1900 Process Shutdown

LOG SHEET NO. 1

RUN NUMBER 21

START DATE 9/2/86

PAGE ___ OF ___

DAT.	TIME	I.	COMBUSTION CONTROL PANEL: LOWER CHAMBER TEMPERATURE, °F (RECORDER)	UPPER CHAMBER TEMPERATURE, °F (RECORDER)	LOWER CHAMBER O_2/COMB., % (RECORDER)	UPPER CHAMBER O_2/COMB., % (RECORDER)		FLOW CONTROL PANEL: UPPER CHAMBER FUEL GAS FLOW, SCFM	LOWER CHAMBER FUEL GAS FLOW, SCFM	UPPER CHAMBER BURNER AIR FLOW, SCFM	LOWER CHAMBER BURNER AIR FLOW, SCFM	INTERTIE AIR FLOW, SCFM	(Hilhorst Rack O_2) OFFGAS FLOW, ~~SCFM~~ LB/min.	SECONDARY AIR FLOW, SCFM	CONDENSER WORKING LIQUID FLOW, GPM	PROCESS STEAM FLOW, LB/HR	
9/3	0005	CLW	980	1040	10.3	11.9		10.8	25	58	69	20	62	243	4	22	
	1300	NAA	1100	1070	10.0	8.5		12.5	31	65	45	20	47	65	4	22	
	2000	CLW	1550	1970	15	8.3		10.7	—	36.5	—	20	35.5	70	4	22	
9/4	0000	CLW	1525	1950	14.5	8.5		10.5	—	35	—	20	35.4	65	4	22	
	0400	WED	1520	1950	14.0	8.5		11.8	—	62	—	20	35.6	65	4	22	
	0930	RAP	1650	2150	11	5.5		15	0	95	8	20	39	20	4	64	
	1250	NAA	1750	2200	6.5	3.3		17.5	0	115	0	20	57.2	10	4	108	
	1530	RAP	1950	2200	6.8	6.2		12.5	0	80	8	20	54.2	20	4	103	
	1915	RAP	1900	2200	7.3	6.7		14	0	93	8	20	58.9	20	4	107	
	2130	WD	1950	2200	7	7		12	0	80	~8	20	58.2	20	4	104	
9/5	0100	CLW	1720	1950	11.5	10.4		2	—	20	8	20	29.5	20	3	102	
	1015	JW	1880	2000	6.6	7.8		7.8	0	47	~8	20	54.2	20	3	105	
	1320	RAP	1970	2000	7.5	7.8		6.0	0	37	8	20	53.4	20	3	106	
	1730	RAP	2010	2000	8.2	8.2		6.0	0	34	8	20	53.4	20	3	104	
9/10/86	900	RAP	~~1780~~	2200	14	9		20	0	175	8	18	62	150	3	20	

LOG SHEET NO. 1

RUN NUMBER 21

START DATE 9/2/86

PAGE ___ OF ___

DATE	TIME	IT	COMBUSTION CONTROL PANEL					FLOW CONTROL PANEL									
			LOWER CHAMBER TEMPERATURE, °F (RECORDER)	UPPER CHAMBER TEMPERATURE, °F (RECORDER)	LOWER CHAMBER O_2/COMB., % (RECORDER)	UPPER CHAMBER O_2/COMB., % (RECORDER)		UPPER CHAMBER FUEL GAS FLOW, SCFM	LOWER CHAMBER FUEL GAS FLOW, SCFM	UPPER CHAMBER BURNER AIR FLOW, SCFM	LOWER CHAMBER BURNER AIR FLOW, SCFM	INDEXTIPE AIR FLOW, SCFM	(Hitec Rack #2) OFFGAS FLOW, SCFM LB/min.	SECONDARY AIR FLOW, SCFM	CONDENSER WORKING LIQUID FLOW, GPM	PROCESS STEAM FLOW, LB/HR	
9/6/86	1740	RAP	1630	2200	5	7		23	4	150	20	50	62	180	0	99	
9/7	1456	JSV	1330	2000	9.5	10		20	2	136	7	51	61.1	140	25	98	
	1800	RAP	1580	2000	7	10		19	2	130	7	51	61.6	140	38	99	

LOG SHEET NO. 2

RUN NUMBER 21
START DATE 9/2/86
PAGE ___ OF ___

Note: draw line at top of recorder bar and mark the date and time

FLOW CONTROL PANEL

DATE	TIME	INIT.	1 FUEL GAS °F	2 BURNER AIR TEMP., °F	3 AMBIENT AIR TEMP., °F	4 UPPER ASH DOOR GLOVEBOX TEMP., °F	5 LOWER ASH DOOR GLOVEBOX TEMP., °F	6 MAIN RAM GLOVEBOX TEMP., °F	LOWER CHAMBER FUEL GAS TOTALIZER, LB	UPPER CHAMBER FUEL GAS TOTALIZER, LB	LOWER CHAMBER BURNER AIR TOTALIZER, LB	UPPER CHAMBER BURNER AIR TOTALIZER, LB	OFFGAS TOTALIZER, LB	UNDERFIRE AIR TOTALIZER, LB	SECONDARY AIR TOTALIZER, LB	PROCESS STEAM TOTALIZER, LB
9/3/86	0004	WD	78	98	81	95	98	79								
9/3/86	1300	RA	86	132	104	91	161	107								
	2200	CLL	92	144	111	209	174	116								
	2359	WED	90	142	110	211	171	115								
9/4	0400	CLL	91	143	110	210	166	112								
	0930	DAS	93	142	113	218	170	118								
	1250	DAS	95	146	118	230	187	137								
	1540	RA	96	153	122	235	197	126								
	1915	JM	100	158	124	239	202	132								
	2130	DM	99	159	123	239	209	136								
9/5	0100	WD	98	162	120	238	211	135								
	1010	JSW	95	152	115	216	192	127								
	1320	RA	99	160	123	223	209	134								
	1530	RA	104	165	125	225	215	138								
9/6	0900	RA	96	150	116	230	197	137								

LOG SHEET NO. 2

Note: draw line at top of recorder bar and mark the date and time

RUN NUMBER 21
START DATE 9/2/86
PAGE ___ OF ___

FLOW CONTROL PANEL

DATE	TIME	INIT.	1 FUEL GAS TEMP., °F	2 BURNER AIR TEMP., °F	3 AMBIENT AIR TEMP., °F	4 UPPER ASH DOOR GLOVEBOX TEMP., °F	5 LOWER ASH DOOR GLOVEBOX TEMP., °F	6 MAIN RAM GLOVEBOX TEMP., °F	LOWER CHAMBER FUEL GAS TOTALIZER, LB	UPPER CHAMBER FUEL GAS TOTALIZER, LB	LOWER CHAMBER BURNER AIR TOTALIZER, LB	UPPER CHAMBER BURNER AIR TOTALIZER, LB	OFFGAS TOTALIZER, LB	UNDERFIRE AIR TOTALIZER, LB	SECONDARY AIR TOTALIZER, LB	PROCESS STEAM TOTALIZER, LB	
9-6-86	1740	[illegible]	100°	159°	122	234	190	139									
9/7/86	1455	[illegible]	95	137	113	215	166	143									
9/7/86	1800	[illegible]	97	139	115	216	170	143									

LOG SIL NO. 3

RUN NUMBER 21
START DATE 9/2/86
PAGE ____ OF ____

DATE	TIME	INIT.	ABSORBER LIQUID FLOW, GPM	VENTURI LIQUID FLOW, GPM	QUENCH LIQUID FLOW, GPM	QUENCH LIQUID PRESSURE, PSIG	VENTURI PRESSURE DROP, IN. WG	MAKEUP WATER FLOW: LB/MIN	MAKEUP WATER TOTALIZER, LB	ABSORBER SUMP GAS TEMP., °F	QUENCH SUMP GAS TEMP., °F	PROCESS LIQUID TEMP., °F	CARBON BED GAS TEMP., °F
			SCRUBBER CONTROL PANEL							Filter Control Re			1 (Recorder 1)
										A	C	B	D
9/3	0010 ~~12~~	G.G	5	5	16	67	48			137	148 ~~150~~	96	171
	1300	RAP	6.5	3	16	74	42			156	179 ~~109~~	109 ~~174~~	171
	2200	Chf	6.5	2.6	15.8	72	31			155	162 ~~106~~	106 ~~162~~ DAH	198
9/4	2359	DM	6.5	2.6	15.8	72	29			153	162 ~~107~~	107 ~~162~~ DAH	198
9/5	0400	Chf	5.5	2.5	15.8	72	31			153	162 ~~105~~	105 ~~162~~ DAH	200
	0540	DAH	6.8	2.8	15.8	72	40			161	169	111	211
	1250	DAH	7.0	2.5	15.8	72	45			165	184	112	211
	1541	JSV	7.1	1.5	15.8	77	45			165	192	117	212
	1915	RAP	7.1	2.0	15.8	76	45			165	118	187	220
	2130	DM	7.1	1.5	15.8	77	46			165	119	191	226
	0100	WD	7	1.7	16	75	37			154	106	171	215
	1015	Cf	7.0	2.0	16.0	75	38			162	181	116	220
	1320	RAP	7	20	14	77	38			162	184	118	228
9/6	0905	JSV	6.8	1.8	16	76	40			167	~~190~~ 186	108	228
	1730	DAH	6.8	1.2	16	76	40			168	189	115	226

LOG SHEET NO. 3

RUN NUMBER 21
START DATE 9/2/86
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DATE	TIME	INIT.	ABSORBER LIQUID FLOW, GPM	VENTURI LIQUID FLOW, GPM	QUENCH LIQUID FLOW, GPM	QUENCH LIQUID PRESSURE, PSIG	VENTURI PRESSURE DROP, IN. WG	MAKEUP WATER FLOW: LB/MIN	MAKEUP WATER TOTALIZER, LB	ABSORBER SUMP GAS TEMP., °F	QUENCH SUMP GAS TEMP., °F	PROCESS LIQUID TEMP., °F	CARBON BED GAS TEMP., °F
			SCRUBBER CONTROL PANEL							Filter Control Ra			1 (Recorder)
										A	C	B	D
9/7	1500	NAA	6.5	2.0	16.0	73	39			165	185	125	211
9/7	1808	JAM	6.5	2.0	16.0	75	40			168	189	128	211

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DATE	TIME	INIT.	(Recorder 2) FILTER CONTROL PANEL NO. 1 (Recorder 3) ABSORBER GAS OUTLET TEMP., °F (A)	CONDENSER GAS OUTLET TEMP., °F (B)	SUPERHEATER GAS OUTLET TEMP., °F (C)	HEPA PLENUM GAS OUTLET TEMP., °F (D)	PRIMARY HX WORKING LIQUID OUTLET TEMP., °F (E)	PRIMARY HX PROCESS LIQUID INLET TEMP., °F (F)	PRIMARY HX PROCESS LIQUID OUTLET TEMP., °F (A)	SECONDARY HX COOLING LIQUID INLET TEMP., °F (B)	SECONDARY HX COOLING LIQUID OUTLET TEMP., °F (C)	SECONDARY HX WORKING LIQUID INLET TEMP., °F (D)	SECONDARY HX WORKING LIQUID OUTLET TEMP., °F (E)	CONDENSER WORKIN LIQUID OUTLET TEMP., °F (F)			
9/1/86	~~1205~~ 0005	WD	~~139~~ 126	~~144~~ 122	~~144~~ 145	~~145~~ 165	~~100~~ 100	133	100	59	71	100	66	121			
	1300	RPW	145	141	175	~~145~~ 196	113	155	111	65	80	98	75	141			
	2017	WD	133	128	162	196	113	151	111	62	77	113	72	130			
	0003	WD	131	127	160	195	112	150	110	62	77	111	72	128			
	0400	WD	131	127	161	195	110	150	110	61	76	111	70	130			
	0945	DAA	150	145	177	196	117	160	115	62	78	115	72	143			
	1255	DAA	158	155	181	215	121	165	118	65	81	118	75	157			
	1540	JSV	~~158~~ 157	155	191	205	120	165	117	65	81	120	75	153			
	1915	DAA	158	155	197	215	120	165	116	65	81	118	75	155			
	2130	RPW	160	156	193	222	120	165	116	65	81	118	75	155			
9-5-86	0100	DAA	127	122	165	210	110	150	108	62	76	118	71	123			
	1010	JSV	155	151	195	210	117	160	113	63	80	110	73	150			
	1320	RPW	155	152	195	225	120	161	115	65	82	115	75	150			
	1530	JSV	155	151	195	225	120	161	116	65	81	117	75	151			
9/1/	[illegible]	JSV	155	153	190	225	117	162	113	61	77	113	62	78			

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DATE	TIME	INIT.	(Recorder 2) FILTER CONTROL PANEL NO. 1 (Recorder 3)														
			A A	B B	C C	D D	E E	F F	A A	B B	C C	D D	E E	F F			
			ABSORBER GAS OUTLET TEMP., °F	CONDENSER GAS OUTLET TEMP., °F	SUPERHEATER GAS OUTLET TEMP., °F	HEPA PLENUM GAS OUTLET TEMP., °F	PRIMARY HX WORKING LIQUID OUTLET TEMP., °F	PRIMARY HX PROCESS LIQUID INLET TEMP., °F	PRIMARY HX PROCESS LIQUID OUTLET TEMP., °F	SECONDARY HX COOLING LIQUID INLET TEMP., °F	SECONDARY HX COOLING LIQUID OUTLET TEMP., °F	SECONDARY HX WORKING LIQUID INLET TEMP., °F	SECONDARY HX WORKING LIQUID OUTLET TEMP., °F	CONDENSER WORKIN LIQUID OUTLET TEMP., °F			
9-6-86	1740	JM	168	160	180	225	120	167	115	65	82	120	76	157			
9-7-86	1500	JM	160	138	182	221	130	165	126	71	100	120	93	131			
9-7-86	1808	JM	162	141	173	208	135	165	130	71	101	130	96	131			

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DATE	TIME	INIT.	FILTER CONTROL PANEL NO. 1: PROCESS LIQUID SPECIFIC GRAVITY	PROCESS SUMP INLET pH	PROCESS SUMP OUTLET pH	BUILDING SUMP pH	CONDENSATE SUMP pH	FILTER CONTROL PANEL NO. 2: 1 FROM ABOVE INCINERATOR OFFGAS CO_2, %	1 FROM ABOVE INCINERATOR OFFGAS CO, %	2 HEPA PLENUM OFFGAS CO_2, %	2 HEPA PLENUM OFFGAS CO, %	Final Flow ~~INDUCED BLOWER FLOW, SCFM~~ LB/min	Final Flow ~~PROCESS LIQUID NOZZLE FLOW, GPM~~ Totalizer, LB	PROCESS LIQUID BLOWDOWN FLOW, LB/MIN	PROCESS LIQUID BLOWDOWN TOTALIZER, LB	CONDENSATE FLOW, LB/MIN	CONDENSATE TOTALIZER, LB
9/2/86	0010 ~~1240~~	WD	~1	7.2	7	3.8	6.6	—	—	—	—	62.2	27804	29	33696	0	0	92
	1300	DMA	1.01	7.6	7	3.4	6.7	—	—	—	—	40.6	10426	53	6423			—
	2019	WD	1.02	7	7	3	6.6	—	—	—	—	35.3	89444	50	86550			—
9/3/86	0000	CHP	1.018	7.2	7	3.2	6.6	—	—	—	—	35.5	97409	58	98883	0	0	3.29
	0400	CHP	1.018	7.2	7	3.1	6.7	—	—	—	—	35.4	106026	61	112150	0	0	3.29
	0945	DMA	1.018	7.4	6.3	3.1	6.7	—	—	—	—	45.37	118235	56	130628	0	0	4.02
	1300	DMA	1.018	7.0	2.0	3.2	6.7	—				56.4	127082	33	141165			4.86
	1900	DMA	1.023	7.2	3.2	6.3	6.6	~~4.0 μm~~	4.0 μm	—	—	58.8	145692	60	163116	0	0	8.19
	2130	RAV	1.027	7.2	2.8	6.5	6.6					50.2	153337	59	170425			8.19
9/5/86	0100	DM	1.027	6.4	3.8	6.6	6.6					30.50 ~~[illegible]~~	162432 ~~[illegible]~~	63	18282			8.19
	1005	JW	1.035	7.1	2.6	5.1	6.5	—	—	—	—	54.6	181572	65	21407			—
	1320	DMA	1.035	7.3	6.0	6.4	6.5	—	—	—	—	53.1	192310	58	225575	0	0	"
	1530	CH	1.035	7.4	2.2	6.4	6.4	—	—	—	—	53.4	199165	60	232741	0		8.19
9/6/86	0857	JW	1.021	7.2	2.1	4.2	4.5	—	—	—	—	62.0	244470	57	288977	—	—	—
	1740	JW	1.05	6.1	3.3	6	4.6					62.2	274568	52	314384			—

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DATE	TIME	INIT.	FILTER CONTROL PANEL NO. 1					FILTER CONTROL PANEL NO. 2										
			PROCESS LIQUID SPECIFIC GRAVITY	PROCESS SUMP INLET pH	PROCESS SUMP OUTLET pH	BUILDING SUMP pH	CONDENSATE SUMP pH	1 INCINERATOR OFFGAS CO_2, %	1 INCINERATOR OFFGAS O_2, %	2 HEPA PLENUM OFFGAS CO_2, %	2 HEPA PLENUM OFFGAS O_2, %	Final Flow ~~INPUT BLOWER FLOW, SCFM~~ LB/min	Final Flow ~~PROCESS LIQUID HOLDING FLOW, GPM~~ Totalizer, LB	PROCESS LIQUID BLOWDOWN FLOW, LB/MIN	PROCESS LIQUID BLOWDOWN TOTALIZER, LB	CONDENSATE FLOW, LB/MIN		CONDENSATE TOTALIZER, LB
9/2	1900	[illegible]	1.022	6.4	3.3	6.0	4.4	[illegible]	[illegible]	—	—	61.2	343443	41	38690	0	0	11.75
	1808	JSV	1.04	6.4	2.4	6.4	4.4	—	—	—	—	60.5	355604	80	389,059	—	—	—

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LIQUID BURNER CONTROL PANEL

DATE	TIME	INIT.	FUEL OIL FLOW, ~~GPM~~ LB/min	FUEL OIL ~~WASTE LIQUID FLOW, GPM~~ Totalizer, LB	MIXTURE FLOW, LB/MIN	MIXTURE TOTALIZER, LB	Liq Burner Air Rack 16/min (Rack 5)	Liq. Burner Air Totalizer 16	Tank #1 Level, %	Feed Pressure, psig	Atomizing Steam Flow, lb/h		
9/3/86	1305	RA	— not in operation →										
	2220	CLL	— On	Natural Gas	→								
9/4	0000	DM	— On	Natural Gas	→								
	0400	WD	— "	"	"	—	5.5	—	—				
	0445	BMA					7.86	—	—				
	1300	BMA	—	~~179~~	2.26	42.17	14.2	—	88.9	47.3			
	1359	JSV	—	—	2.59	197.4	14.0		72.7	59.0	108		
	1534	JSV	—	—	2.62	447.3	14.0	—	49.5	59.0	112		
	1917	WD			2.64	690.4	16.0	—	30	51.2	107		
	2131	KW	—	—	2.64	1048	15.89	—	4.75	52.4	104		
9/5	0100	CLL	~~On~~ -On Natural Gas	~~Natural~~	(on natural Gas) 0.00	1272276	5.96	—		P1 = 3.5* 36.2	102	*Residuals?	
	1005	JSV	—	—	2.67	71.9	16.4		87.5	59.0	105		
	1320	RM	—	—	2.64	608	16.2	—	33.7	54	106		
	1530	JSV	—	—	2.66	931.8			11.0	64.9	98		

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FIELD MEASUREMENTS, ZONE II

DATE	TIME	INIT.	CAUSTIC TANK LEVEL, IN.	SCRUBBER LIQUID FILTER PRESSURE DROP, PSID	PROCESS LIQUID FILTER PRESSURE DROP, PSID	CHECK GAS SAMPLE LIQUID TRAP (✓)	STRAINER INLET/OUTLET PRESSURE, PSIG	QUENCH TOWER PRESSURE DROP, IN. WG	ABSORBER TOWER PRESSURE DROP, IN. WG	OFFGAS HEPA#1 PRESSURE DROP, IN. WG	OFFGAS HEPA#2 PRESSURE DROP, IN. WG	CONDENSER PRESSURE DROP, IN. WG	SUPERHEATER PRESSURE DROP, IN. WG	CARBON BED PRESSURE DROP, IN. WG	CARBON BED HEPA PRESSURE DROP, IN. WG	Makeup water Totalizer, LB.
9/3	0015	CAL	~39"	8	2		71/69		1.4	0.8	0.3	0.3	0.35	1.25	0.7	436176
	1255	CAL	≈37"	0	17.5		77/76		7.2	1.2	0.2	.16	.15	.84	.45	440441
	1720	SFR	37"	0	4		75/74		1	1.3	0.2	.18	.25	.8	.50	449236
	2220	CAL	37	2	2		75/73		0.5	0.8	0.1	.05	.05	.6	.5	443172
9/4	0005	WD	~38	2	~3		75/73		0.2	0.9	0.1	0.1	0.06	0.5	0.25	044464
	0400	WD	~38	2	3		75/73		0.2	0.9	0.1	0.1	0.06	0.5	0.28	044627
	0700	DAH	~38	~2	~4		74/72		0.6	2.6	0.13	0.14	0.10	0.6	0.32	044836
	1300	SFR	38	5	0		77/22		1.3	3.5	0.3	0.30	0.10	0.7	2.8	0445910
	1520	SFR	39	7	0		75/21		1.3	5.9	0.3	0.23	.15	0.7	1.3	0450990
	1916	JOV	30.5	0	6		79/77		1.4	0.45	0.3	0.30	0.31	1.2	0.7	045253
	2130	CAL	18.5	0	7		79/78		1.4	0.75	0.3	0.32	0.3+	1.2	0.7	045347
9/5	0104	WD	~39	0	8		77/76		0.2	0.35	0.2	0.08	0.4	0.23	0.45	045504
	1010	SFR	~36	0	8		77/75		1.0	1.0	0.5	.30	.25	1.2	.50	045882
	1300	AAA	12	0	7		80/79		1.2	1.5	0.3	.28	.25	1.05	0.50 / 1.05	046016

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FIELD MEASUREMENTS, ZONE II

DATE	TIME	INIT.	CAUSTIC TANK LEVEL, IN.	SCRUBBER LIQUID FILTER PRESSURE DROP, PSID	PROCESS LIQUID FILTER PRESSURE DROP, PSID	CHECK GAS SAMPLE LIQUID TRAP (✓)	STRAINER INLET/OUTLET PRESSURE, PSIG	QUENCH TOWER PRESSURE DROP, IN. WG	ABSORBER TOWER PRESSURE DROP, IN.WG	OFFGAS HEPA#1 PRESSURE DROP, IN. WG	OFFGAS HEPA#2 PRESSURE DROP, IN. WG	CONDENSER PRESSURE DROP, IN. WG	SUPERHEATER PRESSURE DROP, IN. WG	CARBON BED PRESSURE DROP, IN. WG	CARBON BED HEPA PRESSURE DROP, IN. WG	Makeup water Totalizer, LB.
9-7	1450	CB	28.5	2.5	2.5		76/74		2.4	.8	.6	.41	.37	~~0.8~~ 1.3	~~1.8~~ 0.8	048000
	1810	JW	25.5	0	1.0		78/77		2.3	1.05	0.65	0.41	.35	1.3	0.65	048122

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FIELD MEASUREMENTS, OUTSIDE

DATE	TIME	INIT.	CHECK UPS SYSTEM (✓)	STEAM GENERATOR DEIONIZER, MEGOHMS	NITROGEN MANIFOLD PRESSURE, PSIG	NATURAL GAS METER, FT^3	CHECK AUXILIARY GENERATOR (✓)						
9/3	0020	Chal	✓	67	1680	1705053	✓	UF Tank - Start 1029 gal					
	1245	CG	✓	16.5	1680	1718856	✓						
	1830	JW	✓	14.9	1680	172350	✓						
	2025	WD	✓	17.5	1690	1724939	✓						
	2230	Chal	✓	17.5	1680	1724988	✓						
9/4	0400	Chal	✓	16.2	1680	1730622	✓						
	0945	DAA	✓	17.5	1680	1735586	✓						
	1300	JFR	✓	18	1680	1738818	✓						
	1520	JFR	✓	18	1680	1740050	✓						
	1915	DAA	✓	17.2	1680	1742339	✓						
	2130	Chal	✓	17.2	1690	1743271	✓	26" / 572 gal in UFT					
9/5	0100	Chal	✓	18	1690	1744944	✓						
	1010	CG	✓	18.0	1700	175148	✓						
	1330	CG	✓	17.4	1700	175234	✓						
	1530	JFR	✓	18.0	1700	175281	✓						
	2000	Chal	✓	[illegible]	1700	1754301	[illegible]	46"	[illegible]		UFT		

0

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DATE	TIME	INIT.	CHECK UPS SYSTEM (✓)	STEAM GENERATOR DEIONIZER, MEGOHMS	NITROGEN MANIFOLD PRESSURE, PSIG	NATURAL GAS METER, FT^3	CHECK AUXILIARY GENERATOR (✓)						
					LD MEASUREMENTS, OUTSIDE								
9/6	1730	DAA	✓	~~[illegible]~~	1700	177302	✓						
9/7	1500	JFR.		0	1700	179171							
	1800	DAA	✓	0	1700	179443	✓						

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LIQUID BURNER, ZONE II

DATE	TIME	INIT.	ATOMIZER IDENTIFICATION	ATOMIZING MEDIUM	ATOMIZING MEDIUM PRESSURE AT LANCE, PSIG	LIQUID PRESSURE AT LANCE, PSIG						
9/4	1300	DBM			80	60						

APPENDIX B. INCINERATOR OPERATING CONDITIONS

4) Feed Cut-off System Documentation

CAI Process Log #3

2/20/87

Checkout of waste stream shut down circuits -

Upper chamber temperature low =

1013 (RAP)

Current switch set to trip 8 CR (Comp. Control Panel) at 1200°F. Current source (10-50 MADC) substituted for E/I output for UC thermocouple. Current source reduced to simulate drop in UC temperature below 1200°F. Waste liquid shutoff valve serving liquid burner observed to close. ~~to~~ Voltage on coil for solid waste feed timer 5 TR observed to drop from 117 VAC to 0.0 VAC, dropping-out coil and serving to interrupt solid waste feeding system. (Comb. Cont Panel)

1052 (RAP) Upper chamber O_2 concentration low =

Current switch set to trip 12 CR (Cont Control Panel) at 3.0% O_2. Current source substituted for output of O_2 analyzer (10-50 MADC). Current source reduced to simulate drop in UC oxygen concentration below 3.0%. Waste liquid shutoff valve serving liquid burner observed to close. Coil voltage for solid waste feed timer 5 TR observed to drop from 117 VAC to -0- VAC, dropping-out coil and serving to interrupt solid waste feeding system.

1135 (RAP) Process liquid pH low:

Current switch set to trip 4 CR (Filter Control Panel #1) at 1.0 pH. Current source substituted for output of pH transmitter (10-50 MADC). Current source reduced to simulate drop of process liquid pH below 1.0. Waste liquid shutoff valve serving liquid burner observed to close. Coil voltage for solid waste feed timer 5 TR observed to drop from 117 VAC to 0.0 VAC, dropping-out timer coil, serving to interrupt solid waste feeding system.

1316 (RAP) Offgas CO concentration high:

Current switch set to trip 2 CR (Flow Rack) at an indicated offgas CO concentration above 90 ppm (18.4 MADC). Current source substituted for pH output of CO analyzer on 0-100 ppm range (4-20 MADC). Current source then increased to a value above 18.4 MADC. Waste liquid shutoff valve serving liquid burner observed to close. Coil voltage for timer in solid waste feeding circuit (5 TR) observed to drop from 117 VAC to 0.0 VAC, dropping-out timer and serving to interrupt solid waste feeding system.

APPENDIX C. FEED PREPARATION & FEED RATE DATA

1) LIQUID FEED RATES

Liquid Feed Rate Data

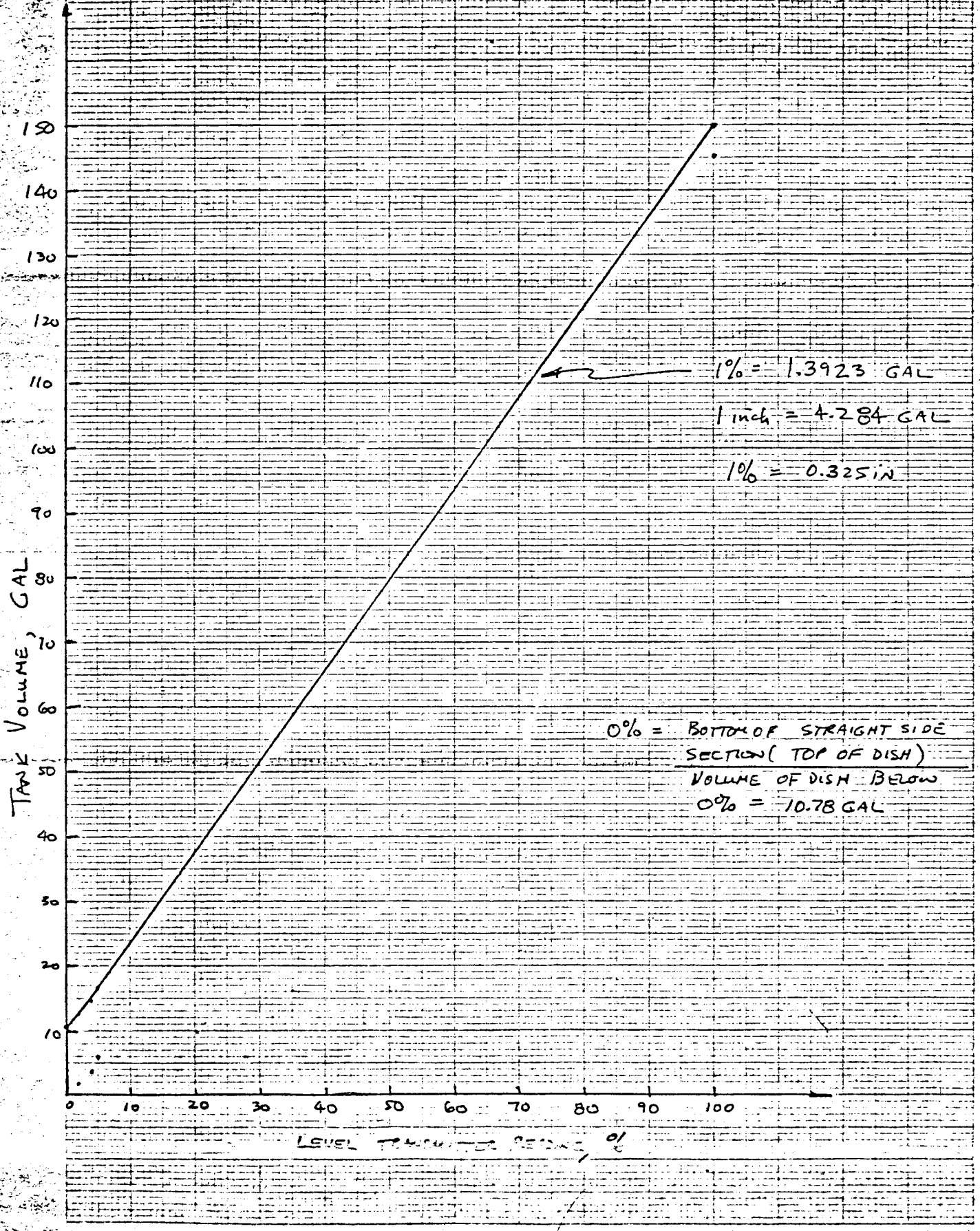
Condition 1--9/4/86		Condition 2--9/5/86	
Alumagel	0.249 w/o	Alumagel	0.249
Fuel Oil	34.93 w/o	Fuel Oil	34.69 w/o
CCl_4	44.84 w/o	CCl_4	45.35 w/o
TCE	19.99 w/o (*19.39)	TCE	19.71 w/o (*19.12)

* TCE wt% corrected to 97% analysis of TCE feedstock

Sample Period and Time EPA M-5	VOST	Flowmeter/ Corrected lbm/min	Corrected Flowrate lbm/hr	POHC Feed lbm/hr CCl_4	97% TCE
LA-1-M5-1 1310-1445	**LA-1-V-1** 1315-1335	2.26/2.45	147	65.91	28.50
	LA-1-V-2 1401-1421	2.59/2.78	166.8	74.80	32.34
	LA-1-V-3 1443-1503	2.59/2.78	166.8	74.80	32.34
	LA-1-V-4 1525-1545	2.62/2.84	170.4	76.39	33.04
LA-1-M5-2 1852-2015	**LA-1-V-5** 1824-1844	2.64/2.86	171.6	76.92	33.30
	LA-1-V-6 1938-1958	2.64/2.86	171.6	76.92	33.30
LA-1-M5-3 2125-2245		2.64/2.86	171.6	76.92	33.30
LA-2-M5-1 0950-1120	**LA-2-V-1** 0958-1018	2.67/2.89	173.4	78.63	33.17
	LA-2-V-2 1044-1104	2.67/2.89	173.4	78.63	33.17
LA-2-M5-2 1220-1340	**LA-2-V-3** 1216-1236	2.64/2.86	171.6	77.84	32.78
	LA-2-V-4 1302-1322	2.64/2.86	171.6	77.84	32.78
LA-2-M5-3 1440-1600	**LA-2-V-5** 1448-1508	2.66/2.88	172.8	78.37	33.04
	LA-2-V-6 1527-1547	2.66/2.88	172.8	78.37	33.04

FED TANK #1 VOLUME CALIBRATION

(KYNAR-LINED TANK)



JSV 8/7/86

LOS ALAMOS CAI
LIQUID FEED FLOWRATE CALIBRATION

Date 11/25/86 Liquid WATER @ 75°F Data Recorded by John S. Kowalski

Flowmeter Type MICROMOTION MODEL C

Data Point No.	Pump Stroke Setting (%)	Micromotion Readout (lb/min)	Chart Reading (lb/min)	Measured Quantities H_2O Vol. (mL)	Measured Quantities Time (sec)	Calculated Flowrate (lb/min)
1	70	2.03	2.06	1218	74.01	2.18
2	70	2.03	2.06	1278	77.25	2.19
3	100	2.95	2.23	1515	62.56	3.20
4	100	2.95	2.23	1508	62.15	3.21
5	85	2.60	2.32	1300	61.87	2.78
6	85	2.58	2.32	1315	62.91	2.76
7	75	2.28	2.30	1441	77.60	2.46
8	75	2.28	2.30	1398	75.16	2.46
9	60	1.84	1.86	1248	84.06	1.96
10	60	1.82	1.85	1235	83.18	1.96
11	45	1.40	1.44	1040	93.56	1.47
12	45	1.41	1.44	896	80.04	1.48
13	30	0.95	0.97	840	113.87	0.98
14	30	0.94	0.97	998	135.17	0.98
15	15	0.44	0.45	830	261.88	0.42
16	15	0.43	0.45	759	245.15	0.41

LOS ALAMOS CAI

Liquid Feed Flowrate Calibration

11/25/86

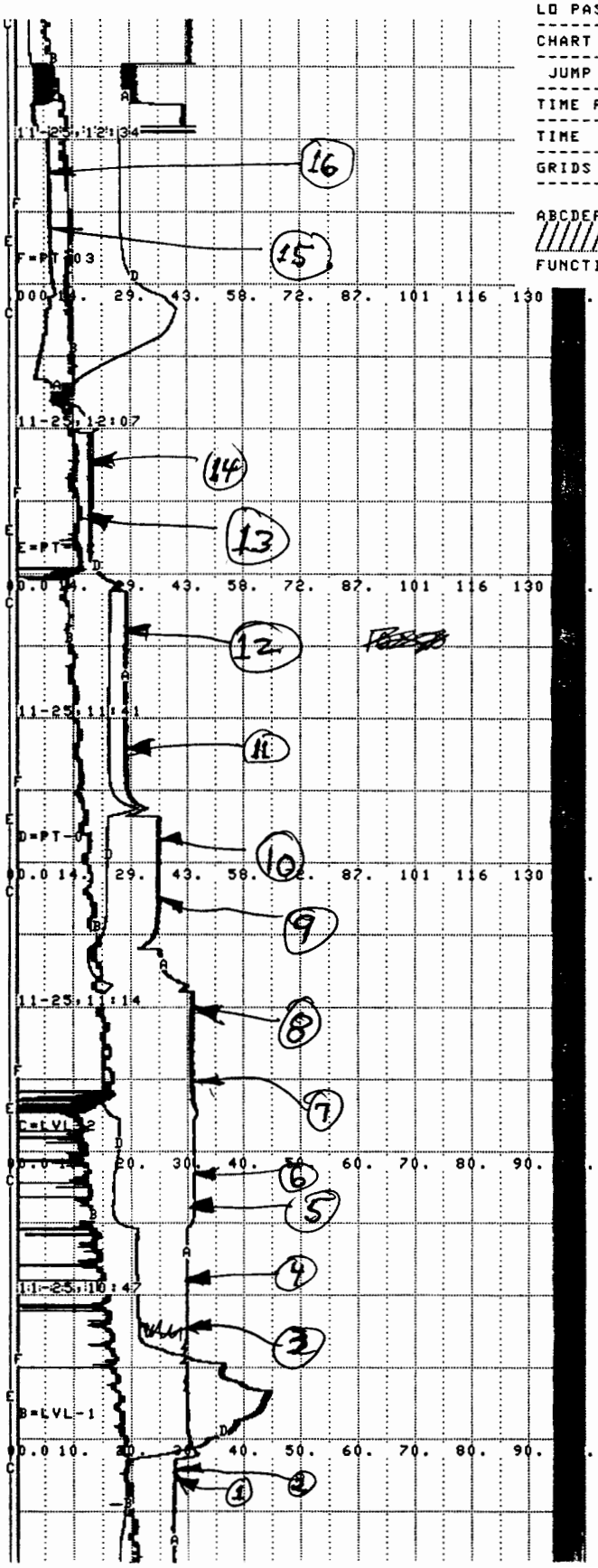
TIGRAPH 200 STATUS

CHANNEL	A	B	C	D	E	
HI SETPOINT %	99	99	99	99	99	9
LO SETPOINT %	0	0	0	0	0	
CHANNEL SELECT	ON	ON	ON	ON	ON	O
CHART MODULE	P1A	P2A	P3A	P4A	P5A	P6
SCALE HI END	7.50	100.	100.	145.	145.	145
SCALE LO END	0.00	0.00	00.0	00.0	0.00	0.0
SCALE UNITS	WASTE	LVL-1	LVL-2	PT-01	PT-02	PT-
LO PASS FILTER	OUT	OUT	OUT	OUT	OUT	OU
CHART SPEED	4.5 IN/HOUR					
JUMP SPEED	OFF IN/HOUR					
TIME FORMAT	MONTH - DAYS,HOURS:MINUTES					
TIME	11-25,10:21 YEAR: '86					
GRIDS ORDERED	BY CHANNEL LINE SYNC 60 HZ					

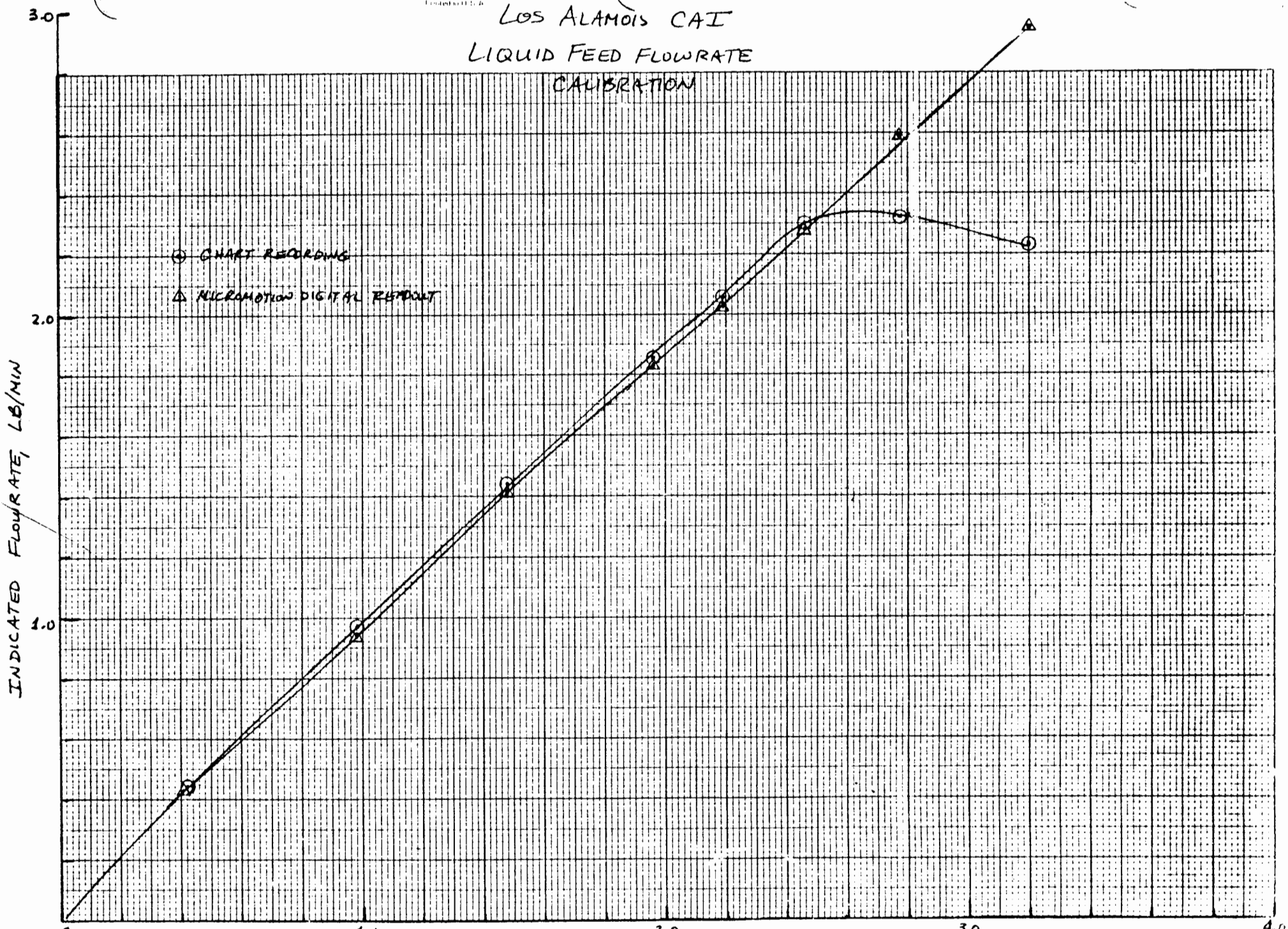
PRINTER TEST COMPLETE.

ABCDEFGHIJKLMNOPQRSTUVWXYZ/abcdefghijklmnopqrstu

FUNCTIONS SAVED



GRAPH PAPER GRAPHIC CONTROLS CORPORATION Buffalo, New York Established U.S.A. SQUARE 10 X 10 TO THE HALF INCH AS 0812 01



LIQUID FEED RATE STRIP CHART

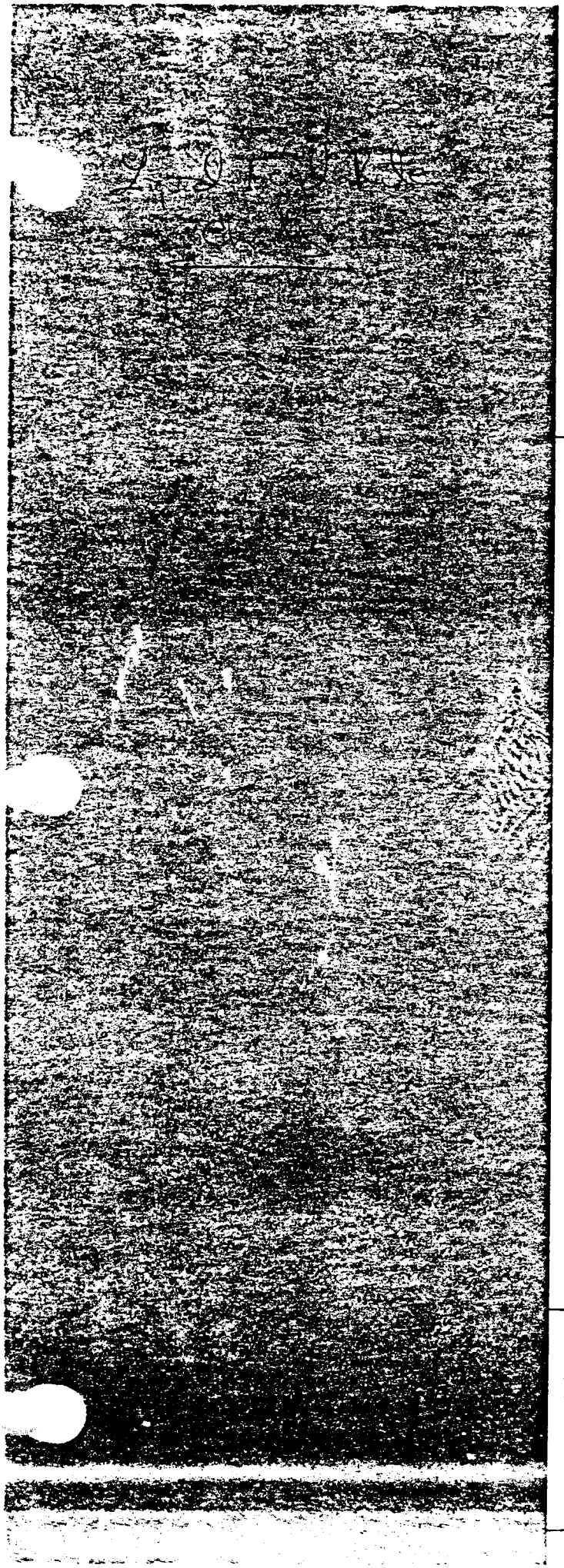
Designations on the following strip chart are as follows:

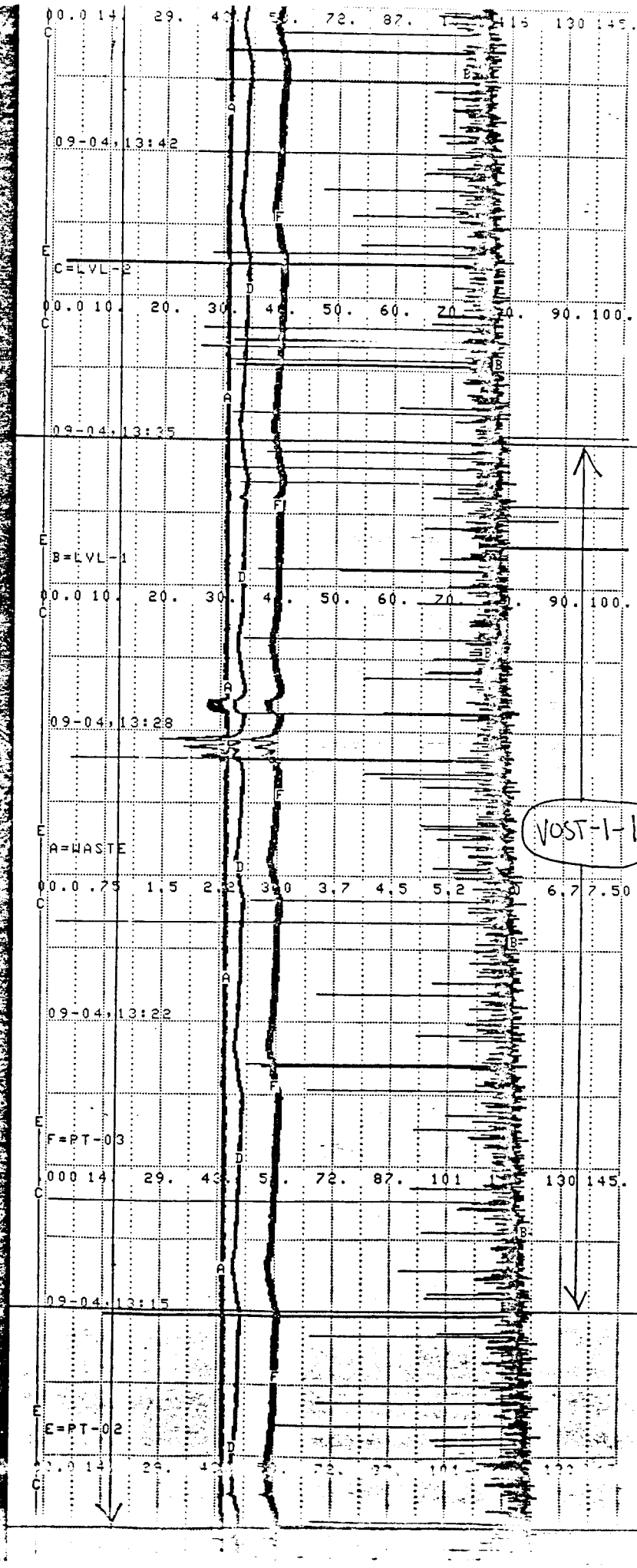
Trace	Designator	Identification
A	WASTE	Waste Feed (0-7.5 lb_m/min)
B	LVL-1	Level in Feed Tank #1 (%)
C	LVL-2	Level in Feed Tank #2 (%)
D	PT-01	Feed Tank #1 Pump Discharge Pressure (0-145 psi)
E	PT-02	Feed Tank #2 Pump Discharge Pressure (0-145 psi)
F	PT-03	Liquid Burner Feed Pressure (0-145 psi)

Please note that date and time are printed periodically on the left hand side of the chart. In addition, trace designators are printed in sequence (A-F) on the left hand side of the chart. When each designator is printed, the appropriate chart scale for that input is also printed (i.e.- A=WASTE, 0-7.5 lb_m/min; B=LVL-1, 0-100%; D=PT-01, 0-145 psi; etc.). The scale for any trace continues for four (4) vertical divisions, until the next trace designator and scale are printed.

To correctly determine the value for a particular trace at any given point on the chart you must refer back to the scale printed for that trace when the trace designator is printed (once every 24 vertical divisions). Traces ARE NOT attenuated to correspond to different scales. Attempts to determine values for a given trace other than with reference to its appropriate scale will result in erroneous readings!

Please note also that beginning with 9/05/86 chart speed was changed from 18 inches/hr to 9 inches/hr to conserve chart paper.

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B=LVL-1
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A=WASTE
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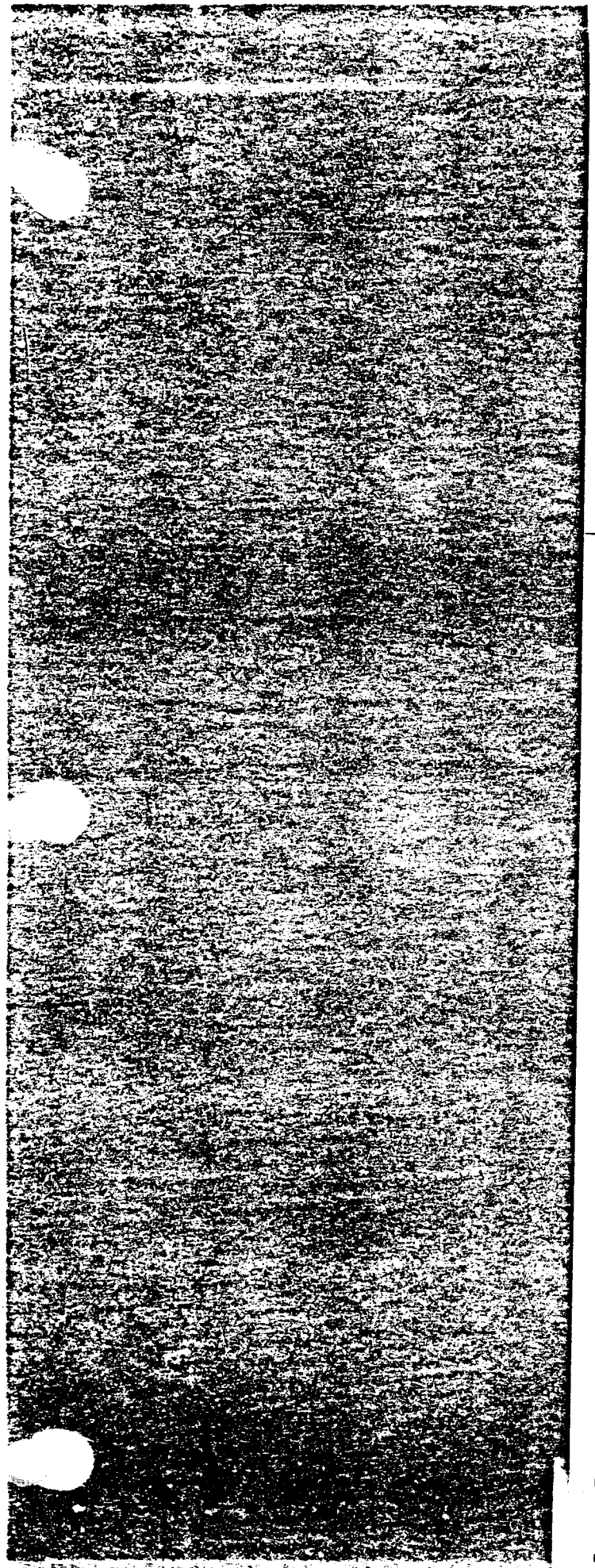
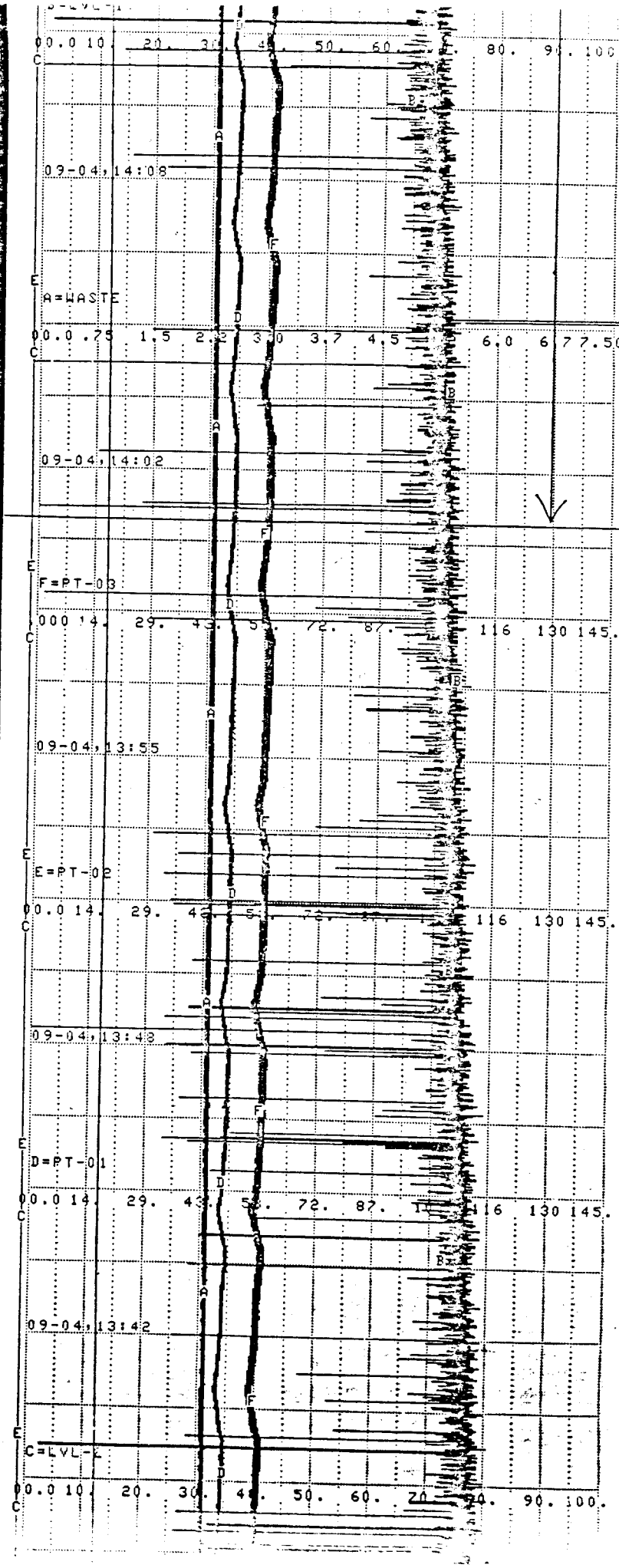
F=PT-03
09-04,13:15
E=PT-02
VOST-1-1

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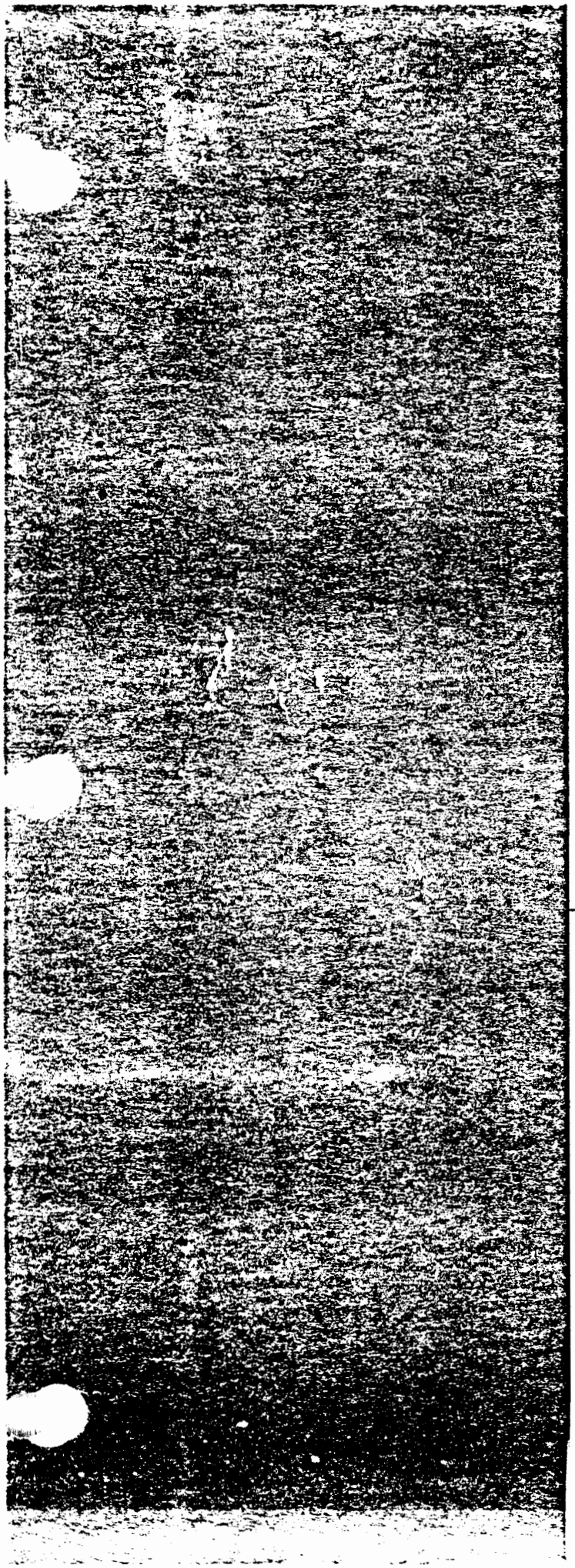

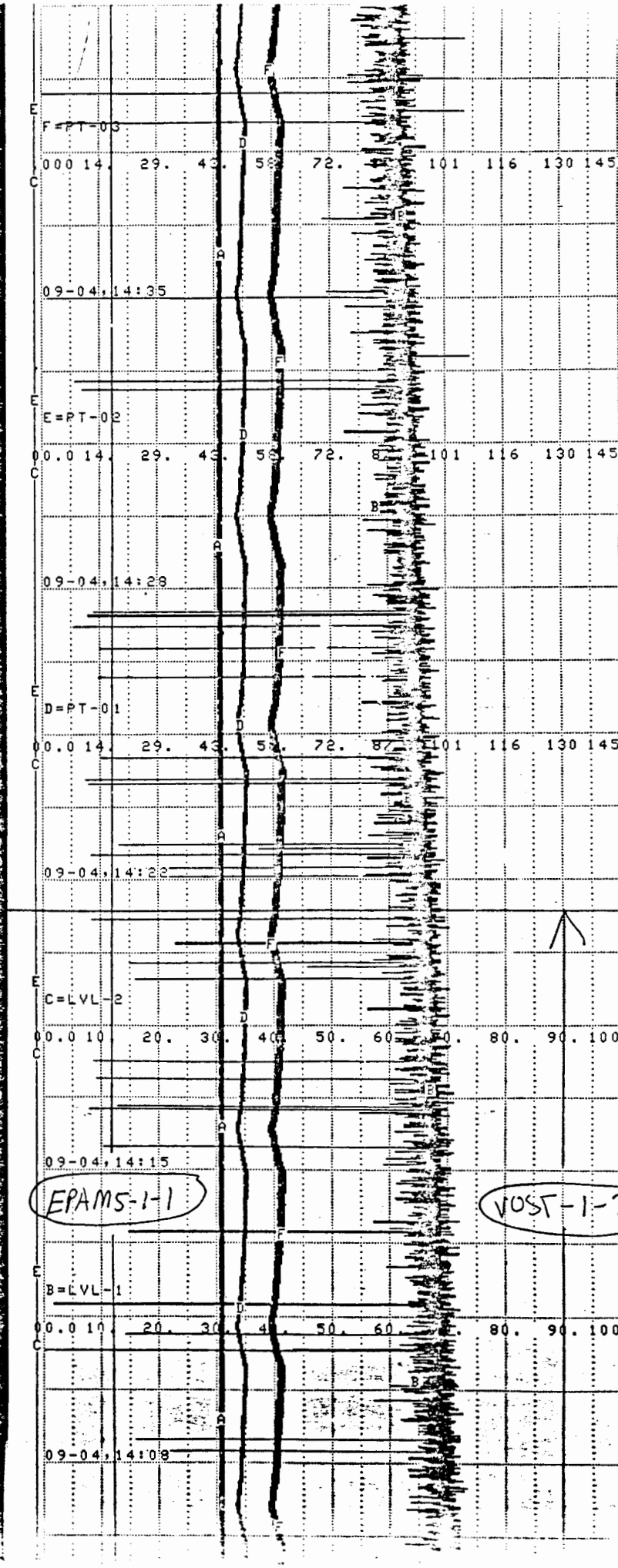
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E=PT-02
00.0 14. 29. 43. 58. 72. 87. 101 116 130 145
09-04,14:28
D=PT-01
00.0 14. 29. 43. 58. 72. 87. 101 116 130 145
09-04,14:22
C=LVL-2
00.0 10. 20. 30. 40. 50. 60. 70. 80. 90. 100
09-04,14:15
EPAMS-1-1
VOST-1-
B=LVL-1
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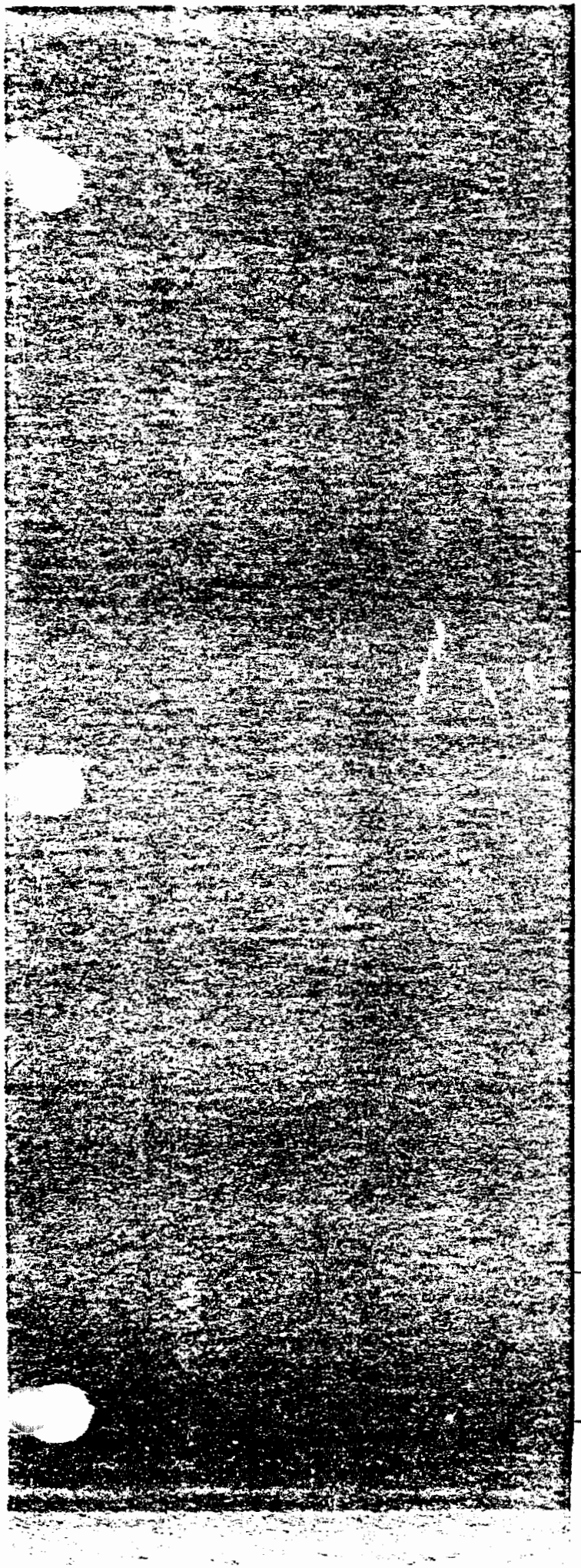

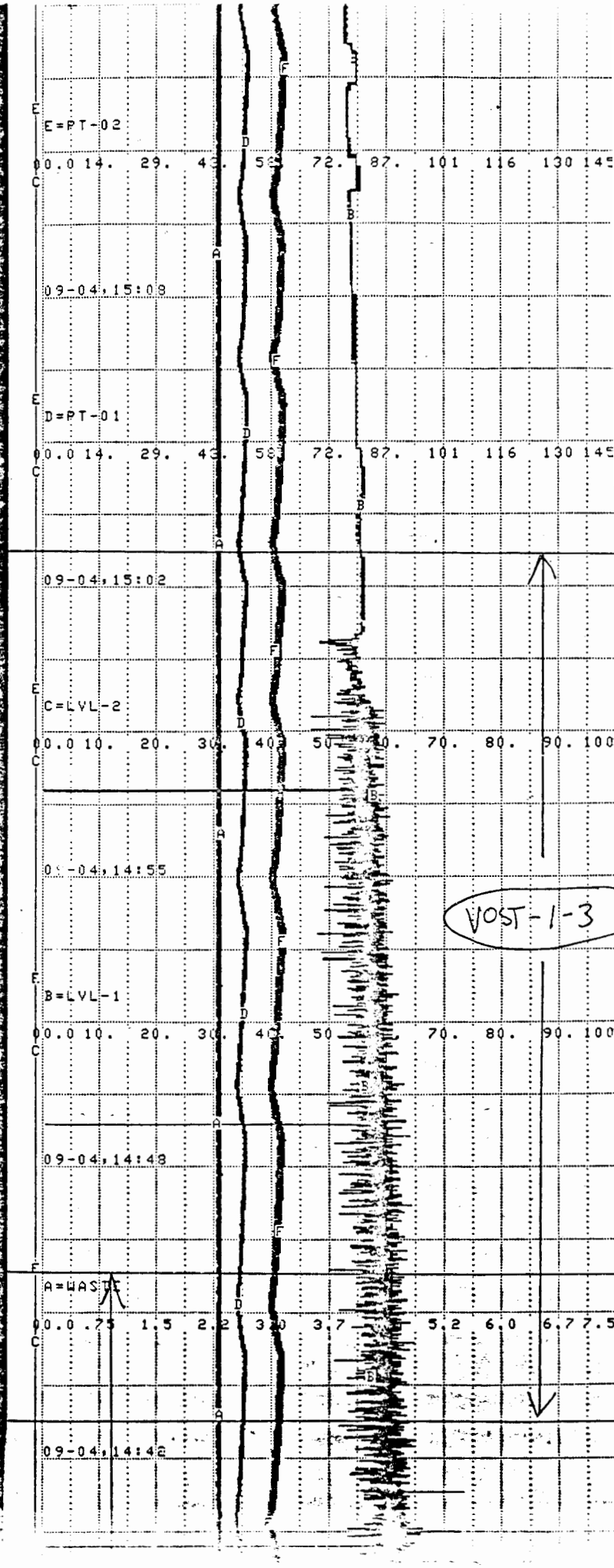
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09-04,15:02
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09-04,14:55
VOST-1-3
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00.0 10. 20. 30. 40. 50. 60. 70. 80. 90. 100
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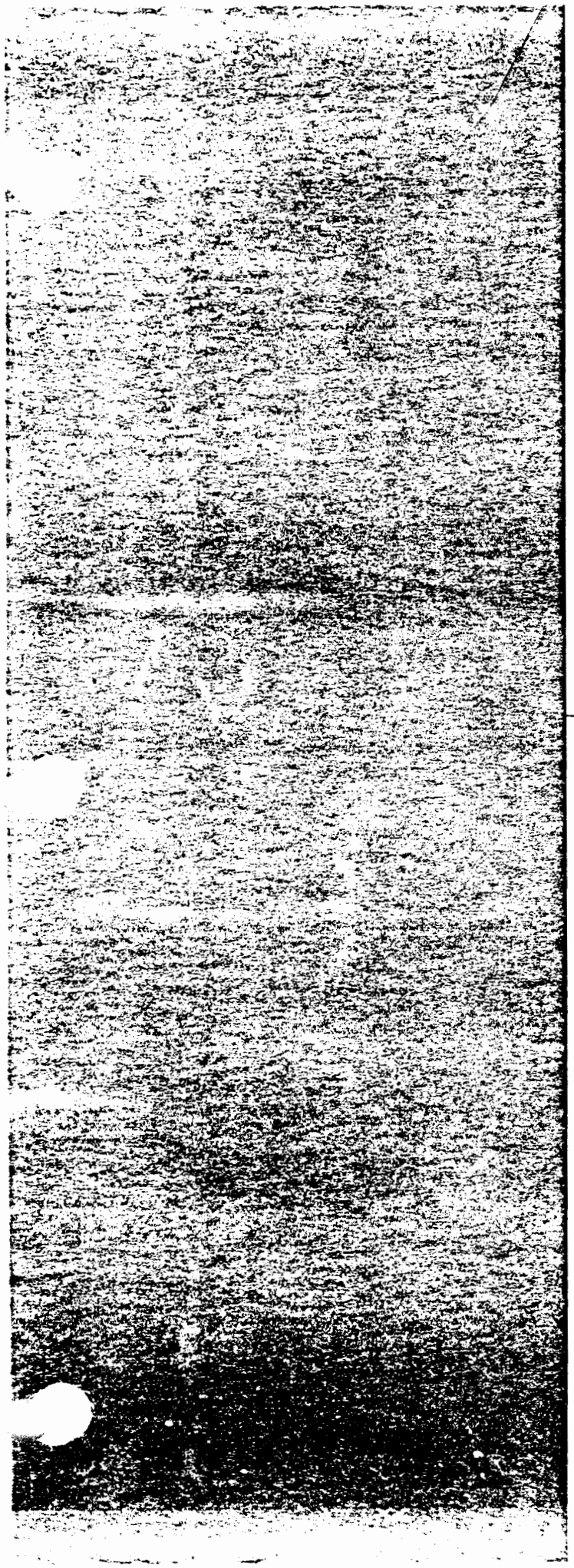
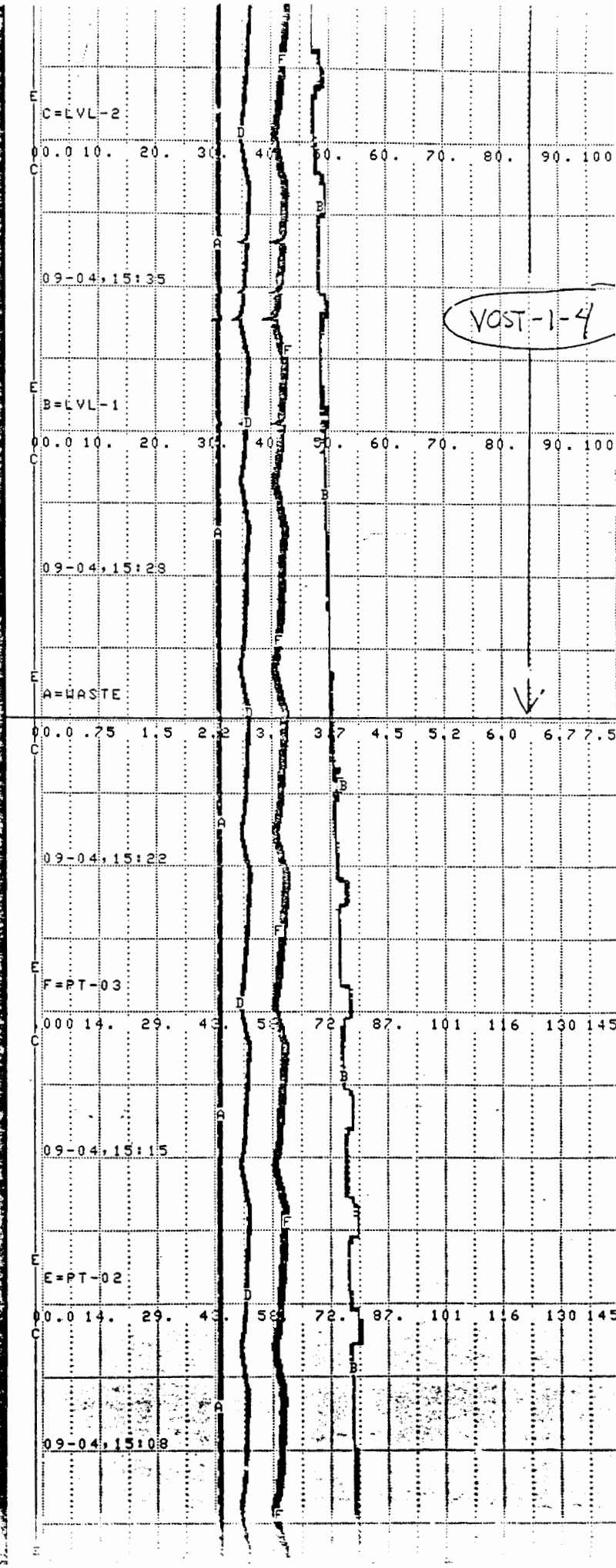
00.0 .75 1.5 2.2 3.0 3.7 4.5 5.2 6.0 6.7 7.5
09-04,14:42

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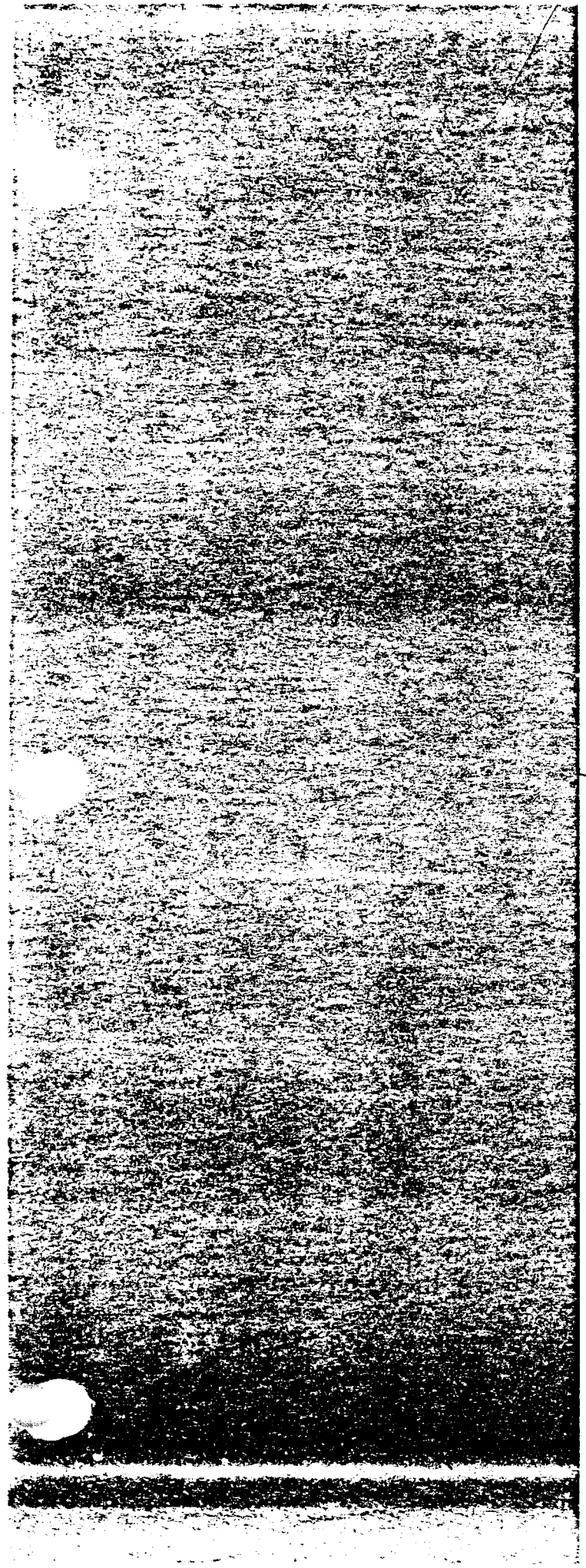

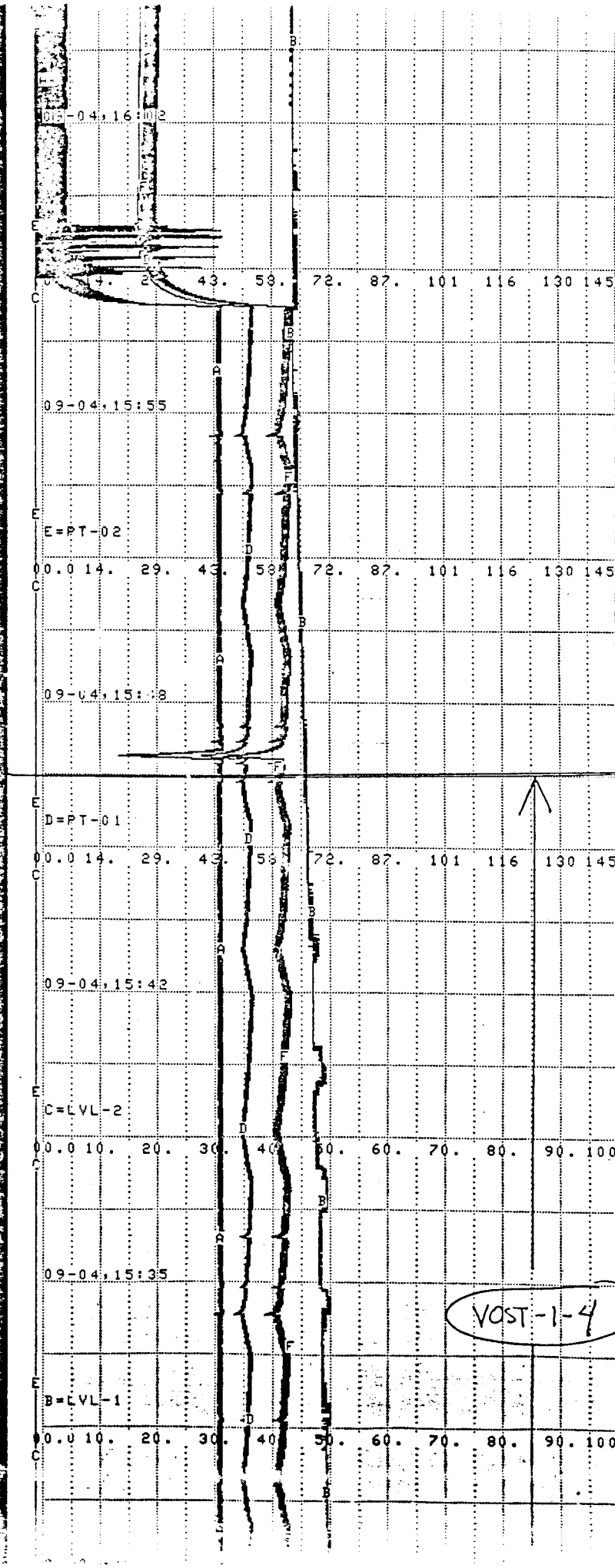
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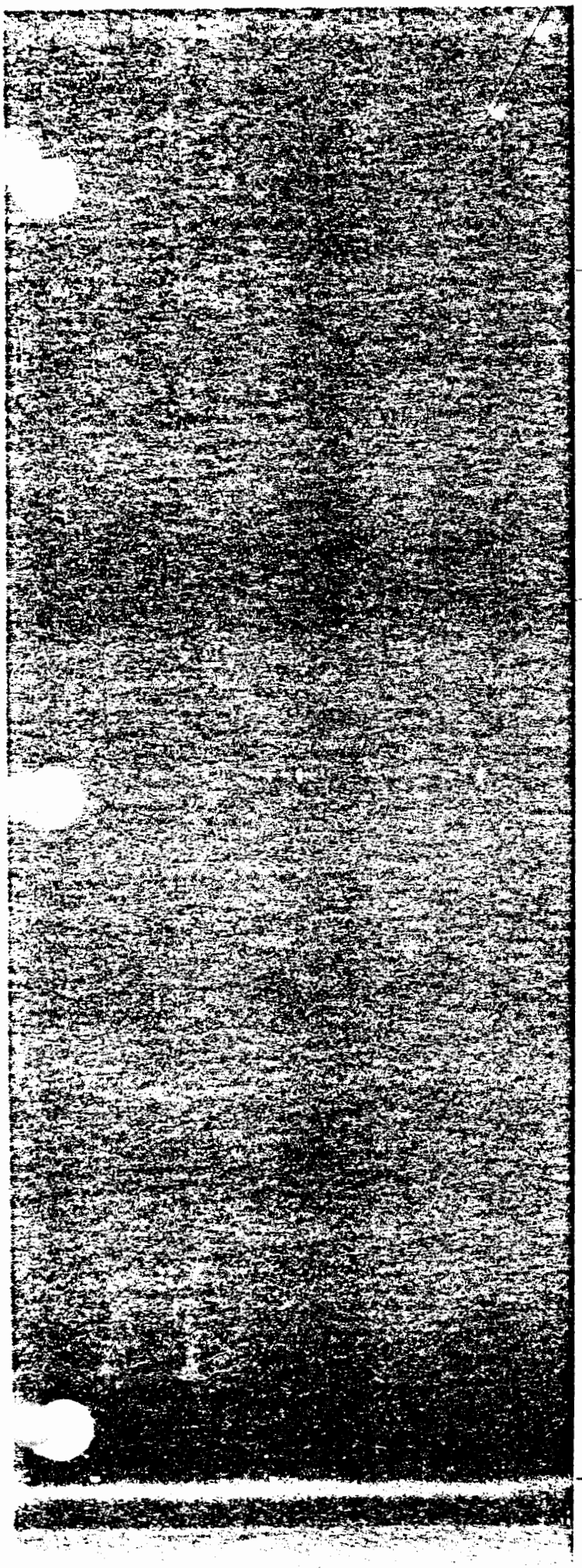
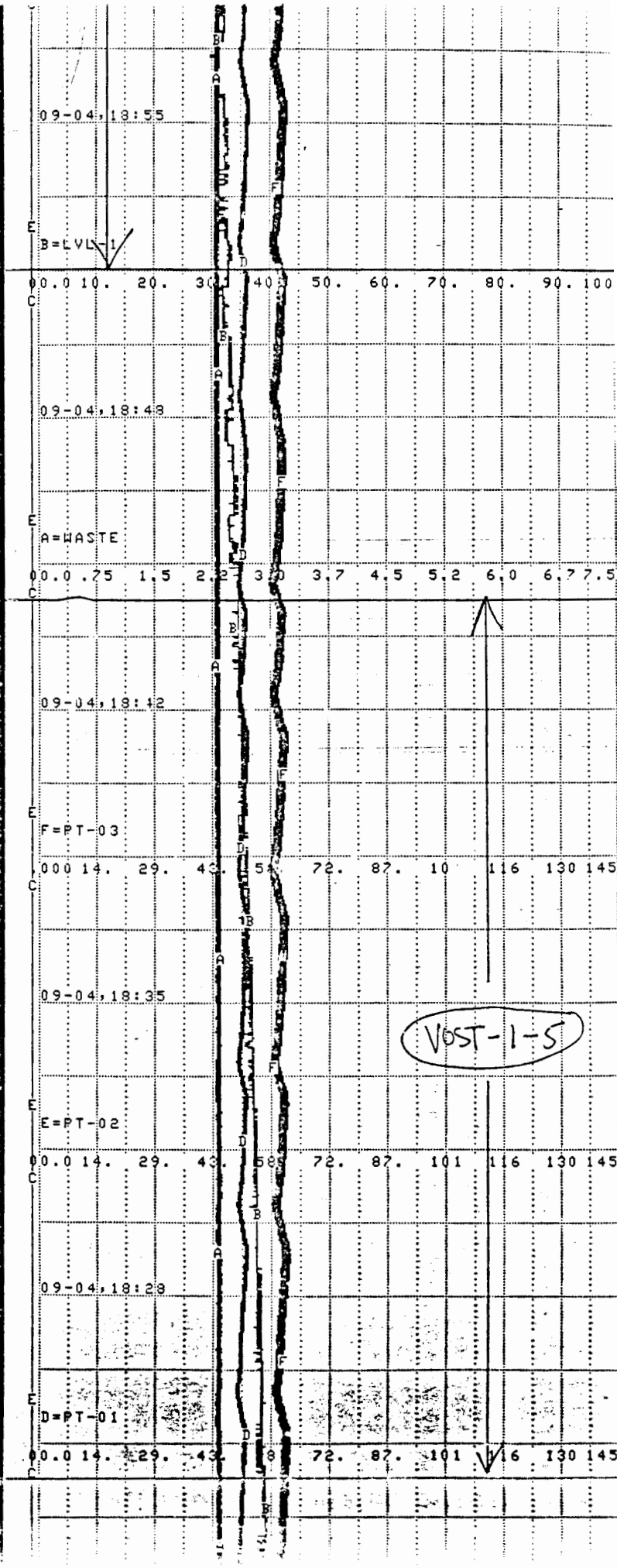
D=PT-01
0.0 14. 29. 43. 58. 72. 87. 101 116 130 145
09-04,15:42
C=LVL-2
0.0 10. 20. 30. 40. 50. 60. 70. 80. 90. 100
09-04,15:35
B=LVL-1
0.0 10. 20. 30. 40. 50. 60. 70. 80. 90. 100
VOST-1-4

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09-04,18:42
F=PT-03
000 14. 29. 43. 58. 72. 87. 101 116 130 145
09-04,18:35
VOST-1-5
E=PT-02
00.0 14. 29. 43. 58. 72. 87. 101 116 130 145
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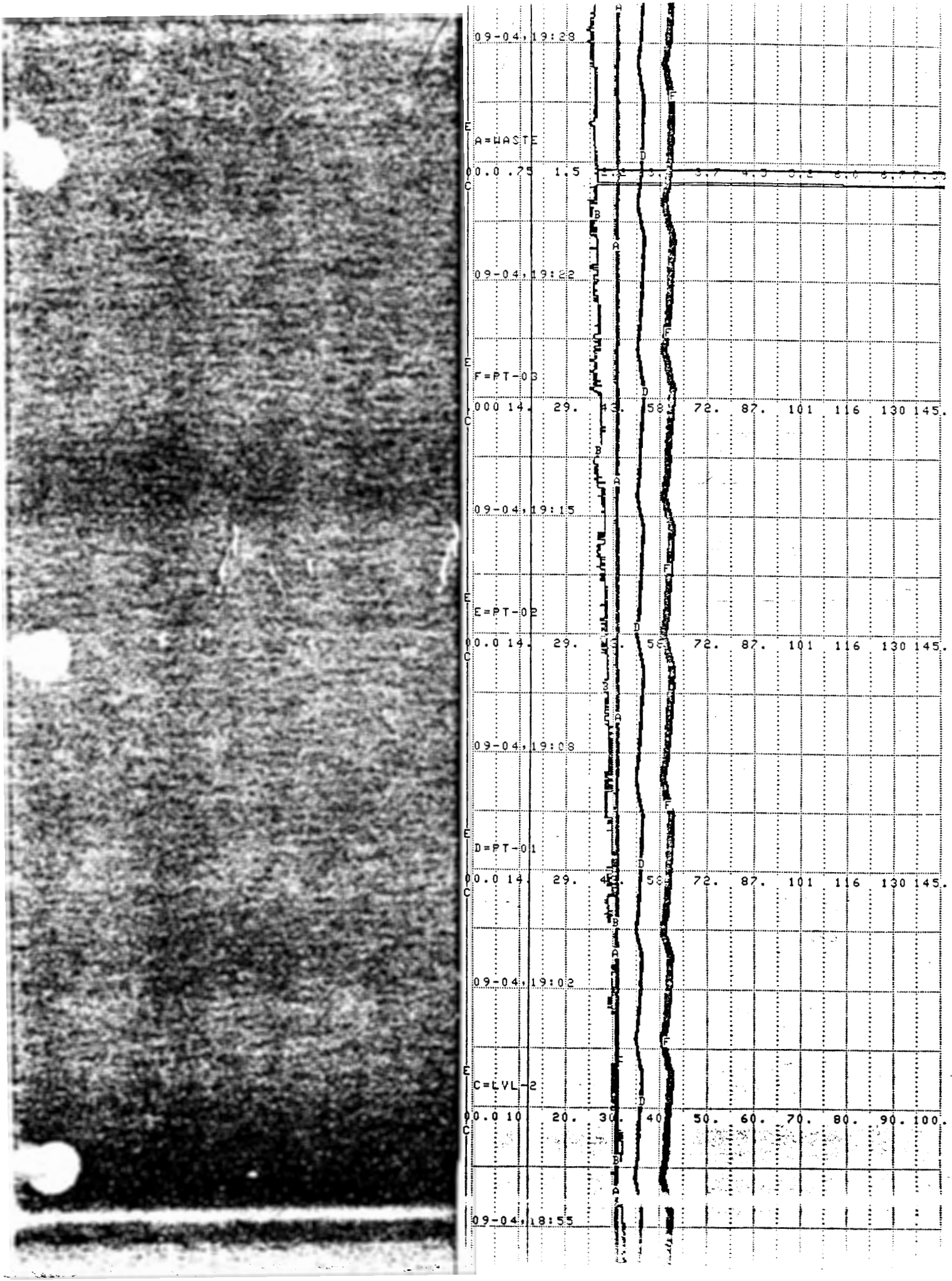
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09-04,19:08
D=PT-01
00.0 14. 29. 72. 87. 101 116 130 145.
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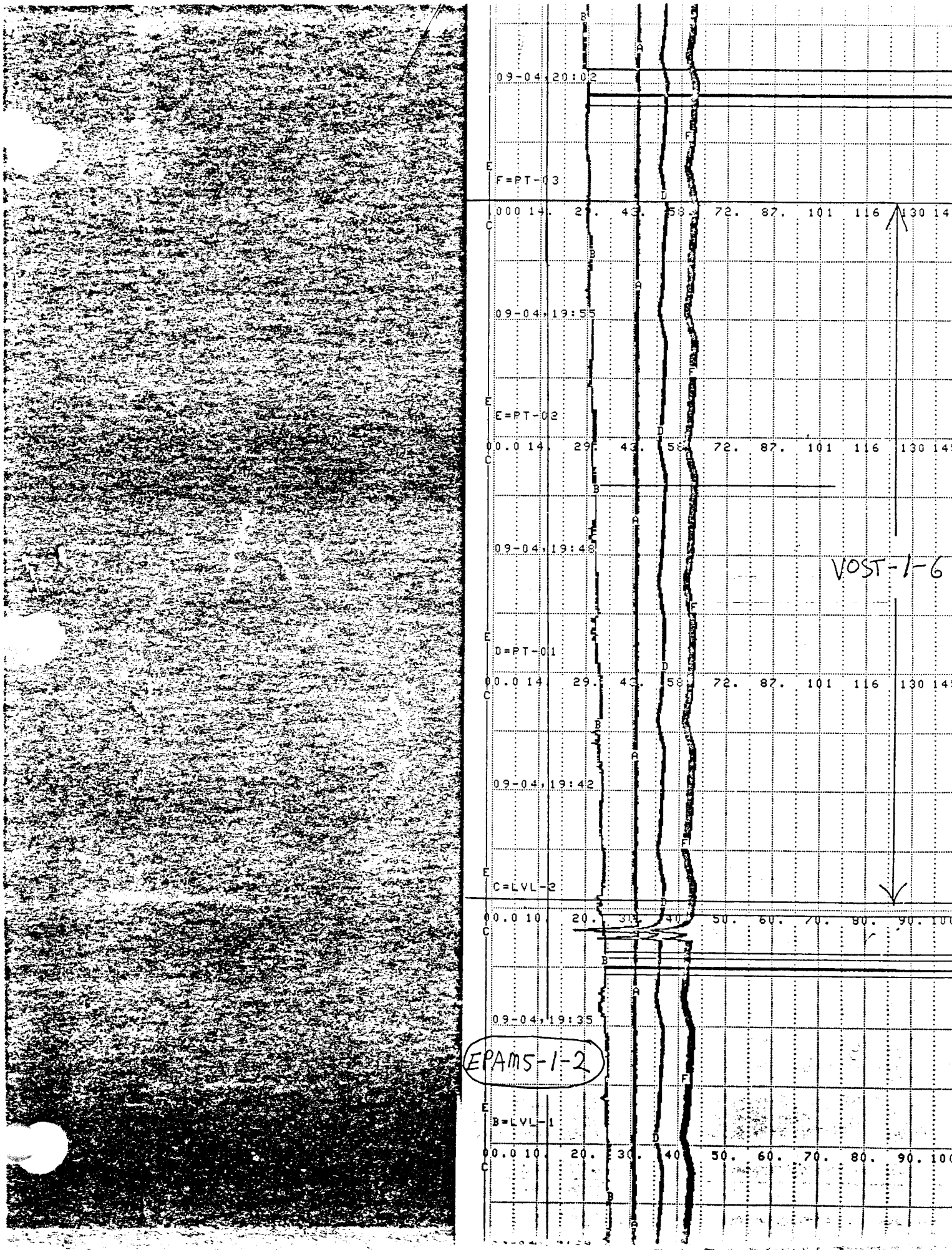
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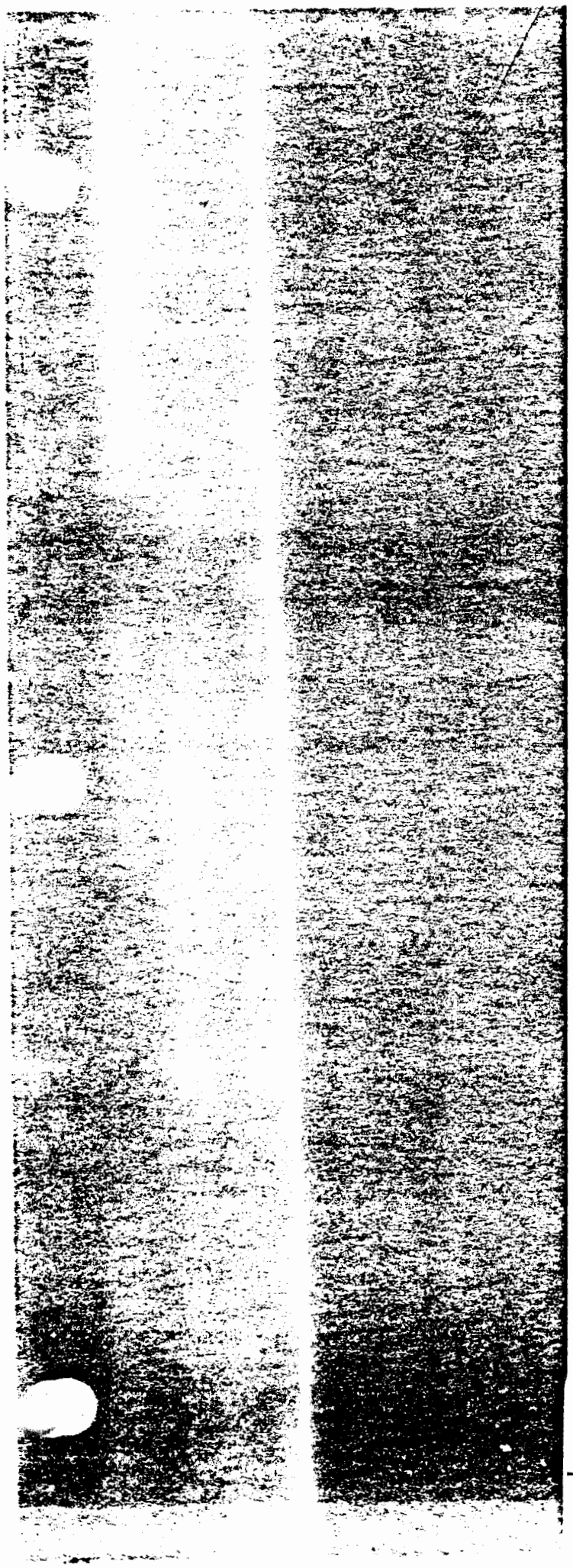
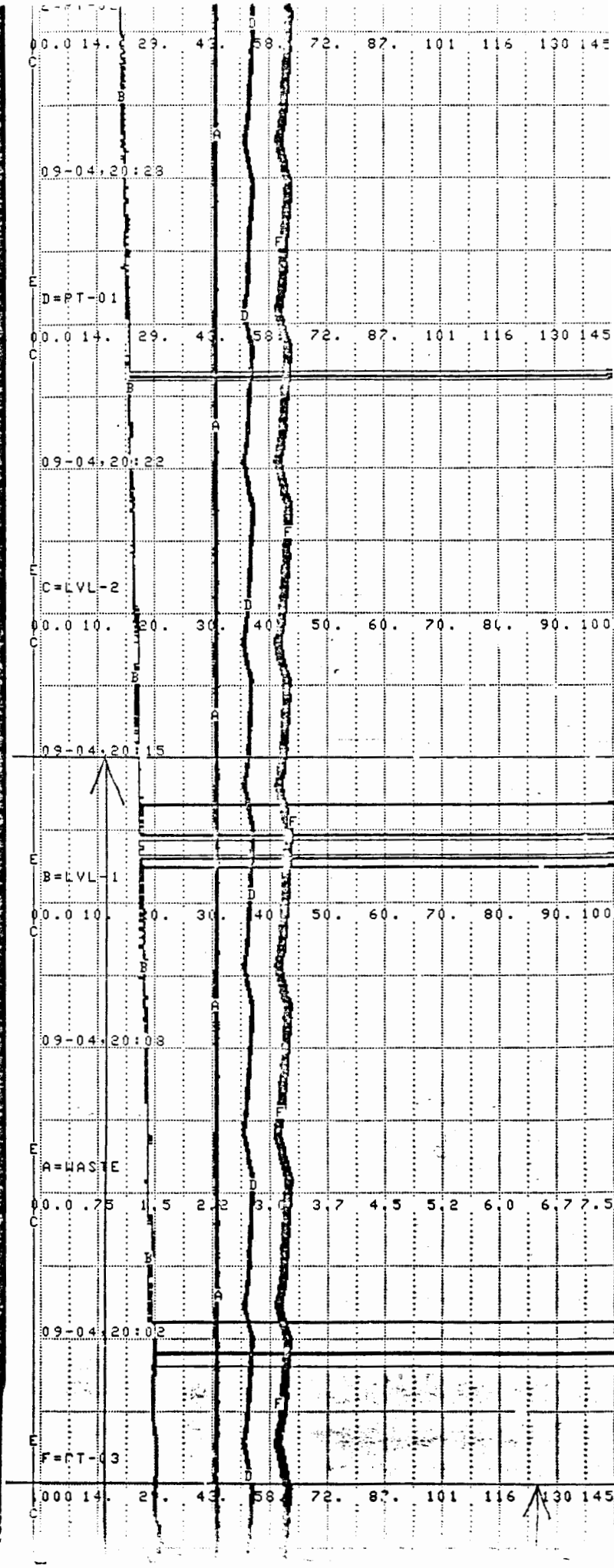
B=LVL-1
VOST-1-6
EPAM5-1-2

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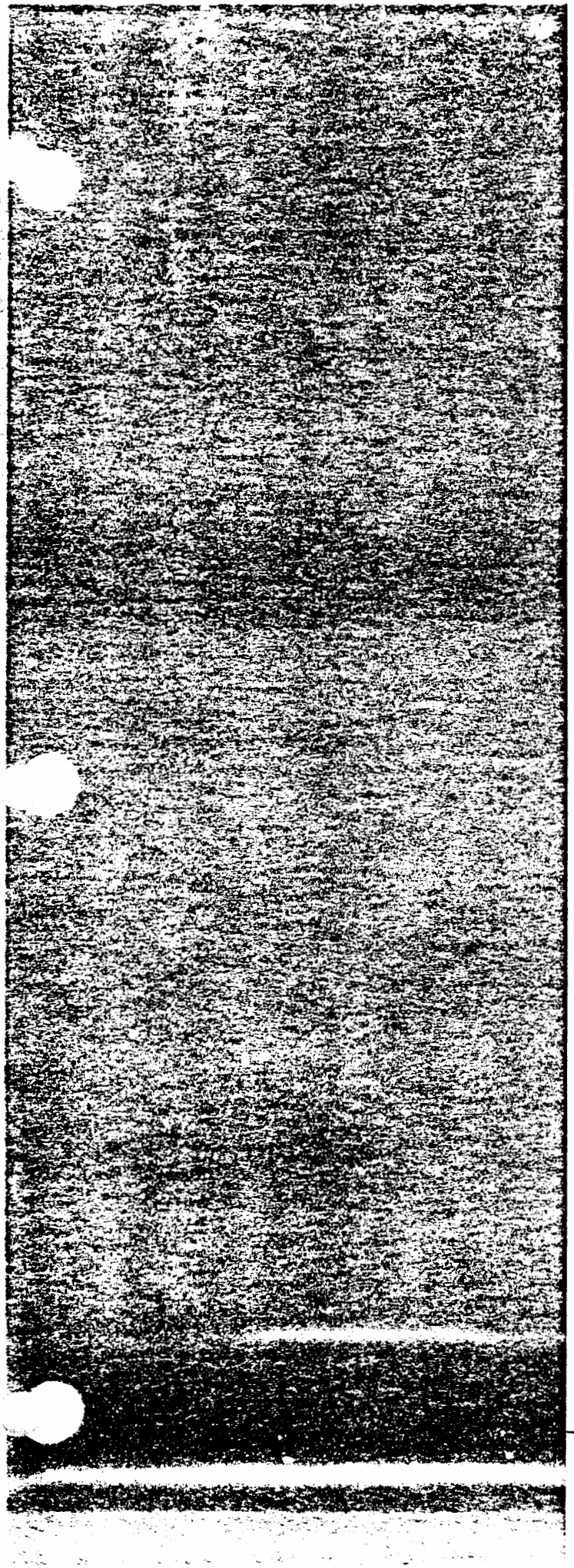
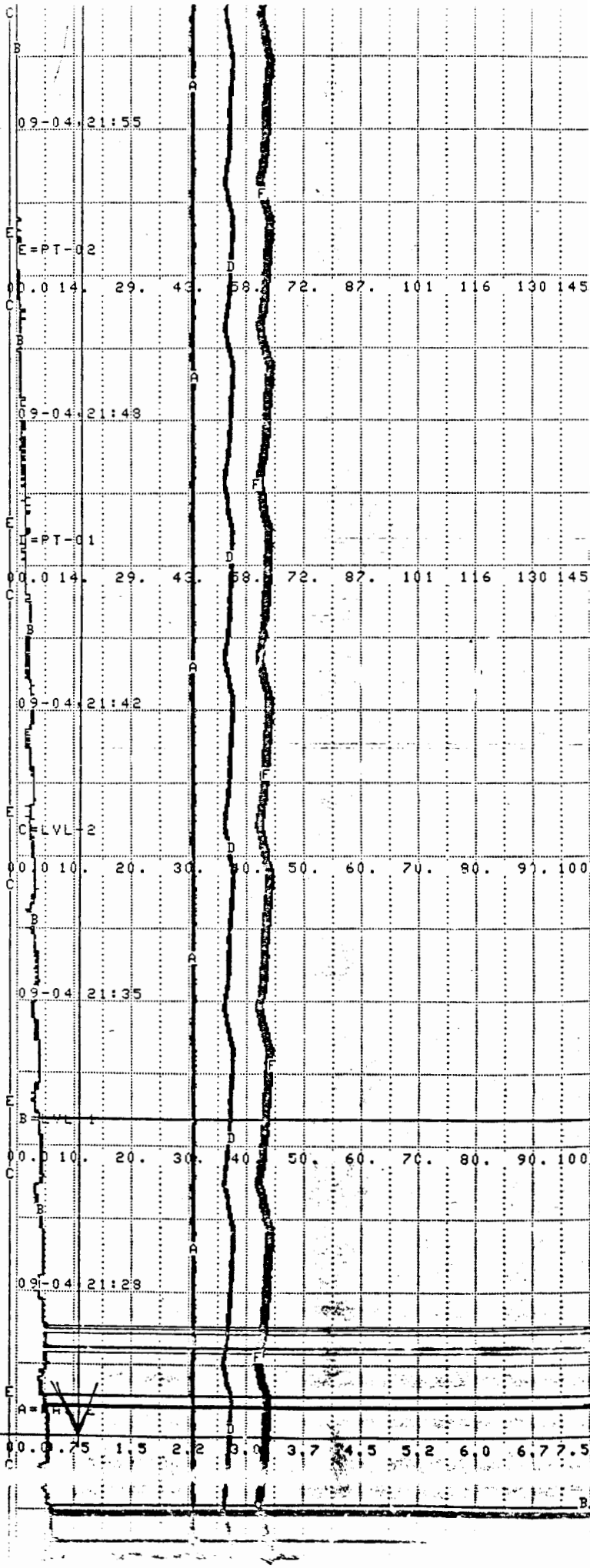
F=PT-03

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09-04 21:42
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09-04 21:35
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09-04 21:28
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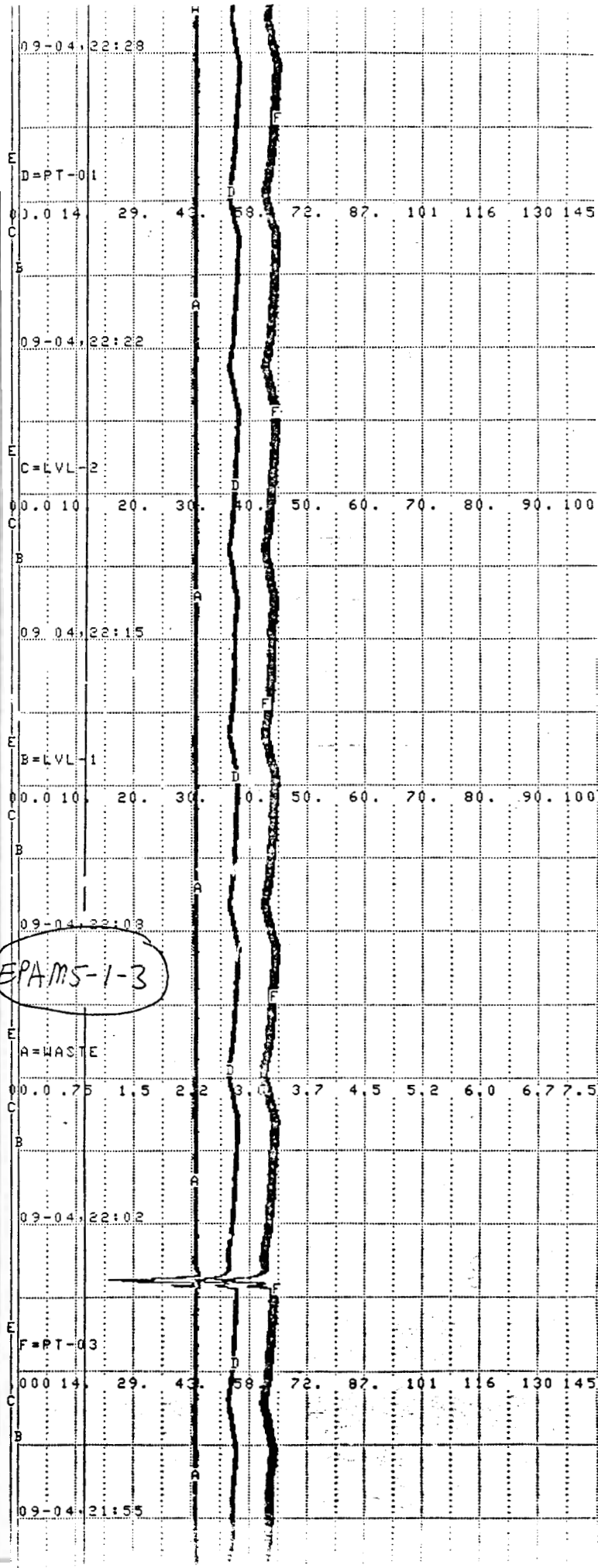
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09 04,22:15
B=LVL-1
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09-04,22:08
EPAMS-1-3
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00.0 .75 1.5 2.2 3.0 3.7 4.5 5.2 6.0 6.7 7.5
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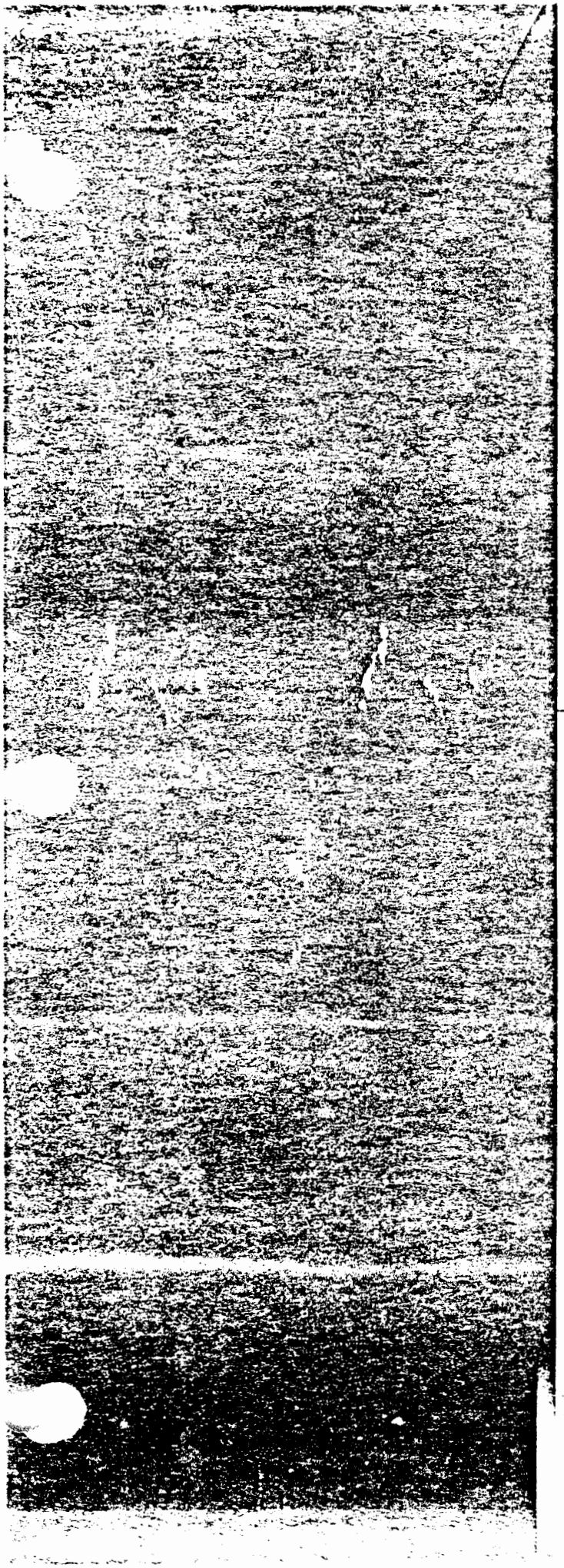

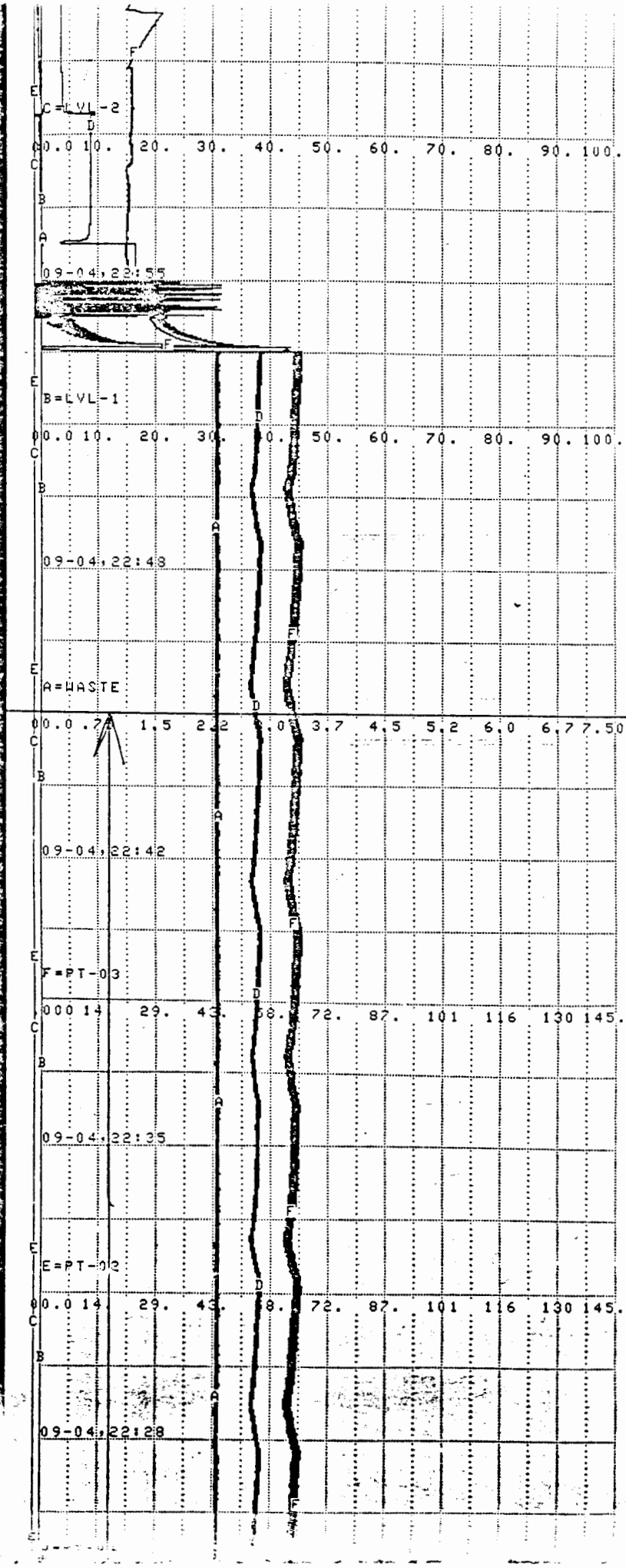
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09-04,22:48
A=WASTE
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09-04,22:42
F=PT-03
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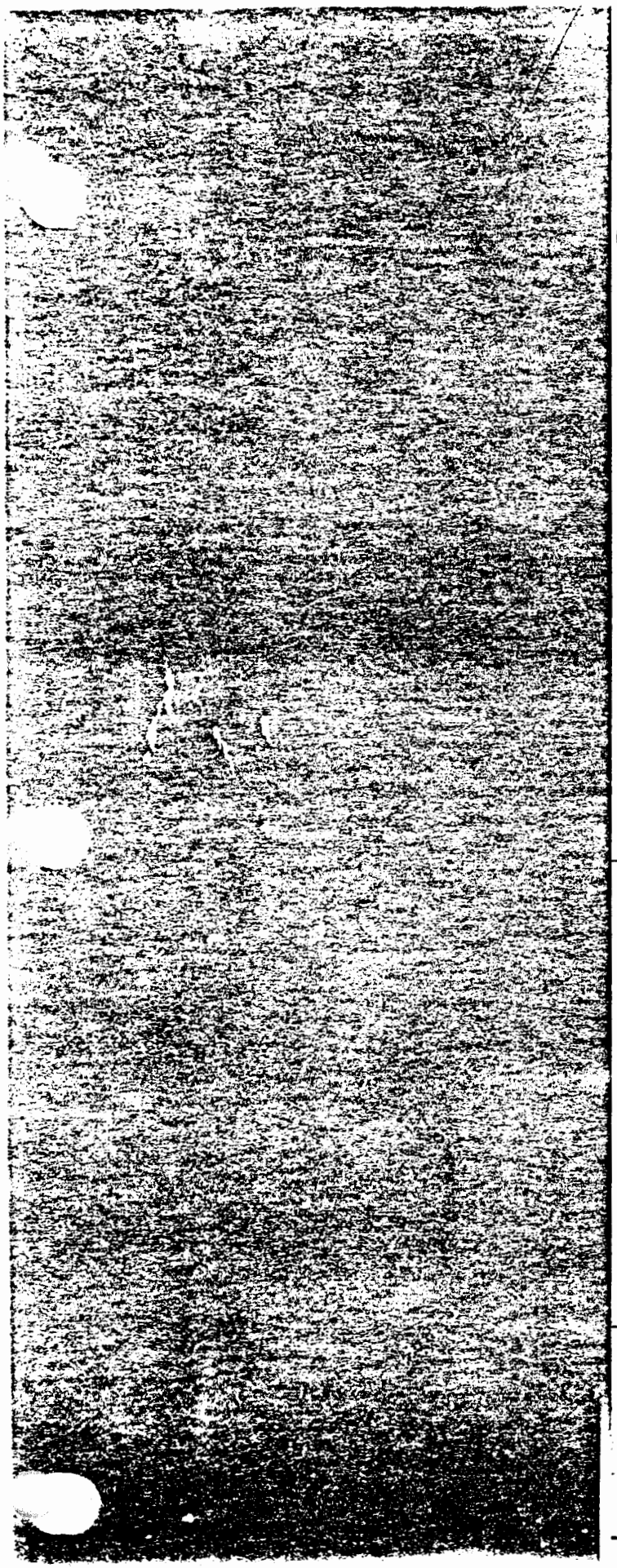
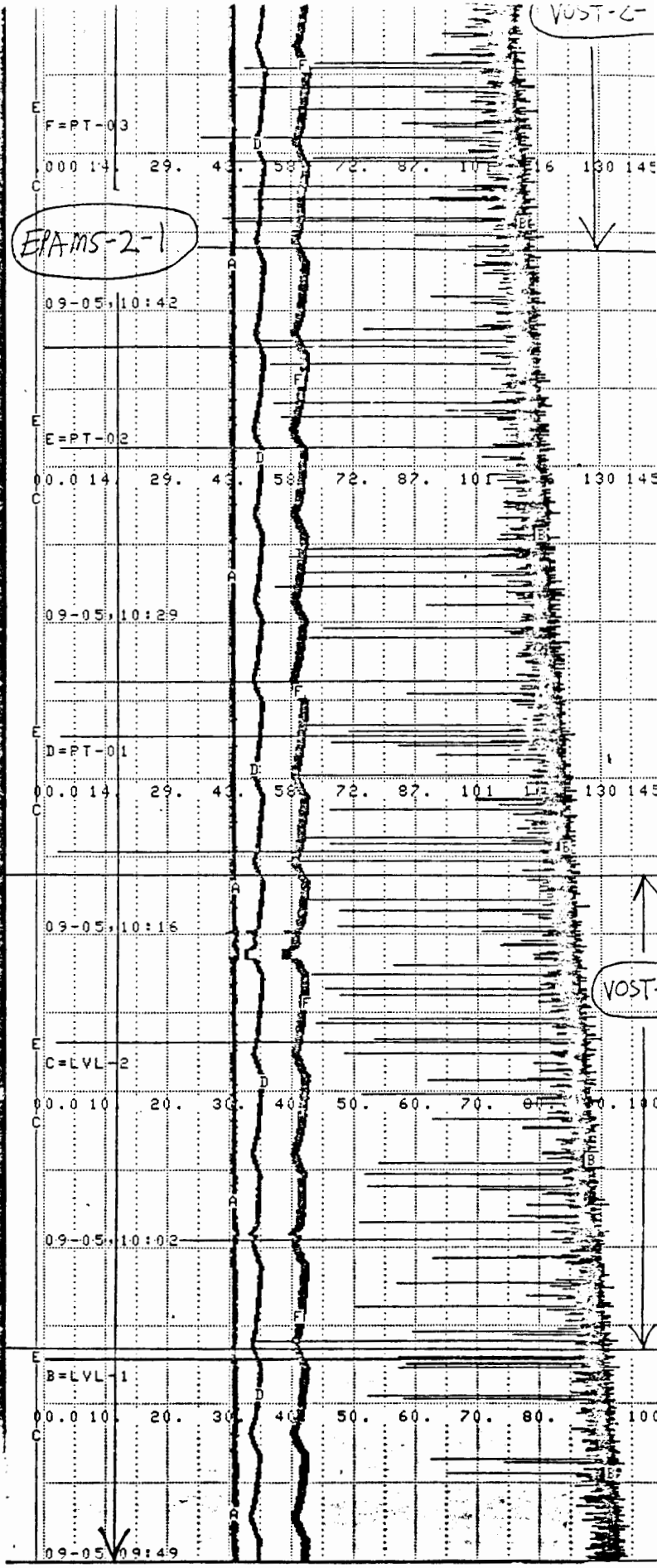
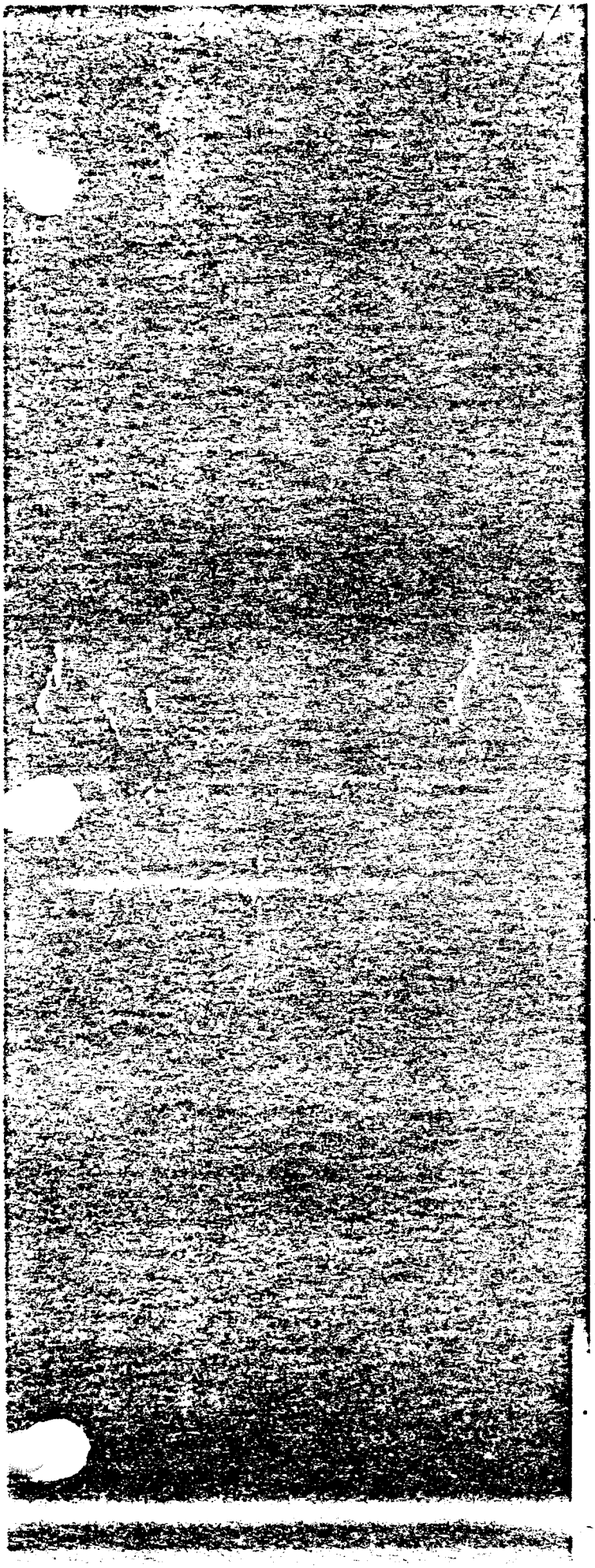
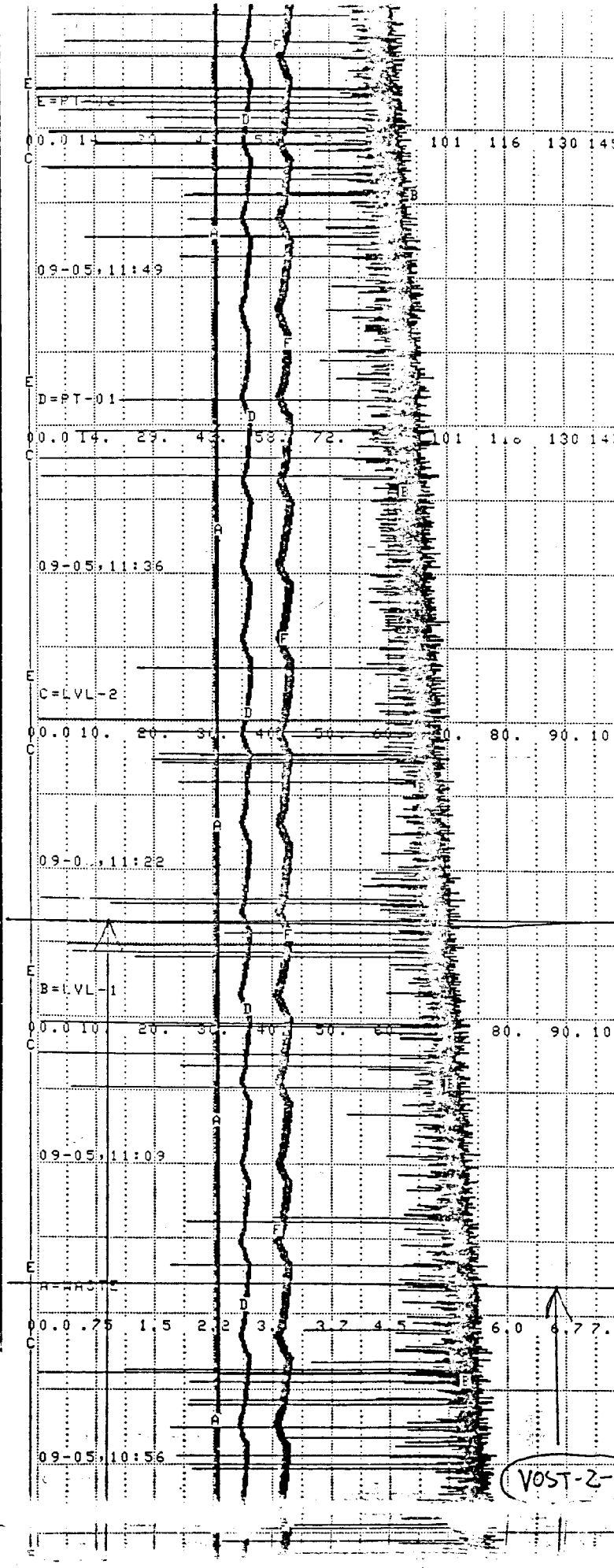




TIGRAPH 200 STATUS

CHANNEL | A | B | C | D | E |

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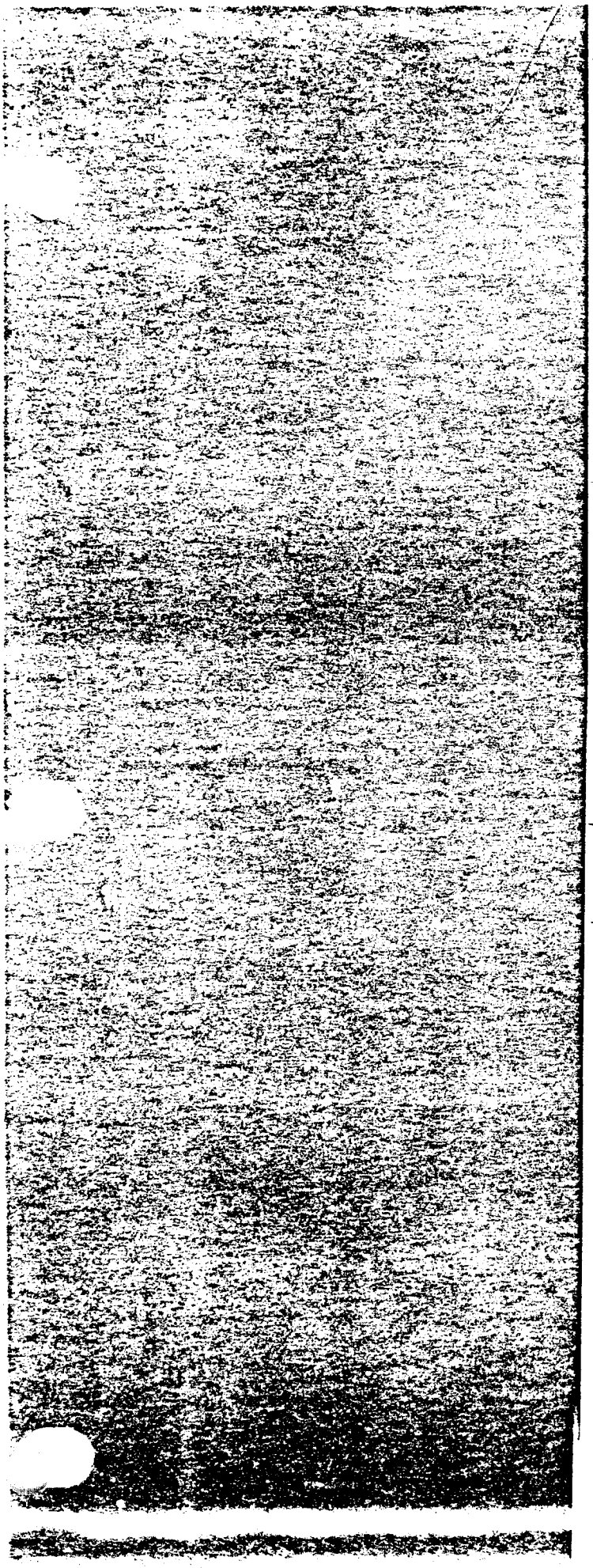
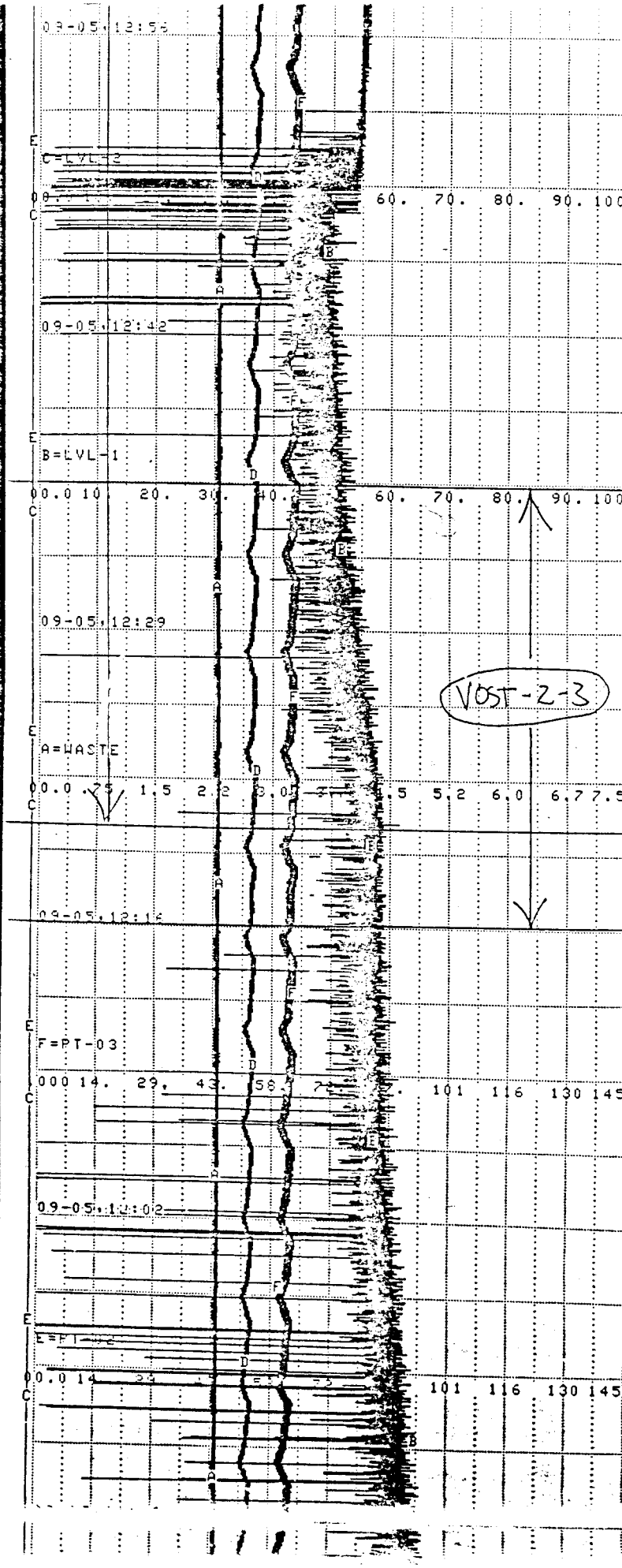
VOST-2-

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60. 70. 80. 90. 100
09-05.12:42
B=LVL-1
60. 70. 80. 90. 100
09-05.12:29
VOST-2-3
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09-05.12:16
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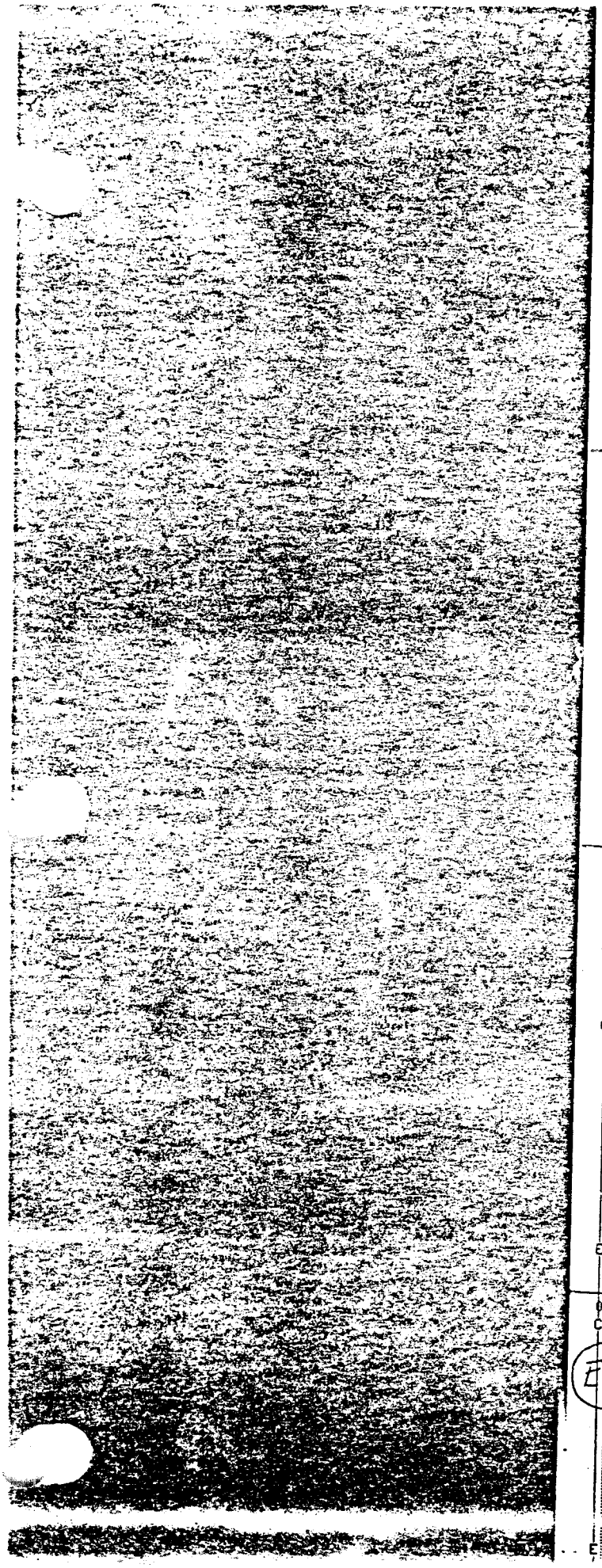
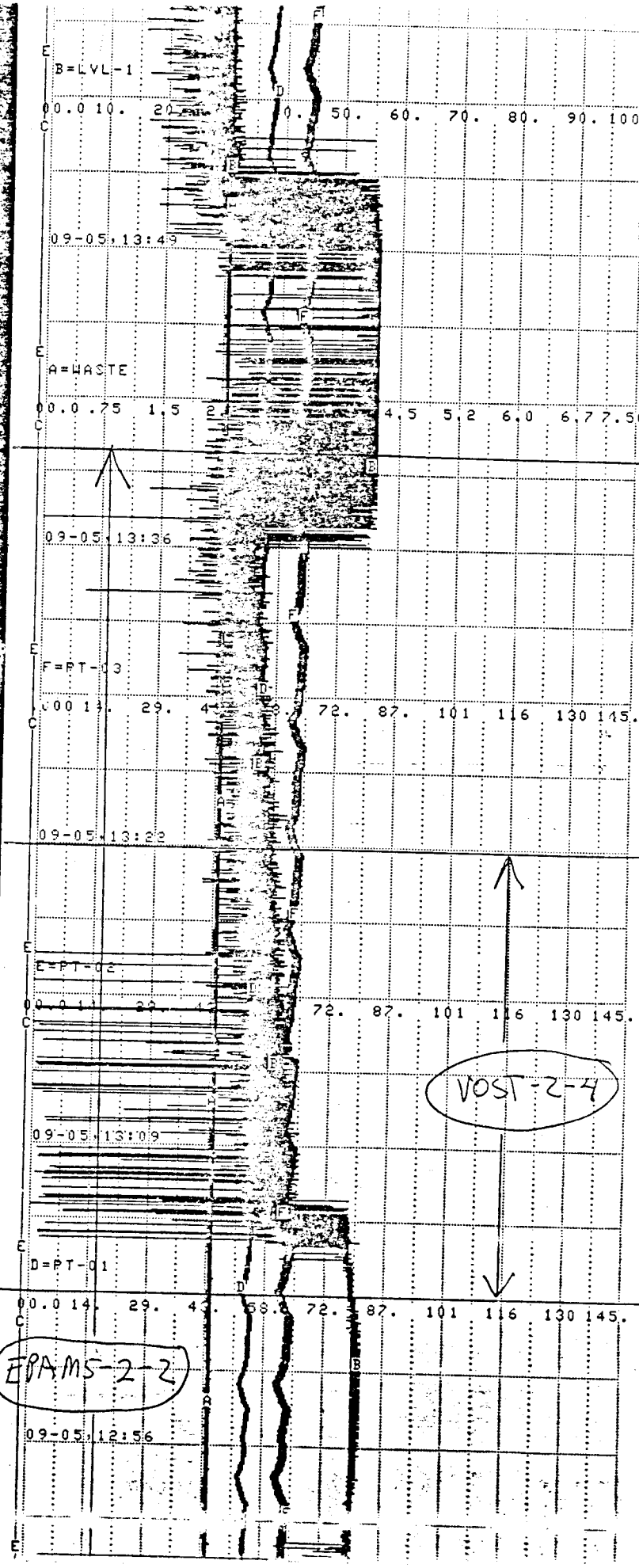
09-05.12:02
101 116 130 145

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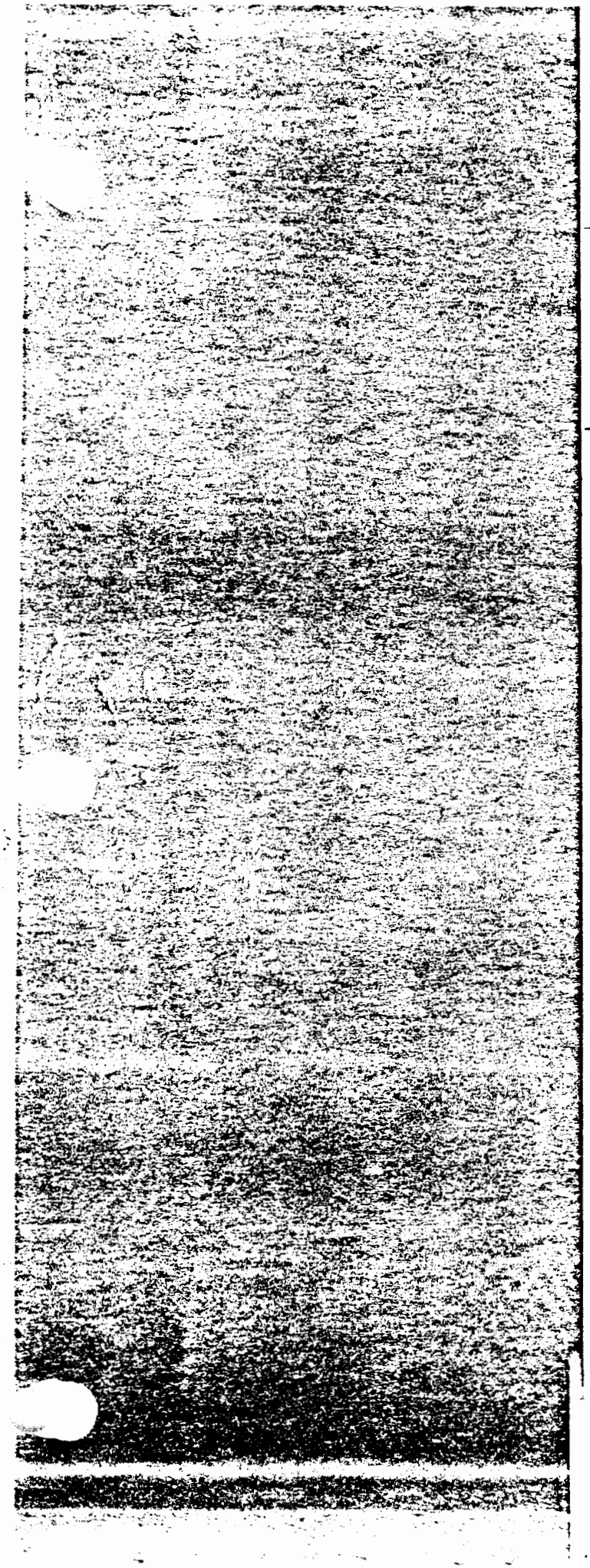
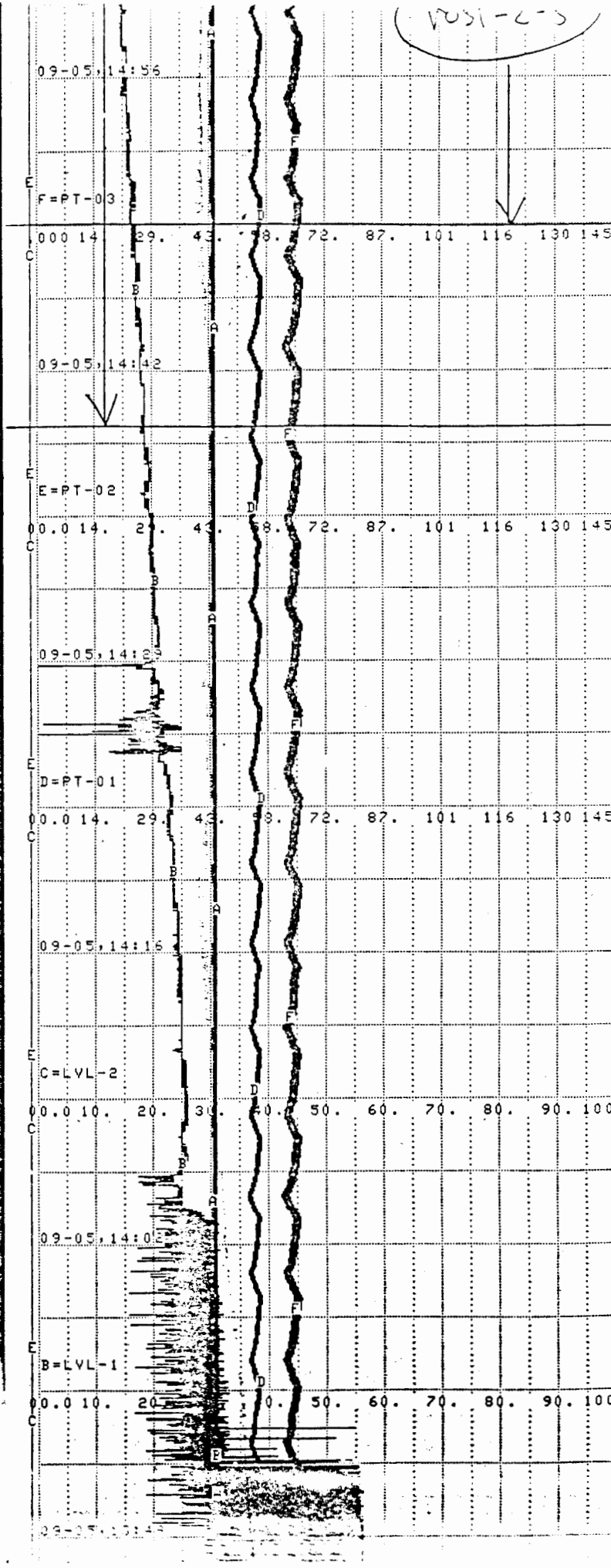
VOST-2-4
EPAMS-2-2

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09-05,14:42
E=PT-02
00.0 14. 29. 43. 58. 72. 87. 101 116 130 145
09-05,14:29
D=PT-01
00.0 14. 29. 43. 58. 72. 87. 101 116 130 145
09-05,14:16
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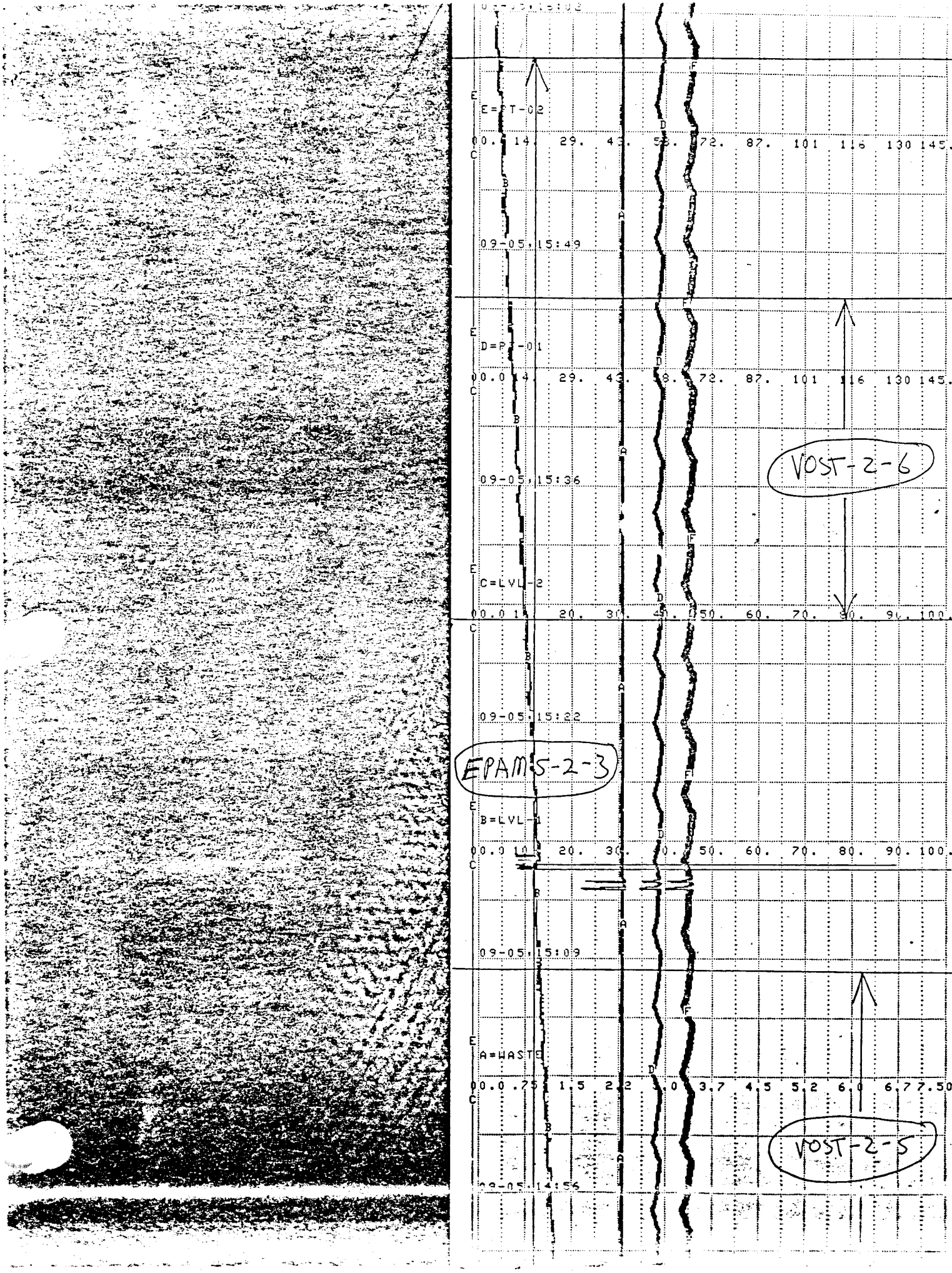
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D=PT-01
09-05,15:36
VOST-2-6
C=LVL-2
09-05,15:22
EPAM5-2-3
B=LVL-1
09-05,15:09
A=WASTE
VOST-2-5

APPENDIX C. FEED PREPARATION & FEED RATE DATA

2) LIQUID FEED PREPARATION

1/

1/4/86 RCRA Legend Batch Feed Preparation

0730 TCE drum #1 on scale, Gross wt = 251.6 lb

0842 Transferred contents of drum #1 to Tank 53.4 lb

Level Ind = 19.0%

251.6
53.4
198.2 lb transferred ⇒ 280 − 198.2 =
81.8 to be added

0851 Drum #2 TCE put on scale, Gross = 697.4 lb

697.4
81.8
615.6

Final Gross = 614.4 ⇒ 697.4 − 614.4 = 83.0 added

Total TCE added = 83.0
198.2
281.2 lb

Level Ind. = 23.0%

0910 CCl_4 drum #2 put scale Gross wt = 154.6 lb
53.4
101.2 lb transfe

2/

RCRA batch #2
TCE

Drum #2 G 614.8
280.0 to be added
334.8

614.8
337.6
277.2 actually added

Total TCE = 277.2 lbs

Added ~ 7 lbs additional TCE/CCl_4
out of transfer filter to batch #2

9/5/86

1/

RCRA Liquid Batch #2 Makeup

Fuel Oil

G 400.4
56.2
344.2 = 1st charge
490 - 344.2 = 145.8 needed

G 215.6
145.8
69.8 actual fuel 71.6 ⇒ 144.0 added

215.6
71.6

Total fuel oil added = 344.2
144.0
488.2 lb

CCl_4

Drum #3 G 210.6
45.8
164.8 added

630.0
164.8
465.2

Drum #4 G ~~740~~ 741.0
~~165~~ 465.2 to be added

741.0
267.4
473.6 actual added

275.8

Total CCl_4 473.6
164.8
638.4

0930 CCl_4 Drum #3 Grosswt = 740.2 lb

0940 Sample # CCl_4 Drum #3 taken

630.0	740.2
101.2	528.8
528.8 to be added	211.4

0945 Added balance of CCl_4

Final Grosswt. Drum #3 = 210.6 lb

740.2
210.6
529.6 actually added on this drum #3

Total CCl_4 added to tank = 529.6
101.2
630.8 lb

LEVEL IND = 51.0%

Fuel Oil

Tare (drum #1) = 42.6 lb

Filled drum to gross wt = 387.8
42.6
345.2 in drum

10:40 Tare after transfer #1 = 387.8
53.8
First addition Added to tank = 334.0 lb
490.0
3340
156.0 lb to go

2nd addition to drum
Gross = 230.2
156.0 to be added
74.2

Actual tare = 72.8 lb

11:00 Actual added 230.2
72.8
157.4

Total Fuel Oil Added = 157.4
334.0
491.4 lb

4/86 RCRA Liquid Feed Viscosity Measurement

50 ml liquid feed batch #1 drained into beaker.

Viscosity measurement conditions:

1) 65°F
2) Falling Ball Type Viscosimeter, Gilmont Instrum
Tube Size #2, – Ball densities: glass – 2.53 g/c
S.S – 8.02 "
3) Measured density of feed mixture: 10 cm³ sample
11.84 g / 10 cm³ = 1.184 g/cm³

Data:

Liquid	drop time, Δt, sec	ball
DI H_2O	13.20	glass
"	13.70	"
"	13.92	"
"	13.85	"
liquid feed	7.43	S.S.
"	7.39	"
"	7.19	"
"	7.27	"
"	6.76	"
"	6.80	"
"	6.87	"

Viscosity Calculation:

1) Viscosimeter constant, $K = \dfrac{\mu}{(\rho_f - \rho)\, t_{avg}}$

for D.I. H_2O, $\mu = 1\,cP$, $\rho = 1\,g/cm^3$, $\rho_f = 2.53\,g/cm$

$t_{avg} = 13.67\,sec =$

$$K = \frac{1\,cP}{(2.53-1)\cdot(13.67\,sec)/60} = 2.869$$

2) Viscosity of feed:

$$\mu = K(\rho_f - \rho)\, t_{avg}$$

$$t_{avg} = 7.10\,sec = 0.1184\,min$$

$$\mu = 2.869(8.02 - 1.184)(0.1184)$$

$$\boxed{\mu = 2.32\,cP}$$

RCRA Trial Burn Liquid Feed

Components as actually prepared

	Batch #1		Batch #2	
	lbs	wt%	lbs	wt%
Aluminogel	3.5	0.249	3.5	0.249
Fuel Oil	491.4	34.93	488.2	34.69
CCl_4	630.8	44.84	638.4	45.35
TCE	281.2	19.99	277.2	19.70
	1406.9		1407.3	

APPENDIX C. FEED PREPARATION & FEED RATE DATA

3) SOLID FEED RATES

Solid Feed Rate Data

Feedstocks: CCl_4 100%, TCE 97%

Condition 3--9/6/86 Condition 4--9/7/86

Sample Period & Time	Box #s Fed	Gross Wt. (lbs)	Times Fed	CCl_4 (lbs)	TCE (lbs)
LA-3-M5-1	21	37.20	1029	11.12	5.64
1035-1155	22	37.18	1040	11.06	5.62
	23	37.22	1050	11.10	5.60
LA-3-V-1	24	37.10	1104	11.12	5.54
1036-1056	25	37.20	1117	11.16	5.56
	28	37.28	1130	11.06	5.68
LA-3-V-2	29		1150		
1117-1137	Total	223.18	81 min	66.62	33.64
	Feedrates (lbm/hr) (corrected to 97% TCE)			49.30	24.19
		165.6 lbm/hr		29.85%	14.62%
LA-3-M5-2	34	37.28	1700	11.16	5.64
1707-1832	32	37.42	1713	11.24	5.60
	35	37.36	1725	11.26	5.54
LA-3-V-3	38	37.38	1737	11.12	5.64
1709-1729	36	37.32	1748	11.14	5.64
	40	37.16	1800	11.12	5.56
LA-3-V-4	42	36.58	1812	11.08	5.58
1756-1816	41	37.76	1824	11.10	5.58
	43		1836		
	Total	298.26	96 min	89.22	44.78
	Feedrates (lbm/hr) (corrected to 97% TCE)			55.77	27.22
		186.6 lbm/hr		29.91%	14.56%
LA-3-M5-3	45	36.82	1922	11.30	5.56
1927-2050	47	36.68	1934	11.10	5.58
	46	36.50	1946	11.08	5.54
LA-3-V-5	37	37.48	1959	11.40	5.56
1924-1944	50	36.58	2012	11.08	5.58
	81	36.70	2024	11.08	5.54
LA-3-V-6	87	36.98	2036	11.32	5.64
1957-2017	70		2049		
	Total	257.74	87 min	78.36	39.00
	Feedrates (lbm/hr) (corrected to 97% TCE)			54.05	26.17
		177.6 lbm/hr		30.40%	14.68%

LA-4-M5-1	54	37.20	1342	11.06	6.16
1350-1512	66	36.72	1352	11.16	5.58
	59	36.62	1407	11.10	5.52
LA-4-V-1	86	36.82	1415	11.08	5.58
1349-1409	92	37.12	1427	11.06	5.76
	89	37.04	1439	11.18	5.54
LA-4-V-2	57	36.62	1451	11.06	5.60
1430-1450	71	36.52	1503	11.12	5.52
	xx		1515		.
	Total	294.66	93 min	88.82	45.26
Feedrates (lbm/hr) (corrected to 97% TCE)				57.36	28.28
		190.2 lbm/hr		30.14%	14.90%

LA-4-M5-2	49	36.52	1555	11.06	5.56
1557-1718	65	36.64	1607	11.10	5.54
	82	36.62	1617	11.06	5.52
LA-4-V-3	55	36.60	1629	11.06	5.58
1558-1618	52	37.42	1641	11.26	5.54
	68	36.78	1653	11.10	5.62
LA-4-V-4	73	36.70	1702	11.12	5.56
1638-1658	85	36.74	1714	11.18	5.58
	74		1726		.
	Total	294.02	91 min	88.94	44.50
Feedrates (lbm/hr) (corrected to 97% TCE)				58.68	28.41
		193.8 lbm/hr		30.25%	14.68%

LA-4-V-5	63	36.50	1806	11.10	5.56
1809-1829	61	36.58	1818	11.08	5.58
	76	36.58	1830	11.10	5.56
LA-4-V-6	75	36.76	1840	11.10	5.54
1846-1906	91	36.88	1852	11.08	5.60
	64	36.92	1900	11.24	5.62
LA-4-M5-3	69	36.66	1912	11.10	5.62
1910-2030	83	36.82	1924	11.20	5.54
	88	36.70	1930	11.08	5.56
	56	36.66	1940	11.06	5.60
	79	37.26	1952	11.30	6.04
	53	37.10	2002	11.08	5.54
	80	36.56	2015	11.06	5.54
	6		2027		.
	Total	477.98	141 min	144.58	72.90
Feedrates (lbm/hr) (corrected to 97% TCE)				61.59	30.13
		203.4 lbm/hr		30.25%	14.79%

LOS ALAMOS CAI
RCRA TRIAL BURN
SOLID MATRIX FEED RECORD

Date 9/4/86

Boxes from Last Run

BOX NUMBER	CLOCK TIME BOX FED TO INCINERATOR
1	
2	0815
3	0830
4	0842
5.	08.47
14	0900
15	0915
16	0927
17	0939
18	0951
19	1011
20.	1016
21	1029
22.	1040
23	1050
24	1104
25	1117
28	1130
29	1150
26	1215
30	1612
27	1627
31	1639

LOS ALAMOS CAI
RCRA TRIAL BURN
SOLID MATRIX FEED RECORD

Date 9/6/86

	BOX NUMBER	CLOCK TIME BOX FED TO INCINERATOR
	33	1640
	34	1700
	32	1713
	35	1725
	38	1737
	36	1748
	40	1800
	42	1812
	41	1824
	43	1836
	39	1845
	44	1858
DLM	48	1910
	45	1922
	47	1934
	46	1946
	37	1959
	50	2012
9/7/86	81	2024
	87	2036
	70	2049
9/7/86	60	1029 — Stuck in room.
	62	1312

LOS ALAMOS CAI
RCRA TRIAL BURN
SOLID MATRIX FEED RECORD

Date 9/7/86

BOX NUMBER	CLOCK TIME BOX FED TO INCINERATOR
51	1330
54	1342
66	1352
59	1407
86	1415
92	1427
89	1439
57	1451
71	1503
71	1515
77	1527
78	1540
78	1545
49	1555
65	1607
82	1617
55	1620
52	1641
1[illegible]	1653
73	1702
85	1714
74	1726
67	1733

LOS ALAMOS CAI
RCRA TRIAL BURN
SOLID MATRIX FEED RECORD

Date 9/7/86

BOX NUMBER	CLOCK TIME BOX FED TO INCINERATOR
90	1795
84	1757
63	1806
61	1818 } 4-V-5
76	1830
75	1840
91	1859 } 4-V-6
64	1900
69	1912
83	1924
88	1930
56	1940
79	1952
53	2002
80	2015
6	2027
12	
13	

LFR Dim

Stop

APPENDIX C. FEED PREPARATION & FEED RATE DATA

4) SOLID FEED PREPARATION

RCRA TRIAL BURN SOLID MATRIX

FEED PREPARATION PROCEDURE

Following is a step-by-step procedure for preparation of solid matrix feed material for the RCRA trial burn in the Los Alamos Controlled Air Incinerator. It is emphasized that steps 5 and 6 must be performed using full face respirators equipped with activated carbon canisters.

1. Open the top lid on a box containing a 5 gal polyethylene jug. Unscrew the wide mouth cap and place on top of jug. Label the side of the box with an ID number.

2. Place the box/jug/cap on the digital balance and record the weight in lbs. Record the weight and punch the TR (tare) button on the balance.

3. Add the specified weight (15.28 lbs) of Pel-E-Cel (pelletized ground corn cobs) to the jug using a scoop and large polyethylene funnel supported on the ring stand. Record the actual weight of Pel-E-cel added to the jug. Punch the TR button on the balance. Note: For this operation, a dust mask must be worn.

4. Add the specified amount of water (1.53 lbs) to the jug through a separate funnel. Record the actual weight of water added to the jug.

5. Transfer a drum of carbon tetrachloride (CCl_4) into the liquid feed room with the forklift, placing it on the scale and in the right hemispherical opening in the drum ventilation hood. Verify that both ventilation blowers are on. Make sure the drum pump, transfer line and valve, and intermediate carboy assembly are ready for liquid transfer from the drum. FROM THIS POINT ON, A FULL FACE RESPIRATOR WITH ACTIVATED CARBON CANISTER MUST BE WORN. Remove the bung from the drum and insert the drum pump shaft into the bunghole until the end of the shaft rests on the bottom of the drum. Wrap a rag around the open area between the shaft and the bung to minimize release of vapors. Begin transfer of CCl_4 by pressing the air trigger on the drum pump. Release the trigger before the intermediate 5 gallon polyethylene carboy is full. Place a box/jug which has previously been loaded with Pel-E-Cel and water on the balance. Punch the TR button on the scale. Begin gravity transfer of CCl_4 from the intermediate carboy into the jug through the drain valve on the bottom of the carboy until the desired weight (11.10 lbs) has been reached. Record the actual weight of CCl_4 transferred and punch the TR button on the balance.

6. For addition of trichloroethylene (TCE) into the solid feed matrix, follow the exact procedure as outlined in step 5 above. The desired amount of TCE is 5.55 lbs. Record the actual weight of TCE added. Punch the TR button on the balance and record total weight of the solid matrix package. The desired total weight is 37.0 lbs. Replace cap on polyethylene jug.

RCRA TRIAL BURN SOLID FEED

8/4/86

Box No.	Box+Jug+Cap (lbs)	Pel-e-Cel (lbs)	Water (lbs)	CCl_4 (lbs)	TCE (lbs)	Total Gross Wt. (lbs)
1			20.28	17.16	—	37.44
2			20.16	17.14	—	37.26
3			20.42	16.66	—	37.02
4			20.66	16.80	—	37.74
5			20.52	16.46	—	36.98
6			20.48	16.94	—	37.42
7			20.40	16.56	—	36.96
8			20.46	16.60	—	37.06
9			20.58	16.32	—	36.90
10			20.52	16.82	—	37.34
11			20.60	16.84	—	37.44
12			20.70	16.46	—	37.16
13			20.64	15.76	—	36.40

RCRA TRIAL BURN SOLID FEED

8/22/86

Box No.	Box+Jug+Cap (lbs)	Pel-e-Cel (lbs)	Water (lbs)	CCl_4 (lbs) 8/28 CCl4 (Drum #1)	TCE (lbs) TCE Drum #1 8/29/86	Total Gross Wt. (lbs)
14	3.66	15.32	1.54/20.10	11.10	5.64	37.32
15	3.76	15.30	1.54/20.60	11.18	5.56	36.08
16	3.68	15.30	1.50/20.48	11.18	5.58	37.22
17	3.62	15.32	1.50/20.44	11.10	5.56	36.98
18	3.60	15.32	1.62/20.52	11.12	5.54	37.06
19	3.62	15.40	1.52/20.54	11.08	5.56	37.14
20	3.62	15.32	1.58/20.52	11.08	5.54	37.14
21	3.60	15.30	1.52/20.44	11.12	5.54	37.20
22	3.64	15.32	1.56/20.52	11.06	5.62	37.18
23	3.60	15.30	1.64/20.52	11.10	5.60	37.22
24	3.60	15.32	1.54/20.44	11.12	5.54	37.10
25	3.62	15.42	1.54/20.58	11.16	5.56	37.20
26	3.62	15.30	1.52/20.44	11.08	5.58	37.22
27	3.62	15.32	1.56/20.48	11.26	5.56	37.28
28	3.60	15.34	1.54/20.48	11.06	5.68	37.28
29	3.64	15.30	1.52/20.46	11.14	5.54	37.14
30	3.62	15.42	1.66/20.70	11.08	5.52	37.30
31	3.62	15.30	1.62/20.54	11.12	5.54	37.36
32	3.66	15.28	1.62/20.52	11.24	5.60	37.42
33	3.64	15.34	1.52/20.48	11.20	5.52	37.16
34	3.62	15.32	1.56/20.50	11.16	5.64	37.28
35	3.62	15.34	1.68/20.62	11.26	5.54	37.36
36	3.58	15.30	1.60/20.48	11.14	5.64	37.32
37	3.56	15.42	1.52/20.48	11.40	5.56	37.48

RCRA TRIAL BURN SOLID FEED

8/22/86

Box No.	Box+Jug+Cap (lbs)	Pel-e-Cel (lbs)	Water (lbs)	CCl_4 (lbs)	TCE (lbs)	Total Gross Wt. (lbs)
38	3.60	15.32	1.52/20.44	11.12	5.64	37.38
39	3.62	15.30	1.52/20.44	11.08	5.54	37.14
40	3.58	15.34/18.92	1.52/20.44	11.12	5.56	37.16
41	3.60	15.78	1.54/20.92	11.10	5.58	37.76
42	3.58	15.32	1.52/20.42	11.08	5.58	36.58
43	3.60	15.30	1.56/20.46	11.10	5.70	36.80
44	3.58	15.30	1.52/20.40	11.20	5.58	36.70
45	3.62	15.32	1.56/20.50	11.30	5.56	36.82
46	3.56	15.36	1.50/20.40	11.08	5.54	36.50
47	3.60	15.32	1.53/20.48	11.10	5.58	36.68
48	3.60	15.50	1.52/20.64	11.06	5.66	36.94
49	3.54	15.34	1.50/20.38	11.06	5.56	36.52
50	3.60	15.30	1.50/20.40	11.08	5.58	36.58
51	3.60	15.30	1.50/20.40	11.22	5.54	36.70
52	3.56	15.32	1.52/20.40	11.26	5.54	37.42
53	3.58	15.34	1.54/20.46	11.08	5.54	37.10
54	3.60	15.30	1.52/20.42	11.06	~~5.56~~ 6.16	~~36.38~~ 37.20
55	3.58	15.36	1.52/20.46	11.06	5.58	36.60
56	3.58	15.30	1.54/20.44	11.06	~~5.60~~	~~36.60~~ 36.66
57	3.60	15.28	1.52/20.42	11.06	5.60	36.62
58	3.62	15.38	1.56/20.54	11.10	5.58	36.76
59	3.58	15.32	1.54/20.48	11.10	5.52	36.62
60	3.62	15.30	1.50/20.44	11.12	5.64	36.72
61	3.58	15.30	1.50/20.36	11.08	5.58	36.58

Drum #1 CCl_4

Drum #2 CCl_4

TCE Drum #1 Gross Wt = 692.4 lb, Gross Wt for all boxes filled = 251.6 lb

RCRA TRIAL BURN SOLID FEED

8/22/86

8/28/86 8/29/86

Box No.	Box+Jug+Cap (lbs)	Pel-e-Cel (lbs)	Water (lbs)	CCl_4 (lbs)	TCE (lbs)	Total Gross Wt. (lbs)
62	3.62	15.30	1.52/20.44	11.14	5.54	37.16
63	3.62	15.30	1.50/20.42	11.10	5.56	36.5
64	3.58	15.30	1.50/20.38	11.24	5.62	36.92
65	3.54	15.32	1.50/20.44	11.10	5.54	36.64
66	3.62	15.30	1.52/20.38	11.16	5.58	36.72
67	3.58	15.30	1.50/20.40	11.12	5.60	36.58
68	3.54	15.30	1.52/20.36	11.10	5.62	36.78
69	3.62	15.32	1.50/20.44	11.10	5.62	36.66
70	3.60	15.32	1.50/20.42	11.16	5.60	36.74
71	3.56	15.30	1.52/20.38	11.12	5.52	36.52
72	3.54	15.28	1.52/20.36	11.08	5.54	36.52
73	3.58	15.30	1.60/20.46	11.12	5.56	36.70
74	3.60	15.40	1.54/20.56	11.20	5.58	36.82
75	3.54	15.32	1.70/20.56	11.10	5.54	36.76
76	3.54	15.40	1.52/20.48	11.10	5.56	36.58
77	3.58	15.32	1.46/20.34	11.06	5.54	36.68
78	3.58	15.36	1.62/20.56	11.20	5.54	36.82
79	3.56	15.34	1.56/20.42	11.30	6.04	37.26
80	3.62	15.32	1.54/20.46	11.06	5.54	36.56
81	3.62	15.34	1.54/20.50	11.08	5.54	36.70
82	3.62	15.42	1.52/20.56	11.06	5.52	36.62
83	3.66	15.30	1.54/20.50	11.20	5.54	36.82
84	3.62	15.34	1.54/20.50	11.06	5.54	36.78
85	3.62	15.28	1.54/20.44	11.18	5.58	36.74

8/25/86

8/25/86

RCRA TRIAL BURN SOLID FEED

Box No.	Box+Jug+Cap (lbs)	Pel-e-Cel (lbs)	Water (lbs)	CCl_4 (lbs)	TCE (lbs)	Total Gross Wt. (lbs)
86	3.62	15.28	1.54/20.44	11.08	5.58	36.82
87	3.58	15.30	1.58/20.46	11.32	5.64	36.98
88	3.62	15.28	1.54/20.44	11.08	5.56	36.70
89	3.58	15.36	1.56/20.50	11.18	5.54	37.04
90	3.62	15.42	1.64/20.68	11.28	5.52	37.28
91	3.56	15.34	1.52/20.42	11.08	5.60	36.88
92	3.64	15.32	1.60/20.54	11.06	5.76	37.12
93	3.60	15.28	1.54/20.42		S	
94	3.62	15.44	1.66/20.70			
95	3.64	15.28	1.52/20.44			
96	~~3.62~~ 3.62	~~15.2~~ 15.28	~~1.50/20.38~~			
97	3.64	15.30	1.54/20.48			
98	3.62	15.32	1.58/20.54		NO	CCl4 OR TCE added to this box
99	3.62	15.28	1.54/20.44			
100	3.66	15.28	1.52/20.46			
101	3.60	15.28	1.54/20.42			
102	3.60	15.28	1.52/20.40			
103	3.56	15.28	1.52/20.34			
104	3.62	15.28	1.54/20.44			
105	3.56	15.28	1.53/20.36			
106	3.62	15.30	1.56/20.48			
107	3.60	15.30	1.58/20.48			
108	3.64	15.34	1.52/20.44			
109	3.64	15.30	1.62/20.54			

RCRA TRIAL BURN SOLID FEED

8/26/86

Box No.	Box+Jug+Cap (lbs)	Pel-e-Cel (lbs)	Water (lbs)	CCl_4 (lbs)	TCE (lbs)	Total Gross Wt. (lbs)
110	3.62	15.30	1.52/20.42			
111	3.62	15.28	1.60/20.50			
112	3.64	15.30	1.54/20.48			
113	3.66	15.28	1.62/20.56			
114	3.62	15.26	1.58/20.46			
115	3.62	15.28	1.52/20.42			
116	3.62	15.28	1.54/20.42			
117	3.66	15.28	1.54/20.48			
118	3.64	15.28	1.52/20.42			
119	3.58	15.28	1.54/20.40			
120	3.62	15.28	1.54/20.44			
121	3.62	15.28	1.54/20.42			
122	3.62	15.28	1.58/20.48			
123	3.62	15.28	1.52/20.44			
124	3.64	15.28	1.54/20.44			
125	3.62	15.28	1.52/20.42			
126	3.62	15.32	1.64/20.58			
127	3.58	15.28	1.52/20.38			
128	3.60	15.28	1.54/20.40			
129	3.60	15.28	1.54/20.42			
130	3.54	15.28	1.54/20.36			
131	3.58	15.28	1.54/20.40			
132	3.58	15.28	1.54/20.40			
133						

APPENDIX D. STACK GAS SAMPLING DATA

1) EPA METHOD-5 & VOST SAMPLE PERIOD CHART

M5 & VOST SAMPLE PERIODS

METHOD 5 RUNS	VOST RUNS	
LA-1-M5-1-IMP 9/4 1310-1445	**LA-1-V-1-T,TC** 9/4 1315-1335	**LA-1-V-3-T,TC** 9/4 1443-1503
	LA-1-V-2-T,TC 9/4 1401-1421	**LA-1-V-4-T,TC** 9/4 1525-1545
LA-1-M5-2-IMP 9/4 1852-2015	**LA-1-V-5-T,TC** 9/4 1824-1844	**LA-1-V-6-T,TC** 9/4 1938-1958
LA-1-M5-3-IMP 9/4 2125-2245		
LA-2-M5-1-IMP 9/5 0950-1120	**LA-2-V-1-T,TC** 9/5 0958-1018	**LA-2-V-2-T,TC** 9/5 1044-1104
LA-2-M5-2-IMP 9/5 1220-1340	**LA-2-V-3-T,TC** 9/5 1216-1236	**LA-2-V-4-T,TC** 9/5 1302-1322
LA-2-M5-3-IMP 9/5 1440-1600	**LA-2-V-5-T,TC** 9/5 1448-1508	**LA-2-V-6-T,TC** 9/5 1527-1547
LA-3-M5-1-IMP 9/6 1035-1155	**LA-3-V-1-T,TC** 9/6 1036-1056	**LA-3-V-2-T,TC** 9/6 1117-1137
LA-3-M5-2-IMP 9/6 1707-1832	**LA-3-V-3-T,TC** 9/6 1709-1729	**LA-3-V-4-T,TC** 9/6 1756-1816
LA-3-M5-3-IMP 9/6 1927-2050	**LA-3-V-5-T,TC** 9/6 1924-1944	**LA-3-V-6-T,TC** 9/6 1957-2017
LA-4-M5-1-IMP 9/7 1350-1512	**LA-4-V-1-T,TC** 9/7 1349-1409	**LA-4-V-2-T,TC** 9/7 1430-1450
LA-4-M5-2-IMP 9/7 1557-1718	**LA-4-V-3-T,TC** 9/7 1558-1618	**LA-4-V-4-T,TC** 9/7 1638-1658
LA-4-M5-3-IMP 9/7 1910-2030	**LA-4-V-5-T,TC** 9/7 1809-1829	**LA-4-V-6-T,TC** 9/7 1846-1906

APPENDIX D. STACK GAS SAMPLING DATA

2) EPA METHOD-5 & VOST DATA SUMMARY

DATA FOR HCl REMOVAL, POHC DRE, & ASSOCIATED CALCULATIONS

NOTE #1: FOR ALL SAMPLING PERIODS AND CALCULATIONS, THE FOLLOWING PARAMETERS ARE CONSTANTS:

1) EPA METHOD-5 METER CORRECTION FACTOR (Yd)= 0.9999
2) PITOT TUBE COEFFICIENT (Cp)= 0.84
3) EXHAUST STACK CROSS-SECTIONAL AREA (As)= 0.7773 ft^2
4) CROSS-SECTIONAL AREA OF NOZZLE (An)= 0.000534 ft^2
5) VOST METER CORRECTION FACTOR (Ydv)= 1.0032

NOTE #2: WASTE FEED RATE & FEED MIXTURE % DATA ARE BASED ON CORRECTED FEED RATES & WEIGHT % OF COMPONENTS AS PREPARED (97% TCE FEEDSTOCK ASSUMED).

LA-1-M5-1-IMP **LA-1-V-1-T,TC**
9/4 1310-1445 1315-1335

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
308.6	**35.50**	**84**	**23.19**	**0.74**	**8.6/9.2**	**.4154**	**209**	**64**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0161	**<1**	**542**	**2.45**	**44.84/19.39**	**5**	**20.91**	**32**	**>188/***

LA-1-M5-1-IMP **LA-1-V-2-T,TC**
9/4 1310-1445 1401-1421

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
308.6	**35.50**	**84**	**23.19**	**0.74**	**8.6/9.2**	**.4154**	**209**	**64**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0161	**<1**	**542**	**2.78**	**44.84/19.39**	**5**	**21.71**	**31**	**6780/161**

LA-1-M5-1-IMP **LA-1-V-3-T,TC**
9/4 1310-1445 1443-1503

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
308.6	35.50	84	23.19	0.74	8.6/9.2	.4154	209	64

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0161	<1	542	2.78	44.84/19.39	5	18.91	30	5110/<10

LA-1-M5-1-IMP **LA-1-V-4-T,TC**
9/4 1310-1445 1525-1545

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
308.6	35.50	84	23.19	0.74	8.6/9.2	.4154	209	64

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0161	<1	542	2.84	44.84/19.39	5	20.82	39	>5760/*

LA-1-M5-2-IMP **LA-1-V-5-T,TC**
9/4 1852-2015 1824-1844

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
409	44.23	79	23.08	0.74	8.6/9.2	.4247	213	80

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0121	<1	684	2.86	44.84/19.39	6	21.48	30	>5410/*

LA-1-M5-2-IMP **LA-1-V-6-T,TC**
9/4 1852-2015 1938-1958

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
409	**44.23**	**79**	**23.08**	**0.74**	**8.6/9.2**	**.4247**	**213**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0121	**<1**	**684**	**2.86**	**44.84/19.39**	**6**	**21.36**	**27.5**	**5410/140**

LA-1-M5-3-IMP
9/4 2125-2245

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
399	**41.97**	**66**	**23.08**	**0.68**	**8.6/9.2**	**.4098**	**212**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0184	**<1**	**648**	**2.86**	**44.84/19.39**	**12**	**0.0**	**0**	**0/0**

LA-2-M5-1-IMP **LA-2-V-1-T,TC**
9/5 0950-1120 0958-1018

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
303.8	**38.84**	**71**	**23.05**	**0.57**	**8.0/10.4**	**.3794**	**216**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0200	**<1**	**557**	**2.89**	**45.35/19.12**	**5**	**20.62**	**21**	**63/<10**

LA-2-M5-1-IMP **LA-2-V-2-T,TC**
9/5 0950-1120 1044-1104

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
303.8	38.84	71	23.05	0.57	8.0/10.4	.3794	216	80

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0200	<1	557	2.89	45.35/19.12	5	21.68	24.5	*/*

LA-2-M5-2-IMP **LA-2-V-3-T,TC**
9/5 1220-1340 1216-1236

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
307	41.71	92	23.05	0.64	8.0/10.4	.3785	226	80

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0172	48	540	2.86	45.35/19.12	6	21.82	38	*/<10

LA-2-M5-2-IMP **LA-2-V-4-IMP**
9/5 1220-1340 1302-1322

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
307	41.71	92	23.05	0.64	8.0/10.4	.3785	226	80

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas Cl_4/TCE ng .
.0172	48	540	2.86	45.35/19.12	6	21.17	36	1190/164

LA-2-M5-3-IMP **LA-2-V-5-T,TC**
9/5 1440-1600 1448-1508

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
300.6	**41.60**	**103**	**23.05**	**0.62**	**8.0/10.4**	**.3746**	**229**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0226	**325**	**533**	**2.88**	**45.35/19.12**	**7**	**21.98**	**40**	**4580/115**

LA-2-M5-3-IMP **LA-2-V-6-T,TC**
9/5 1440-1600 1527-1547

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
300.6	**41.60**	**103**	**23.05**	**0.62**	**8.0/10.4**	**.3746**	**229**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0226	**325**	**533**	**2.88**	**45.35/19.12**	**7**	**19.92**	**48**	**5660/110**

LA-3-M5-1-IMP **LA-3-V-1-T,TC**
9/6 1035-1155 1036-1056

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
399	**45.07**	**78**	**23.15**	**0.78**	**8.0/10.1**	**.4287**	**225**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0266	**168**	**640**	**2.76**	**29.85/14.62**	*****	**20.14**	**25**	**2170/231**

LA-3-M5-1-IMP **LA-3-V-2-T,TC**
9/6 1035-1155 1117-1137

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
399	**45.07**	**78**	**23.15**	**0.78**	**8.0/10.1**	**.4287**	**225**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0266	**168**	**640**	**2.76**	**29.85/14.62**	*****	**20.87**	**33**	**2230/235**

LA-3-M5-2-IMP **LA-3-V-3-T,TC**
9/6 1707-1832 1709-1729

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
485.4	**47.21**	**89**	**23.05**	**0.84**	**7.6/10.0**	**.4569**	**216**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0374	**72**	**680**	**3.11**	**29.91/14.56**	**5**	**20.71**	**33**	**5660/1240**

LA-3-M5-2-IMP **LA-3-V-4-T,TC**
9/6 1707-1832 1756-1816

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
485.4	**47.21**	**89**	**23.05**	**0.84**	**7.6/10.0**	**.4569**	**216**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0374	**72**	**680**	**3.11**	**29.91/14.56**	**5**	**20.37**	**33**	**4440/543**

LA-3-M5-3-IMP **LA-3-V-5-T,TC**
9/6 1927-2050 1924-1944

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
297.9	**48.60**	**72**	**23.05**	**0.92**	**7.6/10.2**	**.4464**	**210**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0442	**148**	**533**	**2.96**	**30.40/14.68**	**5**	**21.99**	**25**	**258/6.0**

LA-3-M5-3-IMP **LA-3-V-6-T,TC**
9/6 1927-2050 1957-2017

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
297.9	**48.60**	**72**	**23.05**	**0.92**	**7.6/10.2**	**.4464**	**210**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0442	**148**	**533**	**2.96**	**30.40/14.68**	**5**	**21.04**	**24**	**2993/8.0**

LA-4-M5-1-IMP **LA-4-V-1-T,TC**
9/7 1350-1512 1349-1409

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
254.2	**46.68**	**82**	**23.13**	**0.82**	**5.9/12.3**	**.4190**	**213**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0126	**42**	**466**	**3.17**	**30.14/14.90**	**5**	**20.96**	**25**	**5600/52**

LA-4-M5-1-IMP **LA-4-V-2-T,TC**
9/7 1350-1512 1430-1450

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
254.2	**46.68**	**82**	**23.13**	**0.82**	**5.9/12.3**	**.4190**	**213**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0126	**42**	**466**	**3.17**	**30.14/14.90**	**5**	**20.76**	**32**	**590/<10**

LA-4-M5-2-IMP **LA-4-V-3-T,TC**
9/7 1557-1718 1558-1618

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
284.7	**52.01**	**86**	**23.13**	**1.04**	**7.0/11.0**	**.4405**	**211**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0000	**220**	**529**	**3.23**	**30.25/14.68**	**5**	**20.15**	**34**	**2600/36**

LA-4-M5-2-IMP **LA-4-V-4-T,TC**
9/7 1557-1718 1638-1658

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
284.7	**52.01**	**86**	**23.13**	**1.04**	**7.0/11.0**	**.4405**	**211**	**80**

Particulate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0000	**220**	**529**	**3.23**	**30.25/14.68**	**5**	**17.71**	**32**	**5200/210**

LA-4-M5-3-IMP **LA-4-V-5-T,TC**
9/7 1910-2030 1809-1829

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
297.4	**51.31**	**68**	**23.10**	**1.02**	**8.0/10.2**	**.4428**	**202**	**80**

Parti-culate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0485	**270**	**505**	**3.39**	**30.25/14.79**	**7**	**21.44**	**24**	**6200/162**

LA-4-M5-3-IMP **LA-4-V-6-T,TC**
9/7 1910-2030 1846-1906

IMP GEL H_2O. ml	M5 Samp. Vol. ft^3	Ave. Gas Temp. °F	Baro. Press. in Hg	Ori. delP in Hg	CO_2/O_2 %	Ave. VelP SQRTS in H_2O	Ave. Stack Temp. °F	M5 Samp. Time min.
297.4	**51.31**	**68**	**23.10**	**1.02**	**8.0/10.2**	**.4428**	**202**	**80**

Parti-culate gm	M5 IMP Cl^- mg/l	IMP Soln Vol. ml	Waste Feed Rate lb/m	Feed Mixture CCl_4/TCE %	CO ppm	VOST Samp Vol. l	VOST Gas Temp °C	Offgas CCl_4/TCE ng .
.0485	**270**	**505**	**3.39**	**30.25/14.79**	**7**	**20.36**	**25**	**4900/116**

APPENDIX D. STACK GAS SAMPLING DATA

3) EPA METHOD-5 FIELD DATA SHEETS

DATE: 7-8-85

OPERATOR: C. Fox

$\overline{Yd}$ .9999

$\overline{\Delta H@}$ 1.807

Meter Box: G6

BAROMETRIC PRESSURE (Pb): 29.28

Q	ΔH	ΔP	Yds	STANDARD METER GAS VOLUME (ft³) INITIAL	FINAL	Vds NET	METER BOX GAS VOLUME (ft³) INITIAL	FINAL	VD NET	STANDARD METER TEMP. (°F) IN	OUT	Tds AVG	METER BOX TEMP. (°F) IN	OUT	Td AVG	TIME (MIN) θ	Yd
.39	.5	-1.2	1.0000	0.000	5.000	5.000	312.400	317.576	5.176	76	76	76	106	103.5	105	12.44	1.0139
.39	.5	-1.2	1.0000	0.000	5.000	5.000	317.576	322.739	5.163	76	76	76	104	102.5	103	12.49	1.0129
.65	1.5	-2.2	1.0000	00.000	10.013	10.013	322.739	333.131	10.392	76.5	76.5	76.5	104.5	101.5	103	14.87	1.0018
.65	1.5	-2.2	1.0000	00.000	10.000	10.000	333.131	343.487	10.356	76.5	76.5	76.5	101.5	100	101	14.91	1.0004
.91	3.0	-3.9	1.0000	00.000	10.002	10.002	343.487	353.926	10.439	76.5	76.5	76.5	102	99	100.5	10.55	.9838
.91	3.0	-3.8	1.0000	00.000	10.000	10.000	353.926	364.373	10.447	77	77	77	106	99.5	103	10.62	.9865

Q = Flow Rate (cfm)
ΔH = Orifice Pressure differential (in. H_2O)
ΔP = Standard Meter inlet pressure differential (in. H_2O)
Yds = Standard Meter Correction Factor
Yd = Meter Box Correction Factor

ΔH@ = Orifice pressure differential that gives 0.75 cfm at 70°F and 29.92" Hg (in. H_2O)

$$Yd = (Yds)\frac{Vds}{Vd}\;\frac{Td + 460}{Tds + 460}\;\frac{Pb + \Delta p/13.6}{Pb + \Delta H/13.6}$$

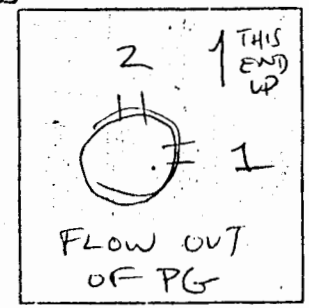
$$\Delta H@ = \frac{0.0317 \cdot \Delta H}{\;}\left[\frac{(Tds + 460)\;\theta}{\;}\right]^2$$

K=8.3 T_m=110
T_s=220
B_{wo}=37

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet
Operator: J. BARABUSZKO
Date: 7/24/86
Run No.: 1
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ~~9~~ 8.3
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: < .005 CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): .5

Start Time: 13:10 AM ~~12:10~~ PM
Finish Time: : AM PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21520
~~Thimble #~~
Beaker #: ____

Ambient Temperature, °F: 80
Barometric Pressure, In. Hg: 23.19
Assumed Moisture, %: 38-39
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: .373 → .313
Probe Heater Setting: 250°
% O_2: 9.2
% CO_2: 8.6
H_2O, ml: 296
Silica Gel, gm: 12.6
Total V_{lc}: 308.6
Stack Area, Ft²: π/4 · Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 95.76 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	P/HSL/F SAMPLE BOX TEMPERATURE T_b °F
1-1	4	12 *	220	.19	(1.58) 1.2	98.59 *	94	91	52	255/246/24[illegible]
	8	6½	220	.19	.78	101.01	90	91	54	256/248/2[illegible]
2	12	6	222	.17	.70	103.25	89	90	61	255/249/24[illegible]
	16	6	222	.17	.70	105.35	89	90	63	256/248/254
3	20	7	214	.19	.78	107.64	90	89	60	255/249/25[illegible]
	24	9	208	.24	.98	110.17	89	89	58	255/250/25[illegible]
4	28	9	197	.23	.94	112.64	86	87	58	256/247/2[illegible]
	32	8	182	.20	.82	115.02	82	84	59	259/250/2[illegible]
							(84)			
TOTAL							AVG. -11	AVG. -9		
AVERAGE	(64)		(209)	(.4154)	(0.74)	(35.62)	AVG. 90 - 20/16	88.75		

NEW Nozzle * Δ TO .313

98.71 NOZZLE 314 313 / 312 312 → 18 .313 K → 4.11

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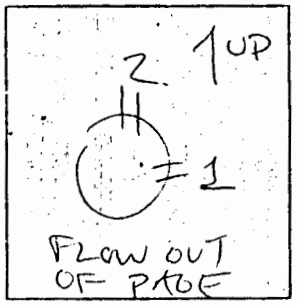
Page 1 of 2

PARTICULATE T[illegible]ING
RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet: ____
Operator: J. BABUSZKO
Date: 9/4/86
Run No.: 1
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM / PM
Finish Time: ____ : ____ AM / PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: .3
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: 296
Silica Gel, gm: 12 1/2
Total V_{lc}: 308 1/2
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b °F
2-1	(4) 36	6	216	.16	.66	117.10	81	81	64	259/253/278
	(8) 40	7 1/2	218	.20	.82	119.43	80	81	58	259/255/250
2	(12) 44	7	219	.17	.70	121.64	80	81	56	260/254/258
	(16) 48	6	220	.15	.62	123.72	80	80	56	257/254/262
3	(20) 52	8	219	.17	.70	125.83	80	79	57	260/258/278
	(24) 56	5	200	.12	.53	127.74	80	79	57	260/259/278
4	(28) 60	4 1/2	191	.11	.45	129.51	79	78	58	260/256/260
	(32) 64	5	181	.13	.53	131.38	79	78	58	261/253/246
TOTAL							AVG. -1	AVG. -3		
AVERAGE							AVG. 80 - 4/16 = 79.75			

149/16

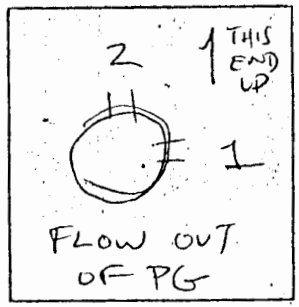
Clean Air Engineering, Inc.

16 x 5 = 80

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet
Operator: J. BRABUSZKO
Date: 9/4/86
Run No.: 2
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ~~.41~~ ~~(.40)~~ 4.1 (DK)
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 6.005 CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/-): ~~5.6~~ 0.6

Start Time: 18:52 AM/PM
Finish Time: : AM/PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21511
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.08
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, In.: .313
Probe Heater Setting: 250°
% O_2: 9.2
% CO_2: 8.6
H_2O, ml: 8395
Silica Gel, gm: 14
Total V_{lc}: 409
Stack Area, Ft²: π/4 · Θ = 12"
Pyrometer No.: NA

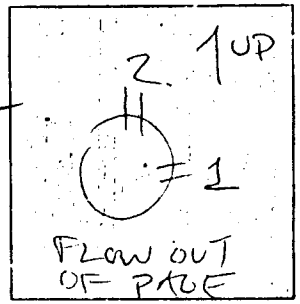
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 31.71 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	~~8~~ 5	6½	220	.22	.90	34.79	85	88	51	270/257/232
	~~8~~ 10	7	221	.23	.94	37.92	82	86	50	270/257/243
2	~~12~~ 15	6	224	.21	.86	40.87	81	85	50	254/258/240
	~~16~~ 20	6	225	.21	.86	43.86	80	84	51	259/258/234
3	~~20~~ 25	6	216	.19	.78	46.71	81	83	50	259/261/234
	~~24~~ 30	5½	214	.18	.74	49.47	80	82	50	259/261/237
4	~~28~~ 35	5	203	.16	.66	52.09	80	81	51	259/260/25[illegible]
	~~32~~ 40	5	187	.16	.66	54.79	~~80~~ 79	80	52	260/259/25[illegible]
							8	29		
				.4066						
TOTAL					0.74		AVG.	AVG.		
AVERAGE	60		213.8	.4247	.8	44.23	AVG. ~~82.3~~	79		

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet
Operator: J. BARABUSZKO
Date: 7/4/86
Run No.: 2
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck ✓
Leak Rate Before: <.005 CFM @ 15 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ AM / PM
Finish Time: 20:15 ~~20:15~~ AM / PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21517
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.08
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total V_{lc}: ____
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

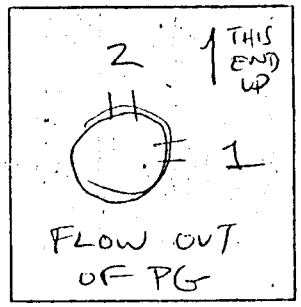
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s (135)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
2-1	~~(4)~~ 36	45	7	222	.22	.90	57.~~87~~53	77	79	52	264/260/251
	~~(8)~~ 40	50	7	223	.22	.90	60.85	77	78	51	260/260/242
2	~~(12)~~ 44	55	5	226	.17	.68	63.51	77	78	54	258/261/241
	~~(16)~~ 48	60	5	226	.17	.68	66.14	77	77	53	256/259/243
3	~~(20)~~ 52	65	5½	215	.16	.66	68.74	76	76	54	260/261/254
	~~(24)~~ 56	70	5½	214	.16	.66	71.33	76	76	56	260/262/253
4	~~(28)~~ 60	75	4	196	.12	.49	73.61	76	76	56	259/260/243
	~~(32)~~ 64	80	4½	182	.13	.53	75.94	75	75	56	260/261/242
TOTAL								AVG.	AVG.		
AVERAGE								AVG.			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAI
Unit#: ____ Inlet/Outlet
Operator: J. BARBUSZKO
Date: 7/4/86
Run No.: 3
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: 4.0
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.01 CFM @ 17 Hg
Leak Rate After: <.01 CFM @ 15 Hg
Static Press., In. H_2O (+/−): .5

Start Time: 21:25 AM/PM
Finish Time: : AM/PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21513
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: 55
Barometric Pressure, In. Hg: 23.08
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 9.2
% CO_2: 8.6
H_2O, ml: 385
Silica Gel, gm: 14
Total V_{lc}: 399
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

MIN/PT ____

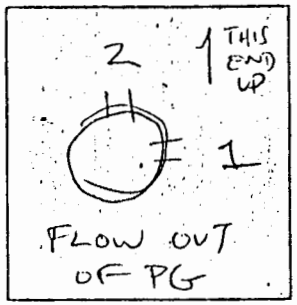
TRAVERSE POINT NUMBER	SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 77.50 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	~~4~~ 5	8	214	.22	.88	80.49	65	65	60	260/265/25
	~~8~~ 10	8	221	.22	.88	83.46	65	65	52	260/266/251
2	~~12~~ 15	8	225	.20	.80	86.34	66	65	50	261/268/245
	~~16~~ 20	8	225	.20	.80	89.28	66	65	53	260/268/244
3	~~20~~ 25	6	220	.17	.68	91.84	67	66	52	261/268/241
	~~24~~ 30	6	214	.16	.64	94.42	67	66	52	257/262/244
4	~~28~~ 35	5	196	.14	.56	96.81	67	66	51	257/257/247
	~~32~~ 40	5	184	.14	.56	99.19	67	66	51	257/258/
TOTAL							AVG.	AVG.		
AVERAGE	80		212	0.4098	0.68	41.97	AVG. 66			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAT
Unit#: ____ Inlet/Outlet
Operator: J. BARABUSZKO
Date: 7/4/86
Run No.: 3
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM / PM
Finish Time: ~~20~~ 21:45 AM / PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total V_{lc}: ____
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

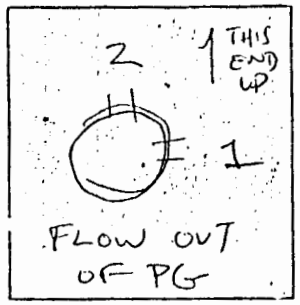
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³ 102.97	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b °F
1-1	~~4~~ 45	7	221	.19	.76	~~102.97~~	67	56	52	256/258/24
	~~8~~ 50	7	224	.19	.76	104.71	67	66	51	257/259/247
2	~~12~~ 55	7	225	.17	.68	107.35	68	66	52	257/258/24
	~~16~~ 60	7	226	.17	.68	109.99	68	67	52	257/259/249
3	~~20~~ 65	6	209	.15	.60	112.48	68	67	52	258/259/248
	~~24~~ 70	6	206	.15	.60	114.98	68	67	52	259/260/24
4	~~28~~ 75	4	198	.12	.48	117.22	67	67	52	259/259/24
	~~32~~ 80	4	184	.12	.48	119.47	67	67	52	259/260/25
TOTAL							AVG.	AVG.		
AVERAGE							AVG.			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet
Operator: J. BALABUSZKO
Date: 9/5/86
Run No.: 1 (CONDITION 2)
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: 3.9
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.01 CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/-): .5

Start Time: 9:50 AM/PM
Finish Time: 11:20 AM/PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21517
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, In.: .313
Probe Heater Setting: 250°
% O_2: 10.4
% CO_2: 8.0
H_2O, ml: 295
Silica Gel, gm: 8.8
Total V_{lc}: 303.8
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

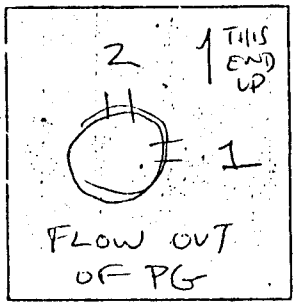
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 19.71 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	~~4~~ 5	4	220	.19	.74	22.47	65	64	46	261/255/2
	~~8~~ 10	4	222	.19	.74	25.22	66	64	42	260/256/2
2	~~12~~ 15	4	225	.17	.66	27.81	68	65	42	260/257/2
	~~16~~ 20	4	226	.16	.62	30.32	70	66	42	259/257/2
3	~~20~~ 25	4	221	.14	.55	32.69	71	67	43	258/256/
	~~24~~ 30	4	218	.14	.55	35.09	71	68	44	259/256/2
4	~~28~~ 35	3	206	.11	.43	37.22	72	69	46	258/257/
	~~32~~ 40	3	186	.10	.39	39.27	73	70	47	258/257/2
						~~244~~				~~257/2~~
				~~.3850~~						
TOTAL			216		0.57		AVG. 69.5	AVG. 66.6		
AVERAGE	80		~~215.5~~	.3794		38.84	AVG. 71			

Clean Air Engineering, Inc.

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet
Operator: J. BAZASUSTKO
Date: 9/5/86
Run No.: 1 (CONDITION 2)
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: <.01 CFM @ 17 Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM / PM
Finish Time: 11:20 AM / PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total V_{lc}: ____
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
1-1	~~4~~ 45	5	221	.19	.74	42.04	72	71	51	258/258/2
	~~8~~ 50	5	226	.18	.70	44.73	75	72	46	257/256/
2	~~12~~ 55	5	228	.15	.59	47.22	76	73	48	257/258/24
	~~16~~ 60	4.5	228	.14	.55	49.64	76	73	50	257/256/25
3	~~20~~ 65	4	217	.13	.51	51.97	76	73	51	257/256/25
	~~24~~ 70	4	218	.13	.51	54.30	77	74	51	257/256/25
4	~~28~~ 75	4	203	.10 ~~.09~~ JB	.39	56.40	77	74	52	256/256/2
	~~32~~ 80	4	198	.11	.43	58.55	78	75	53	255/255/
						-19.71				
			-21							
				.3738						
TOTAL			(217.4)		(0.57)		AVG. 75.9	AVG. 73.1		
AVERAGE	80		(216.4)	.3794			AVG. 71.3			

Clean Air Engineering, Inc.

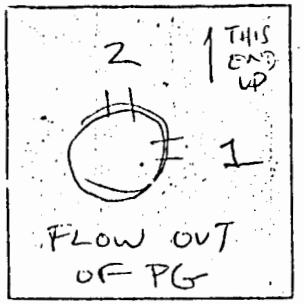
5-1

PARTICULATE TESTING RAW DATA SET

RUN 4, 21517
5

Client/Owner: LANL
Plant: CAT
Unit#: _____ Inlet/Outlet: _____
Operator: J. BAL ABUSZKO
Date: 9/5/86
Run No.: 2 (CONDITION 2)
Sample Box No.: _____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: _____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 2.01 CFM @ 17 Hg
Leak Rate After: _____ CFM @ _____ Hg
Static Press., In. H_2O (+/-): 0.6

Start Time: 12:20 AM (PM)
Finish Time: 1:40 AM (PM)
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21507
Thimble #: _____
Beaker #: _____

Ambient Temperature, °F: _____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: .313
Probe Heater Setting: 250°
% O_2: 8.0
% CO_2: 10.4
H_2O, ml: 296
Silica Gel, gm: 11.0
Total V_{lc}: 307
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 58.80 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
1-1	~~4~~ 5	6	233	.19	.84	61.77	88	87	55	254/261/270
	~~8~~ 10	6	233	.19	.84	64.70	89	88	50	252/261/24[illegible]
2	~~12~~ 15	6	235	.17	.75	67.53	90 JB	89	54	253/263/3[illegible]
	~~16~~ 20	6	234	.17	.75	70.33	~~90~~ 91	90	54	252/265/2[illegible]
3	~~20~~ 25	4 1/2	227	.14	.62	72.91	92	90	57	252/261/2[illegible]
	~~24~~ 30	4 1/2	225	.13	51 ~~.58~~	75.39	93	90	58	252/260/24[illegible]
4	~~28~~ 35	3 1/2	212	.11	.48	77.64	92	90	59	251/260/24[illegible]
	~~32~~ 40	3 1/2	199	.11	.48	79.93	92	90	60	251/261/299
TOTAL			226	.3868 ✓			AVG. 90.875	AVG. 89.25		
AVERAGE	80		~~224~~	.3785	0.64	41.71	AVG. 92			

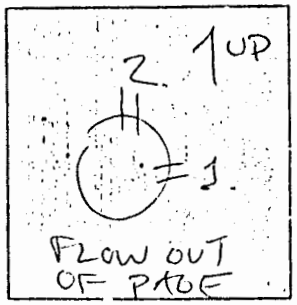
Clean Air Engineering, Inc.

5-2

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAT.
Unit#: ____ Inlet/Outlet
Operator: J. BALABUSZKO
Date: 9/5/86
Run No.: 2 (CONDITION 2)
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: 4.4
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 4.02 CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM PM
Finish Time: 1:40 AM PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total Vlc: ____
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

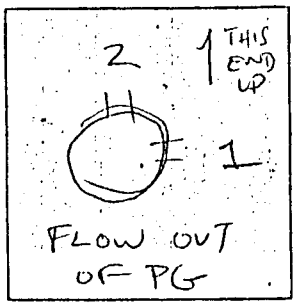
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
2-1	(4) ~~36~~	45	5 1/2	230	.19	.84	82.84	91	90	59	251/260/259
	(8) 40	40	5 1/2	233	.18	.79	85.75	91	90	54	252/264/26.
2	(12) 44	45	5	236	.15	.66	88.43	93	92	58	252/263/26
	(16) ~~48~~	60	5	236	.14	.62	91.04	94	93	60	253/264/505
3	(20) ~~52~~	65	4 1/2	232	.13	.57	93.56	95	94	61	253/265/26
	(24) ~~56~~	70	4	228	.12	.53	95.97	98	96	63	249/264/26
4	(28) ~~60~~	75	4	220	.10	.44	98.26	99	97	65	249/262/3.0
	(32) ~~64~~	80	4	210	.10	.44	100.51	99	98	66	248/263/
TOTAL				(228.125)	.3701			AVG. 92.5	AVG. 93.75		
AVERAGE				226.1	.3785		41.71	AVG.	91.6		

Clean-Air Engineering, Inc.

PARTICULATE TESTING FIELD DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: _____ Inlet/Outlet: _____
Operator: J. BALABUSZKO
Date: 9/5/86
Run No.: 3 (CONDITION 2)
Sample Box No.: _____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: _____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: .02 CFM @ 7 Hg
Leak Rate After: _____ CFM @ _____ Hg
Static Press., In. H_2O (+/−): .5

Start Time: 14:40 AM/PM
Finish Time: 16:00 AM/PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21509
Thimble #: _____
Beaker #: _____

Ambient Temperature, °F: _____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, In.: _____
Probe Heater Setting: 250°
% O_2: 10.4
% CO_2: 8.0
H_2O, ml: 287
Silica Gel, gm: 13.6
Total V_{lc}: 300.6
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

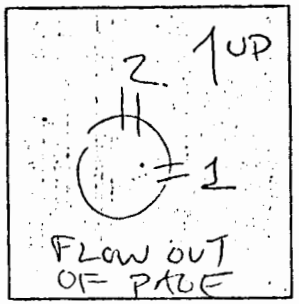
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 2.72 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	4 5	5	232	.18	.79	5.68	99	99	68	260/256/2[illegible]
	8 10	5	235	.19	.84	8.67	98	99	68	260/261/2[illegible]
2	12 15	4½	236	.18	.79	11.55	98	98	63	260/255/2[illegible]
	16 20	4	239	.16	.70	14.31	99	98	64	260/262/2[illegible]
3	20 25	4	234	.13	.57	16.82	103	100	60	259/256/2[illegible]
	24 30	4	232	.12	.53	19.27	104	102	58	259/258/2[illegible]
4	28 35	3	212	.09	.40	21.43	105	103	56	262/256/2[illegible]
	32 40	3	205	.10	.44	23.68	105	104	57	
			~~227~~							
			~~228~~	.3760						
TOTAL			229				AVG. 104	AVG. 100.4		
AVERAGE	8		228.1	.3746	0.63	41.60	AVG. 103			

Clean Air Engineering, Inc.

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF.
Unit#: ____ Inlet/Outlet: ____
Operator: J. BALAGAS
Date: 9/6/86
Run No.: 3 (COMBINATION 2)
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: <.02 CFM @ 17 Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM/PM
Finish Time: 4:00 AM/PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total V_{lc}: ____
Stack Area, Ft²: π/4 D = 12"
Pyrometer No.: NA

Traverse Point Number	MIN/PT ____ Sampling Time θ, min.	Vacuum In. Hg	Stack Temperature T_s, °F	Velocity Head DP_s	Pressure Differential Across Orifice Meter DH, In. H_2O	Initial Volume: Gas Sample Volume V_m, Ft³	Gas Sample Temperature at Dry Gas Meter: Inlet T_m in, °F	Gas Sample Temperature at Dry Gas Meter: Outlet T_m out, °F	Temp. of Gas Leaving Condenser or Last Impinger T_c, °F	Sample Box Temperature T_p, °F
2-1	(4) 36	05 4	235	.17	.75	26.47	106	104	65	258/254/200
	(8) 40	10 4	239	.17	.75	29.31	105	103	56	257/259/249
2	(12) 44	55 4	240	.15	.66	31.97	106	105	58	259/255/22[illegible]
	(16) 48	60 4	239	.14	.62	34.59	106	107	60	260/260/291
3	(20) 52	65 3½	232	.13	.57	37.10	107	107	61	256/257/25[illegible]
	(24) 56	70 3½	226	.13	.57	39.56	105	104	61	258/249/255
4	(28) 60	75 3½	216	.12	.53	42.02	104	102	61	253/261/305
	(32) 64	80 3½	208	.11	.48	44.32	103	105	62	263/264/277
TOTAL			(229.4)	.3732			AVG. 105.3	AVG. 104.6		
AVERAGE			228.8	.3746			AVG. 102.9			

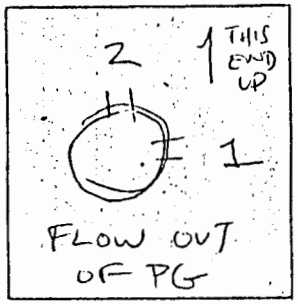
Clean Air Engineering, Inc.

1-1

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet: ____
Operator: J. RAMBUS ZICC
Date: 9/6/86
Run No.: 1 CONDITION 5
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: 4.2
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.005 CFM @ 15 Hg
Leak Rate After: <.01 CFM @ 15 Hg
Static Press., In. H_2O (+) (−): 0.6

Start Time: 10:35 AM PM
Finish Time: ____ : ____ AM PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21557
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.15
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 10.1
% CO_2: 8.0
H_2O, ml: 381
Silica Gel, gm: 18
Total V_{lc}: 399
Stack Area, Ft²: π/4 · Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 45.48 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	~~4~~ 5	7½	225	.24	1.0	48.72	72	71	41	252/252/255
	~~8~~ 10	7½	230	.24	1.0	51.91	72	72	39	253/251/250
2	~~12~~ 15	8	233	.23	.97	~~54.35~~ 53.06	73	72	43	251/253/249
	~~16~~ 20	8	233	.22	.92	58.18	74	73	51	250/253/255
3	~~20~~ 25	5½	227	.16	.67	60.83	75	73	58	251/251/261
	~~24~~ 30	5½	225	.17	.71	63.56	76	74	58	250/252/256
4	~~28~~ 35	5	214	.14	.59	66.05	78	75	57	250/253/256
	~~32~~ 40	5	198	.14	.59	68.06	78	76	57	250/253/250
			223.1	.436 ✓	.81		74.8	73.5		
TOTAL							AVG.	AVG.		
AVERAGE	80		225	0.4287	0.78	45.07	AVG. 78			

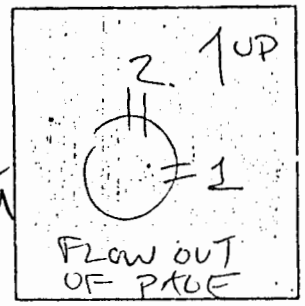
Clean Air Engineering, Inc.

7-2

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF.
Unit#: _____ Inlet/Outlet: _____
Operator: J. SALABUSZKO
Date: 9/6/86
Run No.: RUN 1 CONDITION 3
Sample Box No.: _____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: _____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: _____ CFM @ _____ Hg
Leak Rate After: _____ CFM @ _____ Hg
Static Press., In. H_2O (+/−): _____

Start Time: _____ AM / PM
Finish Time: 11:55 ~~PM~~ AM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: _____
Thimble #: _____
Beaker #: _____

Ambient Temperature, °F: _____
Barometric Pressure, In. Hg: _____
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: _____
Probe Heater Setting: 250°
% O_2: _____
% CO_2: _____
H_2O, ml: _____
Silica Gel, gm: _____
Total V_{lc}: _____
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
2-1	(4) 36	45	7½	230	.23	.97	71.19	79	77	53	254/252/26
	(8) 40	50	7½	234	.22	.92	74.30	80	77	50	249/251/274
2	(12) 44	55	6	235	.18	.76	77.11	81	78	50	250/255/251
	(16) 48	60	6	235	.18	.76	79.94	83	80	50	249/256/330
3	(20) 52	65	5½	229	.17	.71	82.70	85	82	53	247/255/284
	(24) 56	70	5½	227	.17	.71	85.44	86	84	51	248/250/253
4	(28) 60	75	5	220	.14	.59	88.01	88	85	52	247/252/281
	(32) 64	80	5	209	.14	.59	90.55	90	87	54	247/254/251
TOTAL								AVG.	AVG.		
AVERAGE								AVG.			

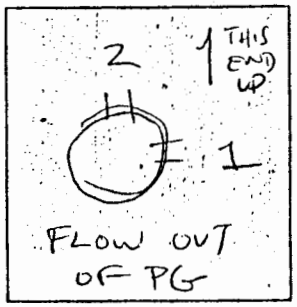
Clean Air Engineering, Inc.

8-1

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet
Operator: S. BALASUSZKO
Date: 9/6/86
Run No.: 2 CONDITION 3
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: 4.0
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.01 CFM @ 17 Hg
Leak Rate After: <.01 CFM @ 15 Hg
Static Press., In. H_2O (+/-): 0.4

Start Time: 17:07 AM/PM
Finish Time: 18:32 AM/PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21514 (2)
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 15.0
% CO_2: 7.6
H_2O, ml: 467
Silica Gel, gm: 16.4
Total V_{lc}: 485.4
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 90.77 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	4 5	6	224	.24	.96	93.94	86	89	54	255/248/
	8 10	6	225	.25	1.0	97.16	88	89	52	254/250/
2	12 15	6	229	.24	.96	100.31	89	90	53	252/250/
	16 20	6	228	.24	.96	103.46	90	90	54	242/257/
3	20 25	5 1/2	218	.20	.80	106.34	88	90	57	253/251/
	24 30	5 1/2	218	.20	.80	109.23	90	91	58	253/254/
4	28 35	4 1/2	204	.16	.64	111.83	90	91	58	253/248/
	32 40	4 1/2	189	.16	.64	114.43	89	91	58	253/251/
			216.9	.4580	.85					
							88.8	~~89.1~~ 90.1		
TOTAL							AVG.	AVG.		
AVERAGE	80		216	.4569	.84	47.21	AVG. 89			

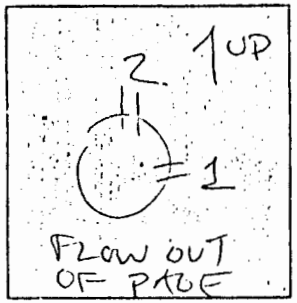
Clean Air Engineering, Inc.

8-2

Client/Owner: LANL
Plant: CAT.
Unit#: _____ Inlet/Outlet: _____
Operator: S RALABUSZKO
Date: 9/6/86
Run No.: 2 CONDITIONS
Sample Box No.: _____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: _____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: _____ CFM @ 17 Hg
Leak Rate After: _____ CFM @ _____ Hg
Static Press., In. H_2O (+/−): _____

PARTICULATE TESTING RAW DATA SET

Start Time: _____ : _____ AM / PM
Finish Time: _____ : _____ AM / PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: _____
Thimble #: _____
Beaker #: _____

Ambient Temperature, °F: _____
Barometric Pressure, In. Hg: _____
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, In.: _____
Probe Heater Setting: 250°
% O_2: _____
% CO_2: _____
H_2O, ml: _____
Silica Gel, gm: _____
Total V_{lc}: _____
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
2-1	(4) 36	45 / 7	223	.25	1.0	117.62	89	91	59	254/252/25[illegible]
	(8) 40	50 / 7	225	.25	1.0	120.87	89	90	58	253/252/307
2	(12) 44	55 / 6	225	.21	.84	123.82	88	90	58	255/252/26[illegible]
	(16) 48	60 / 6	226	.21	.84	126.79	88	90	61	255/252/26[illegible]
3	(20) 52	65 / 6	217	.21	.84	129.76	86	88	62	254/251/2[illegible]
	(24) 56	70 / 6	214	.20	.80	132.64	86	88	64	254/255/27[illegible]
4	(28) 60	75 / 5	206	.17	.68	135.32	86	88	67	254/252/25[illegible]
	(32) 64	80 / 5	189	.17	.68	137.98	85	87	68	255/252/25[illegible]
			215.6		.84					
				.4558						
TOTAL							AVG. 87.1	AVG. 89		
AVERAGE			216.3	.4569	.84		AVG. 88.8			

Clean Air Engineering, Inc.

Page 2 of 2

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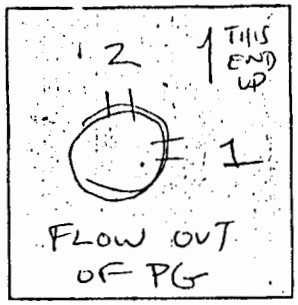
PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAI
Unit#: ____ Inlet/Outlet: ____
Operator: S BALABUS ZKO
Date: 9/6/86
Run No.: 3 CONDITION 3
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: 4.6
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.005 CFM @ 17 Hg
Leak Rate After: <.01 CFM @ 16 Hg
Static Press., In. H_2O (+) (−): 1.4

Start Time: 19:27 AM PM
Finish Time: : AM PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21556 (7)
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ~~10.6~~ ~~10.6~~ 10.2
% CO_2: ~~10.6~~ 7.6
H_2O, ml: 280
Silica Gel, gm: 17.9
Total V_{lc}: 297.9
Stack Area, Ft²: π/4 · D = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 38.20 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b °F
1-1	4 5	6	218	.22	1.0	41.39	73	74	55	256/256/24
	8 10	6	220	.22	1.0	44.57	73	74	50	256/257/24
2	12 15	6½	221	.21	.97	47.69	72	73	51	253/257/25
	16 20	6½	222	.22	1.0	50.88	73	73	57	252/255/25
3	20 25	5½	213	.19	.87	53.85	73	72	61	253/252/25
	24 30	5½	211	.19	.87	56.80	72	72	63	253/256/25
4	28 35	5	200	.16	.74	59.56	72	72	61	252/257/25
	32 40	5	183	.16	.74	62.31	72	72	59	252/258/255
			211		.90		72.5	72.8		
TOTAL							AVG.	AVG.		
AVERAGE	80		210	0.4464	0.92	48.60	AVG. 72			

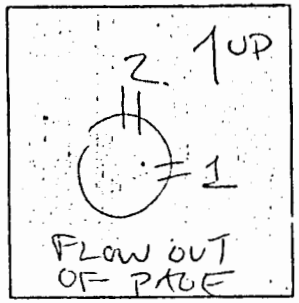
Clean Air Engineering, Inc.

9-2

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAT.
Unit#: _____ Inlet/Outlet: _____
Operator: J. BALABUSZKO
Date: 9/6/86
Run No.: 3 CONDITION 3
Sample Box No.: _____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: _____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: _____ CFM @ _____ Hg
Leak Rate After: _____ CFM @ _____ Hg
Static Press., In. H_2O (+/−): _____

Start Time: _____ : _____ AM / PM
Finish Time: _____ : _____ AM / PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: _____
Thimble #: _____
Beaker #: _____

Ambient Temperature, °F: _____
Barometric Pressure, In. Hg: _____
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In: _____
Probe Heater Setting: 250°
% O_2: _____
% CO_2: _____
H_2O, ml: _____
Silica Gel, gm: _____
Total Vlc: _____
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
2-1	(4) 36	45 / 7½	218	.26	1.2	65.70	71	71	54	253/255/246
	(8) 40	50 / 7½	220	.26	1.2	69.11	72	71	51	253/246/256
2	(12) 44	55 / 6½	221	.21	.97	72.27	71	71	50	253/257/24
	(16) 48	60 / 6½	221	.21	.97	75.40	71	71	50	253/255/250
3	(20) 52	65 / 6	209	.20	.92	78.43	70	71	50	253/257/259
	(24) 56	70 / 6	203	.20	.92	81.48	71	70	50	252/257/25
4	(28) 60	75 / 5	191	.15	.69	84.14	70	70	51	253/256/26
	(32) 64	80 / 5	182	.15	.69	86.60	70	69	52	253/258/251
			208.1		.95		70.8	70.5		
TOTAL							AVG.	AVG.		
AVERAGE			204.6		.93		AVG. 71.7			

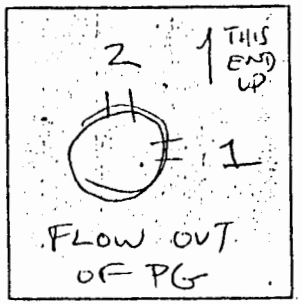
Clean Air Engineering, Inc.

10-1

PARTICULATE TESTING RAW DATA SET

Client Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet: ____
Operator: S. BALABUSZKO
Date: 9/7/86
Run No.: 1 CONDITION 4
Sample Box No.: ____
Meter Box No.: 66
Meter ΔH@: 1.807
K Factor: ____
Pitot Cp: .84 Pitot Leak Ck: ✓
Leak Rate Before: .015 CFM @ 17 Hg
Leak Rate After: .02 CFM @ 5 Hg
Static Press., In. H_2O (+/-): 0.4

Start Time: 13:50 AM/PM
Finish Time: 15:12 AM/PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21510
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.13
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 12.3
% CO_2: 5.9
H_2O, ml: 242.6
Silica Gel, gm: 11.6
Total V_{lc}: 254.2
Stack Area, Ft²: π/4 D = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 88.16 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b, °F
1-	15	5	217	.22	1.0	91.38	75	77	56	252/253/201
	20	5	220	.21	.97	94.52	77	78	51	251/247/249
2	125	4½	223	.20	.92	97.60	78	79	48	251/254/259
	130	4½	222	.20	.92	100.68	79	79	48	251/255/255
3	2025	3½	223	.15	.69	103.40	81	81	52	254/256/248
	2430	3½	215	.15	.69	106.10	82	82	53	249/258/261
4	2835	3	196	.12	.55	108.54	82	83	53	250/254/259
	3240	3½	185	.14	.64	111.17	83	83	53	250/253/241
				.0146						
			212.6		.80		~~89.6~~	~~90.3~~		
TOTAL							AVG.	AVG.		
AVERAGE	80		212	0.0190	0.82	46.68	AVG. 82			

Clean Air Engineering, Inc.

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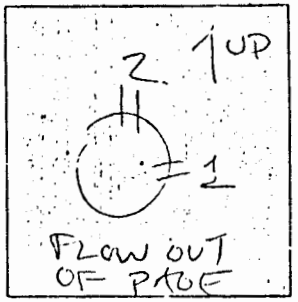
PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: LAF
Unit#: Inlet/Outlet
Operator: S-BAR / 03210
Date: 7/86
Run No: 1 CONDITION 4
Sample Box No.:
Meter Box No.: GG
Meter Box Y: 1.80
K Factor:
Pitot Coefficient: .84 Pitot Leak Ck ✓
Leak Rate Before: CFM @ Hg
Leak Rate After: CFM @ 17 Hg
Static Press., In. H_2O (+/−):

Start Time: AM / PM
Finish Time: 15:12 AM / PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s:
Thimble #:
Beaker #:

Ambient Temperature, °F:
Barometric Pressure, In. Hg:
Assumed Moisture, %:
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.:
Probe Heater Setting: 250°
% O_2:
% CO_2:
H_2O, ml:
Silica Gel, gm:
Total Vlc:
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

MIN/PT 5

TRAVERSE POINT NUMBER	SAMPLING TIME θ, min.	VACUUM In. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
2-1	(4) 36	45	5	219	.23	1.1	114.52	83	85	53	251/256/259
	(8) 40	50	5	222	.24	1.1	117.93	84	85	50	250/257/248
2	(12) 44	55	4 1/2	222	.19	.87	120.96	84	85	52	251/256/266
	(16) 48	60	4 1/2	222	.19	.87	123.98	84	85	53	252/255/241
3	(20) 52	65	4	217	.17	.78	126.85	86	86	54	249/258/255
	(24) 56	70	4	211	.17	.78	129.74	85	86	53	252/255/272
4	(28) 60	75	3	198	.13	.60	132.28	85	86	54	251/256/245
	(32) 64	80	3	192	.13	.60	134.84	85	86	55	250/257/29
				212.9		.84					
TOTAL					.4234			AVG. 84.5	AVG. 85.5		
AVERAGE				212.8	.4190	.82		AVG.			

87.5

Clean Air Engineering, Inc.

11-1

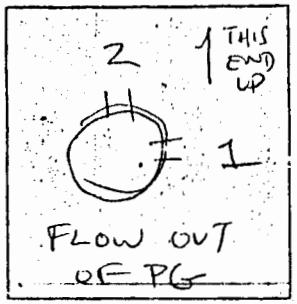
Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet ____
Operator: J. R/ [illegible]
Date: 9/7/86
Run No.: 2 CONDITION 4
Sample Box No.: ____
Meter Box No.: G-6
Meter DH@: 1.807
K Factor: 5.3
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 0.01 CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press.: In. H_2O (+) -1 0.4

15:57 Start Time AM PM

Finish Time 17:16 AM PM

Meter Yd 0.9999

PARTICULATE TESTING
RAW DATA SET



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21512
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.13
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: 270.9
Silica Gel, gm: 13.8
Total Vlc: 284.7
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

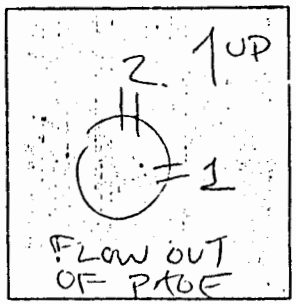
TRAVERSE POINT NUMBER	SAMPLING TIME θ, Min. (MIN/PT ____)	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	GAS SAMPLE VOLUME V_m, Ft³ (Initial Volume: 35.40)	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER: OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	4 5	8 1/2	222	.24	1.3	39.02	86	89	53	259/262/25
	8 10	8 1/2	223	.24	1.3	42.69	87	88	46	259/264/25
2	12 15	7 1/2	224	.21	1.1	46.06	87	88	46	258/259/25
	16 20	7 1/2	224	.21	1.1	49.43	87	89	48	256/259/25
3	20 25	6	214	.17	.90	52.47	86	88	48	256/259/26
	24 30	6	214	.17	.90	55.53	87	88	49	254/258/24
4	28 35	5	194	.15	.80	58.43	88	89	50	255/258/25
	32 40	5	186	.15	.80	61.31	89	90	51	254/258/25
			~~.0193~~							
			~~.0969~~	.0369						
					1.0		87.7	88.6		
TOTAL			212.6				AVG.	AVG.		
AVERAGE	80		211	.4405	1.04	52.01	AVG. 86			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF.
Unit#: ____ Inlet/Outlet: ____
Operator: J. KATSUSUKO
Date: 4/7/86
Run No.: 2 CONDITION 4
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ____
Pitot Cp: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM / PM
Finish Time: 17:20 AM / PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total Vlc: ____
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

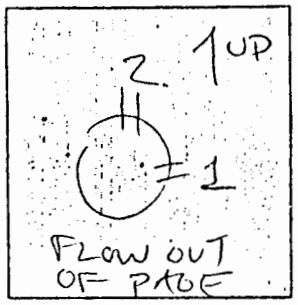
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	(4) 36	45	8	218	.24	1.3	64.86	88	89	51	255/256/24
	(8) 40	50	8	222	.25	1.3	68.50	88	89	49	253/260/258
2	(12) 44	55	8	217	.22	1.2	72.04	84	87	50	255/249/25
	(16) 48	60	8	220	.21	1.1	75.47	83	86	50	254/258/271
3	(20) 52	65	6½	212	.19	1.0	78.68	83	84	52	254/255/260
	(24) 56	70	6½	209	.18	.95	81.79	81	82	51	258/256/249
4	(28) 60	75	5½	191	.15	.78	84.60	79	81	51	255/259/251
	(32) 64	80		182	.15	.78	87.41	79	80	51	
				208.9	.1440			83.1	84.8		
TOTAL						1.1		AVG.	AVG.		
AVERAGE				210.7	.1405	1.1		AVG. 85.9			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF.
Unit#: ____ Inlet/Outlet
Operator: J. SARABUSZKO
Date: 9/7/86
Run No.: 3 CONDITION 4
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck ✓
Leak Rate Before: 2.0 CFM @ 6 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): 0.4

Start Time: 19:10 AM/PM
Finish Time: : AM/PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 2518
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.10
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 10.2
% CO_2: 8.0
H_2O, ml: 279
Silica Gel, gm: 18.4
Total V_{lc}: 297.4
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

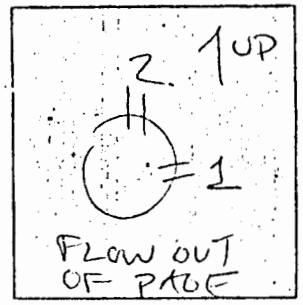
TRAVERSE POINT NUMBER	SAMPLING TIME θ, min. (MIN/PT ____)	VACUUM In. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	GAS SAMPLE VOLUME V_m, Ft³ (Initial Volume: 9.34)	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b, °F
2-1	(4) 36	5	5½	217	-24	1.2	12.90	73	73	59	257/268/281
	(8) 40	10	5½	218	-24	1.2	16.47	73	73	59	257/252/27[illegible]
2	(12) 44	15	5½	221	-21	1.1	19.81	74	73	59	256/254/27[illegible]
	(16) 48	20	5½	221	.21	1.1	23.04	73	72	58	256/261/2[illegible]
3	(20) 52	25	5	212	-19	.99	26.20	72	72	53	257/262/262
	(24) 56	30	5	210	.19	.99	29.42	72	71	53	257/265/26[illegible]
4	(28) 60	35	4	183	.15	.78	32.19	69	70	53	259/265/25[illegible]
	(32) 64	40	4	175	.15	.78	35.00	69	68	53	257/268/25[illegible]
TOTAL								AVG.	AVG.		
AVERAGE		80		202	.4428	1.02	51.31	AVG. 68			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAT.
Unit#: ____ Inlet/Outlet: ____
Operator: J. BAL SUSZKO
Date: 9/7/86
Run No.: 3 CONDITION 4
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/-): ____

Start Time: ____ : ____ AM / PM
Finish Time: 20:30 AM / PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 0
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ~~479~~ 279
Silica Gel, gm: ~~16~~
Total V_{lc}: ~~495~~
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
2-1	(4) 36	6	209	.24	1.2	38.47	66	66	53	257/266/256
	(8) 40	6	210	.24	1.2	41.90	66	66	53	256/267/251
2	(12) 44	6	210	.21	1.1	45.32	66	65	55	257/266/250
	(16) 48	6	207	.21	1.1	48.67	64	64	53	255/258/251
3	(20) 52	5	196	.19	.99	51.84	63	63	52	258/265/247
	(24) 56	5	~~193~~ 195	.19	.99	54.98	63	63	53	" " "
4	(28) 60	5	~~181~~ 173	.15	.78	57.82	64	63	53	255/262/251
	(32) 64	5	169	.15	.78	60.65	64	63	53	254/261/25[illegible]
TOTAL							AVG.	AVG.		
AVERAGE							AVG.			

48.67

Clean Air Engineering, Inc.

APPENDIX D. STACK GAS SAMPLING DATA

4) EPA METHOD-5 PARTICULATE DATA SHEETS

BALANCE _____

OPERATOR J. BALABUS ZICO

DATE 9/4/86

SHEET # 1 OF 1

CLIENT LOS ALAMOS N-C

PLANT WASTE MANAGEM

UNIT INCINERATOR

** 68-2562 * RUN # _____

WEIGHT SHEET * MORE ADDED

RUN #	WT. #	FILTER # OR IDENTIFICATION	TFB	WASH ML	WASH CORR.	GROSS	TARE	
	1	BLANK	B		- - - -			
LANL-1-M5-1	2	1	B	100'	*	66.0268 66.0277	66.0088 66.0097 66.0091 *	.01
LANL-1-M5-2	3	2	B	~~160~~ 170 FINAL VOL.	*	68.9425 68.9431	68.9265 68.9274 68.9268 *	.01
LANL-1-M5-3	4	3	B	~~160~~ 170 FINAL VOL.	*	68.6394 68.6401	68.6203 68.6210 68.6204 *	.01
NL-2-M5-1	5	4	B	140	*	68.4429 68.4436	68.4205 68.4211 68.4208 *	.02
LANL-2-M5-2	6	5	B	147	*	66.1594 66.1581 66.1587	66.1385 66.1395 66.1389 *	.01
LANL-2-M5-3	7	6	B	140	*	64.0790 64.0777 64.0782	64.0548 64.0559 64.0557 *	.02
LANL-3-M5-1	8	7	B	150	*	67.3312 67.3314	67.3049 67.3044 *	.02
LANL-3-M5-2	9	8	B	150	*	66.1345 66.1344	66.0985 66.0979 *	.03
LANL-3-M5-3	10	9	B	140	** *~~68.2562~~ *	68.2556 68.2576 68.2554	68.2117 68.2116 *	.04 44
LANL-4-M5-1	11	10	B	170		67.0595 67.0599	67.0451 67.0461 67.0461	

BALANCE _____

OPERATOR J BMARUSZKO

DATE 9-4-86

SHEET # 1 OF 3

CLIENT LOS ALAMOS N.L.

PLANT WASTE MANAGEMEN

UNIT INCINERATOR

RUN # _____

WEIGHT SHEET

RUN #	WT. #	FILTER # OR IDENTIFICATION	TFB	WASH ML	WASH CORR.	GROSS	TARE	
	1	BLANK	B		- - - -			
	2	21548	F					
	3	21549	F					
	4	21550 /B	F					
	5	21551	F					
	6	21552	F					
	7	21553	F					
	8	21554	F					
	9	21555	F					
LANL-3-MS-3	10	21556	F			3.9628 ★ 3.9628	3.9619 3.9620 ★	.00
LANL 3-MS-1	11	21557	F			3.9448 ★ 3.9449	3.9441 3.9441 ★	.00

BALANCE _____ CLIENT _____

OPERATOR J. BALABUSZKO PLANT _____

DATE 9-4-86 UNIT _____

SHEET # 2 OF 3 RUN # _____

WEIGHT SHEET

RUN #	WT. #	FILTER # OR IDENTIFICATION	TFB	WASH ML	WASH CORR.	GROSS	TARE	
	1	BLANK	B		- - - -			
LANL 2-M5-2 (5)	2	21507	F			3.7718	3.7732	
					*	3.7718	3.7732 *	-.00
BLANK	3	21508	F				3.7809	
							3.7807	
~~LANL 2-2~~ LANL 2-M5-3 (6)	4	21509	F			3.8012	3.8002	
						~~3.8013~~	3.8003 *	.00
					*	3.8015 JB		
LANL-4-M5-1	5	21510	F			3.8136	3.8130	
						3.8133	3.8131	
2 ✓ LANL-1-M5-2-F	6	21511	F			3.8234	3.8260	
					*	3.8233	3.8261 *	-.00
LANL-4-M5-2	7	21512	F			3.8195	3.8183	
						3.8195	3.8184	
3 ✓ LANL-1-M5-3-E	8	21513	F			3.8285	3.8282	
						~~3.8270~~	3.8281 *	.00
					*	3.8282		
LANL 3-M5-2	9	21514	F			3.8321	3.8299	
					*	3.8320	3.8299 *	.00
BLANK	10	21515	F			3.9226	3.9222	
							3.9223	
	11	21516	F				3.8482	
							3.8484	

BALANCE _____ CLIENT _____

OPERATOR J BALABUSZKO PLANT _____

DATE 9-4-86 UNIT _____

SHEET # 3 OF 3 RUN # _____

WEIGHT SHEET

RUN #	WT. #	FILTER # OR IDENTIFICATION	TFB	WASH ML	WASH CORR.	GROSS	TARE	
	1	BLANK	B		- - - - JS			
LANL-MS-1 (14)	2	21517	F		3.8792	~~3.8792~~	3.8808	
						* 3.8792 JS	3.8809 *	-.00
LANL-4-MS-3	3	21518	F			3.8817	3.8714	
						3.8817	3.8715	
	4	21519	F					
#1 ✓ LANL-1-MS-1-F	5	21520	F			3.8833	3.8842	
					*	3.8832	3.8843 *	-.0
LANL-4-MS-3	6	M	B	175		106.3859	106.3485	
						106.3878	106.3481	
						106.3878		
	7	11	B				2.9119	
	8	12	B				2.9157	
LANL-4-MS-2	9	11	B	160		65.3715	65.3460	
						65.3717	65.3472	
							65.3469	
blank	10	12	B	100 (.000047/ml)		67.5662	67.5617	
					*	67.5669	67.5626 *	.00
							67.5622 *	
2nd Acetone blank ~~LANL 4-MS~~	3 11	AA	B	100		107.5203	107.5201	
						107.5205	107.5210	

APPENDIX D. STACK GAS SAMPLING DATA

5) EPA METHOD-5 IMPINGER SOLUTION VOLUMES

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	# ml. sample	SAMPLE RECOVERY BY
~~Impinger Solution Blank - Conditions 1,2~~				
Impinger Solution Blank - Conditions 3,4,1,2	LANL-1,2,3,4-MS-1,2,3-IMP.B	9/6/85	543 ml	d.t CAE
*Impinger Solution-Condition 1 Run 1	LANL-1-MS-1-IMP	9/4/85	542 ml.	d.t CAE
I.S. Condition 1 Run 2	LANL-1-MS-2-IMP.	9/4/85	684 ml.	
I.S. " 1 " 3	LANL-1-MS-3-IMP.	9/4/85	648 ml.	
I.S. " 2 " 1	LANL-2-MS-1-IMP.	9/5/85	557 ml	
I.S. " 2 " 2	LANL-2-MS-2-IMP.	9/5/85	540 ml.	
I.S. " 2 " 3	LANL-2-MS-3-IMP.	9/5/85	533 ml.	
I.S. " 3 " 1	LANL-3-MS-1-IMP.	9/6/85	640 ml	
I.S. " 3 " 2	LANL-3-MS-2-IMP.	9/6/85	680 ml	
I.S. " 3 " 3	LANL-3-MS-3-IMP.	9/6/85	533 ml.	
I.S. " 4 " 1	LANL-4-MS-1-IMP.	9/7/85	466 ml	
I.S. " 4 " 2	LANL-4-MS-2-IMP.	9/7/85	529 ml.	
I.S. " 4 " 3	LANL-4-MS-3-IMP.	9/7/85	505 ml	

ANALYSIS REQUIRED: Cl^- NOTE: SAMPLES WERE COLLECTED IN 0.1N NaOH

*I.S. ≡ Impinger Solution CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

APPENDIX D. STACK GAS SAMPLING DATA

6) VOST FIELD DATA SHEETS

METER BOX FULL TEST CALIBRATION

DATE: 9-2-86 METER BOX Yd: 1.0032 METER BOX: V1

OPERATOR: C. Fox METER BOX ΔH@: — BAROMETRIC PRESSURE (Pb): 29.34

Q	ΔH	ΔP	Yds	Standard Meter Gas Volume (ft³) Initial	Final	(Vds) Net	Meter Box Gas Volume (ft³) Meter Index in L/rev. Initial	Final	(Vd) Net	Standard Meter Temperature In	Out	Tds/Avg	Meter Box Temperature In	Out	Td/Avg	Time (Min.) θ	Yd	ΔH@
.0358	.5	.1	1.0000	0.000	.500	.500			.5061	72	72	72	83.3	80.6	82.0	13.59	1.0050	—
.0356	.5	.1	1.0000	0.000	1.000	1.000			1.0211	72.5	72.5	72.5	88.7	83.3	86.0	27.29	1.0027	—
.0355	.5	.1	1.0000	0.000	.500	.500			.5124	73	73	73	90.5	86	88.0	13.69	1.0018	—

Q - Flow Rate (cfm)
ΔH - Orifice Pressure Differential (in. H O)
ΔP - Inlet Pressure Differential Standard Meter (in. H O)
Yds - Standard Meter Correction Factor (Unitless)
Yd - Meter Box Correction Factor (Unitless)
ΔH@ - Orifice Pressure Differential that gives 0.75 cfm of air at 70°F and 29.92" Hg (in. H O)

$$Yd = (Yds)\left(\frac{Vds}{Vd}\right)\left(\frac{Td + 460}{Tds + 460}\right)\left(\frac{Pb + \Delta P}{Pb + \Delta H}\ \frac{13.6}{/13.6}\right)$$

$$\Delta H@ = \frac{0.0317\ \Delta H}{Pb\ (T + 460)}\left[\frac{(Tds + 460)\ \theta}{Vds.\ Yds}\right]^2$$

$$Q = \frac{17.64 \cdot Vds \cdot Pb}{(Tds + 460)\ \theta}$$

VOST FIELD DATA SHEET
DATA SET # 1

PLANT LANL
LOCATION CA1
OPERATOR Kaufmann
DATE 9/4/86
RUN # 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE < 0.1" Hg/min @ 16"
LEAK CHECK AFTER < 0.1" Hg/min @ 17.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CA1 outlet stack
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~V-1~~ 4
METER BOX NO. V1
Yd 1.0032
Bp 23.17

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 170.00	ΔH	COMMENTS:	Vac
5	~1	70	138	12	12	20	33	32	175.2	1.0	Start Time	5
10	~1	70	133	12	12	23	33	31	180.2	1.0	1315	6
15	~1	75	132	12	12	23	32	31	185.35	1.0		7
20		75	132	13	13	23	32	32	~~19 190.91~~ *	1.0		7
									190.91			
Avg/total							32		20.91	1.0		

CONDENSATE SAMPLES: ~~NA~~ LANL-1-V-1

SAMPLE I.D.: _____ COMMENTS: _____

condition 1

Frosted glass outlet of trap

VOST FIELD DATA SHEET
DATA SET # 2

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 2
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE < 0.1" Hg/min @ 17.5"
LEAK CHECK AFTER < 0.1 Hg/min @ 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~V-1~~ 4
METER BOX NO. U 1
Yd 1.0032
Bp 23.17

Diagram of sample location

Start Time 1401

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 19 ~~20~~9.01	ΔH	COMMENTS: Vac "Hg	
5	~1	75	133	16	12	20	32	30	204.6	1.0	6	
10	~1	75	135	14	11	21	32	31	210.1	1.0	5	
15	~1	75	132	14	11	21	32	31	215.2	1.0	5	
20	~1	75	130	14	12	20	32	31	220.72	1.0	6	
Avg/Total								31	21.71	1.0		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

Condition 1

VOST FIELD DATA SHEET
DATA SET # 3

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 19"
LEAK CHECK AFTER <0.1" Hg/min. @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET 14
METER BOX NO. V1
Yd 1.0032
Bp 23.17

Diagram of sample location

Start Time 1443

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 223.01	ΔH	COMMENTS: Vac
5	~1	65	128	17	13	20	31	29	227.8	1.0	13
10	~1	70	135	15	12	21	31	29	232.6	1.0	14
15	~1	65	138	16	13	21	31	30	237.2	1.0	14
20	~1	65	142	18	14	23	31	31	241.92	1.0	14
Avg/Total								30		1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

Condition 1

High vaccuum during sampling - one of the trapps packed tightly

Final leak check was conducted at the maximum vaccuum the pump could pull

VOST FIELD DATA SHEET
DATA SET # 4

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE < 0.1" Hg/Min @ 19"
LEAK CHECK AFTER < .01/Min @ 19"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~V~~ 4
METER BOX NO. V
Yd 1.0032
Bp 23.17

Diagram of sample location Start Time 1525

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 245.24	ΔH	COMMENTS: Vac
5	~1	75	138	22	21	27	37	38	250.6	1.0	7
10	~1	75	137	21	19	27	38	39	—	1.0	8
15	~1	73	130	20	18	25	39	40	261.1	1.0	8
20	~1	70	137	20	19	27	40	41	266.06	1.0	8
Avg/total								39	20.82	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

condition 1

VOST FIELD DATA SHEET
DATA SET # 5

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 5
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 19"
LEAK CHECK AFTER <0.1" Hg/min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~VA~~ 4
METER BOX NO. VI
Yd 1.0032
Bp ~~23.47~~ 23.08

Diagram of sample location Start Time 1854

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 270.52 ~~270.14~~	ΔH	COMMENTS: VOC
5	~1	75	127	16	18	21	31	30	275.9	~~1.0~~ 1.2	10
10	~1	75	128	15	17	20	31	31	281.0	~~1.0~~ 1.2	10
15	~1	75	132	15	13	20	30	30	286.2	~~1.0~~ 1.2	10
20	~1	70	136	14	12	20	31	29	292.00	~~1.0~~ 1.2	11
Avg/Total								30	21.48	1.2 ~~1.0~~	

CONDENSATE SAMPLES:

SAMPLE I.D.: condition 1

COMMENTS: stop after 20.7 min.

VOST FIELD DATA SHEET
DATA SET # 6

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 19"
LEAK CHECK AFTER <0.1" Hg/min @ 19.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~V-14~~
METER BOX NO. V1
Yd 1.0032
Bp 23.08

Diagram of sample location

Start Time 1938

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 294.32	AH	COMMENTS: VAC
5	~1	75	133	15	13	19	29	27	299.8	1.2	7
10	~1	75	141	13	13	19	28	27	304.95	1.2	8
15	~1	75	140	10	13	19	28	27	—	1.2	9
20	~1	75	133	11	13	19	28	27	315.68	1.2	9
								27.5	21.36	1.2	

CONDENSATE SAMPLES:

SAMPLE I.D.: condition 1

COMMENTS:

VOST FIELD DATA SHEET
DATA SET # 7

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21"
LEAK CHECK AFTER <0.1" Hg/min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3.5
METER BOX NO. V 1
Yd 1.0032
Bp 23.05

condition 2

Diagram of sample location

Start Time 0958

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: ~~[illegible]~~ 0.00	ΔH	COMMENTS: Vac	
5	~1	75	129	11	14	17	19	21	5.42	1.03	10	
10	~1	75	133	9	11	17	20	21	10.60	1.03	10	
15	~1	73	141	9	11	18	21	22	15.60	1.03	10	
20	~1	70	136	10	11	18	21	22	20.62	1.03	10	
Avg/Total								21	20.62	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-1

Frosted area of trap is the gas outlet side

VOST FIELD DATA SHEET
DATA SET # 8

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 2
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21"
LEAK CHECK AFTER <0.1" Hg/min @ 20"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET
METER BOX NO. V1
Yd 1.0032
Bp 23.05

condition 2

Diagram of sample location

Start Time 1044

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 21.49	ΔH	COMMENTS: Vac	
5	~1	75	137	9	13	19	24	24	26.81	1.03	8	
10	~1	75	139	9	12	19	25	24	32.15	1.03	8	
15	~1	75	139	9	12	20	24	25	37.68	1.03	9	
20	~1	75	140	8	12	19	25	25	43.17	1.03	9	
Avg/Total								24.5	21.68	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-2

VOST FIELD DATA SHEET
DATA SET # 9

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 20.5"
LEAK CHECK AFTER <0.1" Hg/min @ 19"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~1~~ 3
METER BOX NO. VI
Yd 1.0032
Bp 23.05

condition 2

Diagram of sample location

Start Time 1216

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 43.78	ΔH	COMMENTS: Vac
5	~1	75	138	9	12	20	37	38	49.50	1.03	7
10	~1	70	138	8	11	21	38	38	54.68	1.03	7
15	~1	75	147	9	10	20	38	37	60.15	1.03	8
20	~1	75	144	8	10	20	40	39	65.60	1.03	8
Avg/Total								38	21.82	1.03	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-3

VOST FIELD DATA SHEET
DATA SET # 10

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # ~~3~~ 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1 "Hg/Min @ 21"
LEAK CHECK AFTER <0.1 "Hg/Min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3.5
METER BOX NO. V I
Yd 1.0032
Bp 23.05

condition 2

Diagram of sample location

Start Time 1302

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 66.30	ΔH	Vac	COMMENTS:
5	~1	70	143	13	15	24	38	36	71.51	1.03	10	
10	~1	75	146	10	12	20	37	34	76.95	1.03	11	
15	~1	75	146	10	14	22	37	35	82.30	1.03	11	
20	~1	75	145	10	12	21	35	33	87.47	1.03	11	
Avg/Total								36	21.17	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-4

VOST FIELD DATA SHEET
DATA SET # 11

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 5
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21"
LEAK CHECK AFTER <0.1" Hg/min @ 18"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~1.1~~ 2.5
METER BOX NO. V 1
Yd 1.0032
Bp 23.05

condition 2

Diagram of sample location

Start Time 1448

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 87.98	ΔH	COMMENTS: Vac
5	~1	75	149	12	12	21	38	37	93.50	1.03	7
10	~1	75	141	12	13	22	39	38	98.75	1.03	7
15	~1	75	139	12	15	24	40	41	104.22	1.03	7
20	~1	75	139	14	15	25	41	43	109.96	1.03	8
Avg/Total								40	21.98	1.03	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-5

VOST FIELD DATA SHEET
DATA SET # 12

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21"
LEAK CHECK AFTER <0.1" Hg/min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET
METER BOX NO. V1
Yd 1.0032
Bp

condition 2

Diagram of sample location

Start Time 1527

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 110.67	ΔH	Vac	COMMENTS:
5	~1	75	136	15	16	26	46	49	116.00	1.03	6	
10	~1	70	133	13	13	24	47	48	120.90	1.03	7	
15	~1	70	130	11	13	25	48	48	125.82	1.03	8	
20	~1	65	137	13	14	25	49	48	130.59	1.03	8	
Avg/Total							48		19.92	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-6

VOST FIELD DATA SHEET
DATA SET # 13

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/MM @ 21"
LEAK CHECK AFTER <0.1" Hg/Min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~1.7~~ 3.5
METER BOX NO. V1
Yd 1.0032
Bp 23.15

condition 3

Diagram of sample location

Start Time 1036

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 0.00	ΔH	COMMENTS: Vac	
5	~1	75	130	15	13	18	24	25	5.00	1.03	9	
10	~1	75	132	13	12	18	24	25	10.00	1.03	10	
15	~1	70	133	12	11	18	24	26	15.07	1.03	11	
20	~1	70	132	14	12	19	25	26	20.14	1.03	11	
Avg/Total								25	20.14	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-3-V-1

VOST FIELD DATA SHEET
DATA SET # 14

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 2
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 18"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3
METER BOX NO. V1
Yd 1.0032
Bp 23.15

condition 3

Diagram of sample location

Start Time 1117

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 20.95	ΔH	Vac	COMMENTS:
5	~1	75	138	14	13	26	29	31	26.23	1.03	5	
10	~1	75	138	12	13	21	31	32	31.48	1.03	6	
15	~1	75	138	10	12	20	32	35	36.65	1.03	6	
20	~1	70	137	12	13	20	34	38	41.82	1.03	7	
Avg/Total								33	20.87	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-3-V-2

VOST FIELD DATA SHEET
DATA SET # 15

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~143~~
METER BOX NO. V I
Yd 1.0032
Bp 23.05

condition 3

Diagram of sample location

Start Time 1709

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 45.71	ΔH	COMMENTS: Vac	
5	~1	75	124	20	20	23	32	32	—	1.02	11	
10	~1	75	131	20	20	25	33	33	56.12	1.02	11	
15	~1	70	131	20	19	25	33	33	61.19	1.02	12	
20	~1	70	129	19	20	24	34	33	66.42	1.02	12	
Avg/Total								33	20.71	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.:

COMMENTS: Traps loaded in train ~5 hrs. before sampling

LANL-3-V-3

VOST FIELD DATA SHEET
DATA SET # 16

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21"
LEAK CHECK AFTER <0.1" Hg/Min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~154~~
METER BOX NO. V1
Yd 1.0032
Bp 23.05

condition 4

Diagram of sample location

Start Time 1756

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 66.83	ΔH	Vac	COMMENTS:
5	~1	.75	128	20	20	23	34	32	72.03	1.02	9	
10	~1	70	128	18	18	23	34	32	77.10	1.02	12	
15	~1	70	132	18	18	[illegible]	[illegible]	[illegible]	82.20	1.02	12	
20	~1	70	133	18	17	22	33	[illegible]	87.20	1.02		
Avg/Total								33	20.37	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-3-V-4

VOST FIELD DATA SHEET
DATA SET # 17

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 5
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/Min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~V-23~~
METER BOX NO. V 1
Yd 1.0032
Bp 23.05

condition 3

Diagram of sample location

Start Time 1924

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 87.75	ΔH	Vac	COMMENTS:
5	~1	75	132	14	13	18	26	25	93.32	1.02	14	
10	~1	75	134	15	14	18	25	25	98.81	1.02	13	
15	~1	75	131	15	14	18	25	25	104.30	1.02	13	
20	~1	75	133	14	13	18	25	24	109.74	1.02	13	
Avg/Total								25	21.99	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-3-V-5

VOST FIELD DATA SHEET
DATA SET # 18

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/M @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~143~~
METER BOX NO. V I
Yd 1.0032
Bp 23.05

condition 3

Diagram of sample location

Start Time 1957

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 10.42	ΔH	Vac	COMMENTS:
5	~1	75	127	15	14	17	25	23	15.73	1.03	7	
10	~1	70	131	15	13	18	25	24	20.97	1.03	9	
15	~1	75	133	15	13	18	25	24	26.20	1.03	10	
20	~1	70	135	14	14	18	25	24	31.46	1.03	10	
Avg/Total								24	21.04	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-3-V-6

VOST FIELD DATA SHEET
DATA SET # 19

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET 235
METER BOX NO. V I
Yd 1.0032
Bp 23.13

condition 4

Diagram of sample location

Start Time 1349

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 33.02	ΔH	Vac	COMMENTS:
5	~1	75	126	13	16	18	23	24	38.54	1.02	11	
10	~1	75	130	12	15	19	24	25	43.80	1.02	11	
15	~1	75	132	12	~~12~~ 15	20	25	27	49.00	1.02	11	
20	~1	70	131	~~14~~ 12	~~11~~ ~~20~~	~~20~~ ~~26~~	~~28~~ 26	28	53.98	1.02	11	
Avg/Total								25	20.96	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-1

VOST FIELD DATA SHEET
DATA SET # 20

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/2/86
RUN # 2
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA 3.5
PROBE HEATER SET ~~V1~~
METER BOX NO. V 1
Yd 1.0032
Bp 23.13

condition 4

Diagram of sample location

Start Time 1430

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 54.66	ΔH	Vac	COMMENTS:
5	~1	75	133	11	14	19	31	32	59.75	1.02	5	
10	~1	75	133	10	13	19	31	32	64.86	1.02	6	
15	~1	70	131	9	11	19	31	32	70.08	1.02	6	
20	~1	75	130	9	11	19	32	32	75.42	1.02	6	
Avg/Total								32	20.76	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-2

VOST FIELD DATA SHEET
DATA SET # 21

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 35
METER BOX NO. V 1
Yd 1.0032
Bp 22.13

condition 4

Diagram of sample location

Start Time 1558

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 75.96	ΔH	Vac	COMMENTS:
5	~1	70	134	11	12	20	33	33	~~80.00~~ 81.00	1.02	6	
10	~1	70	133	13	13	20	34	34	~~84.95~~ 85.95	1.02	6	
15	~1	70	141	10	11	18	34	34	91.03	1.02	6	
20	~1	70	140	10	11	19	34	34	96.11	1.02	6	
Avg/Total								34	20.15	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-3

VOST FIELD DATA SHEET
DATA SET # 22

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3.0
METER BOX NO. V I
Yd 1.0032
Bp 23.13

condition 4

Diagram of sample location

Start Time 1638

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 96.74	ΔH	COMMENTS: Vac
5	~1	65	125	12	13	19	34	33	101.45	1.0	17
10	~1	65	129	11	12	18	33	32	106.00	1.0	17
15	~1	63	131	11	12	18	33	31	110.22	1.0	17
20	~1	55	134	12	11	18	32	31	114.45	1.0	17
Avg/Total								32	17.71	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-4

VOST FIELD DATA SHEET
DATA SET # 23

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 5
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/Min @ 18"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI outlet
PROBE NO. VOST
VOST NO.
FILTER I.D. N/
PROBE HEATER SET
METER BOX NO. V1
Yd 1.0032
Bp 23.5

condition 4

Diagram of sample location

Start Time 1809

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 15.12	ΔH	COMMENTS: /ac
5	~1	75	136	11	13	19	24	23	20.35	1.02	7
10	~1	75	137	10	11	19	24	23	—	1.02	6
15	~1	75	137	10	13	18	24	23	21.40	1.02	6
20	~1	75	131	11	11	19	25	24	36.56	1.02	6
Avg/Total								24	21.44	1.02	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-5

VOST FIELD DATA SHEET
DATA SET # 24

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21"
LEAK CHECK AFTER <0.1" Hg/min @ 20"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~NA~~
METER BOX NO. V I
Yd 1.0032
Bp 22.10

condition 4

Diagram of sample location

Start Time 1846

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 37.01	ΔH	COMMENTS: Vac
5	~1	70	129	11	11	18	25	25	—	1.02	6
10	~1	70	134	10	11	17	25	25	47.20	1.02	8
15	~1	70	134	11	11	18	26	25	52.42	1.02	8
20	~1	70	128	10	11	18	26	26	~~57.~~	1.02	8
									57.57		
Avg/Total								25	20.36	1.02	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-6

VOST FIELD DATA SHEET
DATA SET # 25

PLANT LANL
LOCATION CAT
OPERATOR Kaufmann
DATE 9/7/86
RUN # Audit 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 15"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VT
Yd 1.0032
Bp 23.05

Tank # AAL 12421
start time 2025

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE NA	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 61.85	ΔH	COMMENTS: Vac.
5	~.5	35		12	13	18	26	26	64.38	1.0	2
10	~.5	35		12	12	19	27	26	66.82	1.0	2
15	~.5	35		11	10	19	27	27	69.28	1.0	2
20	~.5	35		11	11	18	28	27	71.78	1.0	2
								27	9.93	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-(1-4)-V-1 - Audit

VOST FIELD DATA SHEET
DATA SET # 26

PLANT LANL
LOCATION CAT
OPERATOR Kaufmann
DATE 9/7/86
RUN # Audit 2
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 15"
LEAK CHECK AFTER <0.1" Hg/min @ 15"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VI
Yd 1.0032
Bp 23.05

Tank # AAL 12421
start time 2100

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE NA	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 72.35	ΔH	COMMENTS: Vac.
5	~.5	37		12	12	18	29	29	75.24	1.0	2
10	~.5	37		10	12	18	29	28	78.00	1.0	2
15	~.5	37		10	11	18	30	29	~~80.79~~ *	1.0	2
20	~.5	37		10	11	18	30	29	~~83.14~~	1.0	2
									83.14		
								29	11.39	1.0	

CONDENSATE SAMPLES:

* 80.96

SAMPLE I.D.: COMMENTS:

LANL-(1-4)-V-2-Audit

VOST FIELD DATA SHEET
DATA SET # 27

PLANT LANL
LOCATION CAT
OPERATOR Kaufmann
DATE 9/6/86
RUN # Audit 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/MIN 615"
LEAK CHECK AFTER <0.1" Hg/MIN 615"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VT
Yd 1.0032
Bp 23.05

Tank # AAL 12421
Diagram of sample location
Start time 2132

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 85.10	AH	COMMENTS: Vac.
			NA								
5	~.5	36		12	10	19	31	30	87.90	1.0	2
10	~.5	36		10	10	18	31	30	90.57	1.0	2
15	~.5	36		11	11	18	32	30	93.35	1.0	2
20	~.5	36		10	10	19	32	30	96.01	1.0	2
								31	10.91	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: COMMENTS:

LANL-(1-4)-V-3-Audit

VOST FIELD DATA SHEET
DATA SET # 28

PLANT LANL
LOCATION CAT
OPERATOR Kaufmann
DATE 9/8/86
RUN # Audit 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 17"
LEAK CHECK AFTER <0.1" Hg/min @ 15"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VT
Yd 1.0032
Bp 23.13

Tank # AAL 11924
start time 0872

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE NA	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 96.66	ΔH	COMMENTS: Vac.
5	~.5	35		14	15	18	21	22	99.25	1.0	2
10	~.5	35		13	13	17	21	22	102.82	1.0	2
15	~.5	35		13	14	17	22	22	104.37	1.0	2
20	~.5	35		14	14	18	22	23	106.78	1.0	2
								22	10.12	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: COMMENTS:

LANL-(1-4)-V-4 - Audit

VOST FIELD DATA SHEET
DATA SET # 29

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/2/86
RUN # Audit 5
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg / max 6.2/7"
LEAK CHECK AFTER <0.1" Hg / max 6 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VI
Yd 1.0032
Bp 23.13

Tank # AAL 11924
Diagram of sample location
start time 0920

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE NA	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 7.48	ΔH	COMMENTS: Vac.
5	~.5	35		13	13	17	25	24	—	1.0	2
10	~.5	35		11	11	17	25	25	12.51	1.0	2
15	~.5	35		~~16~~ 12	~~15~~ 12	16	27	26	15.12	1.0	2
20	~.5	35		13	13	17	25	26	17.76	1.0	2
								25	10.28	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-(1-4)-V-5-Audit

VOST FIELD DATA SHEET
DATA SET # 30

PLANT LANL
LOCATION CAT
OPERATOR Kaufmann
DATE 9/8/86
RUN # Audit 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 17"
LEAK CHECK AFTER <0.1" Hg/min @ 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VI
Yd 1.0032
Bp 28.13

Tank # AAL 11924
start time 0950

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE NA	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 18.59	ΔH	COMMENTS: Vac.
5	~.5	35		10	11	17	27	27	21.20	1.0	2
10	~.5	35		11	10	17	28	27	24.88	1.0	2
15	~.5	35		11	9	17	28	27	26.48	1.0	2
20	~.5	35		11	11	17	28	27	29.19	1.0	2
								27	10.60	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-(1-4)-V-6-Audit

APPENDIX E. SAMPLE CALCULATIONS

1) EQUATIONS FOR EPA METHOD-5 & VOST CALCULATIONS

LOCATION OF DATA FOR EPA METHOD-5 & VOST DRE CALCULATIONS

1. VOLUME OF WATER COLLECTED

Eqn: **Vwstd= (0.471 ft3/ml)*Vlc** , wscf

Vlc: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS

2. VOLUME OF GAS METERED, STANDARD CONDITIONS

Eqn: $\mathbf{Vmstd} = \frac{(17.64\ ^{o}R/in\ Hg)*Vm*Yd*(Pb+DH/13.6)}{(Tm+460)}$, dscf

Vm: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS
Yd: EPA M-5 FIELD DATA, CALIBRATION DATA, RAW DATA SETS
Pb: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS
DH: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS
Tm: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS

3. MOISTURE CONTENT

Eqn: $\mathbf{Bwo} = \frac{Vwstd}{(Vmstd+Vwstd)}$, %

4. MOLECULAR WEIGHT OF DRY GAS STREAM

Eqn: $\mathbf{Md} = .44(\%CO_2)+.32(\%O_2)+.28(\%N_2+\%CO)$

$\%CO_2$: ORSAT READINGS, RAW DATA SETS
$\%O_2$: ORSAT READINGS, RAW DATA SETS
$\%N_2+\%CO := [100-(\%CO_2+\%O_2)]$

5. MOLECULAR WEIGHT OF STACK GAS

Eqn: **Ms=Md(1-Bwo)+18(Bwo)**

6. VELOCITY OF STACK GAS

Eqn: $\mathbf{Vs} = Kp*Cp*(DP)^{1/2}*\frac{(Ts+460)^{1/2}}{(Ms*Ps)^{1/2}}$, ft/sec

Kp: $=85.49\ [ft/sec*\frac{(in\ Hg*lbm/lb\ mole)}{[(in\ Hg*^{o}R)]}]$

Cp: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS
$(DP)^{1/2}$: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS
Ts: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS
Ps: $= [Pb+\frac{DH}{[(13.6\ in\ H_2O/in\ Hg)]}]$

7. TOTAL VOLUMETRIC FLOW OF STACK GAS

Eqn: $Qa = Vs*As*(60\ sec/min)$, acfm

$$Qstd = Qa*Ps*(1-Bwo)*\frac{(17.64\ ^{o}R/in\ Hg)}{(Ts+460)}\ ,\ dscfm$$

As: $=0.7773\ ft^2$ $[(3.14159)*\frac{D^2}{4}$, where D=11.938" (12" Schd. 40)

8. DENSITY OF STACK GAS

Eqn: $$d=\frac{Ps*Ms*(14.696\ psi)}{(Ts+460)*(29.921\ in\ Hg)} * \frac{[\ (lbmole*^{o}R)\ ]}{[10.73\ psi*ft^3]}\ ,\ lbm/ft^3$$

9. MASS FLOW RATE OF STACK GAS

Eqn: $Qm=d*Qa*(60\ min/hr)$, lbm/hr

10. EXCESS COMBUSTION AIR IN STACK GAS

Eqn: $$EA=100*\frac{\%\ O_2}{(0.264*\%N_2 - \%O_2)}\ ,\ \%$$

11. PERCENT ISOKINETIC

Eqn: $$I=K_4*\frac{Vmstd*(Ts+460)}{Ps*Vs*An*THETA*(1-Bwo)}\ ,\ \%$$

An: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS
THETA: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS
K_4: $(0.09450)\ \frac{[in\ Hg*min]}{[^{o}R*sec]}$

12. PARTICULATE CONCENTRATION

Eqn: $$gr/dscf=\frac{Mn}{Vmstd} * (15.43\ gr/gm)$$

$$gr/dscf\ (7\%\ O_2)= (gr/dscf)*\frac{14}{(21 - \%O_2)}$$

$$lbm/hr= (gr/dscf)*\frac{Qstd*(60\ min/hr)}{(7000\ gr/lbm)}$$

Mn: EPA M-5 WEIGHT SHEETS (= Blank + Field weight)

13. CHLORIDE EMISSIONS (as HCl)

Eqn: $$lb/dscf=\frac{(mg/l)*Vsoln*(36.45/35.45)}{(453{,}590\ mg/lbm)*Vmstd} * \frac{[\ liter\ ]}{[1000\ ml]}$$

$$ppmv=(lbm/dscf)*\frac{385.3\ ft^3}{lbmole}*\frac{lbmole}{36.45\ lbm}*(10^6)$$

$$lbm/hr = (lbm/dscf) * Qstd * (60\ min/hr)$$

mg/l: EPA M-5-IMP DATA FROM ANALYTICAL REPORTS
Vsoln: EPA M-5-IMP DATA FROM CHAIN OF CUSTODY FORMS

14. CHLORIDE ENTERING INCINERATOR (as HCl)

Eqn: **From** $CCl_4 = (\text{Feed rate}) * (\text{Weight } \%) * 0.9219 \ \frac{[lbm\ Cl^-]}{[lbm\ CCl_4]}$

From $TCE = (\text{Feed rate}) * (\text{Weight } \%) * 0.8095 \ \frac{[lbm\ Cl^-]}{[lbm\ TCE]}$

$$\text{Total } Cl^- = Cl_{CCL4} + Cl_{Tce}$$

$$\text{As } HCl = (\text{Total } Cl^-) * (36.45/35.45)$$

Feed rate: LIQUID & SOLID FEED RATE DATA
Weight %: LIQUID & SOLID FEED PREPARATION DATA

15. CHLORIDE REMOVAL EFFICIENCY

Eqn: $\% \text{ Efficiency} = \frac{\text{inlet} - \text{outlet}}{\text{inlet}} * 100$

16. CARBON MONOXIDE EMISSIONS

Eqn: $\text{ppmv Corrected to 12\% } CO_2 = (\text{ppmv}) * \frac{12}{\%CO_2}$

$$\text{ppmv Corrected to 50\% Excess Air} = (\text{ppmv}) * \frac{(100 + \%EA)}{150}$$

$$lbm/hr = \frac{(ppmv)(28\ lbm/lbmole)(Qstd)(60\ min/hr)}{(385.3\ ft^3/lbmole)(10^6)}$$

ppmv: CAE SUMMARY OF RESULTS (Tables 5-8, p. 4-10 to 4-13, CO recorder strip chart.

17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS

Eqn: $\underset{(liters)}{Vvstd} = Yd * \frac{Vv * Pb}{(Tv + 273)} * \frac{[0.3858\ ^oK]}{mm\ Hg} * \frac{[760\ mm\ Hg]}{[29.921\ in\ Hg]}$

Yd: VOST FIELD DATA SHEETS
Vv: VOST FIELD DATA SHEETS
Pb: EPA M-5 FIELD DATA SHEETS, RAW DATA SETS
Tv: VOST FIELD DATA SHEETS

18. POHC EMISSIONS--CCl_4

Eqn: $ug/m^3 = \frac{(ng\ CCl_4)}{(Vvstd)}$

$$ppbv = \frac{(ug/m^3)(24.04\ l/gmmole)}{(153.81\ gm/gmmole)}$$

$$lbm/hr = \frac{(ppbv)(153.81\ lbm/lbmole)(60\ min/hr)*Qstd}{(385.3\ ft^3/lbmole)(10^9)}$$

ng CCl_4: LABORATORY DATA--ANALYTICAL REPORTS
Qstd: Calculated in #7 above.

19. POHC EMISSIONS--TCE

Eqn: $ug/m^3 = \frac{(ng\ TCE)}{(Vvstd)}$

$$ppbv = \frac{(ug/m^3)(24.04\ l/gmmole)}{(131.378\ gm/gmole)}$$

$$lbm/hr = \frac{(ppbv)(131.378\ lbm/lbmole)(60\ min/hr)*Qstd}{(385.3\ ft^3/lbmole)(10^9)}$$

ng TCE: LABORATORY DATA--ANALYTICAL REPORTS
Qstd: Calculated in #7 above.

20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl_4

Eqn: $DRE = \frac{lbm/hr\ CCl_4\ in - lbm/hr\ CCl_4\ out}{lbm/hr\ CCl_4\ in} * 100\ ,\ \%$

21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE

Eqn: $DRE = \frac{lbm/hr\ TCE\ in - lbm/hr\ TCE\ out}{lbm/hr\ TCE\ in} * 100\ ,\ \%$

NOTE: A compilation of most of the data required in these equations may be found in Clean Air Engineering's Report on the Los Alamos Controlled Air Incinerator RCRA Trial Burn, Appendix 7-3, "Parameters".

APPENDIX E. SAMPLE CALCULATIONS

2) SAMPLE CALCULATIONS

SAMPLE OF EPA METHOD-5 & VOST DRE CALCULATIONS

SAMPLE PERIODS USED IN CALCULATIONS:
>EPA METHOD-5 #LA-4-M5-3
>VOST #LA-4-V-6

1. VOLUME OF WATER COLLECTED

Eqn: **Vwstd= (0.471 ft3/ml)*Vlc** , wscf

Vwstd= (0.471)*(297.4) = 14.00754 wscf

2. VOLUME OF GAS METERED, STANDARD CONDITIONS

Eqn: $$Vmstd = \frac{(17.64\ {}^{o}R/in\ Hg)*Vm*Yd*(Pb+DH/13.6)}{(Tm+460)}\ ,\ dscf$$

$$Vmstd = \frac{(17.64)*(51.31)*(.9999)*(23.10+1.02/13.6)}{(68+460)}$$

= 39.72309 dscf

3. MOISTURE CONTENT

Eqn: $$Bwo = \frac{Vwstd}{(Vmstd+Vwstd)}\ ,\ \%$$

$$Bwo = \frac{14.00754}{(39.72309 + 14.00754)}\ , \quad = 0.2606993 \quad = 26.1\%$$

4. MOLECULAR WEIGHT OF DRY GAS STREAM

Eqn: $Md = .44(\%CO_2)+.32(\%O_2)+.28(\%N_2+\%CO)$

$\%N2+\%CO := [100-(\%CO_2+\%O_2)] = [100-(8.0+10.2)] = 81.8$

Md = .44(8.0)+.32(10.2)+.28(81.8) = 29.688 lb/lbmole

5. MOLECULAR WEIGHT OF STACK GAS

Eqn: **Ms=Md(1-Bwo)+18(Bwo)**

Ms=29.688*(1-.2606993)+18*(.2606993)=26.64095 lb/lbmole

6. VELOCITY OF STACK GAS

Eqn: $$Vs = Kp*Cp*(DP)^{1/2}*\frac{(Ts+460)^{1/2}}{(MS*Ps)^{1/2}}\ ,\ ft/sec$$

$$Kp: =85.49\ [ft/sec*\frac{(in\ Hg*lbm/lb\ mole)}{[(in\ Hg*{}^{o}R)]}]$$

Eqn: $Ps: = [Pb + \frac{DH}{[(13.6 \text{ in } H_2O/\text{in Hg})]}]$, in Hg

$= [23.10 + \frac{1.02}{13.6}] = 23.175$ in Hg

$$Vs = \frac{85.49*.84*.4428*(202+460)^{1/2}}{(26.64095*23.175)^{1/2}} = 32.92657 \text{ ft/sec}$$

7. TOTAL VOLUMETRIC FLOW OF STACK GAS

Eqn: **Qa = Vs*As*(60 sec/min)** , acfm

As: $=0.7773 \text{ ft}^2$ $[(3.14159)*\frac{D^2}{4}$, where D=11.938] (12" Schd. 40)

Qa = 32.926576*0.7773*60 = 1535.629 acfm

Eqn: $Qstd = \frac{Qa*Ps*(1-Bwo)*(17.64\ ^oR/\text{in Hg})}{(Ts+460)}$, dscfm

$$Qstd = \frac{1535.629*23.175*(1-.2606993)*(17.64)}{(202+460)}$$

= 701.0804 dscfm

8. DENSITY OF STACK GAS

Eqn: $d = \frac{Ps*Ms*(14.696 \text{ psi})}{(Ts+460)*(29.921 \text{ in Hg})} * \frac{[(\text{lbmole}*^oR)]}{[10.73 \text{ psi}*\text{ft}^3]}$, lbm/ft^3

$$d = \frac{(23.175*26.64095*14.696)}{(202+460)*(29.921)(10.73)} = 0.04269085 \text{ lb/ft}^3$$

9. MASS FLOW RATE OF STACK GAS

Eqn: **Qm=d*Qa*(60 min/hr)** , lbm/hr

Qm=0.04269085*1535.629*60 = 3933.44 lb/hr

10. EXCESS COMBUSTION AIR IN STACK GAS

Eqn: $EA = 100*\frac{\%\ O_2}{(0.264*\%N_2 - \%O_2)}$, %

$$EA = 100*\frac{10.2}{(0.264*81.8 - 10.2)}, = 89.51137\ \%$$

11. PERCENT ISOKINETIC

Eqn: $I = K_4*\frac{Vmstd*(Ts+460)}{Ps*Vs*An*THETA*(1-Bwo)}$, %

K4: (0.09450) $\frac{[\text{in Hg*min}]}{[^{o}\text{R*sec}]}$

$$I=\frac{0.09450*39.72309*(202+460)}{23.175*32.926576*0.000534*80*(1-.2606993)}$$

= 103.1132 %

12. PARTICULATE CONCENTRATION

Eqn: $gr/dscf=\frac{Mn}{Vmstd}*(15.43\ gr/gm)$

$$gr/dscf=\frac{0.0485*15.43}{32.926576}=0.0188393$$

Eqn: $gr/dscf\ (7\%\ O_2)=(gr/dscf)*\frac{14}{(21-\%O_2)}$

$$gr/dscf\ (7\%\ O_2)=0.0188393*\frac{14}{(21-10.2)}=.02442131$$

Eqn: $lbm/hr=(gr/dscf)*\frac{Qstd*(60\ min/hr)}{(7000\ gr/lbm)}$

$$lbm/hr=0.0188393*\frac{701.0804*60}{7000}=0.1132102$$

13. CHLORIDE EMISSIONS (as HCl)

Eqn: $lb/dscf=\frac{(mg/l)*Vsoln*(36.45/35.45)}{(453,590\ mg/lbm)*Vmstd}*\frac{[\ liter\ ]}{[1000\ ml]}$

$$lb/dscf=\frac{269*505*(36.45/35.45)}{453,590*39.72309*1000}=7.752083E-06$$

Eqn: $ppmv=(lbm/dscf)*\frac{385.3\ ft^3}{lbmole}*\frac{lbmole}{36.45\ lbm}*(10^6)$

$$ppmv=7.752083E-06*\frac{385.3*(10^6)}{36.45}=81.94451$$

Eqn: lbm/hr=(lbm/dscf)*Qstd*(60 min/hr)

lbm/hr=7.752083E-06*701.0804*60 = 0.32609

14. CHLORIDE ENTERING INCINERATOR (as HCl)

Eqn: From CCl_4=(Feed rate)*(Weight %)*0.9219 $\frac{[lbm\ Cl^-]}{[lbm\ CCl_4]}$

CCl_4=(3.39*60)*(30.25/100)*0.9219 = 56.723 lb/hr

Eqn: From TCE=(Feed rate)*(Weight %)*0.8095 $\frac{[lbm\ Cl^-]}{[lbm\ TCE]}$

TCE=(3.39*60)*(14.79/100)*0.8095 = 24.352 lb/hr

Eqn: Total $Cl^-=Cl_{CCL4}+Cl_{Tce}$ = 56.723 + 24.352 = 81.075

Eqn: Total As HCl=(Total Cl^-)*(36.45/35.45)

= 81.075*(36.45/35.45) = 83.36223

15. CHLORIDE REMOVAL EFFICIENCY

Eqn: % Efficiency = $\frac{\text{inlet - outlet}}{\text{inlet}}$ *100

= $\frac{83.36223 - 0.32609}{83.36223}$ = 99.60882 %

16. CARBON MONOXIDE EMISSIONS

Eqn: ppmv Corrected to 12% CO_2= (ppmv)* $\frac{12}{\%CO_2}$

ppmv Corrected to 12% CO_2= 7* $\frac{12}{8.0}$ = 10.5

Eqn: ppmv Corrected to 50% Excess Air = (ppmv)*$\frac{(100 + \%EA)}{150}$

ppmv Corrected to 50% Excess Air = 7*$\frac{(100 + 89.51137)}{150}$= 8.8439

Eqn: lbm/hr= $\frac{(ppmv)(28\ lbm/lbmole)(Qstd)(60\ min/hr)}{(385.3\ ft^3/lbmole)(10^6)}$

lbm/hr= $\frac{7*28*701.0804*60}{385.3*(10^6)}$ = 0.02139815

17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS

Eqn: Vvstd= Yd* $\frac{Vv*Pb*}{(Tv + 273)}$ *$\frac{[0.3858\ ^oK\ ]}{mm\ Hg}$*$\frac{[\ 760\ mm\ Hg\ ]}{[29.921\ in\ Hg]}$
(liters)

Vvstd= 1.0032*$\frac{20.36*23.10*0.3858*760}{(25 + 273)*29.921}$ = 15.51532 l.

18. POHC EMISSIONS--CCl_4

Eqn: ug/m^3 = $\frac{(ng\ CCl_4)}{(Vvstd)}$ = $\frac{4900\ .}{15.51532}$ = 315.8169

Eqn: ppbv = $\frac{(ug/m^3)(24.04\ l/gmmole)}{(153.81\ gm/gmmole)}$

$$ppbv = \frac{315.8169*24.04}{(153.81)} = 49.36115$$

$$\text{Eqn: } lbm/hr = \frac{(ppbv)(153.81\ lbm/lbmole)(60\ min/hr)*Qstd}{(385.3\ ft^3/lbmole)(10^9)}$$

$$lbm/hr = \frac{49.36115*153.81*60*701.0804}{385.3*(10^9)} = 8.28877E-04$$

19. POHC EMISSIONS--TCE

$$\text{Eqn: } ug/m^3 = \frac{(ng\ TCE)}{(Vvstd)} = \frac{116\ .}{15.51532} = 7.476481$$

$$\text{Eqn: } ppbv = \frac{(ug/m^3)(24.04\ l/gmmole)}{(131.378\ gm/gmole)}$$

$$ppbv = \frac{7.476481*24.04}{131.378} = 1.368072$$

$$\text{Eqn: } lbm/hr = \frac{(ppbv)(131.378\ lbm/lbmole)(60\ min/hr)*Qstd}{(385.3\ ft^3/lbmole)(10^9)}$$

$$lbm/hr = \frac{1.368072*131.378*60*701.0804}{385.3*(10^9)} = 1.96224E-05$$

20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl_4

$$\text{Eqn: } DRE = \frac{lbm/hr\ CCl_4\ in - lbm/hr\ CCl_4\ out}{lbm/hr\ CCl_4\ in} * 100\ ,\ \%$$

$$DRE = \frac{[3.39*(60/100)*30.25] - 8.288766E-04}{[3.39*(60/100)*30.25]} * 100$$

$$= 99.99865\ \%$$

21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE

$$\text{Eqn: } DRE = \frac{lbm/hr\ TCE\ in - lbm/hr\ TCE\ out}{lbm/hr\ TCE\ in} * 100\ ,\ \%$$

$$DRE = \frac{[3.39*(60/100)*14.79] - 1.962239E-05}{[3.39*(60/100)*14.79]} * 100$$

$$= 99.99993\%$$

APPENDIX E. SAMPLE CALCULATIONS

3) PROGRAM FOR DRE & EMISSIONS CALCULATION

```
10 PRINT "SAMPLE CALCULATIONS"
20 PRINT
30 PRINT "ENTER EPA METHOD-5 SAMPLE PERIOD NUMBER"
40 INPUT X$
50 PRINT "ENTER VOST SAMPLE PERIOD NUMBER"
60 INPUT Y$
70 PRINT "XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN ";X$;"--XXXXXXXXXX
"
80 PRINT
90 PRINT
100 PRINT "1. VOLUME OF WATER COLLECTED"
110 PRINT
120 PRINT "ENTER VOLUME H2O COLLECTED IN IMPINGERS & SILICA GEL (M5), ml"
130 INPUT VLC
140 VWSTD=(.0471)*(VLC)
150 PRINT "Vwstd= ";VWSTD;"wscf"
160 PRINT
170 PRINT
180 PRINT "2. VOLUME OF GAS METERED, STANDARD CONDITIONS"
190 PRINT
200 PRINT "ENTER VOLUME OF GAS SAMPLE THROUGH METER (M5) AT METER CONDITIONS, ft
3"
210 INPUT VM
220 PRINT "ENTER AVERAGE DRY GAS METER TEMPERATURE, deg F"
230 INPUT TM
240 PRINT "ENTER BAROMETRIC PRESSURE, in Hg"
250 INPUT PB
260 PRINT "METHOD 5 GAS METER CORRECTION FACTOR= 0.9999"
270 YD=.9999
280 PRINT
290 PRINT "ENTER AVERAGE PRESSURE DROP ACROSS METER BOX ORIFICE, in H2O"
300 INPUT DH
310 VMSTD=17.64*VM*YD*(PB+DH/13.6)/(460+TM)
320 PRINT
330 PRINT "Vmstd= ";VMSTD;"dscf"
340 PRINT
350 PRINT
360 PRINT "3. MOISTURE CONTENT"
370 PRINT
380 BWO=VWSTD/(VMSTD+VWSTD)
390 PRINT "Bwo= ";BWO;"%"
400 PRINT
410 PRINT
420 PRINT "4. MOLECULAR WEIGHT OF DRY GAS STREAM"
430 PRINT
440 PRINT "ENTER PERCENT CO2"
450 INPUT CO2
460 PRINT "ENTER PERCENT O2"
470 INPUT O2
480 N2=100-(CO2+O2)
490 MD=.44*(CO2)+.32*(O2)+.28*(N2)
500 PRINT "Md= ";MD;"lbm/lb_mole"
510 PRINT
520 PRINT
530 PRINT "5. MOLECULAR WEIGHT OF STACK GAS"
540 PRINT
550 MS=MD*(1-BWO)+(18*BWO)
560 PRINT "Ms= ";MS;"lb/lb_mole"
570 PRINT
580 PRINT
590 PRINT "6. VELOCITY OF STACK GAS"
600 PRINT
610 PRINT "ENTER PITOT TUBE COEFFICIENT"
620 INPUT CP
630 PRINT "CONVERSION FACTOR Kp= 85.49 [ft/sec ((lbm/lb-mole inHg)/(R in H2O))^.
5]"
```

```
640 KP=85.49
650 PRINT
660 PRINT "ENTER AVERAGE OF SQRTS OF VELOCITY PRESSURE HEADS OF STACK GAS, in H2
O"
670 INPUT DP
680 PRINT "ENTER AVERAGE STACK TEMPERATURE, deg F"
    INPUT TS
7    S=PB+DH/13.6
710 PRINT
720 VS=KP*CP*DP*((TS+460)^.5)/((MS*PS)^.5)
730 PRINT "Vs= ";VS;"ft/sec"
740 PRINT
750 PRINT
760 PRINT "7. TOTAL VOLUMETRIC FLOW OF STACK GAS"
770 PRINT
780 PRINT "ENTER STACK CROSS-SECTIONAL AREA, ft2"
790 INPUT AS
800 QA=60*AS*VS
810 PRINT "QA= ";QA;"acfm"
820 QSTD=(QA*PS*17.64*(1-BWO))/(TS+460)
821 QWSTD=(QA*PS*17.64)/(TS+460)
822 PRINT "Qwstd= ";QWSTD;"scfm"
830 PRINT "Qstd= ";QSTD;"dscfm"
840 PRINT
850 PRINT
860 PRINT "8. DENSITY OF STACK GAS"
870 PRINT
880 DEN=(PS*14.696*MS)/(29.921*(TS+460)*10.73)
890 PRINT "DENSITY= ";DEN;"lbm/ft3"
900 PRINT
910 PRINT
9    PRINT "9. MASS FLOW RATE OF STACK GAS"
     RINT
940 QM=DEN*QA*60
950 PRINT "Qm= ";QM;"lbm/hr"
960 PRINT
970 PRINT
980 PRINT "10. EXCESS COMBUSTION AIR IN STACK GAS"
990 PRINT
1000 EA=100*(O2/(.264*N2-O2))
1010 PRINT "% EXCESS AIR= ";EA
1020 PRINT
1030 PRINT
1040 PRINT "11. PERCENT ISOKINETIC"
1050 PRINT
1060 PRINT "ENTER CROSS-SECTIONAL AREA OF NOZZLE, ft2"
1070 INPUT AN
1080 PRINT "ENTER TOTAL SAMPLING TIME (M5), min"
1090 INPUT TIME
1100 I=(.0945*(TS+460)*VMSTD)/(PS*VS*AN*TIME*(1-BWO))
1110 PRINT "%I= ";I;"%"
1120 PRINT
1130 PRINT
1140 PRINT "12. PARTICULATE CONCENTRATION"
1150 PRINT
1160 PRINT "ENTER TOTAL AMOUNT OF PARTICULATE MATTER COLLECTED, gm"
1170 INPUT MN
11    GRDSCF=(15.43*MN)/VMSTD
      PRINT "gr/dscf= ";GRDSCF
1200 GRDO=GRDSCF*(14/(21-O2))
1210 LBHR=(GRDSCF*QSTD*60/7000)
1220 PRINT "gr/dscf CORRECTED TO 7% O2= ";GRDO
1230 PRINT "lb/hr= ";LBHR
1240 PRINT
1250 PRINT
1260 PRINT "13. SULFURE EMISSIONS (AS H2S)"
```

```
1260 PRINT "13. CHLORIDE EMISSIONS (AS HCl)"
1270 PRINT
1280 PRINT "ENTER CHLORIDE IN OFFGAS SAMPLE (Subtract 1 for  Blank), mg/L"
1290 INPUT MGCL
1300 PRINT "ENTER TOTAL VOLUME OF IMPINGER SOLUTION (from C of C forms)"
1310 INPUT VSOLN
1320 LBDSCF=MGCL*((VSOLN/1000)*(36.45/35.45))/(453590!*VMSTD)
     PRINT "lb/dscf HCl= ";LBDSCF
1     PPMV=(LBDSCF*385.3*10^6)/36.45
1350 PRINT "ppmv HCl= ";PPMV
1360 LBHCL=LBDSCF*QSTD*60
1370 PRINT "lb/hr HCl= ";LBHCL
1380 PRINT
1390 PRINT
1400 PRINT "14. CHLORIDE ENTERING INCINERATOR (as HCl)"
1410 PRINT
1420 PRINT "ENTER WASTE FEED RATE TO INCINERATOR, lbm/min"
1430 INPUT LBMIN
1440 LBMHR=LBMIN*60
1450 PRINT "ENTER PERCENT CCl4 IN FEED MIXTURE, %"
1460 INPUT CIN
1461 TETIN=CIN/100
1470 PRINT "ENTER PERCENT TCE IN FEED MIXTURE, %"
1480 INPUT TIN
1481 TRIIN=TIN/100
1490 CCL4IN=LBMHR*TETIN
1500 TCEIN=LBMHR*TRIIN
1510 CLCCL4=CCL4IN*.9219
1520 CLTCE=TCEIN*.8095
1530 CL4T=CLCCL4+CLTCE
1540 HCL4T=CL4T*(36.45/35.45)
1550 PRINT "CHLORIDE ENTERING INCINERATOR AS CL-= ";CL4T;"lbm/hr"
1     PRINT "CHLORIDE ENTERING INCINERATOR AS HCl= ";HCL4T;"lbm/hr"
     PRINT
1560 PRINT
1590 PRINT "15. CHLORIDE REMOVAL EFFICIENCY"
1600 PRINT
1610 EFF=100*((HCL4T-LBHCL)/HCL4T)
1620 PRINT "% EFFICIENCY= ";EFF;"%"
1630 PRINT
1640 PRINT
1650 PRINT "16. CARBON MONOXIDE EMISSIONS"
1660 PRINT
1670 PRINT "ENTER PPM CO"
1680 INPUT PPCO
1690 PPMCO=(PPCO*12)/CO2
1700 PRINT "ppmv CO CORRECTED TO 12% CO2= ";PPMCO
1710 PPMEA=PPCO*((100+EA)/150)
1720 PRINT "ppmv CO CORRECTED TO 50% EXCESS AIR= ";PPMEA
1730 PRINT
1740 COHR=((PPCO*28*QSTD*60)/(385.3*(10^6)))
1750 PRINT "CO EMISSION= ";COHR;"lbm/hr"
1760 PRINT
1770 PRINT
1780 PRINT "XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN ";Y$;"--XXXXXXXXXX"
1790 PRINT
1800 PRINT
1810 PRINT "17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS"
1     PRINT
     PRINT "ENTER VOST DRY GAS SAMPLE VOLUME METERED, liters"
1840 INPUT VMV
1850 PRINT "VOST METER CORRECTION FACTOR IS 1.0032"
1860 YDV=1.0032
1870 PRINT
1880 PRINT "ENTER VOST METER OULET TEMPERATURE, deg C"
1890 INPUT TMV
```

```
1900 VVSTD=(.3858*TDV*VMV*PB*760)/(29.921*(TMV+273))
1910 PRINT "Vmstd (VOST)= ";VVSTD;"liters"
1920 PRINT
1930 PRINT
1940 PRINT "18. POHC EMISSIONS--CCl4"
1950 PRINT
1960 PRINT "ENTER CCl4 IN OFFGAS, ng"
     INPUT CCL4
1    TET1=CCL4/VVSTD
1990 PRINT "ug/m3 CCl4= ";TET1
2000 PBTET=(TET1*24.04)/153.81
2010 PRINT "ppbv CCl4= ";PBTET
2020 PRINT
2030 CCL4OUT=(PBTET*153.81*QSTD*60)/(10^9!*385.3)
2040 PRINT "EMISSION RATE OF CCl4= ";CCL4OUT;"lbm/hr"
2050 PRINT
2060 PRINT
2070 PRINT "19. POHC EMISSIONS--TCE"
2080 PRINT
2090 PRINT "ENTER TCE IN OFFGAS, ng"
2100 INPUT TCE
2110 TRI1=TCE/VVSTD
2120 PRINT "ug/m3 TCE= ";TRI1
2130 PBTRI=(TRI1*24.04)/131.378
2140 PRINT "ppbv TCE= ";PBTRI
2150 PRINT
2160 TCEOUT=(PBTRI*131.378*QSTD*60)/(10^9!*385.3)
2170 PRINT "EMISSION RATE OF TCE= ";TCEOUT;"lbm/hr"
2180 PRINT
2190 PRINT
2200 PRINT "20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4"
2210 PRINT
2    DRETET=100*((CCL4IN-CCL4OUT)/CCL4IN)
     PRINT "%DRE FOR CCl4= ";DRETET
2240 PRINT
2250 PRINT
2260 PRINT "21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE"
2270 PRINT
2280 DRETRI=100*((TCEIN-TCEOUT)/TCEIN)
2290 PRINT "%DRE FOR TCE= ";DRETRI
2300 PRINT
2310 PRINT
```

APPENDIX E. SAMPLE CALCULATIONS

4) RESULTS FOR ALL EPA METHOD-5 & VOST PERIODS

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-1-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.53506 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 26.75489 dscf
3. MOISTURE CONTENT
Bwo= .3520242 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.744 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.60983 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 31.62362 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1474.862 acfm
Qstd= 585.7351 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.073075E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3604.335 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 73.5953
11. PERCENT ISOKINETIC
%I= 103.9085 %
12. PARTICULATE CONCENTRATION
gr/dscf= 9.285144E-03
gr/dscf CORRECTED TO 7% O2= 1.101627E-02
lb/hr= 4.661687E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.592128E-08
ppmv HCl= .4654175
lb/hr HCl= 1.613862E-03
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 83.84026 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 86.20529 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.99812 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 6.976744
ppmv CO CORRECTED TO 50% EXCESS AIR= 5.78651
CO EMISSION= 1.276972E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-1-V-1--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.6294 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 12.02861
ppbv CCl4= 1.880033
EMISSION RATE OF CCl4= 2.637567E-05 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 0
ppbv TCE= 0
EMISSION RATE OF TCE= 0 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99996
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 100

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-1-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.53506 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 26.75489 dscf
3. MOISTURE CONTENT
Bwo= .3520242 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.744 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.60983 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 31.62362 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1474.862 acfm
Qstd= 585.7351 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.073075E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3604.335 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 73.5953
11. PERCENT ISOKINETIC
%I= 103.9085 %
12. PARTICULATE CONCENTRATION
gr/dscf= 9.285144E-03
gr/dscf CORRECTED TO 7% O2= 1.101627E-02
lb/hr= 4.661687E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.592128E-08
ppmv HCl= .4854175
lb/hr HCl= 1.613862E-03
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 95.13304 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 97.81662 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.99835 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 6.976744
ppmv CO CORRECTED TO 50% EXCESS AIR= 5.78651
CO EMISSION= 1.276972E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-1-V-2--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 16.28075 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 416.4429
ppbv CCl4= 65.08866
EMISSION RATE OF CCl4= 9.131526E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 9.888982
ppbv TCE= 1.80952
EMISSION RATE OF TCE= 2.168401E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99878
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99993

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-1-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.53506 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 26.75489 dscf
3. MOISTURE CONTENT
Bwo= .3520242 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.744 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.60983 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 31.62362 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1474.862 acfm
Qstd= 585.7351 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.073075E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3604.335 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 73.5953
11. PERCENT ISOKINETIC
%I= 103.9085 %
12. PARTICULATE CONCENTRATION
gr/dscf= 9.285144E-03
gr/dscf CORRECTED TO 7% O2= 1.101627E-02
lb/hr= 4.661687E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.592128E-08
ppmv HCl= .4854175
lb/hr HCl= 1.613862E-03
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 95.13304 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 97.81662 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.99835 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 6.976744
ppmv CO CORRECTED TO 50% EXCESS AIR= 5.78651
CO EMISSION= 1.276972E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-1-V-3--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 14.22778 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 359.1567
ppbv CCl4= 56.13501
EMISSION RATE OF CCl4= 7.875386E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= .7028506
ppbv TCE= .12861
EMISSION RATE OF TCE= 1.541171E-06 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99895
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 100

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-1-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.53506 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 26.75489 dscf
3. MOISTURE CONTENT
Bwo= .3520242 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.744 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.60983 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 31.62362 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1474.862 acfm
Qstd= 585.7351 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.073075E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3604.335 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 73.5953
11. PERCENT ISOKINETIC
%I= 103.9085 %
12. PARTICULATE CONCENTRATION
gr/dscf= 9.285144E-03
gr/dscf CORRECTED TO 7% O2= 1.101627E-02
lb/hr= 4.661687E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.592128E-08
ppmv HCl= .4854175
lb/hr HCl= 1.613862E-03
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 97.18627 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 99.92778 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.99838 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 6.976744
ppmv CO CORRECTED TO 50% EXCESS AIR= 5.78651
CO EMISSION= 1.276972E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-1-V-4--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.21298 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 378.6242
ppbv CCl4= 59.17772
EMISSION RATE OF CCl4= 8.302259E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 0
ppbv TCE= 0
EMISSION RATE OF TCE= 0 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99891
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 100

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-1-M5-2--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 19.2639 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 33.48434 dscf
3. MOISTURE CONTENT
Bwo= .3652046 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.744 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.45504 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 32.60381 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1520.577 acfm
Qstd= 585.3075 dscfm
8. DENSITY OF STACK GAS
DENSITY= .0400535 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3654.265 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 73.5953
11. PERCENT ISOKINETIC
%I= 104.111 %
12. PARTICULATE CONCENTRATION
gr/dscf= 5.57583E-03
gr/dscf CORRECTED TO 7% O2= 6.615392E-03
lb/hr= .0279735
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.630546E-08
ppmv HCl= .4894785
lb/hr HCl= 1.626176E-03
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 97.87068 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 100.6315 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.99838 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 8.372093
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.943813
CO EMISSION= 1.531248E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-1-V-5--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 16.08477 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 336.3431
ppbv CCl4= 52.56933
EMISSION RATE OF CCl4= 7.36976E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 0
ppbv TCE= 0
EMISSION RATE OF TCE= 0 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99904
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 100

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-1-M5-2--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 19.2639 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 33.48434 dscf
3. MOISTURE CONTENT
Bwo= .3652046 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.744 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.45504 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 32.60381 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1520.577 acfm
Qstd= 565.3075 dscfm
8. DENSITY OF STACK GAS
DENSITY= .0400535 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3654.265 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 73.5953
11. PERCENT ISOKINETIC
%I= 104.111 %
12. PARTICULATE CONCENTRATION
gr/dscf= 5.57583E-03
gr/dscf CORRECTED TO 7% O2= 6.615392E-03
lb/hr= .0279735
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.630546E-08
ppmv HCl= .4894785
lb/hr HCl= 1.626176E-03
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 97.87068 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 100.6315 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.99838 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 8.372093
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.943813
CO EMISSION= 1.531248E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-1-V-6--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 16.12798 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 335.4419
ppbv CCl4= 52.42848
EMISSION RATE OF CCl4= 7.350014E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 8.680568
ppbv TCE= 1.5884
EMISSION RATE OF TCE= 1.902037E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99904
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99994

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-1-M5-3--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 18.7929 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 32.55247 dscf
3. MOISTURE CONTENT
Bwo= .3660096 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.744 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.44558 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 31.44541 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1466.551 acfm
Qstd= 564.5271 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.009056E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3527.691 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 73.5953
11. PERCENT ISOKINETIC
%I= 104.9393 %
12. PARTICULATE CONCENTRATION
gr/dscf= 8.721673E-03
gr/dscf CORRECTED TO 7% O2= 1.034775E-02
lb/hr= 4.220246E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.512413E-08
ppmv HCl= .4769912
lb/hr HCl= 1.528428E-03
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 97.87068 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 100.6315 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.99849 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 16.74419
ppmv CO CORRECTED TO 50% EXCESS AIR= 13.88763
CO EMISSION= 2.953768E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN 0--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= .8311138 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 0
ppbv CCl4= 0
EMISSION RATE OF CCl4= 0 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 0
ppbv TCE= 0
EMISSION RATE OF TCE= 0 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 100
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 100

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-2-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.30898 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 29.792 dscf
3. MOISTURE CONTENT
Bwo= .3244594 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.696 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.90112 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 28.96515 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1350.877 acfm
Qstd= 549.894 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.050001E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3282.631 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 93.33716
11. PERCENT ISOKINETIC
%I= 98.59611 %
12. PARTICULATE CONCENTRATION
gr/dscf= 1.035849E-02
gr/dscf CORRECTED TO 7% O2= 1.368102E-02
lb/hr= 4.882345E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.238121E-08
ppmv HCl= .4479967
lb/hr HCl= 1.39831E-03
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 99.33359 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 102.1357 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.99862 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 7.5
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.444573
CO EMISSION= 1.198835E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-2-V-1--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.89277 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 3.964067
ppbv CCl4= .6195708
EMISSION RATE OF CCl4= 8.160311E-06 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= .629217
ppbv TCE= .1151363
EMISSION RATE OF TCE= 1.295288E-06 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99999
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 100

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-2-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.30898 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 29.792 dscf
3. MOISTURE CONTENT
Bwo= .3244594 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.696 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.90112 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 28.96515 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1350.877 acfm
Qstd= 549.994 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.050001E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3282.631 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 93.33716
11. PERCENT ISOKINETIC
%I= 98.59611 %
12. PARTICULATE CONCENTRATION
gr/dscf= 1.035849E-02
gr/dscf CORRECTED TO 7% O2= 1.368102E-02
lb/hr= 4.882345E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.238121E-08
ppmv HCl= .4479967
lb/hr HCl= 1.39831E-03
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 99.33359 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 102.1357 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.99862 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 7.5
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.444573
CO EMISSION= 1.198835E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-2-V-2--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 16.51317 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 0
ppbv CCl4= 0
EMISSION RATE OF CCl4= 0 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 0
ppbv TCE= 0
EMISSION RATE OF TCE= 0 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 100
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 100

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-2-M5-2--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.4597 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 30.78314 dscf
3. MOISTURE CONTENT
Bwo= .319602 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.696 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.95793 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 29.07429 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1355.967 acfm
Qstd= 547.9528 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.000608E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3254.815 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 93.33716
11. PERCENT ISOKINETIC
%I= 102.2372 %
12. PARTICULATE CONCENTRATION
gr/dscf= 8.621474E-03
gr/dscf CORRECTED TO 7% O2= 1.138685E-02
lb/hr= .0404928
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 1.868945E-06
ppmv HCl= 19.75596
lb/hr HCl= 6.144563E-02
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 98.30243 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 101.0754 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.93921 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 9
ppmv CO CORRECTED TO 50% EXCESS AIR= 7.733487
CO EMISSION= 1.433523E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-2-V-3--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.89837 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 0
ppbv CCl4= 0
EMISSION RATE OF CCl4= 0 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= .6289954
ppbv TCE= .1150957
EMISSION RATE OF TCE= 1.29026E-06 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 100
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 100

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-2-M5-2--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Wstd= 14.4597 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 30.78314 dscf
3. MOISTURE CONTENT
Bwo= .319602 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.696 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.95793 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 29.07429 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1355.967 acfm
Qstd= 547.9528 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.000608E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3254.815 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 93.33716
11. PERCENT ISOKINETIC
%I= 102.2372 %
12. PARTICULATE CONCENTRATION
gr/dscf= 8.621474E-03
gr/dscf CORRECTED TO 7% O2= 1.138685E-02
lb/hr= .0404928
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 1.868945E-06
ppmv HCl= 19.75596
lb/hr HCl= 6.144563E-02
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 98.30243 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 101.0754 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.93921 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 9
ppmv CO CORRECTED TO 50% EXCESS AIR= 7.733487
CO EMISSION= 1.433523E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-2-V-4--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.52461 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 76.65251
ppbv CCl4= 11.98054
EMISSION RATE OF CCl4= 1.572376E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 10.56388
ppbv TCE= 1.933014
EMISSION RATE OF TCE= 2.166971E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99979
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99993

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-2-M5-3--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.15826 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 30.10018 dscf
3. MOISTURE CONTENT
Bwo= .3198997 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.696 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.95445 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 28.84042 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1345.06 acfm
Qstd= 540.9073 dscfm
8. DENSITY OF STACK GAS
DENSITY= 3.982402E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3213.94 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 93.33716
11. PERCENT ISOKINETIC
%I= 101.271 %
12. PARTICULATE CONCENTRATION
gr/dscf= 1.158525E-02
gr/dscf CORRECTED TO 7% O2= 1.530127E-02
lb/hr= 5.371324E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 1.300532E-05
ppmv HCl= 137.4746
lb/hr HCl= .4220803
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 98.98987 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 101.7823 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.58531 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 10.5
ppmv CO CORRECTED TO 50% EXCESS AIR= 9.022401
CO EMISSION= .0165094 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-2-V-5--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.91261 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 287.822
ppbv CCl4= 44.98564
EMISSION RATE OF CCl4= 5.828188E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 7.226971
ppbv TCE= 1.322416
EMISSION RATE OF TCE= 1.46341E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99925
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99996

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-2-M5-3--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.15826 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 30.10018 dscf
3. MOISTURE CONTENT
Bwo= .3198997 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.696 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.95445 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 28.84042 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1345.06 acfm
Qstd= 540.9073 dscfm
8. DENSITY OF STACK GAS
DENSITY= 3.932402E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3213.94 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 93.33716
11. PERCENT ISOKINETIC
%I= 101.271 %
12. PARTICULATE CONCENTRATION
gr/dscf= 1.158525E-02
gr/dscf CORRECTED TO 7% O2= 1.530127E-02
lb/hr= 5.371324E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 1.300532E-05
ppmv HCl= 137.4746
lb/hr HCl= .4220803
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 99.98987 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 101.7823 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.58531 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 10.5
ppmv CO CORRECTED TO 50% EXCESS AIR= 9.022401
CO EMISSION= .0165094 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-2-V-6--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 14.06185 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 402.5075
ppbv CCl4= 62.9106
EMISSION RATE OF CCl4= 8.150487E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 7.822583
ppbv TCE= 1.431403
EMISSION RATE OF TCE= 1.584017E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99896
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99996

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-3-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 18.7929 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 34.29146 dscf
3. MOISTURE CONTENT
Bwo= .3540195 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.684 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.54764 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 33.09064 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1543.281 acfm
Qstd= 595.7967 dscfm
8. DENSITY OF STACK GAS
DENSITY= 3.961951E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3668.643 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 87.66143
11. PERCENT ISOKINETIC
%I= 104.7435 %
12. PARTICULATE CONCENTRATION
gr/dscf= .0119691
gr/dscf CORRECTED TO 7% O2= 1.537316E-02
lb/hr= 6.112416E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 7.065262E-06
ppmv HCl= 74.68436
lb/hr HCl= .2525676
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 65.16957 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 67.00792 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.62307 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 0
ppmv CO CORRECTED TO 50% EXCESS AIR= 0
CO EMISSION= 0 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-3-V-1--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.38089 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 141.0842
ppbv CCl4= 22.051
EMISSION RATE OF CCl4= 3.146757E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 15.01864
ppbv TCE= 2.748162
EMISSION RATE OF TCE= 3.349773E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99937
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99986

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-3-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 18.7929 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 34.29146 dscf
3. MOISTURE CONTENT
Bwo= .3540195 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.684 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.54764 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 33.09064 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1543.281 acfm
Qstd= 595.7967 dscfm
8. DENSITY OF STACK GAS
DENSITY= 3.961951E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3668.643 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 87.66143
11. PERCENT ISOKINETIC
%I= 104.7435 %
12. PARTICULATE CONCENTRATION
gr/dscf= .0119691
gr/dscf CORRECTED TO 7% O2= 1.537316E-02
lb/hr= 6.112416E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 7.065262E-06
ppmv HCl= 74.68436
lb/hr HCl= .2525676
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 65.16957 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 67.00792 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.62307 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 0
ppmv CO CORRECTED TO 50% EXCESS AIR= 0
CO EMISSION= 0 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-3-V-2--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.5217 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 143.6698
ppbv CCl4= 22.45513
EMISSION RATE OF CCl4= 3.204427E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 15.14009
ppbv TCE= 2.770387
EMISSION RATE OF TCE= 3.376863E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99935
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99986

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-3-M5-2--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 22.86234 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 35.05499 dscf
3. MOISTURE CONTENT
Bwo= .3947409 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.616 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.03069 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 35.46793 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1654.154 acfm
Qstd= 603.8125 dscfm
8. DENSITY OF STACK GAS
DENSITY= 3.917261E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3887.851 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 85.08031
11. PERCENT ISOKINETIC
%I= 105.6542 %
12. PARTICULATE CONCENTRATION
gr/dscf= 1.646219E-02
gr/dscf CORRECTED TO 7% O2= 2.095188E-02
lb/hr= 8.520066E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 3.122017E-06
ppmv HCl= 33.00173
lb/hr HCl= .1131068
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 73.44641 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 75.51823 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.85022 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 7.894737
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.169344
CO EMISSION= 1.316383E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-3-V-3--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.33617 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 369.0622
ppbv CCl4= 57.68322
EMISSION RATE OF CCl4= 8.34235E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 80.85463
ppbv TCE= 14.79506
EMISSION RATE OF TCE= 1.827653E-04 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99851
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99933

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-3-M5-2--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 22.86234 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 35.05499 dscf
3. MOISTURE CONTENT
Bwo= .3947409 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.616 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 25.03069 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 35.46793 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1654.154 acfm
Qstd= 603.8125 dscfm
8. DENSITY OF STACK GAS
DENSITY= 3.917261E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3887.851 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 85.08031
11. PERCENT ISOKINETIC
%I= 105.6542 %
12. PARTICULATE CONCENTRATION
gr/dscf= 1.646219E-02
gr/dscf CORRECTED TO 7% O2= 2.095188E-02
lb/hr= 8.520066E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 3.122017E-06
ppmv HCl= 33.00173
lb/hr HCl= .1131068
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 73.44641 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 75.51823 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.85022 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 7.894737
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.169344
CO EMISSION= 1.316383E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-3-V-4--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.08439 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 294.344
ppbv CCl4= 46.00501
EMISSION RATE OF CCl4= 6.653406E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 35.99748
ppbv TCE= 6.586943
EMISSION RATE OF TCE= 8.136936E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99881
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99969

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-3-M5-3--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.03109 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 37.24975 dscf
3. MOISTURE CONTENT
Bwo= .2736127 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.624 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 26.44352 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 33.56022 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1565.182 acfm
Qstd= 691.9908 dscfm
8. DENSITY OF STACK GAS
DENSITY= .0417649 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3922.179 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 88.68949
11. PERCENT ISOKINETIC
%I= 97.96301 %
12. PARTICULATE CONCENTRATION
gr/dscf= 1.830901E-02
gr/dscf CORRECTED TO 7% O2= .0237339
lb/hr= .1085971
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.76803E-06
ppmv HCl= 50.40115
lb/hr HCl= .197966
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 70.87877 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 72.87817 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.72836 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 7.894737
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.28965
CO EMISSION= 1.508623E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-3-V-5--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 16.72119 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 15.42953
ppbv CCl4= 2.411585
EMISSION RATE OF CCl4= 3.99705E-05 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= .3588262
ppbv TCE= 6.565925E-02
EMISSION RATE OF TCE= 9.295465E-07 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99992
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 100

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-3-M5-3--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.03109 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 37.24975 dscf
3. MOISTURE CONTENT
Bwo= .2736127 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.624 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 26.44352 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 33.56022 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1565.182 acfm
Qstd= 691.9908 dscfm
8. DENSITY OF STACK GAS
DENSITY= .0417649 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3922.179 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 88.68949
11. PERCENT ISOKINETIC
%I= 97.96301 %
12. PARTICULATE CONCENTRATION
gr/dscf= 1.830901E-02
gr/dscf CORRECTED TO 7% O2= .0237339
lb/hr= .1085971
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 4.76803E-06
ppmv HCl= 50.40115
lb/hr HCl= .197966
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 70.87877 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 72.87817 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.72836 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 7.894737
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.28965
CO EMISSION= 1.508623E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-3-V-6--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 16.05268 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 186.4487
ppbv CCl4= 29.14132
EMISSION RATE OF CCl4= 4.829991E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= .4983593
ppbv TCE= 9.119149E-02
EMISSION RATE OF TCE= 1.29101E-06 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.9991
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99999

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-4-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 11.97282 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 35.2284 dscf
3. MOISTURE CONTENT
Bwo= .2536549 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.436 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 26.53521 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 31.46675 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1467.546 acfm
Qstd= 665.7653 dscfm
8. DENSITY OF STACK GAS
DENSITY= .041854 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3685.36 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 132.3264
11. PERCENT ISOKINETIC
%I= 96.29657 %
12. PARTICULATE CONCENTRATION
gr/dscf= 5.518786E-03
gr/dscf CORRECTED TO 7% O2= 8.880805E-03
lb/hr= 3.149328E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 1.229404E-06
ppmv HCl= 12.99559
lb/hr HCl= 4.910967E-02
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 75.79017 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 77.92812 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.93698 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 10.16949
ppmv CO CORRECTED TO 50% EXCESS AIR= 7.744212
CO EMISSION= 1.451448E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-4-V-1--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.99329 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 350.1468
ppbv CCl4= 54.7268
EMISSION RATE OF CCl4= 8.726861E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 3.251363
ppbv TCE= .5949456
EMISSION RATE OF TCE= 8.103513E-06 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99848
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99997

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-4-M5-1--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 11.97282 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 35.2284 dscf
3. MOISTURE CONTENT
Bwo= .2536549 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.436 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 26.53521 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 31.46675 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1467.546 acfm
Qstd= 665.7653 dscfm
8. DENSITY OF STACK GAS
DENSITY= .041854 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3685.36 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 132.3264
11. PERCENT ISOKINETIC
%I= 96.29657 %
12. PARTICULATE CONCENTRATION
gr/dscf= 5.518786E-03
gr/dscf CORRECTED TO 7% O2= 8.880805E-03
lb/hr= 3.149328E-02
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 1.229404E-06
ppmv HCl= 12.99559
lb/hr HCl= 4.910967E-02
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 75.79017 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 77.92812 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.93698 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 10.16949
ppmv CO CORRECTED TO 50% EXCESS AIR= 7.744212
CO EMISSION= 1.451448E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-4-V-2--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.47713 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 38.12077
ppbv CCl4= 5.958152
EMISSION RATE OF CCl4= 9.501004E-05 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= .6461146
ppbv TCE= .1182283
EMISSION RATE OF TCE= 1.61034E-06 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99983
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99999

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-4-M5-2--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 13.40937 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 38.99047 dscf
3. MOISTURE CONTENT
Bwo= .2559048 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.56 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 26.60174 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 32.97937 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1538.092 acfm
Qstd= 698.2259 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.211337E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3886.454 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 103.3058
11. PERCENT ISOKINETIC
%I= 101.6252 %
12. PARTICULATE CONCENTRATION
gr/dscf= 0
gr/dscf CORRECTED TO 7% O2= 0
lb/hr= 0
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 6.735335E-06
ppmv HCl= 71.19683
lb/hr HCl= .2821671
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 77.07608 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 79.25029 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.64396 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 8.571428
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.77686
CO EMISSION= 1.522216E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-4-V-3--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 14.92449 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 174.2103
ppbv CCl4= 27.2285
EMISSION RATE OF CCl4= 4.553617E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 2.412143
ppbv TCE= .4413822
EMISSION RATE OF TCE= 6.305009E-06 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99922
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99998

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-4-M5-2--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 13.40937 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 38.99047 dscf
3. MOISTURE CONTENT
Bwo= .2559048 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.56 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 26.60174 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 32.97937 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1538.092 acfm
Qstd= 698.2259 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.211337E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3886.454 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 103.3058
11. PERCENT ISOKINETIC
%I= 101.6252 %
12. PARTICULATE CONCENTRATION
gr/dscf= 0
gr/dscf CORRECTED TO 7% O2= 0
lb/hr= 0
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 6.735335E-06
ppmv HCl= 71.19683
lb/hr HCl= .2821671
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 77.07608 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 79.25029 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.64396 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 8.571428
ppmv CO CORRECTED TO 50% EXCESS AIR= 6.77686
CO EMISSION= 1.522216E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-4-V-4--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 13.20327 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 393.8417
ppbv CCl4= 61.55618
EMISSION RATE OF CCl4= 1.029448E-03 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 15.90515
ppbv TCE= 2.910379
EMISSION RATE OF TCE= 4.157386E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99824
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99985

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-4-M5-3--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
/wstd= 14.00754 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 39.72309 dscf
3. MOISTURE CONTENT
Bwo= .2606993 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.688 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 26.64095 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 32.92657 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1535.629 acfm
Qstd= 701.0804 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.269085E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3933.44 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 89.51137
11. PERCENT ISOKINETIC
%I= 103.1132 %
12. PARTICULATE CONCENTRATION
gr/dscf= .0188393
gr/dscf CORRECTED TO 7% O2= 2.442131E-02
lb/hr= .1132102
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 7.752083E-06
ppmv HCl= 81.94451
lb/hr HCl= .32609
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 81.0752 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 83.36223 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.60882 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 10.5
ppmv CO CORRECTED TO 50% EXCESS AIR= 8.943864
CO EMISSION= 2.139815E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-4-V-5--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 16.39335 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 378.2022
ppbv CCl4= 59.11177
EMISSION RATE OF CCl4= 9.9261E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 9.882058
ppbv TCE= 1.808253
EMISSION RATE OF TCE= 2.593594E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99839
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99991

XXXXXXXXXX--EPA METHOD-5 BASED CALCULATIONS FOR RUN LA-4-M5-3--XXXXXXXXXX
1. VOLUME OF WATER COLLECTED
Vwstd= 14.00754 wscf
2. VOLUME OF GAS METERED, STANDARD CONDITIONS
Vmstd= 39.72309 dscf
3. MOISTURE CONTENT
Bwo= .2606993 %
4. MOLECULAR WEIGHT OF DRY GAS STREAM
Md= 29.688 lbm/lb_mole
5. MOLECULAR WEIGHT OF STACK GAS
Ms= 26.64095 lb/lb_mole
6. VELOCITY OF STACK GAS
Vs= 32.92657 ft/sec
7. TOTAL VOLUMETRIC FLOW OF STACK GAS
QA= 1535.629 acfm
Qstd= 701.0804 dscfm
8. DENSITY OF STACK GAS
DENSITY= 4.269085E-02 lbm/ft3
9. MASS FLOW RATE OF STACK GAS
Qm= 3933.44 lbm/hr
10. EXCESS COMBUSTION AIR IN STACK GAS
% EXCESS AIR= 89.51137
11. PERCENT ISOKINETIC
%I= 103.1132 %
12. PARTICULATE CONCENTRATION
gr/dscf= .0188393
gr/dscf CORRECTED TO 7% O2= 2.442131E-02
lb/hr= .1132102
13. CHLORIDE EMISSIONS (AS HCl)
lb/dscf HCl= 7.752083E-06
ppmv HCl= 81.94451
lb/hr HCl= .32609
14. CHLORIDE ENTERING INCINERATOR (as HCl)
CHLORIDE ENTERING INCINERATOR AS Cl-= 81.0752 lbm/hr
CHLORIDE ENTERING INCINERATOR AS HCl= 83.36223 lbm/hr
15. CHLORIDE REMOVAL EFFICIENCY
% EFFICIENCY= 99.60882 %
16. CARBON MONOXIDE EMISSIONS
ppmv CO CORRECTED TO 12% CO2= 10.5
ppmv CO CORRECTED TO 50% EXCESS AIR= 8.843864
CO EMISSION= 2.139815E-02 lbm/hr
XXXXXXXXXX--DRE CALCULATIONS FOR VOST RUN LA-4-V-6--XXXXXXXXXX
17. VOST SAMPLE TRAIN GAS METERED AT DRY STANDARD CONDITIONS
Vmstd (VOST)= 15.51532 liters
18. POHC EMISSIONS--CCl4
ug/m3 CCl4= 315.8169
ppbv CCl4= 49.36115
EMISSION RATE OF CCl4= 8.288766E-04 lbm/hr
19. POHC EMISSIONS--TCE
ug/m3 TCE= 7.476481
ppbv TCE= 1.368072
EMISSION RATE OF TCE= 1.962239E-05 lbm/hr
20. DESTRUCTION AND REMOVAL EFFICIENCY OF CCl4
%DRE FOR CCl4= 99.99865
21. DESTRUCTION AND REMOVAL EFFICIENCY OF TCE
%DRE FOR TCE= 99.99993

APPENDIX F. CHAIN OF CUSTODY FORMS

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
① Fuel Oil Feed Stock	LANL-1-V-1-F.O.F.	9/4/86	LANL-CAI personnel
- Conditions 1,2,3,+4			
② Alumagel Feed Stock	LANL-2-M5-1-ALGL	9/5/86	LANL-CAI
-Condition 2			
Alumagel Feed Stock	LANL-1-M5-1-ALGL	9/4/86	LANL-CAI
-Condition 1			
③ Cellulosic (Pel-E-Cel)	LANL-3,4-V-1,2,3,-PEL	9/6/86	d.k. CAE
feedstock-Conditions 3 + 4			
④ Incinerator Ash-post	LANL-3-V-3-I.A	9/6/86	LANL-CAI
Condition 3			
Incinerator Ash-post	LANL-4-M5-1,2,3-I.A.	9/7/86	"
Condition 4			
HEPA filter (fresh)	LANL-1-V-1-HEPA	9/4/86	"
HEPA filter (used)	LANL-4-V-3-HEPA(il)	9/8/86	"

ANALYSIS REQUIRED? (① CCl_4, TCE, Cl^-) (② - SAME AS ①) (③ - SAME AS ①) (④ - CCl_4, TCE, Cl^-, pH)

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
Caustic Sol'n - Condition 1	LANL-1-V-1-C.S.	9/4/86, 13:42	dave kubak CAE
Runs 1, 2, 3			
Caustic Sol'n - Condition 2	LANL-2-V-1-C.S.	9/5/86	dave kubak CAE
Runs 1, 2			
Caustic Sol'n - Condition 2	LANL-2-V-3-C.S.	9/5/86	d.k. CAE
Run 3			
Caustic Sol'n - Condition 3	LANL-3-V-1-C.S.	9/6/86	d.k. CAE
Run 1			
Caustic Sol'n - Condition 3	LANL-3-V-2-C.S.	9/6/86	d.k. CAE
Runs 2 + 3			
Caustic Sol'n - Condition 4	LANL-4-V-1,2,3-C.S.	9/7/86	d.k. CAE
Runs 1, 2 + 3			

ANALYSIS REQUIRED: Cl-

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	# ml. sample	SAMPLE RECOVERY BY
~~Impinger Solution Blank~~				
~~- Conditions 1,2~~				
Impinger Solution Blank	LANL-1,2,3,4-M5-1,2,3-IMP. B.	9/6/85	543 ml	d.t CAE
- Conditions 3,4,1,2				
*Impinger Solution-Condition 1 Run 1	LANL-1-M5-1-IMP	9/4/86	542 ml.	d.t CAE
I.S. Condition 1 Run 2	LANL-1-M5-2-IMP.	9/4/86	684 ml.	
I.S. " 1 " 3	LANL-1-M5-3-IMP.	9/4/86	648 ml.	
I.S. " 2 " 1	LANL-2-M5-1-IMP.	9/5/86	557 ml	
I.S. " 2 " 2	LANL-2-M5-2-IMP.	9/5/86	540 ml.	
I.S. " 2 " 3	LANL-2-M5-3-IMP.	9/5/86	533 ml.	
I.S. " 3 " 1	LANL-3-M5-1-IMP.	9/6/86	640 ml	
I.S. " 3 " 2	LANL-3-M5-2-IMP.	9/6/86	680 ml	
I.S. " 3 " 3	LANL-3-M5-3-IMP.	9/6/86	533 ml.	
I.S. " 4 " 1	LANL-4-M5-1-IMP.	9/7/86	466 ml	
I.S. " 4 " 2	LANL-4-M5-2-IMP.	9/7/86	529 ml.	
I.S. " 4 " 3	LANL-4-M5-3-IMP.	9/7/86	505 ml	

ANALYSIS REQUIRED: Cl^- NOTE: SAMPLES WERE COLLECTED IN 0.1N NaOH

*I.S. ≡ Impinger Solution CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
Activated Charcoal (fresh)	LANL-1-V-1-A.C.(F.)	9/4/86	LANL-CAI personnel
- precondition 1+2 9/4/86			
Activated Charcoal (used)	LANL-1,2-V-1,2,3-A.C.(U)	9/6/86	LANL-CAI personnel
pre condition 3 - post condition 1+2			
Activated Charcoal (used) - pre-	LANL-3-V-2-A.C.(U.)	9/6/86	LANL-CAI personnel
Condition 4 — post Condition 3			
Activated Charcoal (used)	LANL-4-V-1,2,3-A.C.(U)	9/7/86	LANL-CAI personnel
- post Condition 4			

ANALYSIS REQUIRED: CCl_4, TCE, Cl^-, pH

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
* Makeup Water - Condition 1 Run 1	LANL-1-V-1-M.W.	9/4/86	dave kubale CAE
MW - Condition 1 Run 2	LANL-1-V-2-M.W.	9/4/86	d.k.
MW - Condition 1 Run 3	LANL-1-V-3-M.W.	9/4/86	d.k
MW - Condition 2 Run 1	LANL-2-V-1-M.W.	9/5/86	d.k
MW - Condition 2 Run 2	LANL-2-V-2-M.W.	9/5/86	d.k
MW - Condition 2 Run 3	LANL-2-V-3-M.W.	9/5/86	d.k
MW - Condition 3 Run 1	LANL-3-V-1-M.W.	9/6/86	dk
MW - Condition 3 Run 2	LANL-3-V-2-M.W.	9/6/86	dk
MW - Condition 3 Run 3	LANL-3-V-3-M.W.	9/6/86	dk
MW - Condition 4 Run 1	LANL-4-V-1-M.W.	9/7/86	dk
MW - Condition 4 Run 2	LANL-4-V-2-M.W.	9/7/86	dk
MW - Condition 4 Run 3	LANL-4-V-3-M.W	9/7/86	dk

ANALYSIS REQUIRED: CCl_4, TCE, Cl^-

* Makeup Water ≡ MW

CARRIER: Rit Kat

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
① CCl_4 feed stock	LANL-1-V-1-CCl_4	9/4/86	LANL-CAI personel
- Conditions 1,2,3,+4			
② TCE feed stock	LANL-1-V-1-TCE	9/4/86	"
- Conditions 1,2,3,+4			
* ③ Liquid Mixture Feed	LANL-1-V-1-L.M.F.	9/4/86	"
Condition 1 Run 1			
L.M.F. - Condition 1 Run 2	LANL-1-V-2-L.M.F.	9/4/86	"
L.M.F. - Condition 1 Run 3	LANL-1-V-3-L.M.F.	9/4/86	"
L.M.F. - Condition 2 Run 1	LANL-2-V-1-L.M.F.	9/5/86	"
L.M.F. - Condition 2 Run 2	LANL-2-V-2-L.M.F.	9/5/86	"
L.M.F. - Condition 2 Run 3	LANL-2-V-3-L.M.F.	9/5/86	"

ANALYSIS REQUIRED: ① % CCl_4 ② - % TCE ③ % CCl_4, % TCE, Cl^-, FILTERABLE PARTICULATE.

* L.M.F.

CARRIER: Ruth Kerl

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
*S.D.L.-Condition 1 Run 1	LANL-1-V-1-S.D.L.	9/4/86	dave kubak CAE
S.D.L.-Condition 1 Run 2	LANL-1-V-2-S.D.L.	9/4/86	d.k. CAE
S.D.L.-Condition 1 Run 3	LANL-1-V-3-S.D.L.	9/4/86	d.k. CAE
S.D.L.-Condition 2 Run 1	LANL-2-V-1-S.D.L.	9/5/86	d.k.
S.D.L.-Condition 2 Run 2	LANL-2-V-2-S.D.L.	9/5/86	d.k
S.D.L.-Condition 2 Run 3	LANL-2-V-3-S.D.L.	9/5/86	d.k.
S.D.L-Condition 3 Run 1	LANL-3-V-1-S.D.L.	9/6/86	d.k.
S.D.L.-Condition 3 Run 2	LANL-3-V-2-S.D.L	9/6/86	d.k.
S.D.L.-Condition 3 Run 3	LANL-3-V-3-S.D.L.	9/6/86	d.k.
S.D.L.-Condition 4 Run 1	LANL-4-V-1-S.D.L.	9/7/86	
S.D.L.-Condition 4 Run 2	LANL-4-V-2-S.D.L	9/7/86	
S.D.L.-Condition 4 Run 3	LANL-4-V-3-S.D.L.	9/7/86	

ANALYSIS REQUIRED: CCl_4, TCE, Cl^-, pH.

*S.D.L. = Scrubber Discharge Liquid

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Lab LOCATION: CAI outlet

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
VOST Trap	1-V-1-T	9/4/86	P. Kaufmann
Box #1	1-V-1-TC		
	1-V-2-T		
	1-V-2-TC		
	1-V-3-T		
	1-V-3-TC		
	1-V-4-T		
Box #2	1-V-4-TC		
	1-V-5-T		
	1-V-5-TC		
	1-V-6-T		
	1-V-6-TC		
Field Blank #1	1-V-(1-6)-T		
Field Blank #2	1-V-(1-6)-TC		
VOST condinsate Bottle	1-V-(1-6)-Con		

CARRIER: Pete Kaufmann

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Labs LOCATION: CAI outlet

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
VOST Trap Box #3	2-V-1-T	9/5/86	P. Kaufmann
	2-V-1-TC		
	2-V-2-T		
	2-V-2-TC		
	2-V-3-T		
	2-V-3-TC		
	2-V-4-T		
Box #4	2-V-4-TC		
	2-V-5-T		
	2-V-5-TC		
	2-V-6-T		
	2-V-6-TC		
Field Blank Box #1	2-V-(1-6)-T		
Field Blank Box #2	2-V-(1-6)-TC		
VOST condensate Box #5	2-V-(1-6)-Con		

CARRIER: Pitt Pool

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Lab LOCATION: CAI Outlet

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
VOST Trap	3-V-1-T	9/6/86	P. Kaufmann
	3-V-1-TC		
Box #5	3-V-2-T		
	3-V-2-TC		
	3-V-3-T		
	3-V-3-TC		
	3-V-4-T		
Box #6	3-V-4-TC		
	3-V-5-T		
	3-V-5-TC		
	3-V-6-T		
	3-V-6-TC		
Field Blank Box #7	3-V-(1-6)-T		
Field Blank	3-V-(1-6)-TC		
VOST condensate	3-V-(1-6)-TCN		

CARRIER: Pitt Kaufmann

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Lab LOCATION: CAI Outlet

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
VOST Traps #6	4-V-1-T	9/7/86	D. Kaufmann
	4-V-1-TC		
VOST #5	4-V-2-T		
	4-V-2-TC		
	4-V-3-T		
	4-V-3-TC		
	4-V-4-T		
VOST #4	4-V-4-TC		
	4-V-5-T		
	4-V-5-TC		
	4-V-6-T		
	4-V-6-TC		
Field Blank #3	4-V-(1-6)-T		
Field Blank #3	4-V-(1-6)-TC		
VOST Condensate	4-V-(1-6)-CON		

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Lab LOCATION: CAI Corbett

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
Vost Traps	(1-4)-V-1-T-A	9/7/86	P. Kaufmann
Fuel Tanks	(1-4)-V-1-TC-A		
	(1-4)-V-2-T-A		
	(1-4)-V-2-TC-A		
	(1-4)-V-3-T-A		
	(1-4)-V-3-TC-A		
	(1-4)-V-4-T-A	9/8/86	
	(1-4)-V-4-TC-A		
	(1-4)-V-5-T-A		
	(1-4)-V-5-TC-A		
	(1-4)-V-6-T-A		
	(1-4)-V-6-TC-A		
Trip Blank	(1-4)-V-All-T		
Trip Blank	(1-4)-V-All-TC		

CARRIER: Pat Kaufmann

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

APPENDIX G. HEPA FILTER SPECIFICATIONS

HIGH EFFICIENCY PARTICULATE AIR FILTERS

High efficiency particulate air (HEPA) filters, once known as absolute filters, were originally developed as the particulate attenuation stage of a chemical, biological, radiological (CBR) filtration adsorber unit for use by the U.S. Armed Services. In the late 1940's the U.S. Atomic Energy Commission (AEC) adopted them for use for the containment of airborne radioactive particulates in the exhaust ventilation systems of experimental reactors, nuclear laboratories, and nuclear processing plants.

Much of the early CBR absolute particle filter study and development programs were conducted by the U.S. Army Chemical Corps. On adoption of absolute filters by the AEC, Oak Ridge National Laboratory was assigned the study and development program to optimize HEPA filtration design for nuclear service. The results of this on-going program have been published in "Design, Construction, and Testing of High-Efficiency Air Filtration Systems for Nuclear Application", USAEC Report ORNL/NSIC-65, and later under the Energy Research and Development Administration (ERDA) as the "Nuclear Air Cleaning Handbook", ERDA-76-21. The Second Edition of ERDA-76-21 (excerpt attached) was the nuclear industry standard at the time of design and construction of the Los Alamos Treatment Development Facility (TDF).

The purpose of a nuclear air cleaning system is to provide protection of the public, plant operating personnel, and the environment from airborne radioactive particles and gases which are, or could be, generated or released from operations conducted in a nuclear reactor, fuel fabrication or processing plant, radiochemical operation, laboratory, or other nuclear operation. Such a system is characterized by operation at very high particulate contaminant collection efficiencies, generally orders of magnitude above commercial or industrial applications.

In nuclear process off-gas cleaning applications, the HEPA filters are generally preceded in the process line by scrubbers, cyclones, and/or common air filters, which extend the operating life of the HEPA filters, but the HEPA filters are used as the final barrier between a process or contained space in which radioactive particles could be generated, and the point of release to the atmosphere (the facility stack).

The application of HEPA filtration has expanded markedly in the high technology industries of aerospace, micro-electronics, and pharmaceuticals. Clean rooms, environmental rooms, and laminar flow systems are also now wide spread in such areas as food processing, film manufacturing, and hospitals. Not all of these applications require the performance and construction of filters used in

nuclear service. Excerpts from a filter manufacturer's catalog are attached.

In the 1960's, the American Association for Contamination Control convened a committee to write specification standards for HEPA filters (IES CS-1T) which resulted in three grades of HEPA filters, i.e., Industrial, Nuclear, and Laminar Flow. The Nuclear Grade specification has been further refined into a Military Specification, Mil-F-51068D, Filter, Particulate, High Efficiency, Fire Resistant.

High efficiency filtration theory and the significance of particle size is subject to considerable misunderstanding both within and without the nuclear industry. The mechanism for particle retention in a filter medium is by impaction and by diffusion. As air flows through a filter medium, it encounters obstacles in the form of randomly-oriented fibers and it must change direction of flow around the fibers. Particles, due to greater inertia than gas molecules, resist directional changes and tend to continue in their original paths and to collide with the fibers. High flow rates and large particles favor particle filtration by impaction. The second mechanism, diffusion, results from the fact that very small particles behave more as true gases. If a difference in concentration of particles exists in one area of an air stream, the particles tend to diffuse, or migrate, to areas of lower concentration until a uniform distribution is reached. Since the concentration of particles in the vicinity of a fiber surface is reduced (particles contacting the surface are held and are not re-entrained into the air stream), particles from the main body of gas migrate toward the fibers. Diffusion is favored by small diameter filter fibers and low gas velocities, and is effective for small particles only.

In filter efficiency studies, it has been theorized that there is likely to be a particle size too small for effective impaction and too large to be affected by diffusion. Thus the particle size/filtration efficiency curve should possess a minimum at some particle size/flow rate combination. During WW-II, Irving Langmuir studied the fundamental processes involved in filtration of chemical smokes for the U.S. Army Chemical Corps, and concluded that 0.3 micrometer (micron) particles are the most difficult to capture in a filter medium. Later studies by Victor La Mer at Columbia University determined that particles some what smaller than 0.3 micron are harder to filter. At operating conditions recommended for nuclear grade HEPA filters, calculations indicate a particle diameter of from 0.09 to 1.0 microns as the most difficult to filter. Nuclear grade HEPA aerosol penetrant tests are therefore conducted with dioctyphthalate (DOP) which produces the smallest diameter test aerosol (0.3 micron) yet attainable for a repeatable, homogeneous test. Nuclear grade HEPA filters must

demonstrate a removal efficiency of not less than 99.97% of 0.3 micron particles. This efficiency increases as the filter becomes loaded, but reaches a limit when air flow restriction increases the pressure drop across the filter, which must then be replaced.

The HEPA filters received at Los Alamos are routinely purchased by the Laboratory's Materials Management and Transportation (MAT) Division according to current Department of Energy (DOE) and Nuclear Regulatory Commission (NRC) Nuclear Grade specifications. The filters are shipped by the manufacturer to the DOE Rocky Flats Plant, Colorado, and are subjected to aerosol penetrant tests prior to being shipped to Los Alamos. After installation in a plenum in Los Alamos, Group HSE-5, Industrial Hygiene, performs an in-situ aerosol penetrant test. The filters must pass the 0.3 micron aerosol test with a removal efficiency minimum of 99.97%. Facilities and processes involving plutonium or other transuranic isotopes have a minimum of double HEPA filtration; that is, two filter banks in series, each in-situ tested to meet the 99.97% minimum removal efficiency requirement.

At the Los Alamos Treatment Development Facility (TDF) the Controlled Air Incineration (CAI) process off-gas passes through a treatment train consisting of a quench column (to reduce the gas temperature), a high energy aqueous venturi scrubber (for particulate removal, which serves to increase the life of the HEPA filters), a condenser and re-heater (which reduces the water content of the gas stream and subsequent condensation on the upstream filter face which can "blind" the filter, increasing the pressure drop across the filter), and finally a common air cleaning, or roughing, filter, which also assists in extending the useful life of the HEPA filter. True gases are of molecular size, and are not trapped by a particulate filter. Additional environmental protection from volatile radioisotopes, such as radioiodine, and organic vapors is provided by the activated carbon adsorption bed. A final HEPA filter is provided to contain any carbon fines that might sift through the downstream bed screen.

Chapter 4.3.3, Radioactive Plant Emissions Under Normal Operations, of the Final Safety Analysis Report (FSAR) for the Transuranic Contaminated Solid Waste Treatment Development Facility (LA-7971-MS, July 1979) (copy attached) contains an evaluation of the particle removal efficiencies by the variable throat venturi scrubber. This evaluation (table, page 4-28) shows a relatively small deviation in the overall removal efficiency over a wide differential pressure range. The HEPA filter efficiency (99.97% for 0.3 micron particles) is not dependent on the venturi. The venturi does however, influence the operating lifetime of the HEPA filters. The difference in particulate concentration of the

gases at the inlet of the filters does affect the particulate concentration in the gases at the facility stack. However, over the operating range of the venturi, this change is only þ about 5 or 6%, thus the impact on the environment is negligible. The ability to change the venturi differential pressure does provide the combustion engineers with a method of controlling the atmospheric negative inside the incinerator to adjust to differences in feed mixtures and rates, and the other variables in the combustion process. It is, therefore, appropriate that the venturi scrubber differential pressure remain a variable to be set at the operator's discretion rather than be fixed as a regulatory parameter.

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NUCLEAR AIR CLEANING HANDBOOK

DESIGN, CONSTRUCTION, AND TESTING OF HIGH-EFFICIENCY AIR CLEANING SYSTEMS FOR NUCLEAR APPLICATION

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1. Introduction

1.1 BACKGROUND

A nuclear air cleaning system is provided to protect the public and plant operating personnel from airborne radioactive particles and gases which are, or could be, generated or released from operations conducted in a nuclear reactor, fuel fabrication or processing plant, radiochemical operation, laboratory, or other nuclear operation. Such a system is characterized by operation at very high contaminant collection levels, generally orders of magnitude greater than those exhibited by air cleaning systems employed in commercial, industrial, or pollution control applications. The component almost universally included in such systems is the high-efficiency particulate air (HEPA) filter. This type of filter may be supplemented by common air filters, bag filters, cyclones, scrubbers, or other devices used in more conventional applications but is nearly always employed in the nuclear air or gas cleaning system as the final barrier between a contained space (in which radioactive particulates could be generated) and the point of release to the atmosphere (i.e., the stack) or to an environmentally controlled space of the facility.

The prevention of even extremely low concentrations of airborne contamination is fundamental to the safe operation of a nuclear facility.[1] It is also an important factor in the economic operation of such facilities. Although protection of the health and safety of the public and of plant personnel is the primary consideration, the high costs of decontamination and the possibility of shutdown of the facility in the event of an accidental airborne release of radioactive material are also important considerations.

Radioactive substances tend to deposit or "plate out" on ducts, components, and other exposed surfaces and, in time, become sources of persistent ionizing radiation. This deposition can severely complicate maintenance and operation of a facility unless eliminated close to the source. These problems are of particular concern in power reactors and fuel reprocessing facilities because of their potential for releasing large amounts of radioactive material in the event of a system malfunction or upset.

1.2 PURPOSE AND SCOPE

Much of the information pertinent to the design, construction, and testing of very-high-efficiency air and gas cleaning systems for nuclear applications is contained in limited-distribution topical reports, technical papers, and job specifications that are often not readily available to designers. Although there is a growing body of standards relating to the subject, the background information necessary for their effective interpretation is scattered. The purposes of this handbook are to summarize available information in a manner that is useful to the designer, to point out shortcomings in design and construction practice, and to provide guides and recommendations for the design of future systems. The handbook summarizes findings from the literature and air cleaning practices at laboratories, production facilities, power and research reactors, and radiochemical and fuel reprocessing facilities. The judgments and recommendations presented reflect the experience of users and conditions that exist in operating systems where airborne radioactive material is being successfully controlled on a day-to-day basis, often in situations where personnel have had to live with, or adapt to, serious deficiencies in design or construction.

This handbook is limited to the mechanical or hardware phase of design. Functional design—the sizing of a system or selection of components to meet the needs of a specific application—is beyond its scope. The design of ventilation systems, of which the air cleaning systems are a part, is also beyond the scope of the handbook except as the ventilation

system design affects the operation and reliability of the air cleaning facilities, or, conversely, as the air cleaning facilities affect the operation and reliability of the ventilation system. The functional design of nuclear air cleaning systems is covered in Safety Monograph No. 17 of the International Atomic Energy Agency (IAEA),[2] in various Regulatory Guides of the Nuclear Regulatory Commission (NRC),[3-5] and in the ERDA Manual.[6] The functional design of ventilating systems is covered in *Industrial Ventilation*,[7] the ASHRAE handbooks,[8] ANSI Z9.2,[9] and numerous textbooks. The handbook does not cover the theories of air filtration or gas adsorption; however, discussions of air filtration theory can be found in White's and Smith's *High Efficiency Air Filtration*[10] and Davies' *Air Filtration*;[11] gas adsorption theory of interest to the nuclear industry is covered best in the proceedings of the biennial AEC (now ERDA) Air Cleaning Conferences.

1.3 DESIGN CONSIDERATIONS

The design of nuclear air cleaning systems is complicated by the extremely high collection efficiencies required to meet the maximum permissible concentration (MPC) values that have been established for radioactive substances in air.[1] In many conventional situations (i.e., commercial, industrial, and air pollution control), dust, chemical fumes, and other contaminants can be detected by the human senses before they reach concentrations that pose a serious immediate threat to health or safety. The situation is quite different in nuclear systems because of the complete insensitivity of man to the presence of radioactivity, even at levels that represent an immediate danger to life, and because of possible long-term effects of exposures even at low levels. The lowest threshold limit values (TLV)[12] specified for most chemical contaminants in air are at least two orders of magnitude higher than the MPC of any radioactive material.

The common air filters used in conventional air cleaning applications are unable to decontaminate air to the levels required to meet these MPCs. Even the best of such filters exhibit number decontamination factors (DF) no greater than 6 to 7 for submicron particles (i.e., those having an aerodynamic diameter of less than 1 μm), and the DF of most filters is 2 or less for particles in this range.[13,14] To meet the requisite MPCs for contaminants present as, or adsorbed on, particulate matter, the HEPA filter must be used. By definition,[15] this type of filter must have a minimum number efficiency[16] of 99.97% for 0.3-μm particles; that is, a number decontamination factor of at least 3333 for all measurable particles, at any concentration, down to at least a 0.3-μm aerodynamic diameter. Similarly, the iodine adsorption units used in nuclear air and gas cleaning service must also exhibit collection (i.e., decontamination) efficiencies substantially greater than adsorption units used in fume and odor control and most toxic or noxious gas control applications. For these components to function at their required performance levels, the manner in which they are installed, the connecting ductwork, and the ancillary components required to complete the air cleaning function must all meet standards of design and installation substantially higher than those which prevail in most nonnuclear situations. That such high standards can be met routinely and on a continuing basis is evidenced by the superlative safety record of most nuclear installations and by the control of releases to the atmosphere even under severe upset conditions.

If airborne radioactive material is released from the system, there is the possibility of seriously contaminating occupied spaces of the plant, as occurred in the St. Laurent fuel meltdown incident in France, or of contaminating the surrounding countryside, as occurred in the Windscale reactor incident in England several years ago. Even a minor incident, in terms of the actual weight or volume of radioactive material released, could shut down a costly facility for an extended period of time. The costs of decontamination can be thousands of times the losses due to such ordinary hazards as fire, explosions, or chemical spills, as illustrated below by the loss experience due to a small glove box accident at an ERDA laboratory.[17]

Casualty loss due to fire	$100
Casualty loss due to explosion	$500
Cost of cleanup and decontamination	$76,200

In addition, the deposition and "plate out" of radioactive particulate matter and gases in and on ductwork, housings (i.e., equipment casings), filters, and other air cleaning system components limits access, obstructs maintenance, and increases the cost of operation. The designer must appreciate these substantial differences between nuclear and conventional air cleaning systems. Concentrations of radiotoxic materials in the air cannot be maintained below statutory limits[1] if the design or layout of the system, or selection or installation of components, is

deficient. Some operations in the past have relied to some extent on dilution of airborne radioactive wastes with large volumes of air, followed by dispersal in the atmosphere. This practice is no longer acceptable in view of recent "as low as reasonably achievable" (ALARA) regulations, and heavy emphasis must be placed on positive removal of radioactive particulates, fumes, and gases by means of well-designed and -maintained filtration and adsorption systems.

1.4 SPACE CONSIDERATIONS

The location and space allocations for exhaust and air cleanup systems must receive close attention beginning with the early stages of building planning and layout and continuing through construction of the facility. Failure to provide adequate space for ductwork in early building layouts often results in the inability to achieve good aerodynamic design, in excessive velocity and pressure losses that can compromise system operation, and in dynamic conditions that can cause outleakage of contamination, even in ductwork that operates under negative pressure. Poor location of filter housings, fans, and dampers may limit their accessibility and thereby decrease ability to maintain the system. Also, since filters are collectors of radioactive (or potentially radioactive) dust, they can contain substantially greater concentrations of radioactive material than the air of the contained space served by the system. Changing filters in open attics or crowded spaces of the building increases risks at a time when risk is already higher than normal. Adequate access to and space surrounding housings and filter installations decreases this risk. Space allotted for access to housings and equipment must not be encroached upon for storage, field shops, or other operational conveniences during the life of the facility.

1.5 SYSTEM FLEXIBILITY

A shortcoming often encountered in ventilation and air cleaning system designs is failure to anticipate the possibility of future system modification. Although lack of ventilation system flexibility may create no problems in nuclear reactors and other facilities that have a fixed function, in radiochemical operations and particularly in laboratories and experimental facilities where change is almost standard procedure, provision for future system modification at the time of original system design can pay for itself many times over. The rebuilding of radioactively contaminated ducts and air cleaning systems is costly and hazardous, at best, and can be even more costly and hazardous when some provision for flexibility has not been left in the original design. Because of the radioactivity problem, the costs of modifying or rebuilding a nuclear plant exhaust or air cleanup system may run five to ten times the cost of similar work carried out in a nonradioactive system. Provision for expansion of a system, including extra housing space, reserve fan and motor capacity, additional tie-on points, and sufficient mechanical joints in ductwork to permit reasonably easy dismantling, should be given serious consideration in initial planning.

Temporary systems may not justify the extra capital investment for providing flexibility. Nevertheless, the designer should keep in mind that temporary systems often become permanent or are adapted for other purposes. Short cuts in design that make the modification of even a temporary system difficult can often become very costly to the owner in the long run.

1.6 COORDINATION OF DESIGN AND CONSTRUCTION

The mechanical contractor cannot be expected to supply more than the minimum requirements shown in the drawings and specifications. He cannot be expected to build a system having the special features and requirements of a nuclear air cleaning system unless the design details and specifications clearly define them. It is the functional designer's responsibility to correctly interpret the owner's needs and to develop clear and accurate system criteria. It is the mechanical designer's responsibility, in turn, to interpret these criteria and translate the functional design requirements into detailed equipment and construction drawings and specifications that can be followed by workmen with no experience in this specialty. It is also the mechanical designer's responsibility to ensure that the system, as it will be built, will meet the owner's needs in terms of a safe, effective, reliable, maintainable, and economic system.

An example of poor design and construction coordination occurred in a power reactor containment purge system. The facility designer, when allocating space for ventilation and air cleaning

equipment, allowed a nominal 144-in. width for a six-wide bank of 24- by 24-in. HEPA filters. No verification of this dimension was made by the mechanical designer, and the drawings went to the constructor who proceeded to pour concrete. The difficulty that developed is that a six-wide bank of 24- by 24-in. filters should be installed in a housing at least 151 in. wide (and preferably 158 in. wide) to provide room for a reliable filter mounting frame and to provide ease of filter changing. This type of error should have been recognized in the mechanical design stage. To make matters worse, no embedments were provided in the concrete to which the filter mounting frame could be seal-welded. This error resulted in a filter installation that is, at best, questionable.

It is also important for contractual relationships to be carefully defined and enforced. If the constructor is to be responsible for correct performance of the installed system, then test procedures, identification of the parties who will make and evaluate test results, and requirements for remedying errors and deficiencies must all be specified in the contract documents. It is not enough merely to require that the system meet some minimum dioctyl phthalate (DOP) test efficiency (usually 99.95%). If the system is to meet its intended service requirements, technical requirements must be carefully followed during preparation, review, and contractual acceptance of drawings and specifications, as well as during performance of the work in the field.

1.7 COST CONSIDERATIONS

Shortcuts and compromises with good design practice result in unduly high operating costs throughout the life of the system, as well as reduced system reliability and performance. A common error in the planning and design of nuclear air cleaning systems is to place too much emphasis on first (i.e., capital) costs. Minimizing first costs often results in high operating and maintenance costs if desirable optional features are omitted or if sacrifices are made in the amount or quality of space provided for components, equipment, and ductwork. During the life of the system, operating and service costs usually far exceed the first cost of building the system. A survey by the Harvard Air Cleaning Laboratory showed that operation and maintenance accounted for more than 85% of the total cost of owning a nuclear air cleaning system, based on 20-year amortization.[18]

Errors are sometimes made in choosing between alternate methods of accomplishing a desired objective because of the failure to consider all aspects of cost. When estimating capital costs of air cleaning systems, for example, the costs of special filter housings, dampers, fire protection facilities, clothing-change facilities, and other unusual (as compared with conventional air cleaning practice) provisions are often overlooked and may result in substantial avoidable maintenance costs for the sake of a few dollars' savings in first costs. For example, higher efficiency prefilters may greatly extend the life of the downstream HEPA filters and perhaps have longer life themselves, thereby increasing the time between filter changes. This is important because replacement of highly contaminated HEPA filters may cost as much as 50¢ per cfm of installed capacity.[19] Often, when estimating filter replacement costs, only the "do" phase of the operation is considered, with little or no heed given to the "make ready" and "put away" phases; yet these are generally the most time consuming and costly phases of a filter change in a nuclear air cleaning system. The time-consuming activities of clothing change, preinstallation inspections, health physics monitoring, and decontamination of the area and equipment after the change are often overlooked. Other factors overlooked are escalations of labor and materials cost and the ability to extend HEPA filter life by the selection of various combinations of prefilters, bank size, airflow rate, or other system parameters. Appendix B provides a form to assist the designer in estimating capital and operating costs and a form that breaks down a filter (or adsorber) change into at least its major elements.

1.8 PURPOSE OF THE HANDBOOK

The information given in this handbook will supplement the designer's previous knowledge and understanding of ventilation and air cleaning system design and construction by supplying background information on components and requirements for these very specialized applications. Hopefully through the use of this handbook, the experienced functional designer will be better able to evaluate an owner's requirements and to establish essential system criteria; the experienced mechanical designer will be better able to translate these criteria into effective system designs; and mechanical contractors will be provided with the knowledge needed to effectively carry out the intent of these designs to

provide safe, reliable systems at reasonable cost. The previous issue of the handbook[20] has provided background information for a growing family of national standards covering air and gas cleaning systems for nuclear applications; the new issue will hopefully assist designers and engineers in using and interpreting those standards. It is also hoped that the volume will provide a rationale for the engineer, the manager, and the designer to justify the more costly, but necessary, features that a nuclear air cleaning system demands.

1.9 GLOSSARY

1.9.1 Dictionary of Acronyms and Initialisms

ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
AEC	Atomic Energy Commission (see ERDA, NRC)
AFI	Air Filter Institute
AgX	Silver-exchanged zeolite
ALAP	As low as practicable (obsolete term for ALARA)
AISC	American Institute of Steel Construction
ALARA	As low as reasonably achievable
AMCA	Air Moving and Conditioning Association
AMD	Aerodynamic mean diameter (of particles)
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BET	Brunauer, Emmett, and Teller (test for surface area of adsorbents)
BWR	Boiling water reactor
CBR	Chemical biological radiological (filter)
CFD	Continuous fire detector
CH_3I	Methyl iodide
CFR	Code of Federal Regulations
CG	Concentration guide
CRSI	Concrete Reinforced Steel Institute
CWS	Chemical Warfare Service
DBA	Design basis accident
DBS	Deep-bed sand (filter)
DBGF	Deep-bed glass fiber (filter)
DF	Decontamination factor
DOP	Dioctyl phthalate
ERDA	Energy Research and Development Administration
ES	Equipment specification
ESF	Engineered safety feature (system)
FRP	Fiber-reinforced plastic
GMA	Gas metal arc (welding)
GTA	Gas tungsten arc (welding)
HEP	Hazard equivalent plutonium
HEPA	High-efficiency particulate air (filter)
HF	Hydrogen fluoride
HTGR	High-temperature gas-cooled reactor
HVAC	Heating, ventilating, and air conditioning
HWESF	Hanford Waste Encapsulation and Storage Facility
IAEA	International Atomic Energy Agency
IES	Institute of Environmental Sciences
KI	Potassium iodide
Kr	Krypton
LOCA	Loss-of-coolant accident
LMFBR	Liquid-metal fast breeder reactor
LWR	Light water reactor
MMD	Mass median diameter (of particles)
MPC	Maximum permissible concentration
MPL_d	Maximum permissible loading, desorption
MPL_i	Maximum permissible loading, ignition

NBS	National Bureau of Standards
NFPA	National Fire Protection Association
NMD	Number mean diameter (of particles)
NRC	Nuclear Regulatory Commission
NRL	Naval Research Laboratory
NSIC	Nuclear Safety Information Center
OBE	Operating basis earthquake
ORNL	Oak Ridge National Laboratory
PL	Permissible leakage
PSU	Permanent single unit (adsorber)
PVA	Polyvinyl acetate
PWR	Pressurized water reactor
QA	Quality assurance
QAS	Quality assurance station
RG	Regulatory Guide
RH	Relative humidity
RSIC	Reactor Shielding Information Center
RTV	Room temperature vulcanizing (sealant or caulking compound)
SAR	Safety analysis report
SGTS	Standby gas treatment system
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SRL	Savannah River Laboratory
SSE	Safe shutdown earthquake
TEDA	Triethylene diamine
TFE	Tetrafluoroethylene (plastic)
TLV	Threshold limit value
TURF	Thorium-Uranium Recycle Facility
UL	Underwriters' Laboratories
Xe	Xenon

1.9.2 Units of Measure and Metric Equivalents Used in This Handbook

cfm	cubic feet per minute	×	0.000472	= m^3/sec	cubic meters per second
fpm	feet per minute	×	0.00508	= m/sec	meters per second
ft	feet	×	0.3048	= m	meters
g	grams				
gal	gallons	×	3.78532	= liters	liters
gpm	gallons per minute	×	0.06309	= liters/sec	liters per second
gr	grains	×	0.0648	= g	grams
gr/ft^3	grains per cubic foot	×	2.288	= g/m^3	grams per cubic meter
hr	hours				
Hz	Hertz				
in.	inches	×	2.54	= cm	centimeters
in.wg	inches water gage	×	0.24836	= kPa	kilopascals
$in.^3$	cubic inches	×	0.01639	= liters	liters
lb	pounds	×	0.4536	= kg	kilograms
m	meter				
μm	micrometer				
mCi	millicuries				
μCi	microcuries				
min	minutes				
mR	milliroentgen				
millirem	milliroentgen equivalent man				
millirad	millirad				
ppm	parts per million				
psf	pounds per square foot	×	4.883	= kg/m^3	kilograms per cubic meter
psi	pounds per square inch	×	57.820	= g/cm^2	grams per square centimeter
rad	(unit of) radiation				
rem	roentgen equivalent man				
scfm	standard cubic feet per minute (see cfm)				
sec	seconds				
tonne	1000 kilograms				

1.9.3 Terms and Phrases

absolute filter. Obsolete term for HEPA filter.

acceptance test. A test made upon completion of fabrication, installation, repair, or modification of a system, unit, component or part to verify to the user or owner that the item meets specified requirements.

activation analysis. A method for identifying and quantitatively measuring chemical elements in a sample. Atoms in the sample are first made radioactive by bombardment with neutrons, charged particles, or other nuclear radiation; they then give off characteristic nuclear radiation by which they can be identified and their relative abundance can be determined.

adsorber. A device for removing gases or vapors from air by means of preferential physical condensation and retention of molecules on a solid surface. Adsorbers used in nuclear applications are often impregnated with chemicals to increase their activity for organic radioactive iodine compounds.

adsorber cell. A modular replaceable adsorber element.

AEC filter. A HEPA filter with fiberglass medium. Obsolete term for HEPA filter.

aerosol. A dispersion of very small particles and/or droplets in air.

air cleanup system. A system provided to decontaminate the air in, or exhausted from, a contained space following a system upset or prior to personnel access to the contained space.

air-generated DOP. See DOP.

ALAP. As low as practicable. Obsolete term for ALARA.

ALARA. As low as reasonably achievable. The design philosophy used to determine the need for, or extent of, air cleaning and off-gas facilities, based on their cost effectiveness in reducing adverse impacts with respect to offsite and onsite dose criteria. Formerly known as ALAP.

bag in, bag out. A method of introducing and removing items from a contaminated enclosure that prevents the spread of contamination or opening of the contaminated space to the atmosphere through the use of plastic bagging material.

case, casing. The frame or cell sides of a modular filter element.

clean-air device. A clean bench, clean work station, downflow module, or other equipment designed to control air cleanness (particle count) in a localized working area and incorporating, as a minimum, a HEPA filter and a fan.

clean-air system. An air cleaning system designed to maintain a defined level of air cleanness, usually in terms of a permissible number of particles in a given size range, within an enclosed working area.

clean room. An occupied room designed to maintain a defined level of air cleanness under operating conditions. Inlet air is cleaned by HEPA filters.

coating. Paint or other protective surface treatment applied by brushing, spraying, or dipping (does not include metallic plates).

contained space (contained volume). A building, building space, room, cell, glove box, or other enclosed volume in which air supply and exhaust are controlled.

containment (containment vessel or building). A gastight enclosure around a nuclear reactor or other nuclear facility designed to prevent fission products from escaping to the atmosphere.

contaminated exhaust system. An air cleaning system that is designed to remove harmful or potentially harmful particulates, mists, or gases from the air exhausted from contained space.

contamination. Any unwanted material in the air, in process fluids, or on surfaces. For the purposes of this handbook, contamination is usually assumed to be radioactive.

contamination zone. An isolable area which is, or which could become, contaminated and which is designed to facilitate decontamination.

controlled area. An area to which access is restricted.

cover gas. An inert gas, under pressure, provided in a contained space or process equipment item to prevent inleakage of air.

criticality. The state of sustaining a chain reaction, as in a nuclear reactor. When fissionable materials are handled or processed, they must be kept in a subcritical geometry, configuration, or mass to avoid accidental criticality.

critical system, unit, or item. One that is essential for adequate or safe operation, failure of which would cause loss of function.

CWS filter. Chemical Warfare Service filter—a term used for a HEPA filter with cellulose-asbestos

medium, kraft paper separators, and untreated plywood casing. Obsolete term for HEPA filter.

decay heat. The heat produced by radioactive materials as nuclides spontaneously transform into other nuclides or into different energy states. Each decay process has a definite half-life.

decontamination. The removal of unwanted substances from personnel, rooms, building surfaces, equipment, etc.

decontamination factor. A measure of air cleaning effectiveness; the ratio of the concentration of a contaminant in the untreated air or gas to the concentration in the treated air or gas.

demister. The preferred generic term for devices used to remove entrained moisture from air (see *Thesaurus of Engineering and Scientific Terms*). Also a trademark of Otto H. York Company.

design basis accident (DBA). The most serious accident that can be hypothesized from an adverse combination of equipment malfunction, operating errors, and other unforeseen causes.

design pressure. The pressure that is used for the structural design of a unit, component, or system, and which includes allowance for forces encountered under system upset conditions.

double filtration. An arrangement of two filters in series with the second providing backup protection against leakage or failure of the first. Also a series arrangement intended to increase the total filtration efficiency.

DOP aerosol. A dispersion of dioctyl phthalate (DOP) droplets in air. Monodisperse DOP is generated by controlled vaporization and condensation of liquid dioctyl phthalate to give a cloud of droplets with diameters of approximately 0.3 μm. Polydisperse DOP is generated by blowing compressed air through liquid dioctyl phthalate and exhausting through special nozzles under controlled conditions to produce a cloud of droplets with a light-scattering mean diameter of approximately 0.7 μm.

dose. The amount of ionizing radiation energy absorbed per unit mass of irradiated material at a specific location. In the human body it is measured in rems; in inanimate bodies it is measured in rads.

double containment. An arrangement of double barriers in which the second barrier provides backup protection against leakage through or failure of the first.

dry-type filter. A filter having a medium that is not coated with an oil or adhesive to improve its retention of large particles.

enclosed filter. A filter that is completely enclosed on all sides and both faces except for reduced end connections or nipples for direct connection into a duct system. Enclosed filters are installed individually because there is a separate run of duct to each filter unit.

engineered safety feature (ESF). A unit or system that is provided to directly mitigate the consequences of a DBA.

extended-medium filter. A filter having a pleated medium or a medium in the form of bags, socks, or other shape to increase the surface area relative to the frontal area of the filter.

face guard. A screen, usually made from 4-mesh galvanized hardware cloth, permanently affixed to the face of a filter unit to protect it against damage caused by mishandling.

face shield. A screen or protective grille placed over a filter unit after it is installed to protect it from damage that might be caused from operations carried on in the vicinity of the filter.

fail safe. A design to give equipment the capability to fail without producing an unsafe condition.

filter. A device having a porous or fibrous medium for removing suspended particles from air or gas that is passed through the medium.

filter bank. A parallel arrangement of filters on a common mounting frame enclosed within a single housing.

final filter. The last filter unit in a set of filters arranged in series.

functional design. The establishment of airflow rates, airflow capacities, types of components to be employed, general system layout, operational objectives and criteria, decontamination factors and rates, space allocations, and other overall features of a system.

gas chromatograph. An analytical instrument used for quantitative analysis of extremely small quantities of organic compounds whose operation is based upon the absorption and partitioning of a

gaseous phase within a column of granular material.

gas residence time. The calculated time that a contaminant or test agent theoretically remains in contact with an adsorbent, based on active volume of adsorbent and air or gas velocity through the adsorber bed.

glove box. A sealed enclosure in which all handling of items inside the box is carried out through long rubber or neoprene gloves sealed to ports in the walls of the enclosure. The operator places his hands and forearms in the gloves from the room side of the box so that he is physically separated from the glove box environment but is able to manipulate items inside the box with relative freedom while viewing the operation through a window.

HEPA filter. High-efficiency particulate air filter—also obsoletely known as AEC, CWS, superinterception, absolute, and superhigh-efficiency filter. A throwaway extended-pleated-medium dry-type filter with (1) a rigid casing enclosing the full depth of the pleats, (2) a minimum particle removal efficiency of 99.97% for thermally generated monodisperse DOP smoke particles with a diameter of 0.3 μm, and (3) a maximum pressure drop of 1.0 in.wg when clean and operated at its rated airflow capacity.

hot. Highly radioactive.

hot cell. A heavily shielded enclosure in which radioactive materials can be handled remotely with manipulators and viewed through shielding windows to limit danger to operating personnel.

in-box. Refers to an item within a glove box that can be handled or manipulated only by means of the box gloves or tools within the box.

in-cell. Refers to an item located within a cell or enclosure that can be handled or manipulated only by means of manipulators and/or a crane and other tools within the cell.

in-duct filter. Refers to a single-filter arrangement in which the filter unit is clamped between two sections of duct or taped into a space between two sections of duct.

in-place test. Penetration test of filter units or charcoal adsorbers made after they are installed.

inches of water. A unit of pressure or pressure differential (1 in.wg = 0.036 psi).

ionizing radiation. Any radiation (alpha, beta, or gamma) that directly or indirectly displaces electrons from the outer domains of atoms.

isotope. One of several forms or nuclides of the same chemical element that have the same number of protons in the nucleus and therefore have the same chemical properties, but have differing numbers of neutrons and differing nuclear properties.

kidney system. An air cleaning system that recirculates the air of a contained space.

leaktightness. The condition of a system, unit, or component where leakage through its pressure boundary is less than a specified maximum value at a specified pressure differential across the pressure boundary.

maximum permissible dose. The dose of ionizing radiation which competent authorities have established as the maximum that can be absorbed without risk to human health.

mechanical design. Detailed design of a system which results in exact layouts, equipment specifications, shop drawings, installation details and drawings, sizing and layout of ducts, housings and equipment, and other details necessary to achieve the objectives and meet criteria established in functional design.

medium (plural, media). The filtering material in a filter.

mounting frame. The structure to which a filter unit is clamped and sealed.

normal off-gas. The normal gaseous discharge from a process or process equipment item.

nuclear reactor. An apparatus in which a chain reaction of fissionable material is initiated and controlled.

off-gas. The gaseous effluent from a process or operation.

off-line system. One that is not operating or is normally held in standby.

on-line system. One that is operating or is normally in operation, as opposed to an off-line system.

open-face filter. A filter with no restrictions over the ends or faces of the unit, as opposed to the enclosed filter with reduced-size end connections.

operating pressure. The desired pressure corresponding to any single condition of operation.

overpressure. Pressure in excess of the design or operating pressure.

particle, particulate. A minute piece of solid matter having measurable dimensions. Also a radioactive particle (alpha, beta) which can liberate ionizing radiation or (neutron) which can initiate a nuclear transformation.

penetration. The measure of the quantity of a test agent that leaks through or around an air cleaning device when the device is tested with an agent of known characteristics under specified conditions; penetration is expressed as a percentage of the concentration of the test agent in the space upstream of the air cleaning device.

poison. Any material that tends to decrease the effectiveness of an adsorbent by occupying adsorption sites on the surface of the adsorbent or by reacting with the impregnants in the adsorbent.

prefilter. A filter unit installed ahead of another filter unit to protect the second unit from high dust concentrations or other environmental conditions. The prefilter usually has a lower efficiency for the finest particles present in the aerosol than the filter it protects (see **roughing filter**).

production test. A test made on each item or a sample of items or product from a production run to verify that the item meets specification requirements.

PSU adsorber. An adsorber that is permanently installed in a system and that can be emptied of and refilled with adsorbent without removing it from the system.

qualification test. A test made on a product or equipment item when it is proposed as a candidate to meet certain service requirements, which will verify to the user or owner that the item can meet his requirements (see **production test**).

rad. Radiation absorbed dose, the basic unit of ionizing radiation. One rad is equal to the absorption of 100 ergs of radiation energy per gram of matter.

radiation. The propagation of energy through matter or space in the form of electromagnetic waves or fast-moving particles (alpha and beta particles, neutrons, etc.). Gamma rays are electromagnetic radiation in which the energy is propagated in "packets" called photons.

radioactivity. The spontaneous decay or disintegration of an unstable atomic nucleus accompanied by the emission of radiation.

redundant unit or system. An additional and independent unit or system which is capable of achieving the objectives of the basic system and is brought on-line in the event of failure of the basic system.

rem. Roentgen equivalent man. The unit of absorbed radiation dose in rads multiplied by the relative biological effectiveness of the radiation.

roughing filter. A prefilter with high efficiency for large particles and fibers but low efficiency for small particles; usually of the panel type.

scrubber. A device in which the gas stream is brought into contact with a liquid so that undesirable components in the gas stream are removed by reacting with or dissolving in the liquid.

separators. Corrugated paper or foil (usually aluminum alloy or plastic) used to separate the folds of a pleated filter medium and to provide air channels between them.

service environment. The aggregate of conditions (temperature, pressure, humidity, radioactivity, chemical contaminants, etc.) that surround or flow through a system, unit, or component while serving the conditions of design.

shielding. A mass of absorbing material placed around a radioactive source to reduce ionizing radiation to levels not hazardous to personnel.

shock overpressure. The pressure intensity over and above atmospheric or operating pressure produced by a shock wave from an explosion, a suddenly closed damper, or other event.

specific radioactivity. Radioactivity per unit weight of a material.

spill. Accidental release of radioactive or other contaminating materials.

split system. A filter system consisting of two or more trains operating in parallel; one or more of the trains may be on standby.

standby system. One held in reserve.

surveillance test. A test made periodically to establish the current condition of a system, unit, component, or part.

system upset. An accident, system malfunction, or transient condition.

test program. A formalized schedule of tests which specifies the sequence of tests, the procedures to be employed, and the acceptance criteria.

train. A set of components arranged in series. In a filter system this may be as simple as a damper, HEPA filter, fan, and damper or as complex as a damper, condenser, moisture separator, heater, prefilter, HEPA filter, charcoal adsorber, another charcoal adsorber, HEPA filter, fan, and damper.

treatment. The process of removing all or a part of one or more chemical components, particulate components, or radionuclides from an off-gas stream.

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13. Number decontamination factor, DF, is the ratio of the number concentration of particles in the unfiltered air to the number concentration in the filtered air. Where no subscript is appended, decontamination factor in this handbook means number decontamination factor, as opposed to decontamination factor based on mass of particulate (DF_m), intensity of radioactivity (DF_r), or volume concentration (DF_v).

14. E. J. Bauer et al., "The Use of Particle Counts For Filter Evaluation," *ASHRAE Journal*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, October 1973, pp. 53–59.

15. IES CS-1, *Standard for HEPA Filters*, Institute of Environmental Sciences, Mt. Prospect, Ill., current issue. (Formerly American Association for Contamination Control.)

16. The efficiency of a HEPA filter is based on its absolute particulate collection effectiveness; that is, the efficiency is relative to the number of particles present (see Sect. 3.2). The efficiency of common air filters, on the other hand, is based on the mass concentration of particulate matter (see Table 2.4) or on the staining effect of particulates on a reference surface, which is, of course, very subjective.

17. "Hazardous Solvent Use Causes Explosion In Glove Box" in *Serious Accidents*, U.S. Atomic Energy Commission, Issue No. 261, Feb. 25, 1966.

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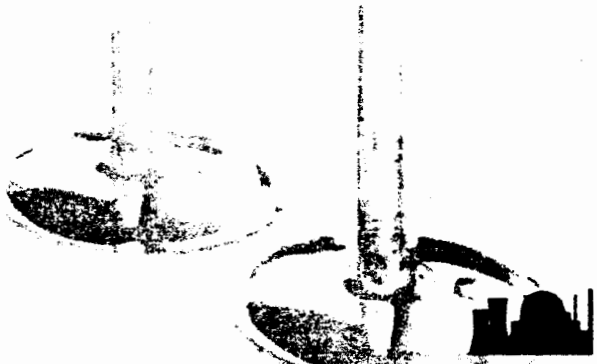

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FILTRATION THEORY

II. FILTRATION THEORY

An air stream is broken up into many smaller streams as it traverses the narrow, tortuous passages within a porous filter bed and entrained dust particles are brought into close proximity to the filter elements. Filtration takes place when a dust particle in the air contacts a filter fiber and sticks to it. All filters remove particles very much smaller than the smallest pores or openings so that removal of particles by "straining" is not a major consideration.

As a matter of fact, if particles were removed by straining, all pores would soon become completely clogged by one or more particles and air flow would cease. Instead, particle deposition takes place throughout the depth of the filter and, ideally, a dense, high resistance dust layer does not build up on the filter surface.

Deposition of particles on filter fibers occurs in several ways. It is believed that electrostatic attraction between particle and filter may be of importance in some cases. It is known that many airborne particles possess a measurable electrical charge and it has been theorized that filters composed of synthetic plastics capable of acquiring a substantial electrical charge by friction would make excellent filters. In practice, results with plastic filter elements have not been especially impressive. At the present time too little is known about the role of electrostatic charge in air filtration.

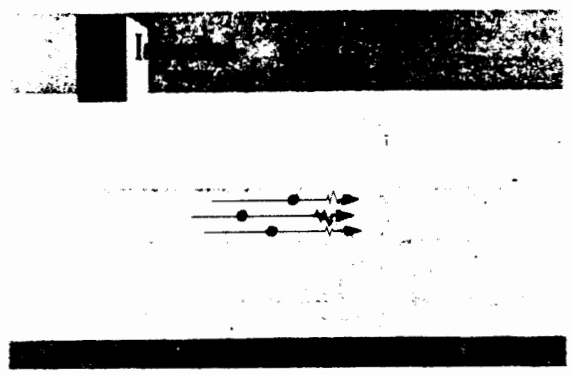
Direct interception also plays a part in filtration; in effect, a particle flowing through the porous bed literally bumps into a fiber directly in its path. This filtration action, like straining and electrostatic charge, is believed to be of minor importance in the majority of cases.

Most dust separation takes place by ***impaction*** and by ***diffusion.*** Diffusion accounts for the collection of small particles, i.e., those less than 1.0 micrometer and especially those less than 0.1 micrometer, while impaction is generally effective for larger particles.

IMPACTION

As air flows through a filter, it encounters obstacles in the form of randomly-oriented fibers and it must bend or change its direction to flow around these fibers.

Because of their inertia, particles resist change in direction and tend to continue on in their original paths and to collide with fibers regardless of the changing path of the air.

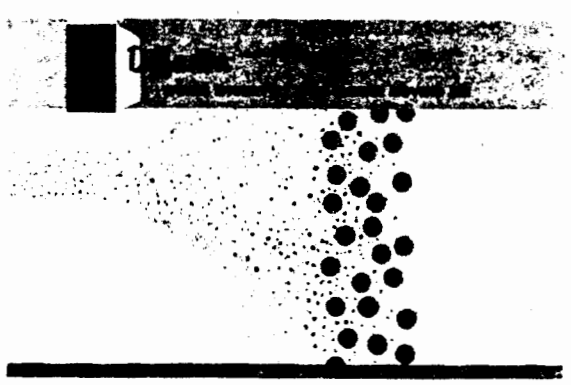


The effectiveness of particle collection by impaction is improved by increasing filtration velocity and decreasing the diameter of the filter fibers. For a given filter and air flow rate, collection efficiency improves with particles of larger size.

DIFFUSION

In some respects, very small particles behave as true gases. If a difference in concentration of particles exists in one area of the air stream, particles from another area tend to diffuse from the region of higher to the region of lower concentration until a uniform distribution is reached.

Since the concentration of particles in the air in the vicinity of a fiber surface is zero (i.e., particles contacting the fiber surface are held and cannot be re-entrained into the air stream), particles "stream" or "diffuse" from the main body of gas toward the fibers. Diffusion is favored by small diameter filter fibers and low gas velocities



through the filter bed and is effective for small particles only.

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when the filter resistance exceeds the mechanical strength of the fibers, whereas beds of stiff, large-diameter fibers remain rigid even when plugged with dirt, (although there is a tendency for dirt to blow through the rigid structure when dust buildup is excessive). Filters composed of coarse fibers, as well as electrostatic precipitators, are customarily coated with a sticky oil to prevent dirt "blowoff".

Service life is an important filter characteristic since it is directly related to the cost of replacement and maintenance services.

II. FILTER TESTING

Several standard tests have been developed for rating air filters. Historically, a method proposed by the American Society of Heating and Ventilating Engineers (ASHVE) in 1933 was the first to receive general acceptance for testing panel-type air filters for supply air service and it is still in use today. In 1938, the National Bureau of Standards (NBS) proposed a test method having special application for electrostatic precipitators but it was used, also, with filters capable of capturing particles of small size. In 1951, one filter manufacturer proposed a modified ASHVE test in which a series of test dusts of narrow particle size range would be used for filter evaluation. Another group of approximately a dozen filter manufacturers, acting together as the American Filter Institute (AFI), proposed a different modification of the ASHVE test and have submitted it to the U.S. Dept of Commerce for acceptance as a voluntary trade standard.

During World War II the Army Chemical Corps engaged in extensive research and development activities directed toward improving smoke filters for use in service gas masks. Since gas mask filters must possess filtration efficiencies far greater than those required of supply air cleaners, the ASHVE and NBS tests were totally inadequate as they lacked the ability to discriminate between smoke filters of varying capability. Therefore, the Chemical Corps adopted the DOP test which is based on the use of a dioctyl phthalate test smoke of extremely small size and an optical evaluation of the smoke fraction penetrating the filter.

Many other test methods and test aerosols have been used for experimental studies of filter performance but most commercial filters are rated by one or more of the above test methods. Therefore, each will be described in some detail and its proper field of application and limitations noted.

A. ASHVE Test*

For this test a filter is operated at its rated air flow capacity and a known weight of a prepared dust is injected into the air supply to the filter. A measured fraction of the cleaned air is passed through a sampling filter and the collected dust determined by weight. Filter efficiency is determined on a weight retention basis from the dust loading in the cleaned air and the dust loading in the entering air, calculated from (1) the known weight of dust fed to the filter (2) the air flow rate and (3) the duration of the test. Dust loading to the filter should be approximately 1 grain per thousand cubic feet and the duration of the test at least 30 minutes.

The test dust is composed of 50% by weight lamp black and the remainder ash from Pocohontas coal passing a 200 mesh screen (i.e. <74 microns in size).

The principal objections to the ASHVE test are as follows:

1. since the test dust dispersal mechanism does not break up the lamp black fraction into unitary particles and since the coal ash contains many large particles, in any case, even the poorest air filters receive high dust retention ratings by this test. All filters reasonably effective for the removal of ordinary atmospheric dust uniformly give $>99\%$ dust retention efficiency by the ASHVE test. Therefore, it is a reasonable test method for filters designed to remove only the very coarsest atmospheric particles.

2. the test dust is not adequately specified so that users may be assured of starting with the same particle size content. In addition, the dust dispersal mechanism has not been sufficiently well defined to prevent very great variations in size composition of test dusts generated by various laboratories. Consequently, it has been difficult to duplicate test results in other laboratories.

3. dust is injected at a single point upstream of the filter and good dust distribution across the entire face of the filter is not always obtained, especially with filters having very low air flow resistance.

4. when poor dust distribution exists ahead of the test filter, considerable difficulty may be

This information has been superseded by recent ASHRAE test criteria. Complete information was not available for this printing.

RATING AIR FILTER PERFORMANCE

experienced in obtaining a truly representative sample on the clean air side of the filter undergoing tests.

B. ASHRAE Test Description

ASHRAE Standard 52-68 is a method of testing air cleaning devices used in general ventilation for removing particulate matter. The test procedures described in this standard are based on principles employed for many years in determining the comparative performance of air cleaning equipment. The standard defines terms used in the industry. It clarifies ambiguities such as the difference between the Dust Spot Test Procedure and a test employing injection of a synthetic aerosol such as ASHRAE standard test dust.

None of the other tests described herein yield results which are absolutely reproducible. However, the use of the methods described in ASHRAE 52-68 will at least assure that each tester of air filters will be using standardized methods and equipment.

The standard describes the Atmospheric Dust Spot Test and equipment in detail, and how to determine the efficiency of an air cleaning device when using that method. It also describes synthetic dust loadings, and how to determine dust arrestance, and how to graphically display such pairs as efficiency versus dust loading, and pressure drop versus dust loading.

The ASHRAE 52-68 test is a test procedure based upon the atmospheric test method to determine filter *efficiency*. Using a synthetic dust loading, it also determines *arrestance*.

The term efficiency refers only to those tests which are related to atmospheric air and its contaminants. The term arrestance refers to tests which measure the weight of a synthetic dust which has been injected into the airstream.

Efficiency is determined by opacity of filter targets. Two filter targets are employed. One is located downstream of the filter being tested and is run 100% of the time. The other is located upstream of the filter and is run intermittently as controlled by a percentage meter. The percentage of "on" time for the upstream sample is adjusted so that both upstream and downstream targets are of equal opacity at the end of the tests.

Efficiency then (in percent) $E=100\left(1-\frac{Q_1}{Q_2}\cdot\frac{O_2}{O_1}\right)$

Where: Q_1 - total quantity of air drawn through the upstream target.

Q_2 - total quantity of air drawn through the downstream target.

O_1 - Opacity of dust spot on upstream target.

O_2 - Opacity of dust spot on downstream target.

Arrestance is determined by feeding a standard test dust* into a wind tunnel which holds the test filter. Increments of dust are fed into the test filters (each increment not to exceed 2 gm per 1000 CFM of test air) until the filter reaches a given pressure drop. Any dust that is passed by the test filter is captured in an accurately weighed (to nearest 0.5 gm) HEPA filter. Then, the fan is shut off and the filter is weighed again. All dust in the duct between the test filter and the HEPA filter is collected and weighed.

The arrestance is determined as follows:

$$A=100\left(1-\frac{W_2}{W_1}\right)$$

W_2-weight of dust passing test filter.

W_1-weight of dust fed.

* Composed of 72% by weight standardized air cleaner test dust fine; 23% Molocco black, 5% by weight no. 7 cotton linter ground in a Wiley Mill to pass a 4 mm screen in the mill.

For example: Suppose 600 gms of dust were fed, and the total amount of dust passing the test filter was 100 gm. Then W_2=100 gm

W_1=600 gm

$$A = 100\left(1-\frac{100\text{ gms.}}{600\text{ gms.}}\right)$$

$$=100\left(1-.17\right)$$

$$=83\%$$

RATING AIR FILTER PERFORMANCE

C. NBS Discoloration Test

The purpose of this test is to measure the reduction in soiling properties of ventilation air on the assumption that this is one of the major objectives of supply air cleaning. It is a more rigorous test than that provided by the ASHVE method. Samples of cleaned and uncleaned air are drawn through white paper sampling filters simultaneously and the sampling rate of the cleaned air adjusted until the two white sampling filters discolor at the same rate. Dust collection efficiency is determined from the ratio of the two sampling rates. Discoloration of the test filter papers is measured with a photocell by noting the decrease in intensity of a standard illumination source shining through the paper. Atmospheric dust is commonly used as the test material for electrostatic precipitators and the more efficient types of fibrous filters. For less efficient filters, and for accelerated tests, the NBS specifies an *artificial test dust* composed of 96% by weight of Cottrell-precipitated pulverized fuel fly ash plus 4% carbon black. In addition, cotton linters may be injected into the air stream to test lint holding capacity of a filter.

The principal objection to the NBS discoloration test (using outdoor air as the test aerosol) is that atmospheric dust varies in size, loading, and composition depending on location (e.g. rural, urban, and industrial atmospheres), season and weather (dry, windy weather produces large quantities of coarse airborne dust whereas practically all dust disappears following a rain or snow storm). Therefore, it is often impossible to duplicate results from day to day or from city to city. Objections to the NBS test using the resuspended synthetic test dust are similar to those cited for the ASHVE test.

D. Fractional Particle Size - Efficiency Air Filter Test

This test follows the procedures of the ASHVE method quite closely except that it substitutes size-graded fractions of Arizona road dust for the test dust composed of 50% Arizona road dust and 50% lamp black. Five test dusts are prepared by elutriation and size graded into fractions containing particles of 0-5, 5-10, 10-20, 20-40 and 40-80 micrometers. The unknown filter is tested successively with each of the sized dust fractions and the test data plotted to yield a smooth curve showing filter efficiency (expressed as the % by wt. retained) for each particle size in the range 0-80 micrometers.

From the theoretical standpoint, this procedure represents an excellent test method, as the results can be used to estimate filter efficiency against a wide variety of aerosols. Further improvements, compared to the ASHVE test, include injection of the test dust at 4 points in the duct cross section (instead of a single dust feed point) and an improved dust dispersion mechanism.

Objections have been raised that the dust separation techniques do not yield fractions sufficiently uniform in size to make the results obtained by this method very reliable. In any case, as the procedure requires 5 times as many filter efficiency tests as the ASHVE and NBS methods, its use has not been widely accepted.

E. AFI Test Code

Section I of the AFI test code, applying to unit viscous impingement and dry-type air filters used in general ventilation, and Section II, applicable to electrostatic precipitators and filters capable of removing the discoloring particulate materials from atmospheric air are the only parts now available. Section III, for testing self cleaning impingement type filters, has not been published as yet. Section I of the AFI test is closely similar to the ASHVE test procedure but seeks to improve it by specifying a standard test dust available from a commercial source. Dust content of the cleaned air is determined not from sampling downstream of the filter, as in the ASHVE test and NBS test, but by passing all the cleaned air through a second filter (capable of retaining not less than 99% of the dust passing the test filter) and measuring the weight increase. As in the ASHVE and fractional size-efficiency test, inlet dust loadings are determined from the weight of dust fed into the air stream over a known time interval and a knowledge of the air flow rate. In addition, the dust dispersal mechanism and operational details are closely regulated so that although there is no assurance that the bulk powders are completely dispersed, it is claimed that there is at least good reproducibility of the size characteristics of the aerosol that is produced.

The test dust selected by the AFI contains 72% Arizona road dust-fine; 24% K-1 carbon black and 3% no. 7 cotton linters.

Section II of the AFI test is a modified NBS atmospheric dust discoloration test. The test equipment and manner of conducting the test are specified in considerable detail.

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F. DOP Test For Filter Efficiency

As practiced by the Army Chemical Corps, a homogeneous dioctylphthalate fog is generated by mixing air containing DOP vapor at 170°C and clean air at 25° C in a volume ratio of 1:4. The concentration is adjusted to about 40 grains per thousand cubic feet and particle size to 0.3 micrometer. Commercial filters are usually tested at 5 and filter papers at 10.5 fpm air velocity. Particle size and smoke concentrations upstream and downstream of the test filter are determined to a very high degree of accuracy by optical methods utilizing the relative amount of light scattered by the smoke particles.

G. DOP Test For Detecting Pinhole Leaks

The nineteen sixties was the decade of the aerospace and micro electronics industry. Before this time the uses for the absolute filters were largely for radioactive containment. Although there are many other industries that use HEPA filters today, none was so important to the growth into commercial application as the aerospace and electronics industries. With the miniaturization of parts and the requirements for exacting tolerances, engineers began looking for methods of isolating or controlling the areas that were critical in the production or use of these parts. It was no accident that HEPA filters used to "contain" radioactivity were selected as the best and simplest means of controlling harmful airborne contaminants. Early in the sixties means were developed to test clean rooms and clean benches which used absolute or HEPA (High Efficiency Particulate Air) filters. HEPA filters had always been tested for their overall efficiency at the manufacturer's plant, but never had they been subjected to leak testing. It was something of a discovery to find that a filter that was 99.97% efficient on three tenths of a micron could possibly have detectable leakage. The demand for no-leak or zero-probe filters forced manufacturers to establish a second factory test in addition to the efficiency test for buyers wishing leak-tested filters. Flanders calls filters which have been given the probe test SUPER-SEAL filters. These filters have the additional designation "-SL" as a stock number suffix. Hence, a filter that normally would be a (ex.) 7C70-L would become 7C70-SL. These filters are catalogued as Laminar Flow Grade filters.

The probe or scan test as it is usually called varies from the "hot" or thermally-generated DOP test in several ways. First it is a probing of the entire downstream side of the filter to detect "pinhole" leaks. The challenge medium is dioctylphthalate oil which is generated into an aerosol or "cold" fog using air pressure. This aerosol differs from the "hot" DOP in that particle size is not fixed, but covers a range from 0.35 microns. The upstream concentration is fixed at an established amount. A leak is determined as any downstream reading greater than 0.01% of the upstream concentration.

Particle Size Distribution (Ambient Operating Temperature)

99% Less than 3.0 micron
95% Less than 1.5 micron
92% Less than 1.0 micron
50% Less than 0.72 micron
25% Less than 0.45 micron
10% Less than 0.35 micron

The instruments used to detect pinhole leaks in HEPA filters are simpler, far less expensive and are portable compared to the massive instrument that is used to gauge a filter's efficiency. Most probe-tested filters are used in areas such as clean rooms, clean benches, and hoods. In other words, where laminar flow is required the requirement is almost always for a probe-tested filter. The specifications relating to probe tested filters and clean rooms are listed in the clean room systems and products section of our catalog.

Summary

Test codes generally provide for the evaluation of filter resistance by measurement over a range of air flow rates. Dust retention capacity is defined by the AFI code as the weight of the dust in grams which the filter will retain before either (a) 3 consecutive arrestance values are less than 85% of the peak arrestance or (b) resistance of the device reaches the limit recommended by the manufacturer.

In practice, a viscous coated, impingement type filter, capable of retaining 80-95% by wt. of the ASHVE, NBS and AFI redispersed standard test dusts would not be likely to give more than 40-60% efficiency by the NBS discoloration test using resuspended fly ash as the test aerosol nor more than 10-30% efficiency by the NBS discoloration method using atmospheric dust as the aerosol.

Figure 4 summarizes the important characteristics of the various test codes. The ASHVE,

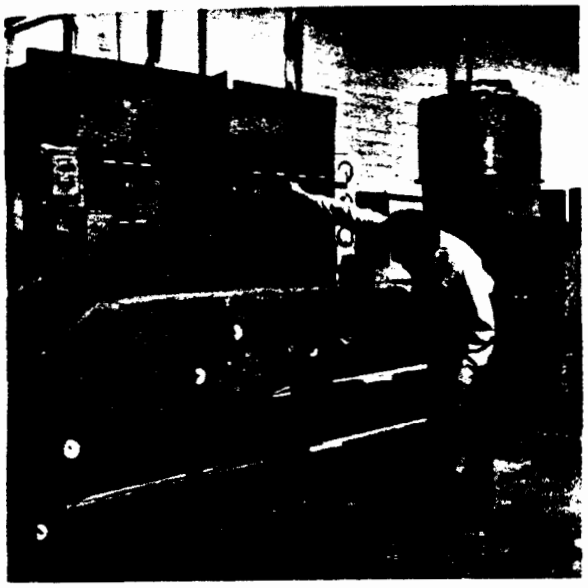
RATING AIR FILTER PERFORMANCE

Test Method	Test Dust	Method of evaluating inlet dust loading	Method of evaluating outlet dust loading	Method of evaluating filter efficiency	Class of filters for which test method is most applicable
ASHVE	Synthetic dust composed of 50% lamp black and 50% ash from Pocahontus coal passing 200 mesh sieve	Pre-weighed charge of dust fed to filter	Air is sampled and weight increase of sample filter measured	Percent retention by weight	Viscous-coated impingement-type ventilation air filters
ASHRAE Efficiency	Atmospheric dust	Staining or discoloration of a white filter paper	Same as inlet	Percent reduction in discoloration properties	Electrostatic precipitators and fibrous air filters capable of effecting substantial reduction in staining properties of ventilation air
ASHRAE Arrestance, Dust Loading	72% Standardized air cleaner test dust, fine. 23% Molocco Black. 5% no. 7 cotton linters	Staining or discoloration of a white filter paper	Air is sampled and weight increase of sample filter measured	Percent retention by weight	Electrostatic precipitators and fibrous air filters capable of effectingsubstantial reduction in staining properties of ventilation air
NBS (a)	Atmospheric dust	Staining or discoloration of a white filter paper	Same as inlet	Percent reduction in discoloration properties	Electrostatic precipitors and fibrous air filters capable of effecting substantial reduction in staining properties of ventilation air.
NBS (b)	Synthetic dust composed of 96% Cottrell-precipitated pulverized coal fly ash and 4% lamp black. Cotton linters may be introduced from a separate feed nozzle	Same as when using atmospheric dust	Same as when using atmospheric dust	Same as when using atmospheric dust	Same as for ASHVE test method. In addition may be used as an accelerated test of air cleaners for which atmospheric dust is a suitable test dust
Fractional Efficiency Method	Arizona Standard Road Dust-fine, separated into 5 fractions containing particles between 0-5, 5-10, 10-20, 20-40, and 40-80 micrometers	Air is sampled and weight increase of sample filter measured	Same as inlet dust loading	Percent retention by weight for each size fraction	Same as for ASHVE test method. Smallest size fraction may have application to tests on filters capable of removing staining fraction of atmospheric dust
AFI Section I	Synthetic dust composed of 72% Arizona Standard Road Dust Fine, 25% K-1 carbon black, 3% No. 7 cotton linters	Same as for ASHVE test	All of cleaned air passed through a pre-weighted filter capable of retaining dust penetrating filter undergoing test	Percent retention bt weight	Same as for ASHVE test method
AFI Section II	Atmospheric dust	Staining or discoloration of a white filter paper	Same as inlet	Percent reduction in discoloration properties	Electrostatic precipitators and fibrous air filters capable of effecting substantial reduction in staining properties of ventilation air
DOP Efficiency (Mil-Std-282)	Droplets of dioctyl-phthalate; uniformly 0.3 micrometer in size	Electronic measurement of amount of light scattered by DOP	Same as inlet loading	Percent by number of droplets penetrating filter	Absolute-type filters and those possessing similar filtration characteristics

RATING AIR FILTER PERFORMANCE

fractional particle size-efficiency, and AFI Section I tests are applicable only to viscous-coated impingement-type panel filters effective for the collection of fibers and coarse particulate material. The NBS and AFI Section II tests, based on discoloration, are applicable to the testing of electrostatic precipitators and air filters capable of removing greater than 95% of the weight of dust plus substantial fractions of the fine (less than 1 micrometer) stain-producing fractions. The DOP test is reserved for evaluating the most efficient filters (called absolute filters) and others of somewhat lesser capabilities.

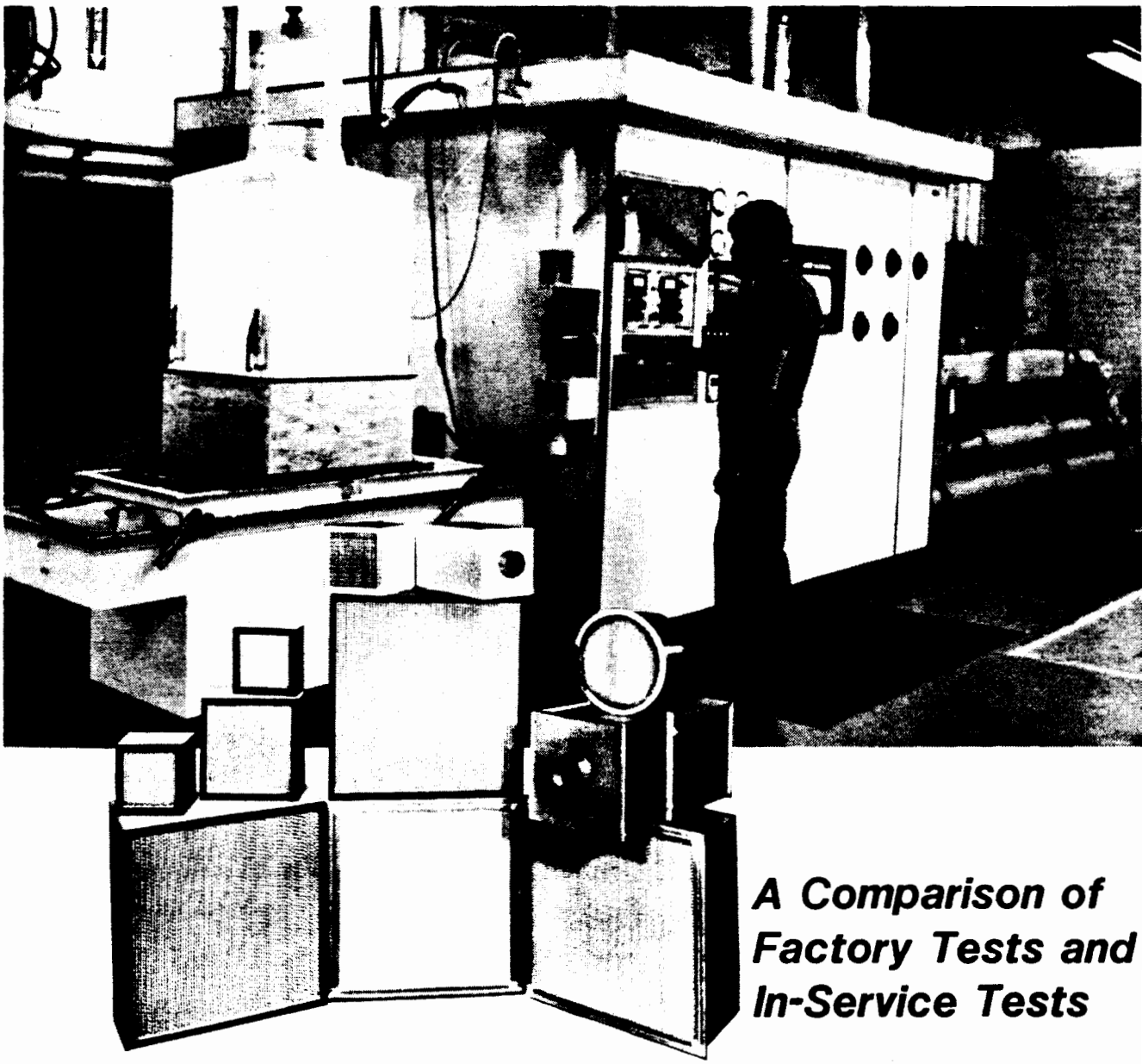
All the test methods yield comparative results only, which may or may not be an accurate reflection of results obtainable in practice. The tests are useful as an ***index of performance*** and may be valuable for comparing one filter with another under identical conditions. The wide range of air contaminants encountered in practice and the varied requirements of users make the application of a single universal filter test impractical. However, among the several tests which are available it is usually possible to select one which most closely duplicates the conditions under which the filter must operate.



Adjusting DOP test equipment for particle size.

Measuring concentration of smoke upstream of filter.

Flanders®



A Comparison of Factory Tests and In-Service Tests

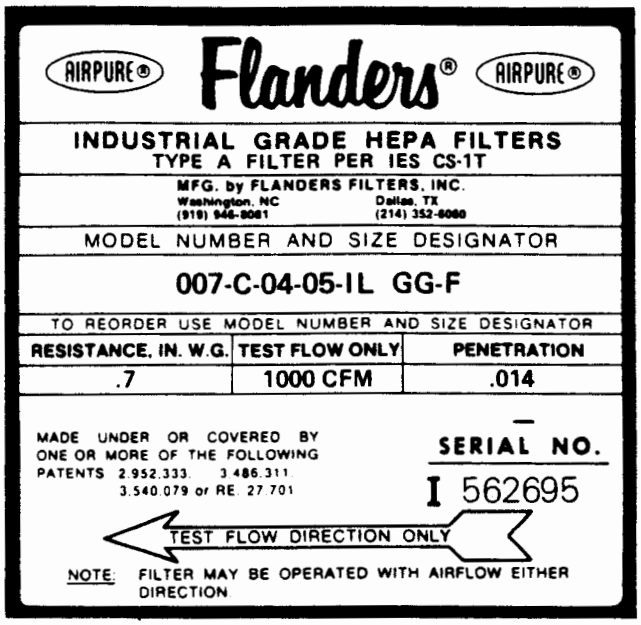
2nd Edition

HEPA FILTERS and FILTER TESTING

Efficiency Testing or, The "Hot" DOP Test

By definition, a hepa filter has a minimum efficiency of 99.97% when challenged with a thermally generated dioctylphthalate (DOP) aerosol whose particle size is 0.3 micrometers (homogeneous-monodispersed). This efficiency is a manufacturing standard above which the filter producer must remain although at Flanders most hepa filters exceed that efficiency and average above 99.98%. Since a filter's efficiency increases as it accumulates particulate matter in service, the initial efficiency is the lowest efficiency during the life of a filter. It is important to note that a filter's initial (clean) DOP efficiency represents the average initial efficiency of that filter. Minute areas of greater penetration, either in the edge sealant between the filter element and the filter's integral frame or in the element itself, are often present, but when the filter is tested these are diluted by the greater amount of clean air passing through the filter. They can be tolerated as long as the overall penetration through the filter does not exceed .03%. (Note: 100% - .03% = 99.97%.)

The instrument used to test filters for efficiency is commonly referred to as the "hot" DOP machine because it uses thermally generated particles to challenge the filter. The hot DOP test was a joint development of the U.S. Army and U.S. Navy and is performed on a forty foot long apparatus called a Q 107 Penetrometer. As shown in the filter label Figure 1, when a filter is tested on the penetrometer two values are taken, the penetration reading and the pressure drop at a specified flow rate (Test Flow). At Flanders these values are recorded on a serialized label that is applied to each filter. Rarely is the information alike on any two filters. Filters larger than 24" X 12" X 5-7/8" are individually packaged and a duplicate label appears on each filter carton. Additionally, a report is sent to the buyer listing the penetration and pressure drop readings relative to the serial number on each filter.


AIRPURE® Flanders® AIRPURE®

INDUSTRIAL GRADE HEPA FILTERS
TYPE A FILTER PER IES CS-1T

MFG. by FLANDERS FILTERS, INC.
Washington, NC (919) 946-8081 Dallas, TX (214) 352-6080

MODEL NUMBER AND SIZE DESIGNATOR

007-C-04-05-IL GG-F

TO REORDER USE MODEL NUMBER AND SIZE DESIGNATOR

RESISTANCE, IN. W.G.	TEST FLOW ONLY	PENETRATION
.7	1000 CFM	.014

MADE UNDER OR COVERED BY ONE OR MORE OF THE FOLLOWING PATENTS 2,952,333, 3,486,311, 3,540,079 or RE. 27,701

SERIAL NO.
I 562695

TEST FLOW DIRECTION ONLY

NOTE: FILTER MAY BE OPERATED WITH AIRFLOW EITHER DIRECTION

Fig. 1

A Flanders Industrial Grade Hepa Filter Label with typical test results entered on the label. Originally, hepa filter specifications called for a maximum pressure drop of 1"w.g. at 1000CFM for a 24"x 24"x 11 1/2" size filter. Most nuclear specifications still require this. However, many filters perform better and manufacturers have rated separator type filters as high as 1200 CFM at 1"w.g. This difference between Test Flow and Rated Flow has caused some confusion in the industry.

The specification, MIL-STD-282, DOP Smoke Penetration and Air Resistance of Filters, describes the operating procedure for testing filters with the penetrometer and is referenced throughout industry. In order to comply with the definition of a hepa filter, each filter is required to be tested for resistance and efficiency. IES CS-1T states, "Hepa Filter . . . having minimum particle collection efficiency of 99.97% for 0.3 micron (micrometers) thermally-generated dioctylphthalate (DOP)

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particles, and maximum clean pressure drop of 1.0 inch water gage . . .". A manufacturer cannot certify that a filter is a hepa filter unless he owns a penetrometer and has had it calibrated according to industry-accepted standards. A type A filter, per IES CS-IT, is "One that has been tested for overall penetration at rated flow with thermally generated DOP smoke . . .". This is the equivalent of the Flanders Industrial Grade Hepa Filter.

The DOP Test (Figure 2) begins with the manufacture of particles that are homogeneous in size (0.3 μm) to form a monodispersed aerosol. To test a filter at 1000 CFM on the Q 107 Penetrometer, outside air is drawn into a duct at 1200 CFM and then divided through three parallel ducts at 85, 265 and 850 CFM (200 CFM is eventually exhausted through an alternate exhaust path). As shown in Figure 2, the top duct contains three banks of heaters and a DOP oil reservoir with a fourth heating element beneath the reservoir. The center duct contains a cooling coil and a bank of heating elements. The air passing through the top duct is heated to approximately 365° F and is then impinged through an orifice onto the DOP oil in the reservoir. The heating causes the DOP oil to evaporate and it is then carried forward to the confluence of the top and center ducts where it is quenched with the cooler air from the center duct. The 0.3 micrometer particle size is controlled here by maintaining the temperature at 72° F. By increasing or decreasing the temperature the particle size can be increased or decreased.

Next, the combined airflow from the upper two ducts is mixed with the remaining 850 CFM from the bottom duct. A series of baffles mixes the aerosol (smoke) thoroughly into the airstream to distribute the aerosol uniformly prior to challenging the filter. A similar set of baffles is located on the exhaust side of the filter being tested to thoroughly mix the effluent. An upstream sample is taken and, when the aerosol concentration reading is between 80 and 100 milligrams per liter, that value is accepted as a 100% challenge. Next, a reading (% concentration) is taken downstream of the filter (downstream of the baffles so that any leakage is thoroughly mixed into the effluent) and is compared to the upstream value. This is read as a penetration, that is, if the downstream concentration is .04% that is the percentage of the upstream value that has penetrated the filter. When subtracted from the 100% value, the filter would have an efficiency of 99.96% and would be rejected.

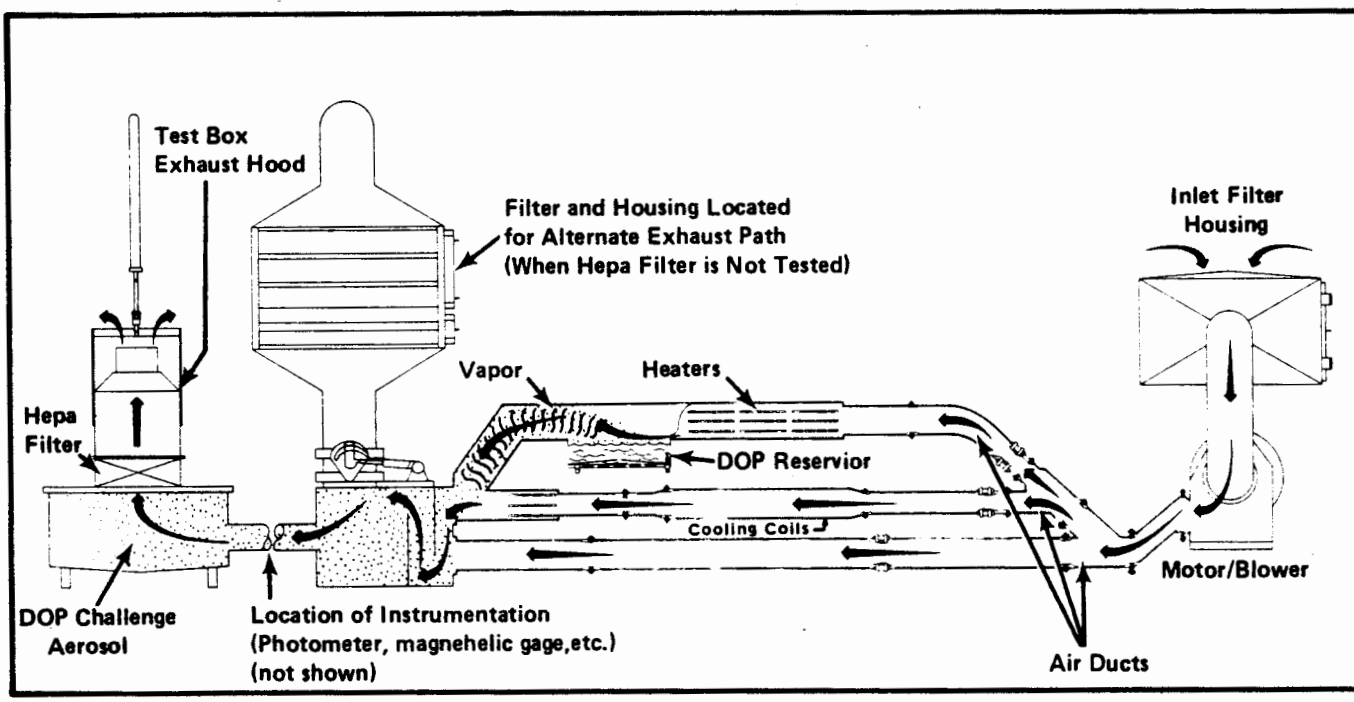

Fig. 2

Q 107 Penetrometer (Instrumentation not shown)

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Instrumentation Q 107 Penetrometer

(1) Temperature Controllers:
(a) Hot Air @ (approx.) 365° F.
(b) Oil Reservoir @ 390° F.
(c) Quench Air @ 72° F.

(2) Mechanical Analyzer:
This enables the operator to determine when he has the correct particle size. Smoke is drawn through a chamber and in between two photomultiplier tubes. The operator reads the particle size on the Size Indicator.

(3) Linear Photometer (.002 to 100%):
This is used for reading the upstream and downstream samples and comparing them. The downstream value as a percentage of the upstream value is the Penetration.

(4) Manometer:
Determines the pressure drop across the filter at the test flow.

(5) Averaging Pitot Tube Systems:
Enables the operator to determine the volume of airflow through the filter.

Probe Testing or, The "Cold" DOP Test

Most containment requirements are satisfied by achieving average filter bank efficiencies of 99.95% or greater. A single pass through a correctly installed and field tested filter or bank of filters is sufficient to accomplish this efficiency although most nuclear facilities, because of additional safety related considerations such as fire protection and redundancy, can have two or more banks of hepa filters in series on the exhaust of their HVAC systems. As previously stated, the areas of greater penetration that can occur on hepa filters, frequently called "pinhole leaks", are tolerated as long as the overall penetration does not exceed .05%.

This is not the case in laminar flow systems (clean work stations, clean rooms, downflow hoods) where the hepa filters are located at the terminus of the air supply entering the clean room or work area. In order to dilute the pinhole leak with the greater volume of clean air passing through the filter, either a considerable distance or some method of agitating such as a baffle would be required. Of course a baffle would be pointless in a laminar flow clean room. Therefore it could happen that the product or process requiring particulate free air during its manufacture or assembly could be located directly downstream of a pinhole leak.

Realizing this, early researchers into clean room techniques developed a procedure to scan or probe the downstream face of a bank of filters in a laminar flow system, not only to locate pinhole leaks in the filter element, but to determine whether the filters were sealed to their mounting frames. A challenge aerosol, usually a cold DOP with a particle size range of from 0.1 to 3.0 micrometers (polydispersed), is generated and introduced upstream of the filter bank while the system is in operation. The downstream side is probed with a portable forward light scattering photometer. Pinhole leaks and filter-to-frame leaks are identified and patched.

Hepa filter manufacturers, confronted with the prospect of failing a field test that could locate defects escaping detection in the overall efficiency test with the Q 107 Penetrometer, began to factory probe filters destined for laminar flow clean rooms. In time, this additional test requirement became an industry standard. The Type C filter, per IES CS-IT, is "One that has been tested for overall penetration . . . and in addition has been leak tested using air generated DOP smoke...". This is the equivalent of the Flanders Laminar Flow Grade Hepa Filter.

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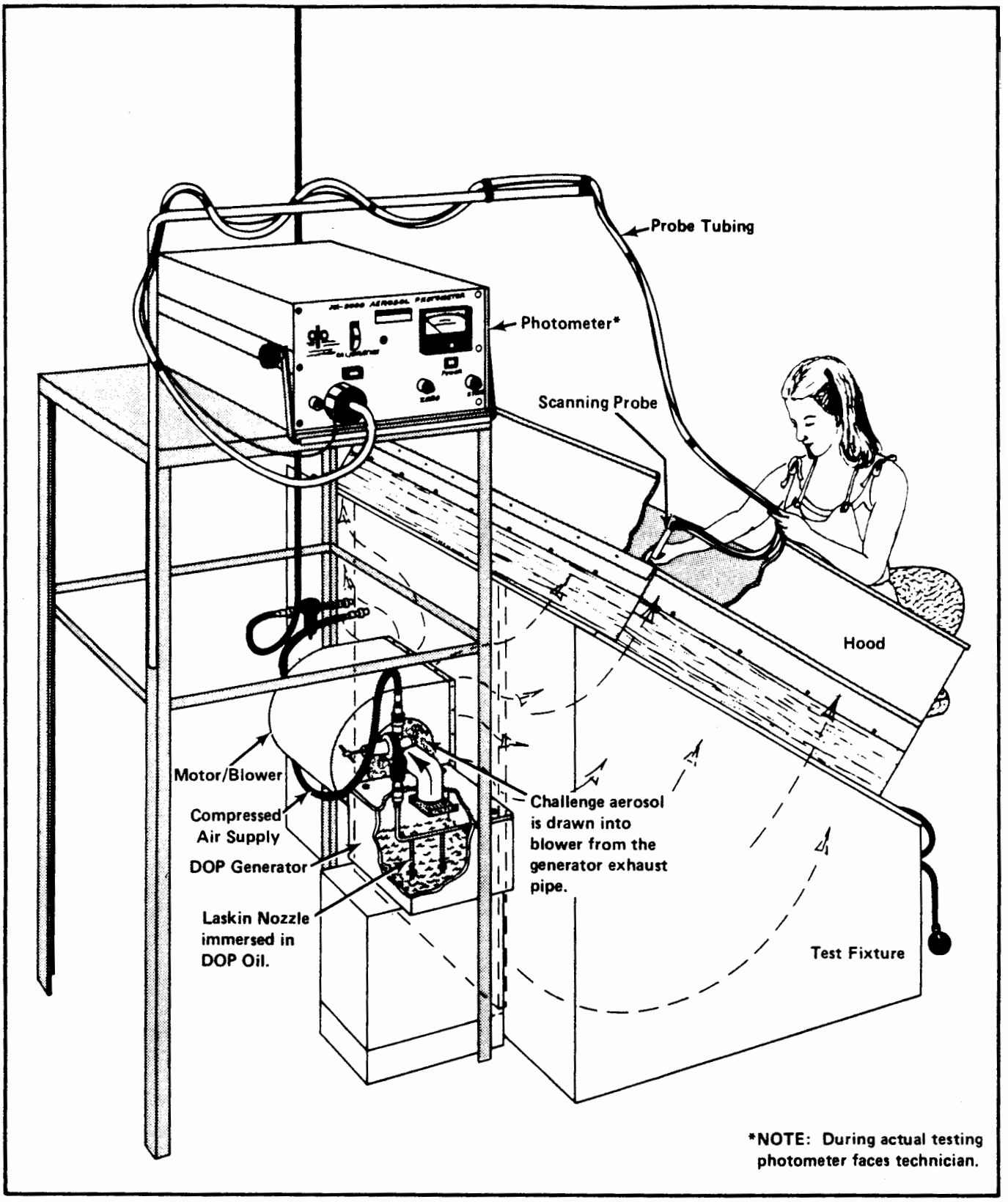

Fig. 3

The "Cold" DOP Test - the entire filter face is scanned for pinhole leaks. (photometer has been turned 90° toward viewer).

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As shown in Figure 3, there are three major components used to perform the "cold" DOP Test; the DOP generator, the test box (plenum) with motor/blower and the light scattering photometer. (The vernacular description "cold" DOP test frequently is used to distinguish between the polydispersed DOP aerosol generated at ambient temperatures and the thermally generated monodispersed aerosol.)

In this case the DOP aerosol is generated by forcing air at 20-25 psig into liquid DOP contained in a reservoir. A sufficient challenge of 10-20 micrograms per liter can be maintained by using one Laskin nozzle per 500 CFM of air or increment thereof.

A single Laskin nozzle is illustrated in Figure 4. There are two sets of holes in the nozzle, one set of four holes is located directly beneath the collar around the bottom of the tube. The second set of four is located in the collar with each hole being positioned directly above the corresponding hole at the base of the tube. The air flowing out of the holes in the tube causes the DOP oil to be drawn through the holes in the collar, fragmenting the liquid into an aerosol. Unlike the homogeneous, monodispersed particles generated by the hot DOP test, the cold DOP is heterogeneous of polydispersed having a particle size distribution as follows: *

99% less than 3.0 micrometers
95% less than 1.5 micrometers
92% less than 1.0 micrometers
50% less than 0.72 micrometers
25% less than 0.45 micrometers
10% less than 0.35 micrometers

Although test plenums vary somewhat in size and design, the arrangement shown in Figure 3 is typical of the type used at Flanders. The essential purpose of the plenum is to mix and disperse the air/aerosol upstream of the filter in order to provide a uniform challenge to the filter. An important feature of the test equipment is the hood or baffle that is located on the air leaving side of the filter. This device prevents the intrusion of particles from the room air onto the downstream face of the filter and is essential to obtain valid results. During the test, the filter is clamped in place between the hood and the test plenum. In older photometers, the operator set the needle of the meter to read at the zero point while holding the probe at the filter face and sampling the effluent from the filter. (Current photometers contain their own filter for setting the zero reading, but there is no specification requiring their use.) Next, an upstream reading is taken through an orifice in the plenum upstream of the filter. If the challenge is insufficient an adjustment is made by increasing the air pressure into the generator and checking the upstream concentration reading until the correct limit is attained.

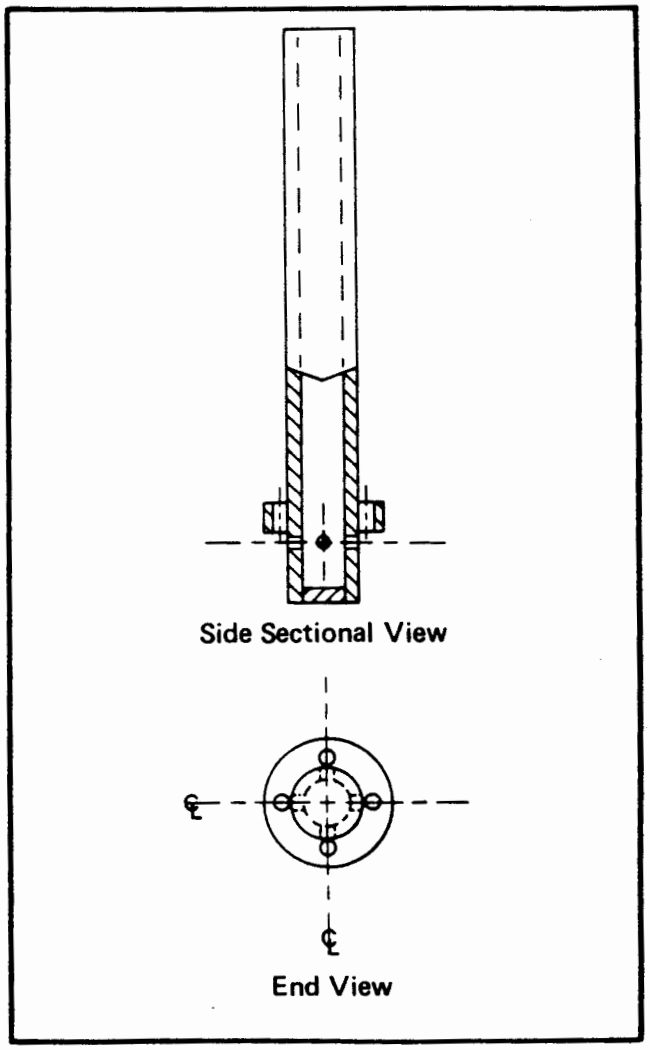

Fig. 4

Laskin Nozzle

* The values in this table were taken prior to the development of a Single Particle, Particle Size Spectrometer with a laser light source. A test system using dual spectrometer systems has been developed to Flanders' specifications and is currently in use to test new filters with higher efficiencies than hepa filters. One discovery is the existence of particles below 0.4 micrometers that were not "seen" by photometers and particle counters.

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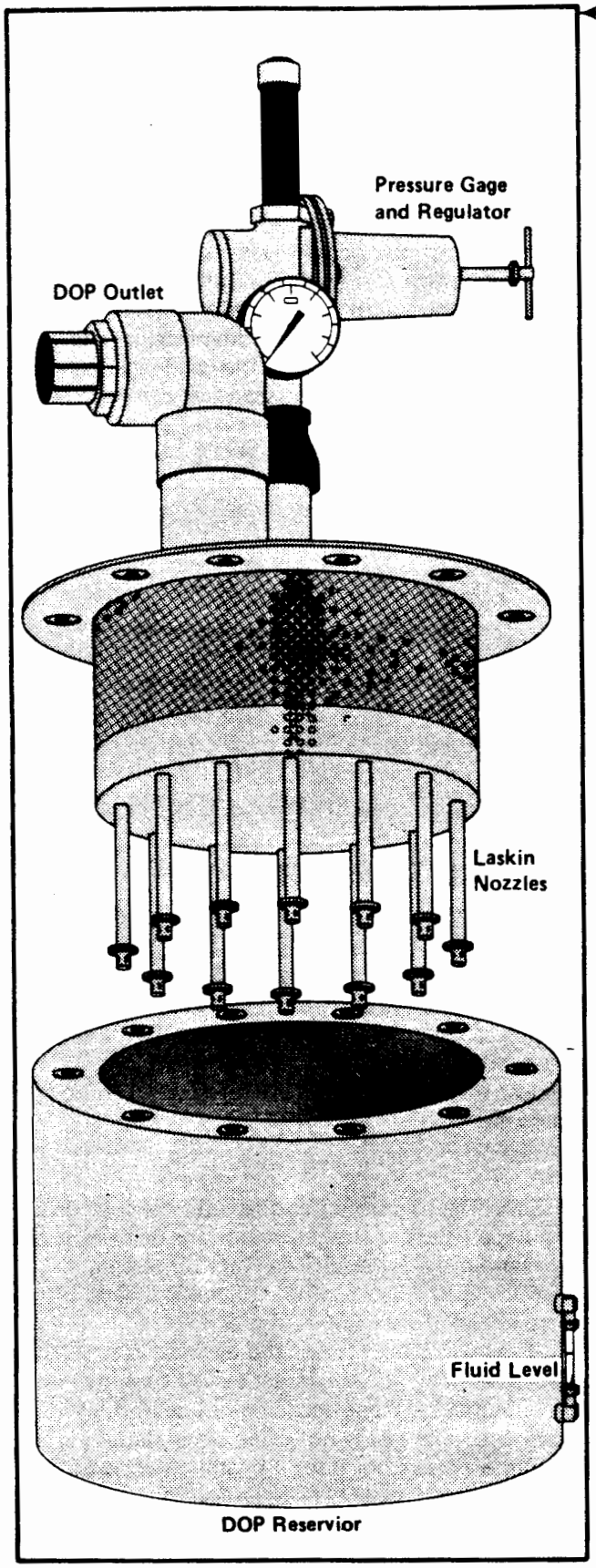
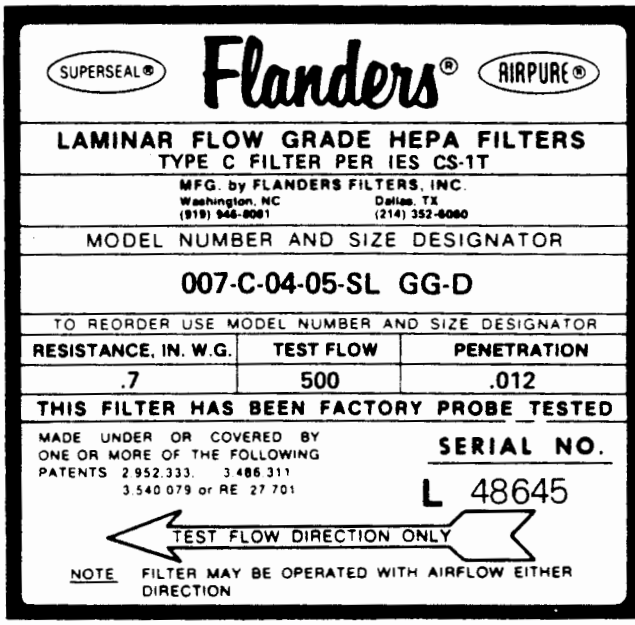


Fig. 5

A DOP generator assembly with a multiplicity of Laskin nozzles as shown. The generators used to test individual filters at Flanders have at least three nozzles. More are required to test larger filter systems.

The photometer probe is connected by flexible tubing to the intake of the light scattering chamber of the photometer. To test the filter the operator scans the perimeter of the pack and then, using slightly overlapping strokes, probes the entire face of the filter. Most photometers sample at 1.0 CFM. Air is drawn through the chamber and any entrained particles present in the sampled air deflect the light source onto the sensitive area of the photomultiplier tube. This causes the needle on the meter to move, indicating the size of the leak by the meter reading. If the photometer reading is greater than .01% the leak is unacceptable and the spot must be repaired. Thus, a leak may not pass smoke in greater proportion than 1:1000 relative to the clean air that surrounds it.

Probe tested filters are frequently and erroneously described as "zero probe" or "99.99" filters with the inference that they have a higher efficiency rating than the minimum efficiency of 99.97% required for Industrial and Nuclear Grade filters.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LAMINAR FLOW GRADE HEPA FILTERS
TYPE C FILTER PER IES CS-1T

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Washington, NC (919) 946-8081 Dallas, TX (214) 352-6060

MODEL NUMBER AND SIZE DESIGNATOR

007-C-04-05-SL GG-D

TO REORDER USE MODEL NUMBER AND SIZE DESIGNATOR

RESISTANCE, IN. W.G.	TEST FLOW	PENETRATION
.7	500	.012

THIS FILTER HAS BEEN FACTORY PROBE TESTED

MADE UNDER OR COVERED BY ONE OR MORE OF THE FOLLOWING PATENTS 2,952,333, 3,486,311 3,540,079 or RE 27,701

SERIAL NO.
L 48645

TEST FLOW DIRECTION ONLY

NOTE FILTER MAY BE OPERATED WITH AIRFLOW EITHER DIRECTION

Fig. 6

A Flanders Laminar Flow Grade Filter Label indicating that the filter has been tested for efficiency and has been probe tested.

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Those manufacturers who do not own a Q 107 Penetrometer to perform the overall efficiency test depend upon this misinformation to justify the minimal expense required to own only the equipment required to perform cold DOP testing. The probe test is described as a more stringent test with the implication that it is therefore better, when it is, in fact, unrelated to the overall efficiency test. At best, the probe test is a supplement, not a substitute, to the overall efficiency test. As described above, the procedure for probe testing includes setting the meter at zero while sampling the effluent from the filter being tested. This procedure could be followed just as easily using a 95% efficient filter! As stated above, some photometers are now equipped with hepa filters which are used as the reference filter, but there is no industry-wide specification requiring their use.

A hepa filter that has a performance rating of 99.99% on cold DOP is one which has no pinhole, cracks or imperfections showing an indicated leak greater than .01% at specific location relative to the upstream concentration. It is pointless to compare this test to the overall efficiency rating obtained with the hot DOP test since there are so many differences including the particle size(s) and concentration of the challenge. A filter which has passed the scan test can have an overall efficiency of 99.97%.

Two Flow Efficiency Testing and Encapsulation

Pinhole leaks in filter media result in greater penetration at lower velocities because the constriction of air flow through a pinhole is a function of the square of the air velocity whenever the constriction of air flow through the filter media is close to a linear function of velocity. Therefore, at 20% or 1/5 of full test flow, a pinhole leak shows up as approximately 25 times greater in proportion to total flow than it does at full flow. Also, at higher velocities particles impact upon the fibers of the filter element whereas at lower velocities Brownian motion causes them to meander and they are more likely to "find" the leak.

The development of acceptance criteria for clean room components resulted in a greater awareness of the existence of pinhole leaks in hepa filters. This, in turn, led to a re-evaluation of the filter test procedures for filters used for radioactive containment. Prior to the advent of commercial nuclear power stations, most of these filters were used either by the U.S. weapons program or in the field of nuclear research. The U.S. Department of Energy (formerly, The Atomic Energy Commission) operates, through prime contractors, several filter test facilities equipped with Q 107 Penetrometers. Hepa filters purchased for weapons and nuclear research facilities are retested en route to these plants.

Not wishing to commit additional time to probe test hepa filters at the retest stations or to raise the purchase price for additional factory testing, a two flow test was adopted wherein the hepa filters were tested at the flow rate specified in Mil-F-51068 (latest issue) and again at 20% of that flow rate. The 20% flow test served to detect any gross pinhole leakage escaping notice in the full flow test. The test is not effective in detecting all pinhole leaks nor does it enable the operator to locate them, but it has been found as an effective device to aid in improving overall filter performance.

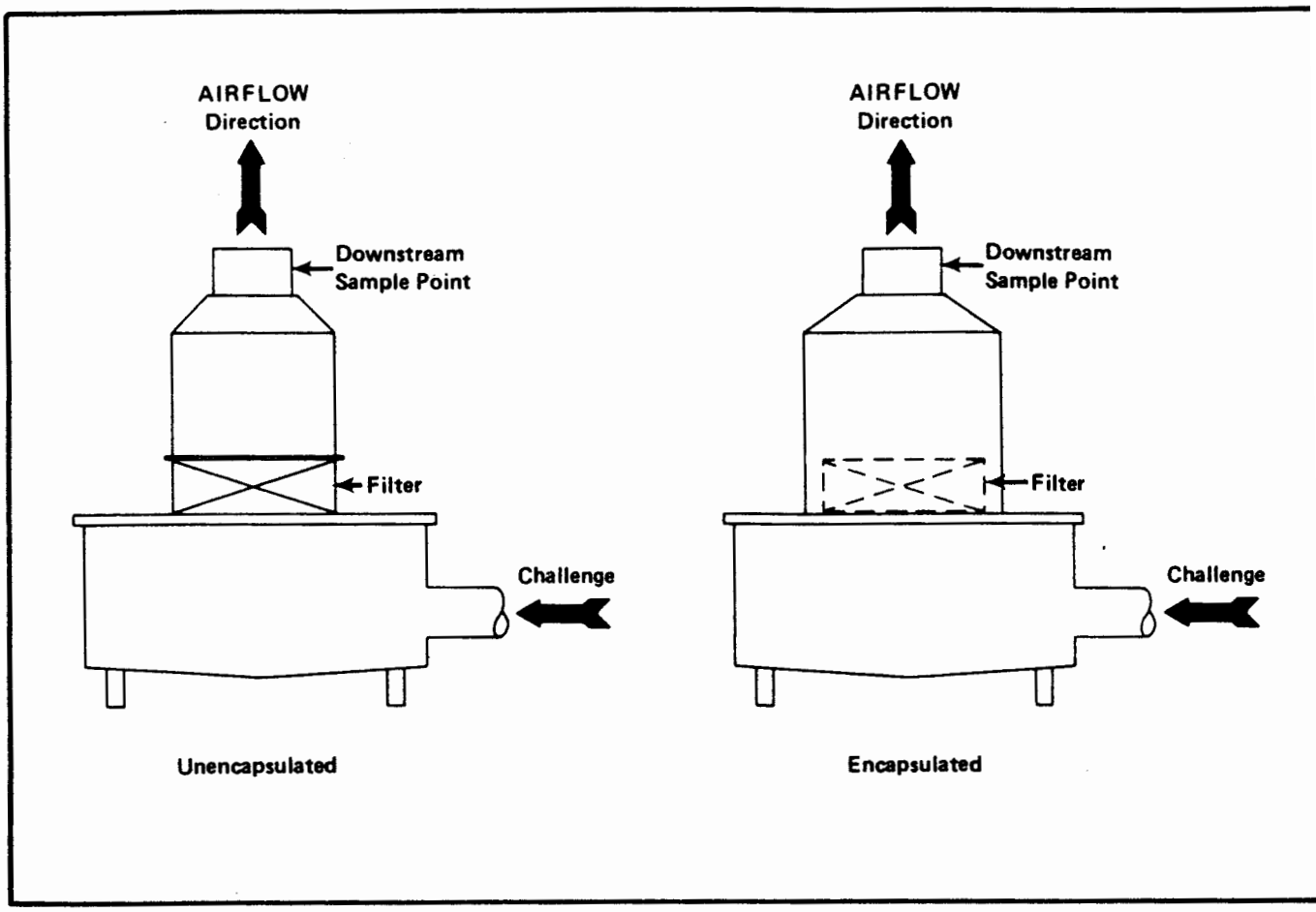
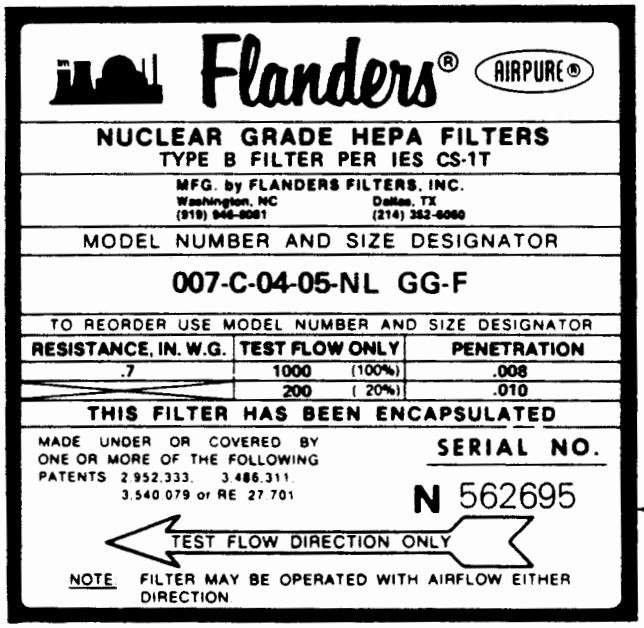


Fig. 7

The filter test portion of the Q 107 shown on the left prior to modifications made for encapsulation and on the right following the addition of encapsulation components.



At the time that the 20% flow test was added to the procedure, a second modification was also made. This was the addition of the encapsulation hood shown in Figure 7. Previously, filters tested for efficiency had only the element and the frame tested. Experience has shown that hepa filters can have frame leakage, caused primarily by improper sealing methods during manufacture, racking of the frame or leakage through the frame material (metal frame filters are particularly susceptible). By enshrouding the entire filter, any leakage through the frame or joints are the corners is included in the overall efficiency of the filter.

Fig. 8

A Flanders Nuclear Grade Filter Label indicating that the filter has been tested for efficiency at two flows while encapsulated.

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In-Service Tests for Hepa Filters

The most stringent factory tests for hepa filters have resulted from the requirements of both the nuclear industry and the operators of laminar flow clean rooms. Experience has demonstrated that hepa filters which have passed these tests do not always arrive at their destination without mishap. Damage can occur during shipping and handling and, once installed, the filter-to-mounting-frame seal or leaks in the mounting frame itself can contribute to a loss of the efficiency of the bank. Consequently, it is not surprising that the nuclear industry and those industries requiring laminar flow clean rooms also require verification of in-service performance of both Nuclear Grade and Laminar Flow Grade Hepa Filters and their supporting frameworks.

By comparison, Industrial Grade Hepa Filters are generally used in industries less structured by either government regulations or industry standards and usually where the user is not concerned with conducting additional field testing to verify performance. This is not to say that Industrial Grade Filters cannot pass certain in-service tests, but they are less likely to do so for two reasons.

First, by not electing to test his filters in service, the owner and/or his designer generally issue a less stringent procurement specification, with the result that the mounting frameworks of filter housings are of mediocre quality, not designed to pass an in-service test. If the owner should decide at a later time to upgrade his hepa filter installation and add in-service testing, he would frequently discover that modification or replacement of his frames is necessary. A major reason for the failure of these filter banks, assuming that undamaged filters have been installed, is the filter-to-frame seal. Bypass leakage has long been a principle cause of improperly installed filters. This can be compounded by frame leaks in welds or caulking or by poor quality workmanship by the installer of the frames.

Second, Industrial Grade Filters are not probe tested at the factory. Since all specifications for laminar flow installations and devices call for probe testing in the field, a certain percentage will fail.

Exclusive of particle monitoring techniques, there are two kinds of field tests used to verify in-service performance. The testing of filter banks in nuclear air cleaning systems is called In-Place Testing. The Probe or Scan Testing procedures discussed above are required for clean rooms and laminar flow devices.

In-Place Testing – Hepa Filter Banks

Hepa filters installed in nuclear air cleaning systems are required to be tested in-service following each filter change and, in certain cases, periodically during the life of the filters. Since each ventilation system differs in design, a standard or uniform test throughout industry is not possible. Therefore, depending upon the arrangement of a particular system, the procedure can vary. The in-place test is frequently called an efficiency test, but the standard, Testing of Nuclear Air Cleaning Systems, ANSI/ASME N510-1980, states;

"Test of an individual HEPA . . .filter are of two types. The test by the factory or quality assurance station is an efficiency determination using a monodisperse challenge . . .the total filter is challenged at one time and a single reading of penetration is obtained.

In-place field test of installed hepa filters are made with a polydisperse DOP aerosol, and do not show the efficiency of the filters but only reveal the presence of leaks in the system, scanning may be used if necessary to locate the leaks . . . The in-place test is not an efficiency test and should not be so considered."*

*The authors have attempted to clarify the difference between factory testing an individual filter for efficiency using a monodisperse aerosol from the in-place test conducted in service which uses a polydisperse challenge under a multitude of varying conditions.

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Under ideal conditions, and with a well-designed filter system, an efficiency test on a bank of filters using a cold DOP challenge can be performed, but such a system would prove to be the exception and not the rule. Figure 9 illustrates such a system. The operator must first generate the cold DOP challenge by the same method and apparatus as described above for probe testing hepa filters at the factory. In order to gain an accurate reading from the bank of filters being tested, the challenge must be uniform across the upstream face of the filter bank. In most cases this can be achieved by introducing the DOP into the system at least ten duct diameters upstream of the bank to obtain thorough mixing of the air/aerosol. However, a uniform challenge is also dependent upon a balanced flow through the bank and careful attention should be given by system designers to this requirement.

Cold DOP is first generated and introduced into the system. Several samples are taken along a linear plane upstream of the bank to verify uniformity. The upstream concentration required is relative to the sensitivity of the instrument, but an acceptable minimum for most photometers is approximately 10 micrograms per liter. This value is accepted as 100% and a sample is taken downstream of the bank and compared to the upstream reading. The downstream reading should be taken far enough from the bank to allow thorough mixing between the bank and the sample. Usually ten duct diameters is sufficient. The penetration cannot exceed .05%.

In performing an in-place test the filter bank is treated as a single filter. Just as individual pinhole leaks are diluted by the greater volume of clean air and escape detection in the efficiency tests performed at the factory, bypass leaks, frame leaks and holes in the medium can escape detection in the in-place test provided the overall penetration does not exceed .05%. Certain holes that are undetected in large filter banks could not accurately be described as pinhole leaks. They can be quite large. For this reason a visual examination of the filters is a good practice whenever possible.

In-place testing is almost always complicated by system design or location. Components such as prefilters, entrainment separators, gas adsorbers and secondary hepa filter banks are frequently arranged in close proximity to one another and to the bank being tested. The ideal system described above and illustrated in Figure 9 has several essential features; a frusto-converging transition piece both upstream and downstream of the bank and ten duct diameters on either side of the bank, unobstructed by other system components. The operator stands an excellent chance of obtaining a balanced flow through this system as well as good mixing both upstream and downstream of the bank. Figure 10 shows a typical nuclear air cleaning system with prefilters, hepa filters, carbon adsorbers and a second bank of hepa filters in series. The hepa filters in the first bank could not be tested because thorough mixing of the air/aerosol would not take place if the DOP were injected between the prefilter and the hepa banks. Further, it would be impossible to take a representative sample in the limited space between the hepa filter and the adsorber. In this system, all the components are located too close to each other for a good test and the housing is too small for man entry. Figure 10 also serves to illustrate another common problem in filter banks that must be tested in-place, the relationship of the duct and plenum design and its effect upon a uniform flow through the filters. Certainly the arrangement, as shown, would have high and low velocity points across the face of the prefilter bank, and although the prefilters themselves would assist in balancing the flow ahead of the hepa filters, the only way to test this particular bank of hepa filters would be to pull both the prefilters and one bank of hepa filters out of the system.

The factors that can contribute to the difficulties of performing an in-place test are as varied as the arrangements that the system planner can design. The standards anticipate these common problems and permit compromise solutions, for example, bypass ducting between system components may be utilized for filter test purposes. In man entry housings where the banks of hepas are too large to generate enough DOP challenge, a portion of the bank may be tested by shrouding adjacent sections. Probe testing techniques may also be utilized and the results averaged to compute a system efficiency. None of these methods fully solves such problems as access into housings that are too small or too remote for man-entry or the problem of uniform challenge where banks in series are located too close together. It is for this reason that in-place testing should be considered as a quantitive rather than a qualitative test. In recent years, Flanders has designed and has manufactured housings with complete in-place test equipment

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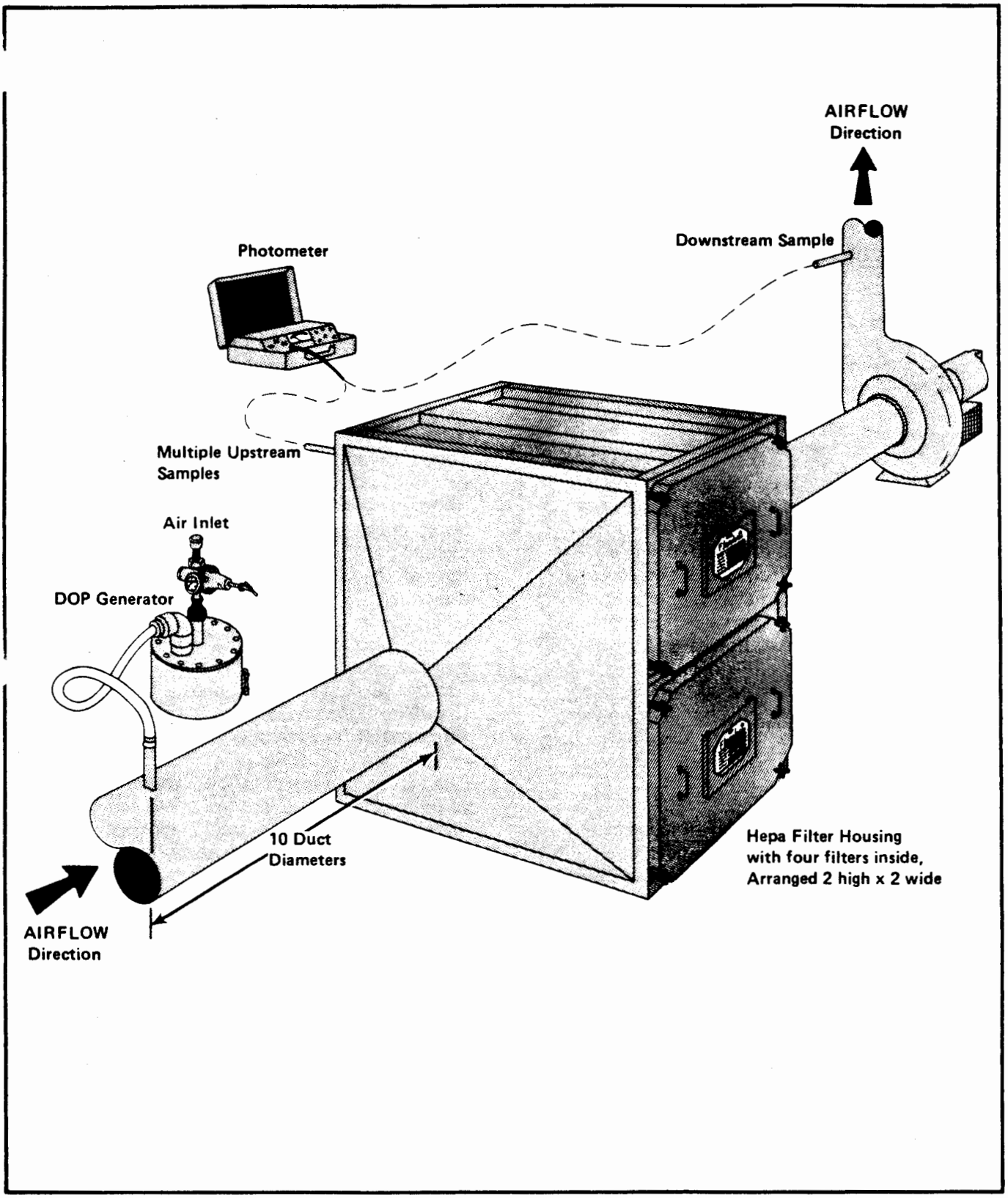

Fig. 9

Testing a ventilating system with a single bank of hepa filters.

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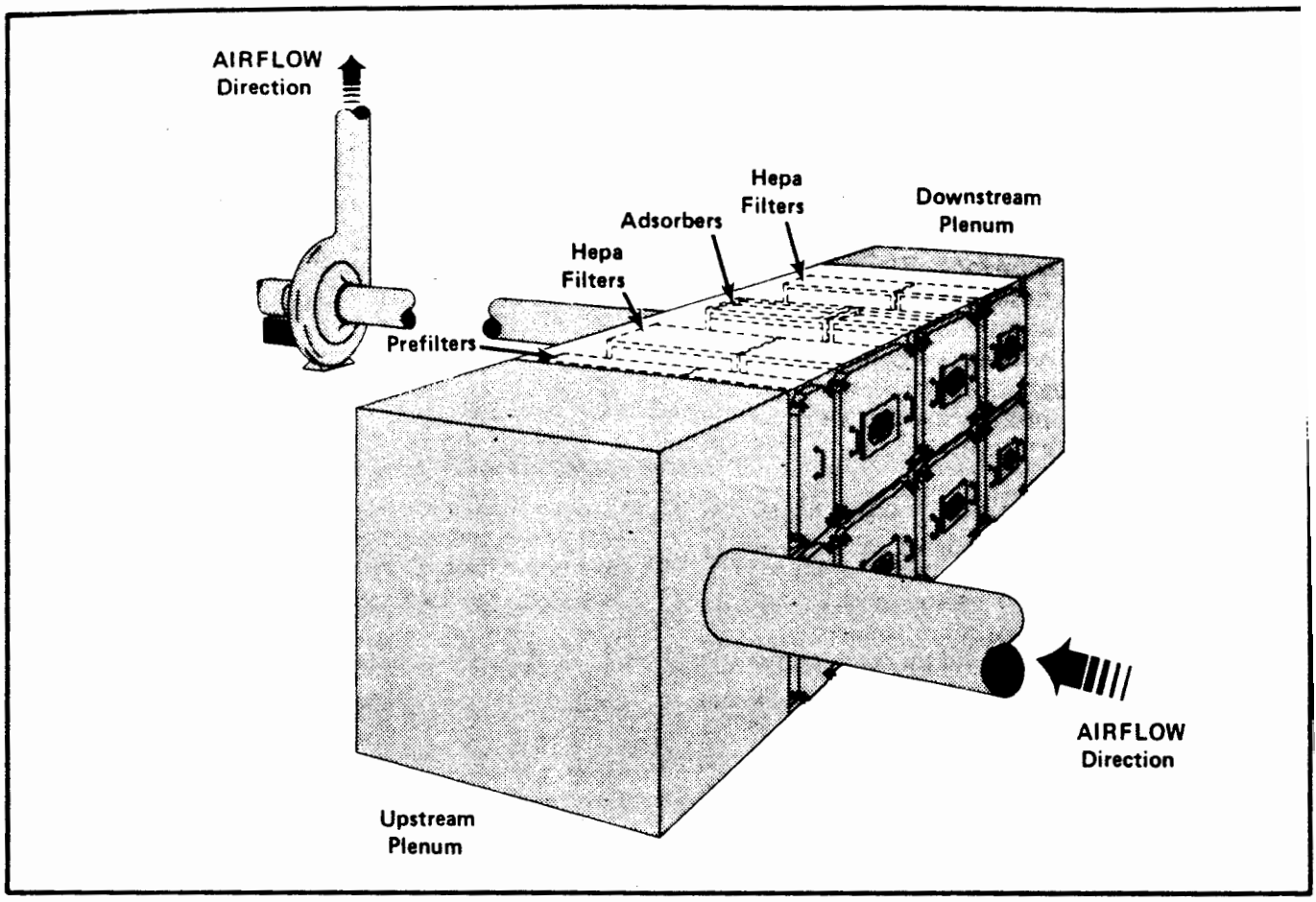

Fig. 10

The Ductwork and Plenums in HVAC Systems are frequently designed to best utilize building space. Filter systems having multiple stages of filters are grouped together for the same purpose, but also to facilitate maintenance operations. Unfortunately, this frequently results in hepa filter banks that are difficult or impossible to test.

built into the housings which permits not only testing of filters from outside the system at a remote location, but the identification of the filter that might be leaking since an individual efficiency leak test is performed on each filter in the system. The built-in test systems are compatible with other components in the housing and approximately two feet is required between consecutive filter banks, regardless of the size of the system.

Clean Room Testing

Nuclear facilities usually have their own health physics personnel and maintenance crews who can perform in-place testing, thus enabling them to enforce industry specifications and design criteria. The same is not always the case in plants having laminar flow clean rooms or clean air devices. Hepa filters and ancillary equipment are not routine components in HVAC system construction and the techniques of their installation and in-service validation are unfamiliar to many facility operators and their mechanical contractors. Even when a contractor can demonstrate previous experience in clean room construction, most of his employees are transitory, working for various contractors on a per job basis rather than for a single employer. As a result, many hepa filter systems are incorrectly installed because of inexperience. To overcome this problem, factory service personnel are available from Flanders to supervise the contractor's installation of the Flanders products during the critical construction phase. Once the installation is satisfactorily completed,

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the service personnel test and certify the job to industry standards.

The control of airborne particulates within a clean room or laminar flow device is dependent upon the efficiency of the filters and their supporting framework, but it is also dependent upon achieving parallel and turbulent free air velocity patterns through the clean room or zone. The subject herein is the in-service testing and validation of the filter banks themselves, but it is important to stress that several other critical tests are conducted during the certification procedure by service personnel including velocity profiles and particle monitoring at work surface levels.

Filters that have first been factory probe tested should also be tested in service in a manner similar to the factory test, by challenging the installed filter and its supporting framework with a polydisperse DOP challenge aerosol introduced upstream of the filter bank and by scanning the downstream face of the bank. As in the testing of nuclear systems in-place, a uniform challenge is required. Standard clean room design criteria call for laminar flow rooms and clean air devices to have a face velocity of 90 fpm, ± 20 fpm, far below the velocity of air required at terminal units in conventional (e.g. non laminar flow) ventilation systems. Consequently, it is not usually difficult in smaller laminar flow systems to generate sufficient amounts of challenge aerosol and to attain uniform dispersement upstream of the filters. However, as the size of the system increases it becomes increasingly more difficult to challenge the entire bank simultaneously. One alternate method of testing is to isolate adjacent sections and test the bank section by section. Where this is not practical, the filters can be tested at the job-site prior to installation using the same test rig that is used at the factory for probe testing. This test verifies that there has been no damage to the filters incurred in transit or during unpackaging and handling. Following this test the filters are installed immediately under close supervision. When all filters have been installed, the seals between the filter and the supporting framework itself and the perimeter of the filter bank are scanned for bypass leakage. Considering the time that it takes to scan a large hepa filter wall or ceiling bank there is a valid arguement for a less time consuming test. A quick and reliable procedure for testing and certifying a large bank in a clean room is the Induction Leak Test developed by Western Electric and Bell Telephone Laboratories engineers. In this test the filter bank is challenged with a minimal amount of DOP, approximately 0.0005 micrograms per liter, but sufficient to maintain an aerosol challenge of 500,000 particles per cubic foot $\geqslant .5\ \mu m$. The test apparatus includes a particle collector (Fig. 12) shaped somewhat like an inverted pyramid and attached to a particle counter. The top of the collector is sized and shaped to cover and overlap the filter being tested, the peripheral supporting framework, the lights and any other components integral to the bank that are adjacent to the filter which represent potential leak paths. The intake of the particle counter is located at the (inverted) apex of the collector. Once the challenge has been introduced and verified, a leak is suspected whenever the particle counter indicated a reading > 50 particles per cubic foot. Conventional scanning techniques are then used to locate the leak.

Fig. 11

Probe Testing a Clean Room Ceiling

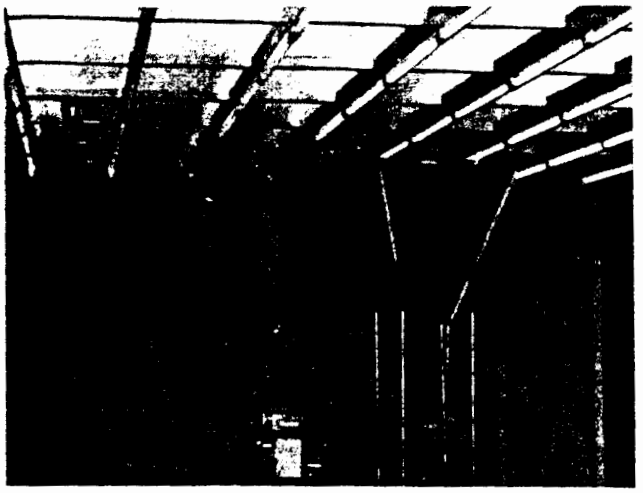

Fig. 12

Induction Leak Test Apparatus

Induction leak testing should not be considered unless the filters are first tested after they have been unpackaged. This procedure may appear to be time-consuming, but far less so than if leaks are located after the filters have been installed in their mounting frameworks.

Conclusion

Figure 13 illustrates the many kinds of test performed at the factory and in the field. Most filters purchased by the Department of Energy are shipped to an intermediate retest facility where they are given a second efficiency test with a Q 107 Penetrometer and are then reshipped to the buyer. Unfortunately, there have been no shortcuts devised to verify the performance of hepa filters, either at the factory or in the field. Typically these filters are susceptible to damage during shipping and handling unless stringent precautions are taken. Historically, hepa filters have been difficult to seal into their supporting framework or housings, a fact which inspired Flanders to develop the fluid filter-to-frame seal in the 1960's. Finally, they are unfamiliar items to most mechanical contractors and construction workers. The matter-of-fact approach used in the installation of standard building components should not be applied when installing these filters.

The verification of filter performance is only as valid as the procedures and instrumentation used in conducting the tests. The principle limitation in recent years has been the sensitivity of forward light scattering devices in detecting particulates smaller than 0.3 micrometers (the standard particle counter used in the field counts particles 0.5 micrometers and larger). The importance of determining filter efficiency on a homogeneous challenge of 0.3 micrometers was based on the theory that this size particle was the most difficult to remove from an airstream by filtration. (As theory had it, impaction efficiency decreased as particle size decreased, whereas diffusion efficiency increased as particle size decreased. When plotted upon a graph showing efficiency relative to particle size, the two curves intersected at 0.3 μm.) This has subsequently been proven to be untrue.

The recent invention of the Single Particle, Particle Size Spectrometer with a laser light source has made it possible to measure removal efficiencies on particles smaller than 0.3 micrometers with convenience, accuracy and reproducibility. A system using two laser spectrometers which samples simultaneously on both the upstream and downstream sides of a filter being challenged with cold DOP aerosol was designed and built to Flanders' specifications and is in use today to test a higher grade of filters. This sophisticated system provides the clean room operator with an efficiency by particle size report for each filter in his laminar flow clean room on a particle size range from .12 to 3.0 micrometers.

The introduction of the laser spectrometer led to the development by Flanders of the new VLSI™ filter in response to the needs of the decreasing geometries of the semiconductor industry and their requirement for cleanliness levels far beyond those required in Federal Standard 209b and other current clean room specifications. In the past two years, Flanders has installed vertical laminar flow ceilings in clean rooms which have operated at less than 20 particles per cubic foot on a particle size of 0.12 μm and larger, far below the old performance levels requiring less than 100 particles per cubic foot 0.5 μm and larger.

The breakthrough on VLSI™ filtration is certain to have far-reaching effects in both the nuclear and clean room industries in years to come. It is too soon to have government or industrial specifications for these filters and their systems, but as more microelectronics industries build facilities for manufacturing the 64K RAM and beyond there will doubtless be the convening of committees to develop new performance specifications.

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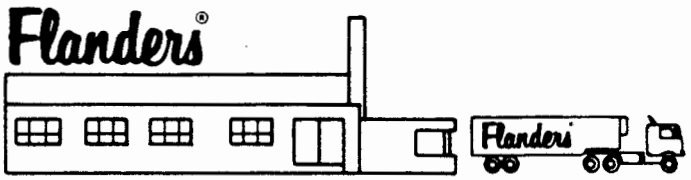
Factory Test Specifications, Field Test Specifications and Applications for Hepa and VLSI[tm] Filters

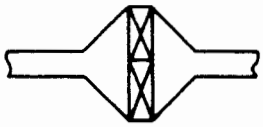


Factory Tests
per Mil-Std-282
IES-CS-1T

Industrial Grade

TYPE A HEPA

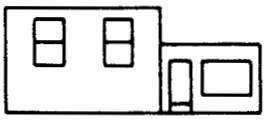
Typical Applications
Supply Air in Various Non-Critical Areas, First Stage Filtration, Hospitals, Food Process, ect. These Filters are Rarely Tested In-Place.



Nuclear Grade

TYPE B HEPA

Dept. of Energy (DOE)



Retest Station
Test per Mil-Std-282

Commercial Reactors
Filters Tested In-Place per ANSI N510.

DOE Operated Test Reactor Program, Nuclear R & D, Weapons Program.
Tested In-Place per ANSI N510 or ERDA 76-21.

Laminar Flow Grade

TYPE C HEPA

Laminar Flow Work Stations and Clean Rooms, Semiconductor Manufacturers. Parenteral Drug Manufacturers.
Service Testing per Fed. Std. 209b and IES CS-2T, 6T.

VLSI[tm] Filter

Laser Spectrometer Test

Semiconductor Manufacturers (Potential for Other Industries)
New Service Test Procedures Will Develop from the New Technology and Instrumentation. (No Industry Testing Standards as yet. Flanders Utilizes an In-House Specification)

Fig. 13

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References

American National Standards

ANSI N509	Standard for Nuclear Power Plant Air Cleaning Units and Components
ANSI N510	Standard for Testing Nuclear Air Cleaning Systems

Institute of Environmental Sciences

IES CS-1T	Standard for HEPA Filters
IES CS-2T	Standard for Laminar Flow Clean Air Devices
IES CS-6T	Testing and Certification of Particulate Clean Rooms

Federal Standards

Fed. Std. 209b	Clean Room and Work Station Requirements, Controlled Environment

Military Standards and Specifications

Mil-Std-282	DOP-Smoke Penetration and Air Resistance of Filters.
Mil-F-51079B (EA)	Filter Medium, Fire Resistant, High Efficiency
Mil-F-51068D (EA)	Military Specification Filter, Particulate, High Efficiency, Fire Resistant.

Books and Pamphlets

136-300-175A	Instruction Manual for the Installation, Operation and Maintenance of Penetrometer, Filter Testing, DOP, Q 107
ERDA 76-21	C.A. Burchsted et al., Nuclear Air Cleaning Handbook, National Technical Information Service, 1976

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Air from the Zone 2 and 3 areas is double HEPA filtered prior to being exhausted through the facility stack.

4.3.3 RADIOACTIVE PLANT EMISSIONS UNDER NORMAL OPERATIONS

Radioactive emissions from the Zones 2 and 3 filter systems will be a small fraction of that from the incineration offgas cleanup train filters (Zone 1). This is due to the relatively smaller quantities of airborne contaminants along with the generally larger particle sizes associated with the sorting and feed preparation operations and other facility activities.

The incineration of 100 lbs of design matrix wastes per hour at a level of 100 nCi/g will contain 4540 μCi of transuranics. Incinerator manufacturers data and the Environmental Protection Agency incinerator acceptance test data indicate an offgas particulate loading of 0.1 grain/ft^3 for the incinerator design installed in the TDF. At the design offgas rate of 30900 ft^3/h, some 200 g of ash containing 20 μCi of transuranics would be carried over into the offgas treatment train.

Particle removal efficiency is a strong function of particle size distribution and density which will be determined during the development test programs. The design particle size distribution is based on the average of data received from Dow Chemical Company, (Rocky Flats)[1] and data from the Environmental Protection Agency incinerator acceptance test data for the type incinerator proposed for the TDF. Cellulosics waste feed for this second set of data was from cigarette filters.

---

[1]Conceptual Design Report for the Transuranic Contaminated Solid Waste Treatment Development Facility, TA-50, Los Alamos Scientific Laboratory, ENG-9 RP-54, September 4, 1973.

Design Particle Size Distribution

Size	Weight Percent
> 10 μ	10
5 - 10 μ	20
2 - 5 μ	40
1 - 2 μ	20
0.5 - 1 μ	10

The variable throat venturi scrubber particle removal efficiency was calculated for each of the above listed fractions at each of three pressure drop settings of the venturi:

$$\eta = 1 - \mathrm{EXP}\ \frac{-6.1 \times 10^{-9} (P_\ell)(d_{pa})^2 (\Delta P)(f)^2}{\mu_g}$$ [1]

ΔP = Pressure loss (cm H_2O)

η = Particle removal efficiency, dimensionless

P_ℓ = Liquid density, g/cm^3

d_{pa} = Aerodynamic particle diameter, μg/cc

μ_g = Gas viscosity, poise

f = Relative liquid/gas velocities (0.20 to 0.25 for air/water)

[1] After Calvert, Lundgren and Month, Transactions APCA, 1970.

		15 ΔP		40" ΔP		80" ΔP	
Size	Inlet	Eff.	Outlet	Eff.	Outlet	Eff.	Outlet
>10μ	17.46	99.99	--	99.99	--	99.99	--
5-10μ	34.93	99.99	--	99.99	--	99.99	--
2-5 μ	69.86	99.97	0.019	99.99	--	99.99	--
1-2 μ	34.93	76.60	8.17	97.90	0.73	99.957	0.015
0.5-1 μ	17.46	32.87	11.72	65.45	6.03	88.06	2.084
Totals	174.60		19.91		6.76		2.099
Overall Efficiency		88.59		96.13%		98.79%	

Using the middle value of 96.13% particulate removal efficiency for the venturi scrubber (normal operating pressure drop is 50"), and assuming no allowance for particulate removal in the quench chamber, liquid-gas separator, packed column scrubber, demister or ash or roughing filters, 7.74 g of ash containing 0.77 μCi of transuranics is expected to impinge on the HEPA filters. Each of the HEPA filters is 99.97% efficient for the removal of 0.3 micron/mass median diameter (MMD) particles.[1] The efficiency increases both above and below this particle size. The stack flow rate is 746,950 SCFH or 2.12 x $10^4 m^3$/hr yielding a plutonium concentration in the effluent of 3.14 x 10^{-18} μCi/mℓ, well below the DOEM 0524 limit of 6 x 10^{-14} μCi/mℓ for soluble plutonium. Additionally, plutonium incinerated at 2300° F is most probably in the oxide form and insoluble except in acid digestion. Therefore, the DOEM chapter 0524 limit of 10^{-12} μCi/mℓ is considered to be the applicable standard.

---

[1] Preliminary Safety Analysis Report, Plutonium Processing Facility, Los Alamos Scientific Laboratory, Group CMB-11, June 15, 1972, with revisions through October 30, 1972.

APPENDIX H. LIQUID FEED BURNER SPECIFICATIONS

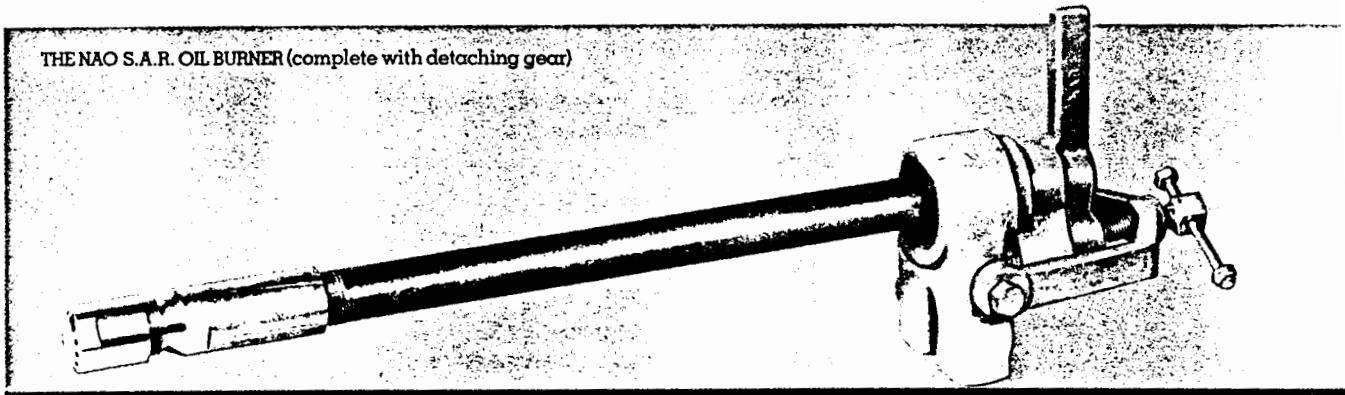
OIL BURNERS RELIABILITY GAS BURNERS VERSATILITY LOW AIR HEXAD BURNERS COMBUS
COMBINATION GAS AND OIL BURNERS COST EFFICIENCY JET MIX BURNERS WORLDWIDE SEF
LINEAR GAS BURNERS FUEL EFFICIENCY FORCED GAS BURNERS HIGH DURABILITY
LOW NOx PRE-HEATED AIR BURNERS RELIABILITY
REFORMER BURNERS

SPECIFY

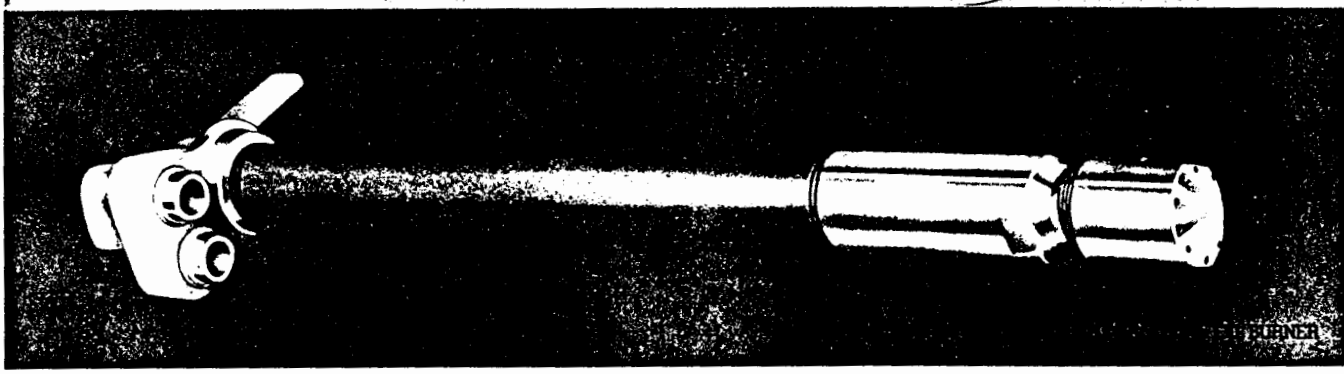
NAO

Steam Atomizing Oil Burners

Types S.A.R. and S.A.L



THE NAO S.A.R. OIL BURNER (complete with detaching gear)



Both burners use a #2240 yoke detaching gear that swings aside easily so that the burner gun can be removed without tools. Oil and steam piping need not be disconnected.

HIGH EFFICIENCY ... LOW MAINTENANCE

For use in process heaters, reformer furnaces, rotary kilns, dryers, boilers, pulverized coal installations, and special furnaces.

FOR ALL GRADES OF LOW AND HIGH VISCOSITY FUELS

ATOMIZATION BY STEAM, AIR OR GAS

NAO atomizing oil burners use steam, compressed air, natural gas, and by-product gas with suitable pressure.

Five sizes are available. Rated capacities range from 10 to 600 gallons per hour.

FLAME PATTERNS

NAO S.A.R. and S.A.L. atomizing oil burners produce solid cone, long solid circular jet, and flat flame patterns, providing optimal heat liberation in widely varying applications. Minor variations meet any modern furnace requirement.

FUEL ACCOMMODATION

The NAO S.A.R. burner accommodates many grades of oil, including Bunker "C," petroleum cracked residuums. It also accommodates tars, pitches, and asphalts when heated to viscosity of 150-200 SSU or less. Larger capacity NAO S.A.L. burners accommodate all grades of liquid fuels.

FLAME STABILITY

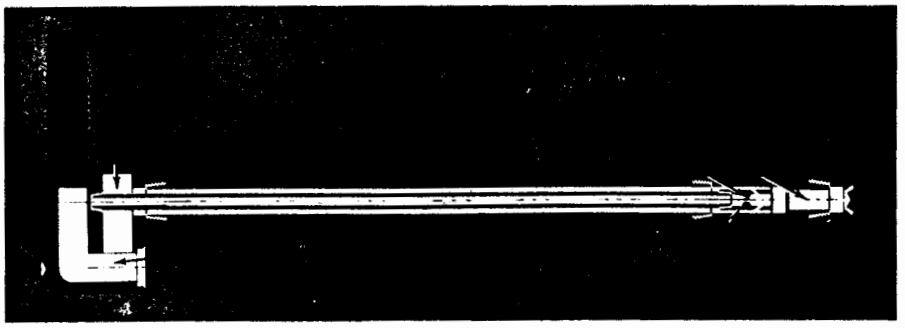
In NAO S.A.R. and S.A.L. oil burners, uniform atomization results in unsurpassed flame stability.

NAO steam atomizing oil burners — the efficient ones that combine required heat liberation and minimal steam consumption.

NAO Steam Atomizing Oil Burners

NAO S.A.R. and S.A.L. Oil Burners

OPERATION AND SPECIFICATION DATA

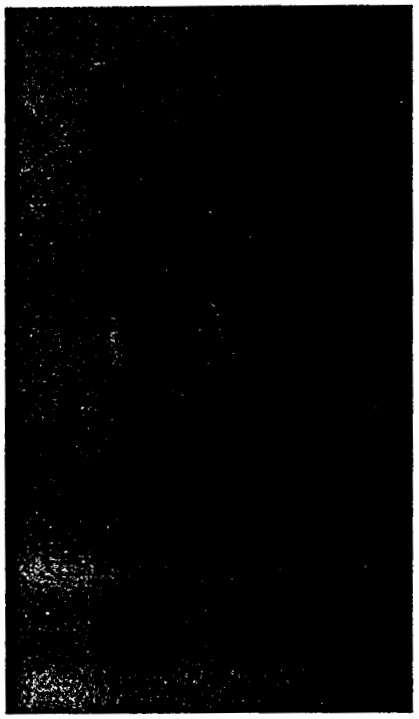


OPERATION

Oil passes through the inner pipe and is sprayed through the orifice. The atomizing medium, usually steam, travels through the outer pipe and becomes turbulent as it is forced through apertures in the core. Thorough steam-oil emulsification occurs in the mixing chamber.

A greater degree of atomization is achieved by passage of the emulsification through the tip, which is drilled to produce the desired flame pattern.

Modifying the burner tip provides a wide variety of flame sizes and shapes.



TYPICAL PIPING ARRANGEMENT FOR NAO S.A.R. AND S.A.L. OIL BURNERS

Note that a by-pass valve may be installed in the piping upstream of the burner inlets for cleaning the passages of the burner gun.

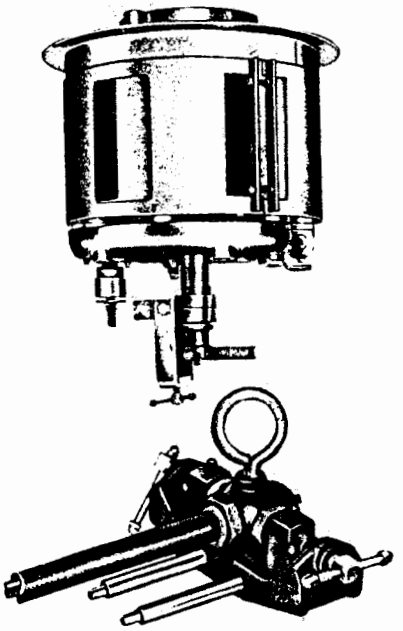
NOMINAL RATED CAPACITIES

These are **nominal** capacities, contingent upon factors such as fuel viscosity, the available pressure of fuels, and the type of unit in which the burner gun is used.

NAO HEXAD UNIT

NAO S.A.R. and S.A.L. burners are usually installed through one of the many varieties of NAO combustion units similar to the Hexad unit shown here. These units may use either fuel oil alone or a combination of gas and oil.

Most NAO combustion units using S.A.R. or S.A.L. burners are complete with primary and secondary air controls, plus a metal encased refractory burner block that provides quick combustion.



DETACHING GEAR (2176)

For special applications, NAO S.A.R. and S.A.L. burners can be equipped with Type 2176 Detaching Gears.

NOMINAL RATED CAPACITIES

Burner Size	U.S. Gal./Hr. Fuel Oil	Heat Liberated BTU/HR. No. 6 Fuel Oil

SPECIFY

NAO

S.A.R. and S.A.L. Oil Burners for

- **High efficiency** • **Low maintenance**
- **Required heat liberation** • **Minimal steam consumption**

National Airoil Burner

National AirOil Burner Company, Inc.

Handling combustion problems the right way since 1912

1284 East Sedgley Avenue, Philadelphia, PA 19134 Telephone (215) 743-5300 Telex 84-5403

Nippon National AirOil Burner Co., Ltd., Tokyo, Japan — National AirOil Burner Co., London, England

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Printed in U.S.A.
2.5M-377W
2M-0678W

RCRA TRIAL BURN
FINAL REPORT
for the
LOS ALAMOS
CONTROLLED AIR INCINERATOR

Submitted to

State of New Mexico
Environmental Improvement Division
Santa Fe, New Mexico

By

LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO

March, 1987

VOLUME II
(Appendices I through O)

APPENDIX I. TRIAL BURN PLAN

RCRA TRIAL BURN PLAN
FOR A MODULAR INCINERATOR
AT THE LOS ALAMOS NATIONAL LABORATORY
IN LOS ALAMOS, NEW MEXICO

Revision 1.0

OCTOBER 1985

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C. Fan Curve

D. Liquid Waste Flow and Combustion Gas Velocity Indicator Meters

E. Analytical Methods

SECTION D
PROCESS INFORMATION

D-5 INCINERATOR

Introduction

This trial burn plan is submitted as part of the RCRA Part B Permit Application requirements (40CFR 270.62) for the Controlled Air Incinerator (CAI) system at the Los Alamos National Laboratory in Los Alamos, New Mexico.

D-5a Justification for Exemption

Some Los Alamos waste forms, for which the incinerator operating permit is being sought, contain significant amounts of some hazardous constituents as listed in Appendix VIII of Part 261, and therefore, Los Alamos will not apply for an exemption as outlined in 264.340 (NMEID 206.D.8.a).

D-5b Trial Burn

D-5b(1) New Incinerator Startup/Shakedown

The Los Alamos incinerator is an operating incinerator. The provisions of 270.62(a) (NMEID 302.E.2.a) do not apply to this system.

D-5b(2) Trial Burn Plan

D-5b(2)(a) Incinerator Performance

Los Alamos seeks an operating permit by way of an additional trial burn of a principal organic hazardous constituent (POHC) with a high degree of difficulty of incineration, and will not submit results of earlier successful trial burns of hazardous wastes as justification for the permit.

D-5b(2)(b) Detailed Engineering Description of Incinerator

1. Manufacturer's Name and Model Number of Incinerator
   The Los Alamos CAI system was manufactured by Environmental Control Products (ECP) of Charlotte, North Carolina. The model number is ECP 500-T.

2. Type of Incinerator

The CAI system consists of a waste feed system and a controlled air incinerator. The Los Alamos CAI was developed through extensive modification and integration of commercially available and custom fabricated equipment. The small production-scale CAI system at Los Alamos was originally designed for the demonstration of volume reduction of combustible solid radioactive wastes. Components of the system include a dual chamber incinerator with a ram feeder for solids and a high intensity vortex liquid injection burner firing into the primary chamber, a secondary combustion chamber (SCC), an ash handling system, a water spray quench column, a high-energy venturi scrubber, a packed-column acid gas absorber followed by an offgas condenser, gas reheater, high efficiency particulate air (HEPA) filters, an activated carbon adsorber, and a final HEPA filter. One of the primary purposes of the CAI is incineration research. Research studies which have been completed in the CAI unit have included the incineration of various radioactively contaminated solid wastes, liquid PCBs, and pentachlorophenol contaminated wood.

A block flow diagram of the CAI incinerator is shown on Figure 1. The block flow diagram begins where the waste and auxiliary fuel is injected into the primary chamber and then traces the flow of the hot combustion gases to the secondary chamber, quench tower, and other pollution control devices with all discharge points noted.

3. Linear Dimensions of the Incinerator Unit Including the Cross-Sectional Area of the Combustion Chamber

The CAI system has two combustion chambers. The lower chamber (primary chamber) dimensions are 4 feet 10 inches inside diameter by 6 feet inside length. The upper chamber (secondary combustion chamber) dimensions are 3 feet 10 inches inside diameter by 6 feet inside length. The rectangular duct between the two chambers has internal dimensions of 1 foot by 3 feet and is 2 feet long. This duct contains the secondary air injectors and therefore functions as part of the secondary combustion chamber. The dimensions of the high-temperature duct between the secondary combustion chamber and the quench tower are 1 foot 8 inches inside diameter by 13

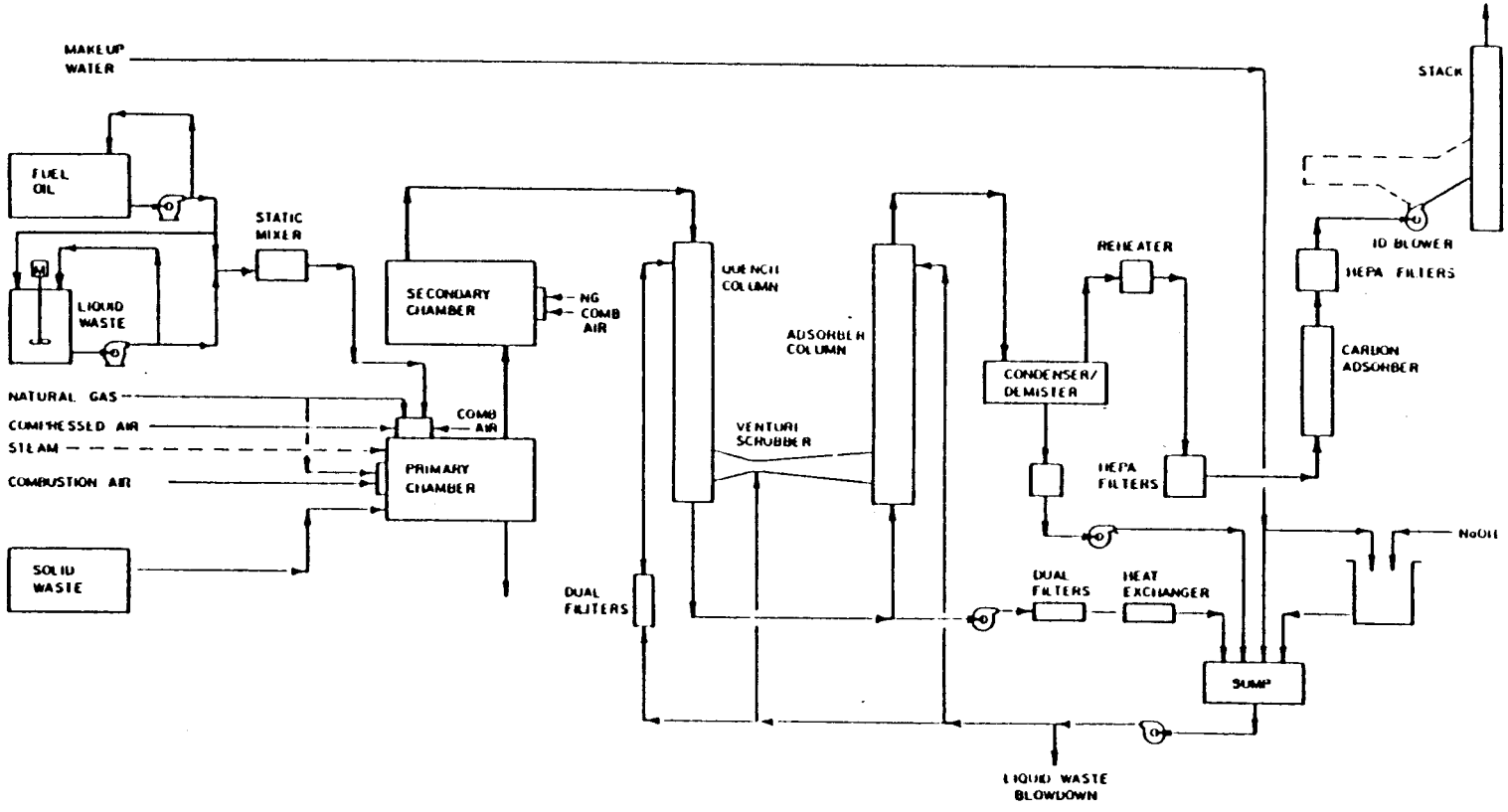


Fig. 1. Block Flow Diagram of CAI System

feet 7 inches long. The duct functions as an extension of the secondary combustion chamber. The volumes of the individual chambers are then approximately 110 ft^3 for the primary chamber, and 105 ft^3 for the secondary combustion chamber.

4. Description of the Auxiliary Fuel Burner System

The auxiliary fuel burner systems in the primary chamber and secondary chamber consist of gas burners. The primary and secondary chamber auxiliary fuel burners are identical. The primary chamber burner is located on the side of the primary chamber, and the SCC burner is located at the entrance to the SCC. Both of the auxiliary fuel burners are rated at 1,500,000 Btu per hour maximum output and are adjustable to suit operational requirements. The gas burners develop maximum rating with 3 inch W. G. gas pressure at the burners. All fittings, regulators, and control valves are Underwriters Laboratory, Chicago, Illinois, approved and assembled to meet the standards of Industrial Risk Insurers, Illinois, or other authority where applicable. Each of the auxiliary fuel burners is temperature controlled and is run with a preset combustion air to fuel ratio. The combustion air for both burners is supplied by a forced draft fan. Both burners are a pre-mix type manufactured by Pyronics, Inc., Cleveland, Ohio.

When fuel oil is used as an auxiliary fuel, it is either (1) injected through the liquid burner instead of waste liquid; or (2) batch-blended with the waste liquid and subsequently injected through the liquid burner as a mixture. An in-line static mixer has been installed to ensure dispersion of the fuel oil in the waste liquid as the mixture is being pumped to the liquid burner.

Method 1 is used to maintain heat in the lower chamber when operating the liquid burner and not feeding liquid waste. Method 1 is also used to flush the liquid feed lines following the completion of a liquid waste burn. Method 2 is used when the heating value of the liquid waste is too low to ensure proper operation of the liquid burner.

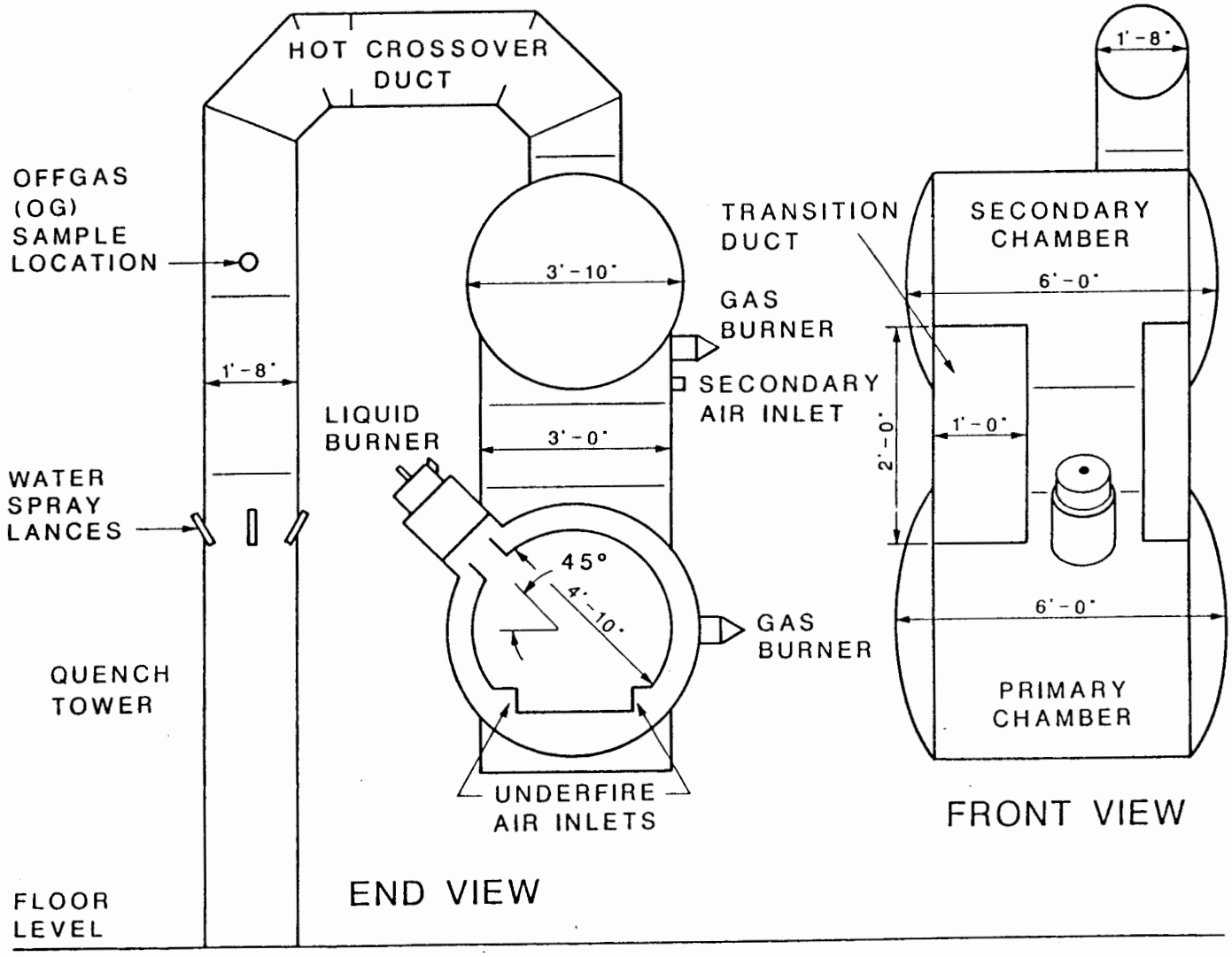


FIGURE 2. SCHEMATIC OF CAI

5. Capacity of Prime Mover

The CAI system prime mover is a Spencer Model G-3040-H-Spec turbine blower which operates as an induced draft (ID) fan. The ID fan is capable of producing an incineration negative pressure of 110 inch W.C. at a flow of 1900 cfm with a discharge pressure of 11.31 psia to accommodate the 7300 feet elevation at Los Alamos. The ID fan has a 40 hp, 3500 rpm motor.

6. Description of Automatic Waste Feed Cutoff

The primary function of the waste feed cut-off interlocks is to prevent the feeding of material at incineration conditions that are inadequate to assure destruction of the materials. During the startup and shutdown of the incinerator or during process upsets, the interlock system automatically stops all waste feed systems and prevents their restart until the incinerator is at proper operating conditions and the interlock is manually reset.

The process parameters identified in Table 1 are tied into an alarm panel and will also cut off the waste feed if the permit conditions for these parameters, as stated in 40 CFR 264.345(e), are exceeded. If any parameter is exceeded, a block valve in the waste liquid feed line to the liquid burner will automatically close, and the initiation signal to the solid waste feeding mechanism will automatically be deactivated. When permit conditions are within limits, neither the waste liquid block valve nor the solid waste feeding mechanism will be prevented from operating. The waste feed cut-off parameter permit condition values for permitted operation under 40 CFR Subpart O will be negotiated between EPA Region VI and Los Alamos based on the results of the RCRA trial burn. A discussion of the automatic waste feed cut-off parameters follows:

- <u>Primary Chamber and SCC Temperatures</u> -- The primary chamber and SCC temperatures are normally controlled to within 50`F below the temperature set-point. It is expected that the 50`F temperature variation will be encountered during normal operation and should not be cause for automatic waste feed cut-off.

- <u>Carbon Monoxide</u> -- Carbon monoxide (CO) concentrations are measured in the HEPA filter plenum and are discussed in Section D-5b(2)(b)7. Based on previous experience with the CAI, Los Alamos suggests that the

Table 1. Automatic Liquid and Solid Waste Feed Cut-Off Parameters

Parameter	
Minimum primary chamber temperature	1550°F
Minimum SCC temperature[a]	1550 or 1750°F
Maximum CO concentration	75 ppm by volume dry basis as measured by the continuous recording CO analyzer, except that for a period not to exceed 9 minutes, the system can continue to burn waste if the CO concentration does not exceed a maximum of 500 ppm.
Minimum scrub solution pH	4.0
Maximum combustion gas velocity[b]	To be determined during test run
Minimum HEPA filter pressure drop	0.1 inch W.C.
Maximum HEPA filter pressure drop	5.0 inch W.C.

[a]The trial burn is designed to determine the performance of the CAI while operating the SCC at two temperatures.

[b]Estimated to be less than 1500 SCFM.

CO automatic waste feed cut-off system be a two-tier system. The two-tier CO system is suggested as an approach to reducing waste feed cut-off situations which are caused by CO spikes. CO spikes are a common occurrence in incinerators during the feeding of liquid and solid wastes. The two-tier CO approach has previously been accepted by EPA Regions III and IV. The two-tier CO approach allows the use of a delay timer which starts if the CO level exceeds the first tier level, but not the second tier level. If at the end of a negotiated time the CO has not dropped below the first tier level, the waste feeds are automatically cut off. If, however, the CO drops below the first tier level before the time period has elapsed, the waste feeds are not cut off. If the second tier, however, is exceeded, the waste feeds are instantaneously cut off.

- Combustion Gas Velocity Indicator (CGVI) -- The CGVI will be measured during the trial burn and during permitted operation using a Fluidics HHR flow tube [see Section D-5b(2)(b)7 and Attachment D]. The CGVI permit condition for permitted operation will be based on the trial burn using the Fluidics flow tube.

- HEPA Filter Pressure Drop -- The pressure drop across each bank of the primary HEPA filters will be continuously monitored. If the filter pressure drop falls below the lower limit, the control system will automatically initiate a fast shutdown of the CAI. If the filter pressure drop exceeds the upper limit, the control system will automatically initiate a controlled shutdown of the CAI.

- Scrub Solution pH -- The acidity of the recycled scrub solution will be controlled by the addition of an alkali solution as required. The pH of the recycled solution will be continuously monitored. Operation of the CAI with a recycle scrub solution pH less than the limit will result in an automatic cutoff of the waste feed.

Three control logic sequences are provided to shut down the process in a safe and orderly manner.

- Controlled Shutdown -- initiated when there is potential for significant damage to minor process components. This is also the normal shutdown mode at the completion of a run. When controlled shutdown is initiated, feeding of waste to the incinerator is stopped, and a programmable set-point generator is activated that directs remote set-point inputs to the temperature controllers, causing a gradual decrease in

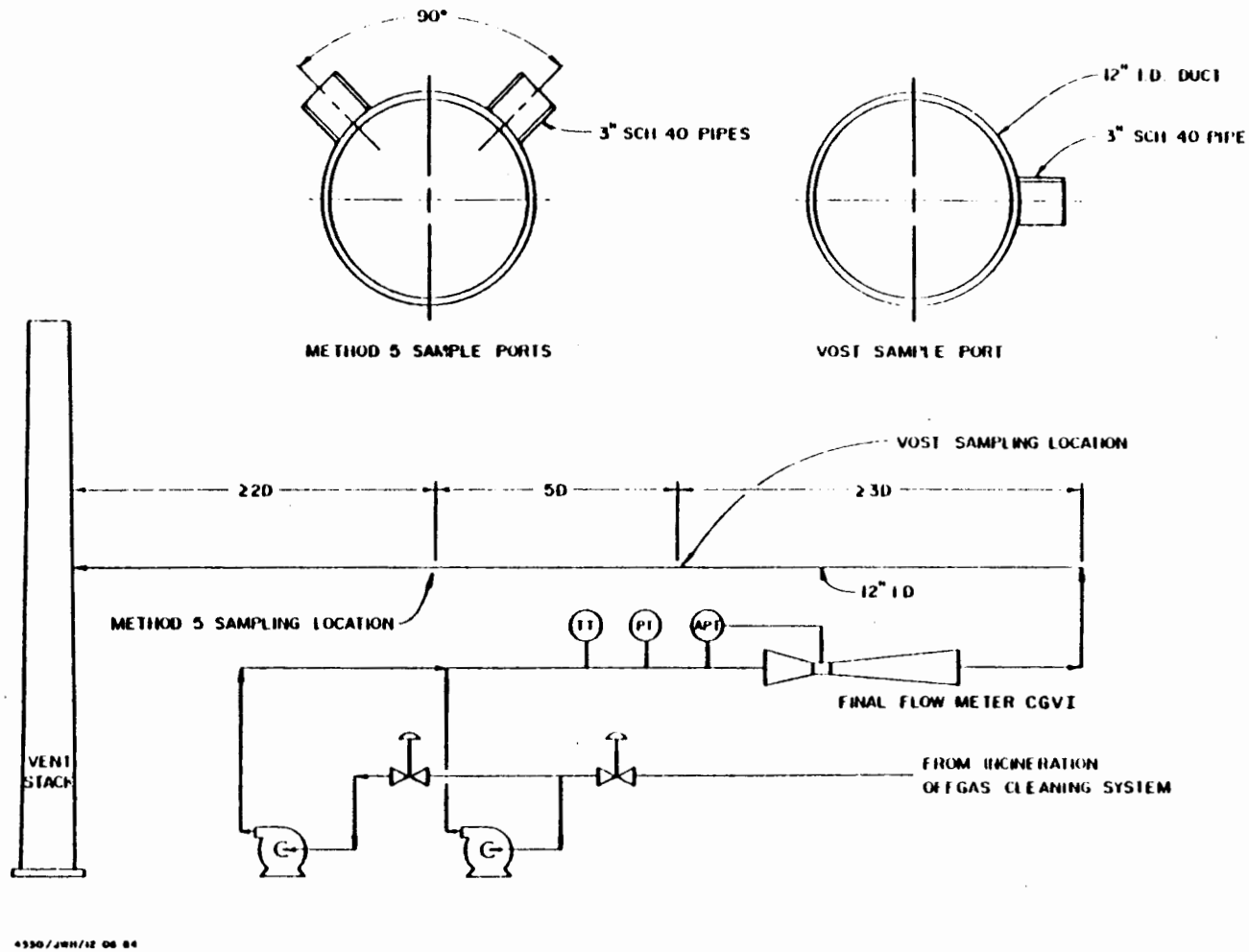


Fig. 3. Location of CGVI Flowmeter

chamber temperatures. Switches internal to the set-point generator cause an orderly timed shutdown of process components.

- Fast Shutdown -- initiated for conditions that could likely result in loss of containment or damage to major process components. Waste feeding is stopped. Following a two-minute timed interval following the last feeding of solid waste (immediately, if feeding liquid waste), the upper and lower chamber burners are shut down and the system valves and dampers are positioned so as to maintain a negative pressure in the system while minimizing flow through the system. Snuffing steam is introduced into the lower chamber. The two-minute delay when feeding solid waste allows for the ignition of pyrolytic gases formed immediately after feeding.

- Scram Shutdown -- initiated at the discretion of an operator. The chain of events are identical to the fast shutdown except that the sequence is not delayed when feeding solid waste. Scram buttons are located at the incinerator and in the control room.

The last two shutdown modes are potentially destructive to the incinerator refractory and are initiated only when the consequences of not shutting down are greater than the consequences to the incinerator during a scram or fast shutdown. It is the responsibility of the operating personnel and the process lead engineer to assess any situation and initiate the proper process shutdown sequence.

7. Stack Gas Monitoring and Pollution Control Equipment

Continuous monitoring of the off gas will be conducted for the combustion gas velocity indicator (CGVI) and CO. A single gas sample stream will be continuously withdrawn from the duct downstream of the reheater and just upstream of the HEPA filter inlet plenum for the CO analyses. Concentrations will be measured using a Foxboro-Wilks Miran II infrared (or equal) analyzer. Levels of CO will be recorded continuously on a strip chart in the control room.

The continuous CGVI monitoring will be recorded in the control room and measured by a Fluidic's HHR flow tube located in a straight run of duct between the ID fan outlet and the combustion gas stack. The CGVI

flowmeter information is supplied in Attachment D and the flowmeter location is shown in Figure 3.

The Los Alamos CAI Pollution Control Equipment (PCE) is shown in Figure 1. The PCE includes the following equipment.

- Quench column
- Venturi scrubber
- Packed absorber column
- Condenser/demister
- Reheater
- High efficiency particulate air (HEPA) filters
- Carbon bed adsorber
- Induced draft fan
- Recycle water system

In the quench column, combustion gases are cooled from the incinerator exit temperature to approximately 160°F by evaporation of scrub solution. Excess solution collects in the separator in the base of the column while the saturated gas phase is routed to the inlet of the venturi scrubber. The outlet temperature of the gas phase is monitored and a system limit of 250°F is imposed to protect the quench column from structural damage. Exceeding the temperature limit causes a waste feed shutoff and initiates an automatic controlled shutdown of the CAI.

The variable-throat venturi scrubber, located between the quench column and the absorber column, removes up to 99 weight percent of the offgas particulates. The intent and use of the venturi scrubber is to prolong the service life of the HEPA filters located further downstream in the PCE by reducing the particulate loading on the filters. The venturi assembly consists of converging and diverging cones with a clamp valve throat to allow the pressure drop to be varied. Venturi pressure drop normally is controlled in the 40 to 60 inch W.C. range. Recycled scrub solution is injected through a nozzle located upstream of the venturi throat.

Hydrochloric acid (HCl) is removed from the gas phase by counter-current contact with recycled scrub solution (or recycled condensate and fresh water) in the packed column absorber. The flow rate of the recycled solution is monitoreo and a low flow limit of 4.0 GPM is imposed to ensure

proper scrubbing of the HCl from the off gas. Operating below the flow rate limit causes a waste feed shutoff and initiates an automatic controlled shutdown of the CAI.

The condenser, mist eliminator, and reheater are included to condition the process exhaust gases before final HEPA filtration. The intent and use of the offgas conditioning system is to prolong the service life of the HEPA filters located further downstream in the PCE by minimizing blinding of the filters with condensate. The condenser lowers offgas temperature, removing water vapor from the scrubbed gas stream. The mist eliminator reduces the amount of water mist that is entrained in the offgas as the offgas leaves the downstream face of the condenser. The offgas is then reheated to a temperature above saturation temperature to avoid condensation and attendant plugging of the HEPA filters.

HEPA filtration is required for final removal of particulates. HEPA filters provide positive assurance that significant amounts of particulates are not vented in the stack gas. The filter module houses two frames (bank) in series, the first consisting of a prefilter and two HEPA filters in parallel, the second being similar but without the prefilter. Each bank of HEPA filters is tested in place for a minimum efficiency of 99.97 percent capture of particles with diameters >0.3 micrometer. The prefilter is rated at 85 percent efficiency. The pressure drop across each bank is monitored with a limit of >0.1 and <5.0 inch W.C. imposed. The lower limit ensures that a HEPA is properly in place (has not "sucked-through"), and the higher limit indicates a loaded filter bank. Operating below the lower limit causes a waste feed shutoff and initiates an automatic fast shutdown of the CAI. Exceeding the higher limit causes a waste feed shutoff and initiates an automatic controlled shutdown of the CAI.

The activated carbon bed adsorber serves as a final removal system for trace organic compounds. The housing for the activated carbon includes a third HEPA filter downstream of the carbon bed, which serves to remove any entrained carbon from the offgas stream. This third bank of HEPA filters is rated at the same capacity and is tested in place to the same efficiency as the primary HEPA filters located upstream of the carbon bed.

The induced draft fan is the prime mover which pulls the combustion gas through the air pollution control equipment.

The scrub solution recycle system is used to minimize liquid blowdown from the offgas cleaning system. Scrub solution usage ranges from 20-40 gal/min depending on the discharge pressure of the scrubber liquid pump and whether or not fresh water is being used in the absorber column. An alkaline solution is added at the process sump tank to maintain the scrub solution pH near the desired level. The addition rate is controlled by a pH sensor on the outlet of the process sump tank. The purge stream from the recycle water system goes to the Los Alamos liquid wastewater treatment system.

8. Liquid Burner Design

The details of the two auxiliary fuel burners are given in Section D-5b(2)(b)4 and Attachment B. A liquid waste burning nozzle and burner system is also located in the primary chamber. The burner is a commercial high intensity vortex liquid injection-type. The burner, a Trane Thermal model LV-2 vortex burner, is mounted on the side of the primary chamber firing downward at a 45° angle from horizontal directly into the chamber (Figure 2). The unit is equipped with its own natural gas pilot and natural gas supply for supplemental heat. Atomization of the liquid feed stream is accomplished with either air or steam through an internal mix nozzle. Details of the Trane burner are given in Attachment B.

9. Construction Materials

The construction materials for the CAI system components are as follows:

COMPONENT	CONSTRUCTION MATERIAL
Primary chamber, secondary chamber and high temperature duct	Carbon steel shell Internal mastic membrane Internal fiberboard insulation (refractory fiber) Internal high density refractory (40% Al_2O_3)

Quench tower, venturi scrubber, absorber tower, duct to condenser	FRP shell (ATLAC 382 resin, with with 5% antimony oxide fire retardant) Hastelloy C-276 Polypropylene
Condenser/demister, duct to HEPA filter plenum	304L stainless steel shell with phenolic resin internal coating and Plasite® paint coating
HEPA filter plenum, absorption tower	Carbon steel shell, Plasite® paint coating
Induced-draft blower, ductwork to blower and from blower to vent stack, vent stack	Carbon Steel

10. Location of Temperature, Pressure, and Flow Indicating and Control Devices

The discussion in this section is based on Figure 4. The numbers given at the end of each heading refer to the equipment location in Figure 4.

a. Primary Chamber and Secondary Combustion Chamber Combustion Temperatures (1,2) -- The combustion gas temperatures of the primary chambers and the secondary combustion chamber are each measured with a type S (platinum/10% rhodium) thermocouple. The primary chamber thermocouple is located in the hot duct between the primary and secondary combustion chambers. The SCC thermocouple is located downstream of the SCC at the entrance to the high temperature duct.

b. Waste Liquid Flow (3) -- Waste liquid flow is measured by a Micro-Motion®, Model C25, gyroscopic/coriolis mass flowmeter. The Micro-Motion flowmeter provides a measurement of instantaneous mass flowrate of the waste liquid being fed to the Trane burner. A detailed description of this flowmeter is given in Attachment D.

c. Solid Waste Flowrate (4) -- Solid waste is typically fed to the CAI in preweighed 1 foot X 1 foot X 2 foot cardboard boxes. These boxes are than transferred to the side ram feeder, which feeds the main ram feeder. The main ram feeder pushes boxes of solid waste into the primary chamber on a timed cycle which can be manually or automatically overriden when necessary. Each time a box of solid waste is fed to the primary chamber, the incinerator operator records the event on a log sheet.

   The solid waste feed rate will be monitored, as is presently done, by the operator entering on a logsheet the weight and time each box of solid waste is fed to the primary chamber. Most of the solid wastes fed to the primary chamber are not RCRA hazardous wastes.

d. Combustion Gas Flowmeter (5) -- The combustion gas flowrate will be measured at a location between the ID fan and the stack by a Fluidic's HHR flow tube. This combustion gas flowrate will be the combustion gas velocity indicator (CGVI) (see Section D-5b(2)(b)7 and Attachment D).

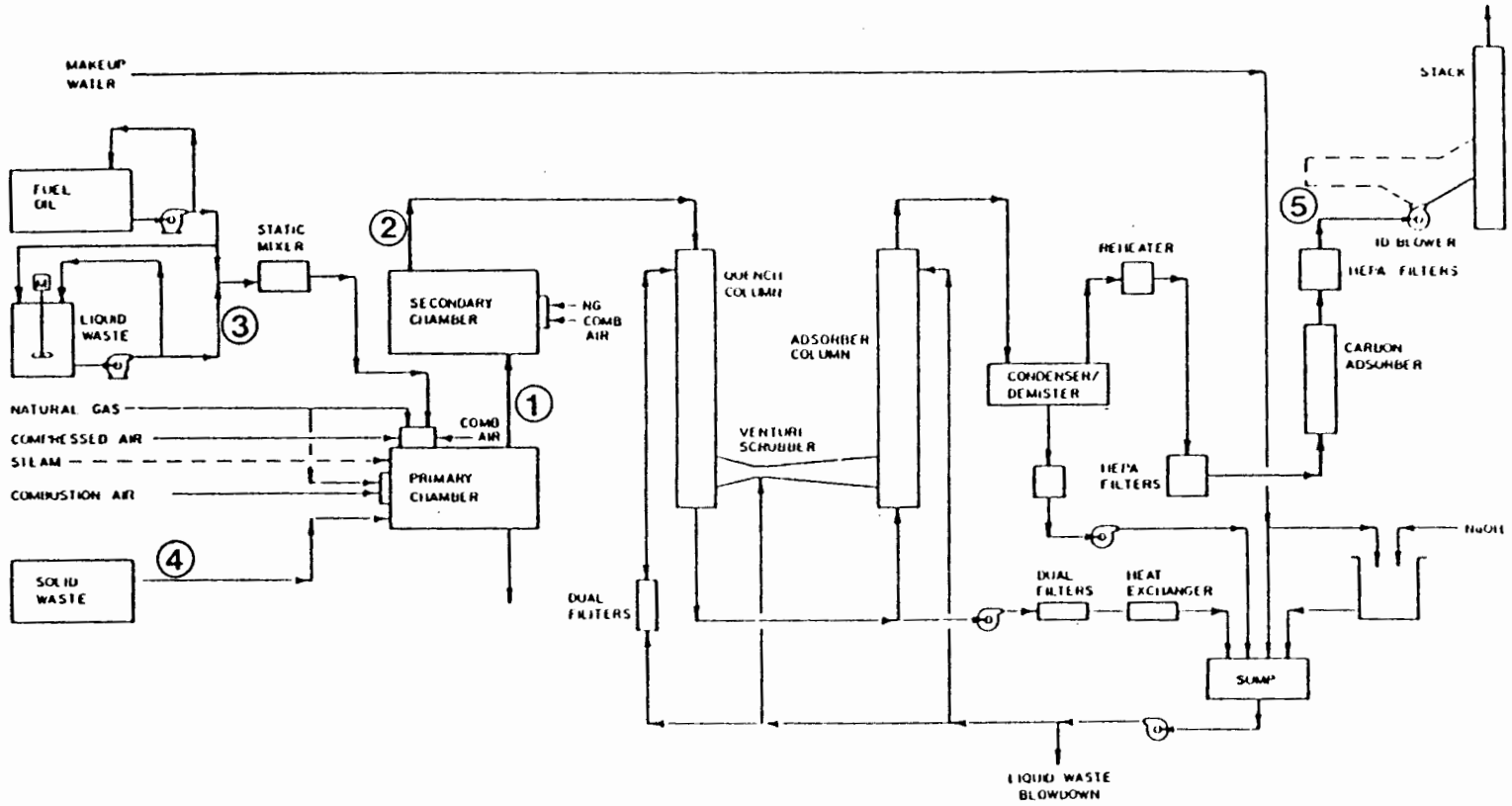


Fig. 4. Location of Temperature, Pressure, and Flow Indicating Control Devices

e. Research Parameter Measurement -- Because the CAI is used and will be used partly as an incineration research system, it is more highly instrumented than typical industrial hazardous waste incinerators. The CAI has many temperature, pressure, and flow indicating instruments not mentioned in this section. These instruments are necessary from the research point of view, but are not necessary to meet the requirements of the 40 CFR 264 Subpart O and 40 CFR 270.62 RCRA incineration and trial burn regulations.

D-5b(2)(c) Sampling, Analysis, and Monitoring Procedures

The objective of a trial burn test is to obtain process data that will:

- Permit calculation of Principal Organic Hazardous Constituent (POHC) destruction and removal efficiency, HCl removal efficiency, and particulate emission concentrations
- Confirm the fate of POHCs treated by the system; that is, destroyed by thermal oxidation, and removed by the air pollution control system, or emitted in the stack gases, ash residues or scrubber water purge stream
- Document the test process feed and operating conditions that will be used in establishing operating permit conditions

The sampling and analysis procedures included in this section are therefore selected to determine the physical-chemical characteristics of the incinerator feed materials (especially the POHC concentrations), material feed rates, the composition and flow rates of the stack gases, and the amounts of POHC discharged in the incinerator ash, the stack gases and the quench-scrubber purge water. The monitoring procedures are selected to measure concentrations of O_2 in the combustion gases and CO in stack gases.

The following sampling and analysis procedures are based on carbon tetrachloride (CCl_4) being used as the POHC. The rationale for selection of CCl_4 as the POHC is presented in Section D-5b(2)(d).

1. Sampling Locations and Procedures

   The locations where solid, liquid, and gaseous samples are collected from the incineration system are shown in Figure 5. All of the materials supplied to the incineration and air pollution control processes including fuel oil, liquid and solid waste feeds, and makeup water are sampled at

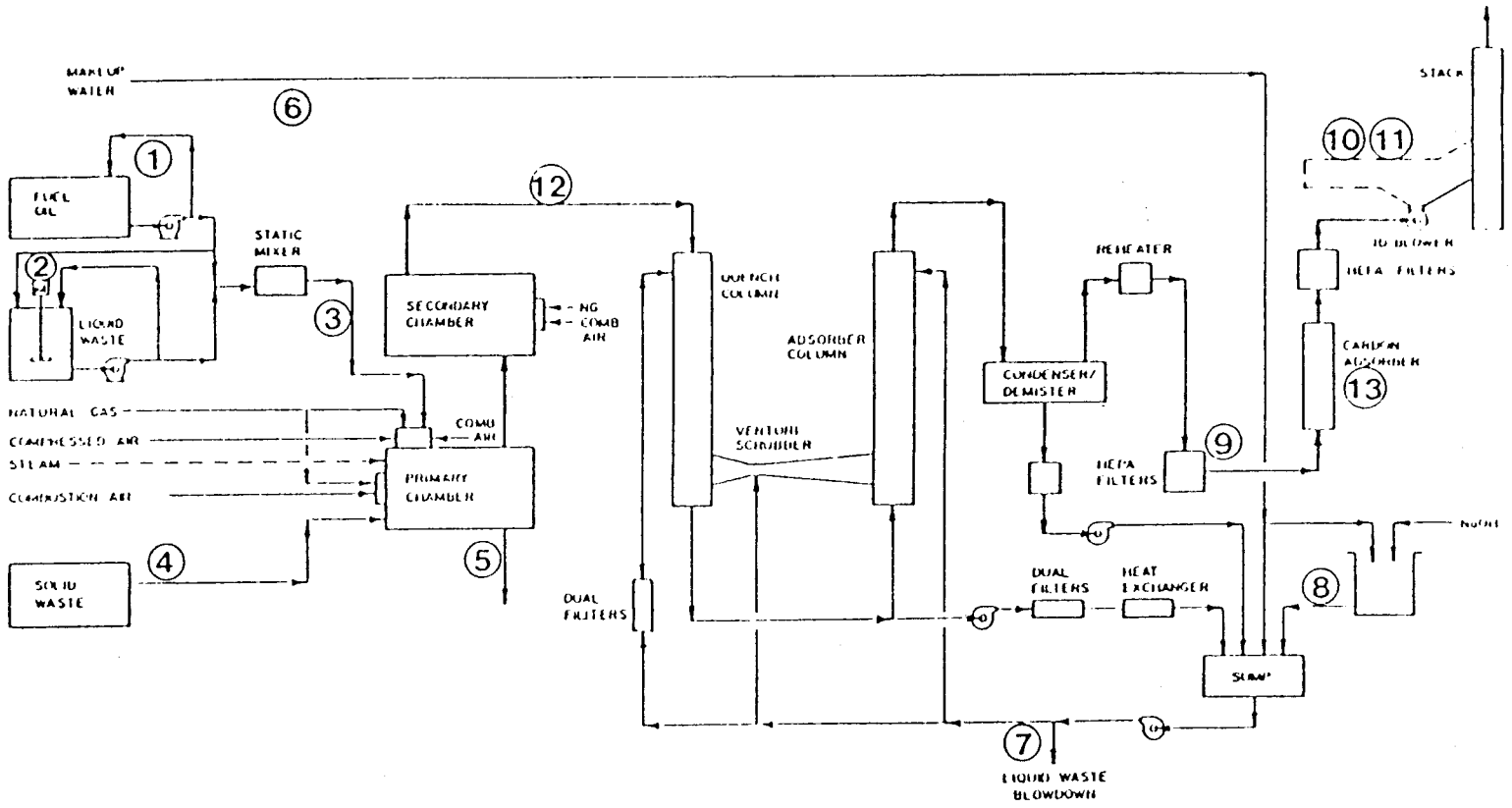


Fig. 5. Location of Sampling Points

locations 1, 2, 3, 4, 6, and 8. Samples of process solids (ash and carbon) and liquid (blowdown water) effluents are collected at locations 5, 13, and 7, respectively. POHC, HCl, and particulate emission samples are collected from the stack gases at locations 10 and 11. The O_2 concentration of the combustion gases is continuously monitored at location 12; CO_2 and CO concentrations are monitored at location 9.

The sampling equipment and the procedures for collecting samples at each location are summarized in Table 2. Sampling frequency and reference methods are included in that table. Additional details regarding each sampling location are discussed below.

a. Fuel Oil (1) -- A representative sample of fuel oil will be collected just before each test sampling run either by taking grab samples from a tap in the fuel oil recirculation line, or by using a coliwasa at an access port in the top of the tank. This sample will be retained for future analysis in case there are problems with analysis of the blended liquid sample taken at location 3.

b. Liquid Waste (2) -- A representative sample will be collected just before each test sampling run either by taking grab samples from the liquid waste recirculation line or by using a coliwasa at a access port in the top of the tank. This sample will also be retained for future analysis in case there are problems with analysis of the blended liquid sample taken at location 3.

c. Liquid Waste Blend (3) -- The organic liquid waste will be prepared in the liquid waste tank and either fed directly to the incinerator or blended with fuel oil in an inline static mixer before being fed to the incinerator. A flow diagram of the waste feed system is shown in Figure 6. Grab samples will be collected from a sample tap in the feed line to the incinerator at the beginning, middle, and end of each replicate sampling run and composited.

d. Solid Waste Blank (4) -- All solids materials will be prepared before the trial burn and stored in sealed containers. A scoop will be used to collect equal size samples from each bulk solids container before

the actual waste feed containers are prepared. The samples will be composited to provide a blank of solids matrix material and placed in a wide-mouth glass bottle with Teflon-lined lid.

e. Incinerator Ash (5) -- Small and possibly negligible amounts of ash are expected to be accumulated during each test sampling run. The ash drop doors will be operated at the end of each test period allowing any accumulated ash to fall into the drop-out hopper where it will be pneumatically conveyed to the ash collection hopper located above the glove box. The sample (if any) will be collected from the double valve drop chute inside the glove box. The ash drop doors and the pneumatic system will be operated before each test run to remove ash accumulated since the previous test.

f. Makeup Water (6) -- Grab samples will be collected from a supply line tap at the beginning and end of each replicate sampling run and composited.

g. Blowdown Water (7) -- Grab samples will be taken from a tap in the liquid waste discharge line to the industrial (radioactive) waste treatment plant. Before each sampling run, two grab samples will be collected 30 minutes apart and composited to provide a blank sample. Grab samples will be taken every 60 minutes during each replicate sampling run and composited for the run.

h. Aklaline Solution (8) -- Sample tank contents after preparing new batch.

i. HEPA Plenum Exhaust Gas (9) -- A gas sample is continuously extracted for carbon monoxide analysis. (CO_2 analysis will be used to confirm stack gas Orsat analyses).

j. Stack Gases (10, 11) -- Samples of the particulates, acid gases, and volatile organics in the offgas will be collected from the exhaust duct at locations 10 and 11 shown in Figure 7. The exhaust duct is designed for isokinetic sampling.

Table 2. Sample Collection Locations, Equipment, and Methods

cation	Description	Access	Equipment	General Procedures/Frequency	Reference Methods[a]
1.	Fuel oil recirculation line	Tap	Glass bottle	Grab sample at beginning and end of each run; composite for each replicate test run	S004,SW846
	Alternate: Fuel oil tank	Top port	Coliwassa; glass bottle	Grab sample prior to each replicate test run	S001,SW846
2.	Liquid waste recirculation line	Tap	Glass bottle	Mix tank contents, collect grab sample at beginning and end of each replicate run and composite	S004,SW846
	Alternate: Liquid waste tank		Coliwassa; glass bottle	Mix tank contents, collect sample prior to each test run	S001,SW846
3.	Liquid waste feed line	Tap	Glass bottle	Grab sample at beginning, middle, and end of each run; composite for each run	S004,SW846
4.	Solids storage containers	Open top	Scoop; glass bottle	Prior to loading waste feed boxes, collect sample from each bulk solids container; composite all samples to obtain blank of solids feed matrix	S007,SW846
5.	Ash drop chute	Valve	Glass bottle	Collect samples from valve at end of each run	S006,SW846
6.	Makeup water supply line	Tap	Glass bottle	Composite grab samples collected at beginning and end of run	S004,SW846
7.	Liquid waste blowdown	Tap	Glass bottle	Collect blank before run; composite hourly grab samples	S004,SW846
8.	Alkaline solution tank	Top port	Dipper, plastic bottle	Sample tank contents after preparing each batch	S002,SW846
9.	HEPA plenum exhaust	Port	Instrument vacuum pump	Continuously extracts and transports gas sample to instrument for CO/CO_2 analysis	
10.	Stack inlet duct	Port	VOST sampling train	Six pairs of sorbent cartridges collected over 3-hour period	S012
11.	Stack inlet duct	Port	EPA M5 sampling train	Collect integrated samples of particulates, moisture, and acid gases; measure stack gas velocity pressure and temperature over 3-hr sampling time; collect from the exhaust of the train integrated bag samples of stack gases for CO_2 and O_2 analysis every 30 min	S008, EPA Methods 1-5
12.	Secondary chamber	Port	Instrument aspirator pump	Continuously extracts and transports combustion gases to instrument for O_2 analysis.	
13.	Adsorber carbon	Port	Thief, glass bottle	Take core sample about 1/2 in. dia. X 6 in. long from inlet side of adsorber after each test	

Prefix S refers to Sampling and Analysis Methods for Hazardous Waste Combustion, EPA-600/8-84-002. SW refers to Test Methods for Evaluating Solid Waste, SW 846, Sec. Ed., July 1982

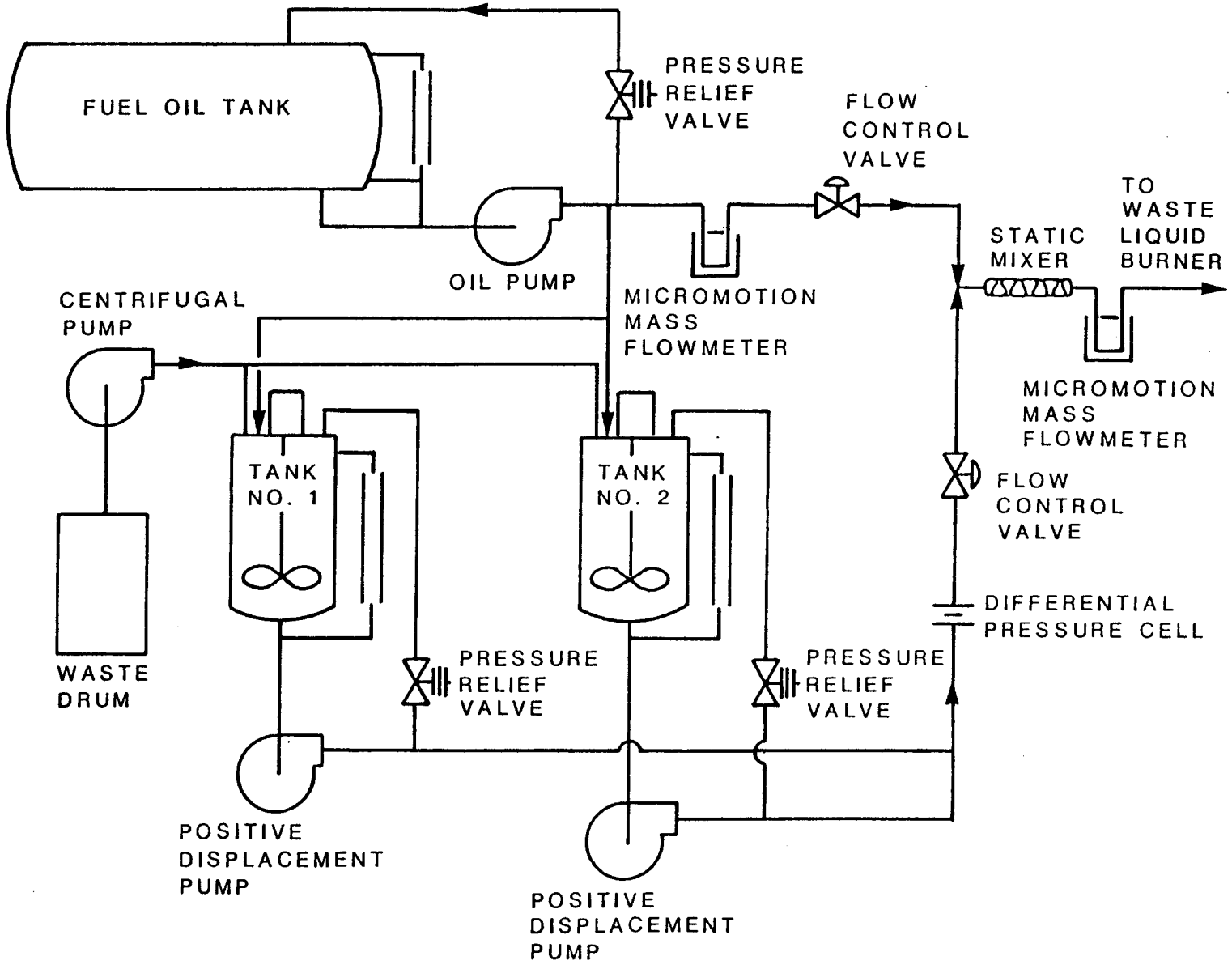


FIGURE 6. CAI LIQUID FEED SYSTEMS

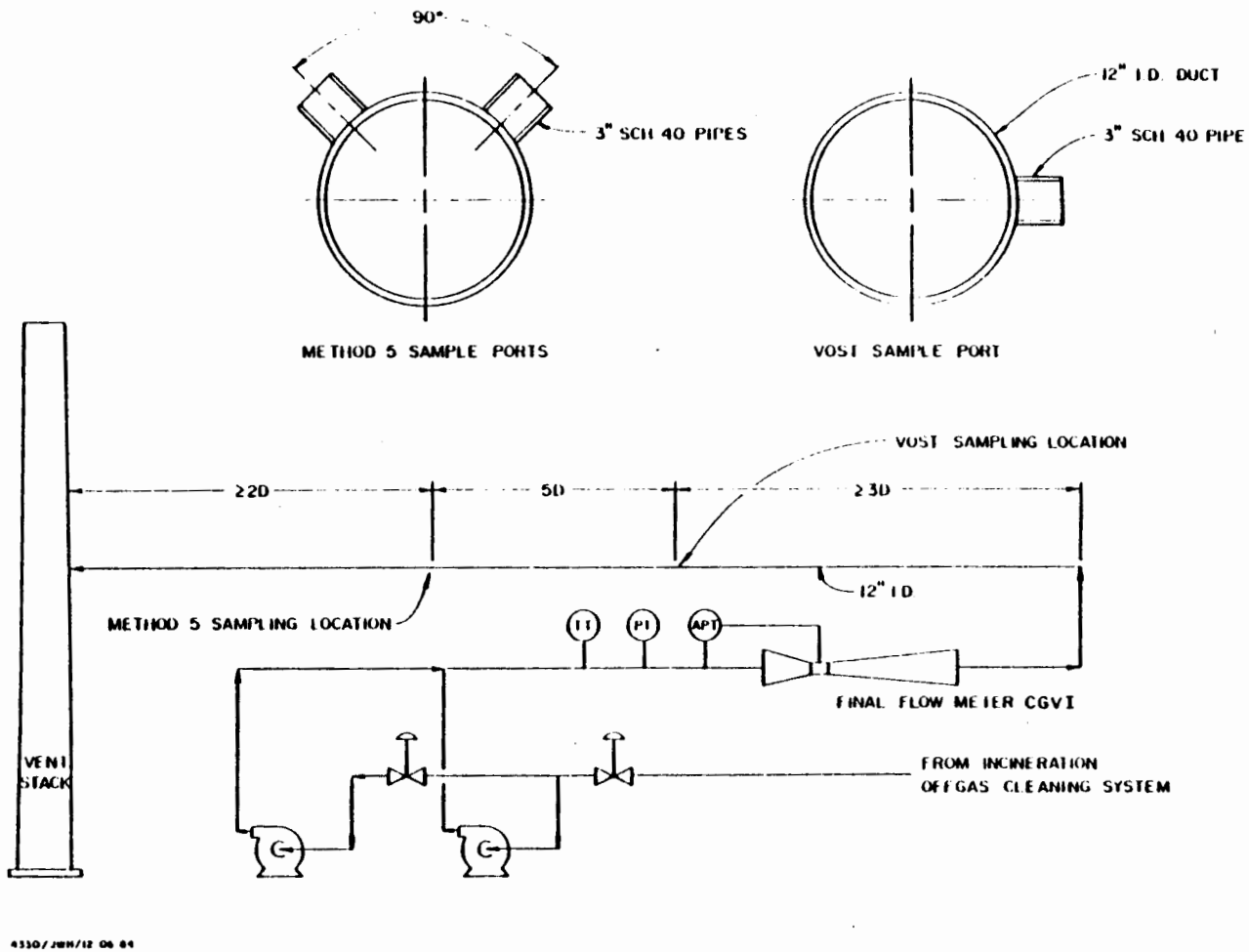
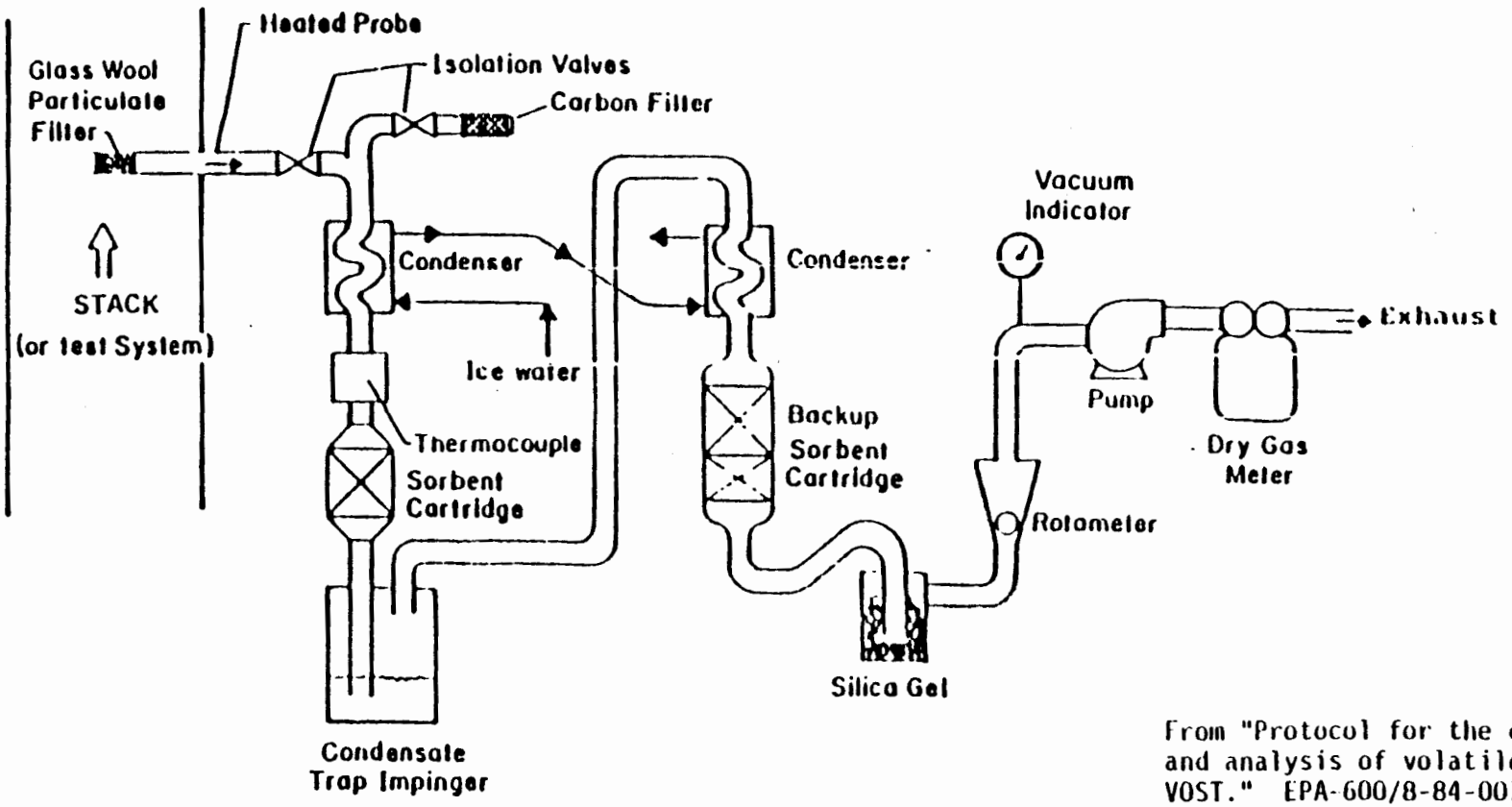


Fig. 7. Stack Gas Sampling Locations



From "Protocol for the collection and analysis of volatile POHC using VOST." EPA-600/8-84-007.

FIG. 8. Schematic of Volatile Organic Sampling Train (VOST)

A volatile organic sampling train (VOST, Figure 8) will be used at location 10 to collect CCl_4 and other volatile organics on sorbent resin according to procedures given in Attachment E. The VOST will be operated for approximately three hours during each test duplicate sampling run. The VOST cartridges will be capped immediately upon removal from the train, wrapped in aluminum foil, placed in glass tubes, and sealed.

An EPA Method 5 (M5, Fig. 9) sampling train will be used at location 11 for collection of particulate and HCl acid gas. The M5 procedures include measurement of the stack gas flow rate and temperature according to EPA Methods 1 and 2. Approximately every 30 minutes, integrated samples will be collected in gas bags from the M5 train exhaust for O_2 and CO_2 determinations by an Orsat analyzer according to EPA Method 3. The M5 train will be operated for approximately three hours to collect approximately 3.5 m^3 stack gas during each replicate sampling run.

k. Combustion Gas (12) -- A sample will be continuously extracted from the hot gas for O_2 concentration analysis.

l. Adsorber Carbon (13) -- A thief will be used to take a core sample (approximately 1/2-inch diameter X 6 inches long) from the inlet gas side of the absorber after each test. The sample will be placed in a glass container with a Teflon-lined lid.

There are three other process wastes that can potentially contain small amounts of CCl_4 in accumulated solids. These wastes are the offgas HEPA filters, the quench recycle liquid filters, and the absorber discharge liquid filters. These filters are not included in the sampling program for the following reasons:

- The amount of solids that will be accumulated in the filters during a 3-hour run is believed to be insignificant because the systems are designed for long term (weeks, months) of service before the filters are removed for disposal.

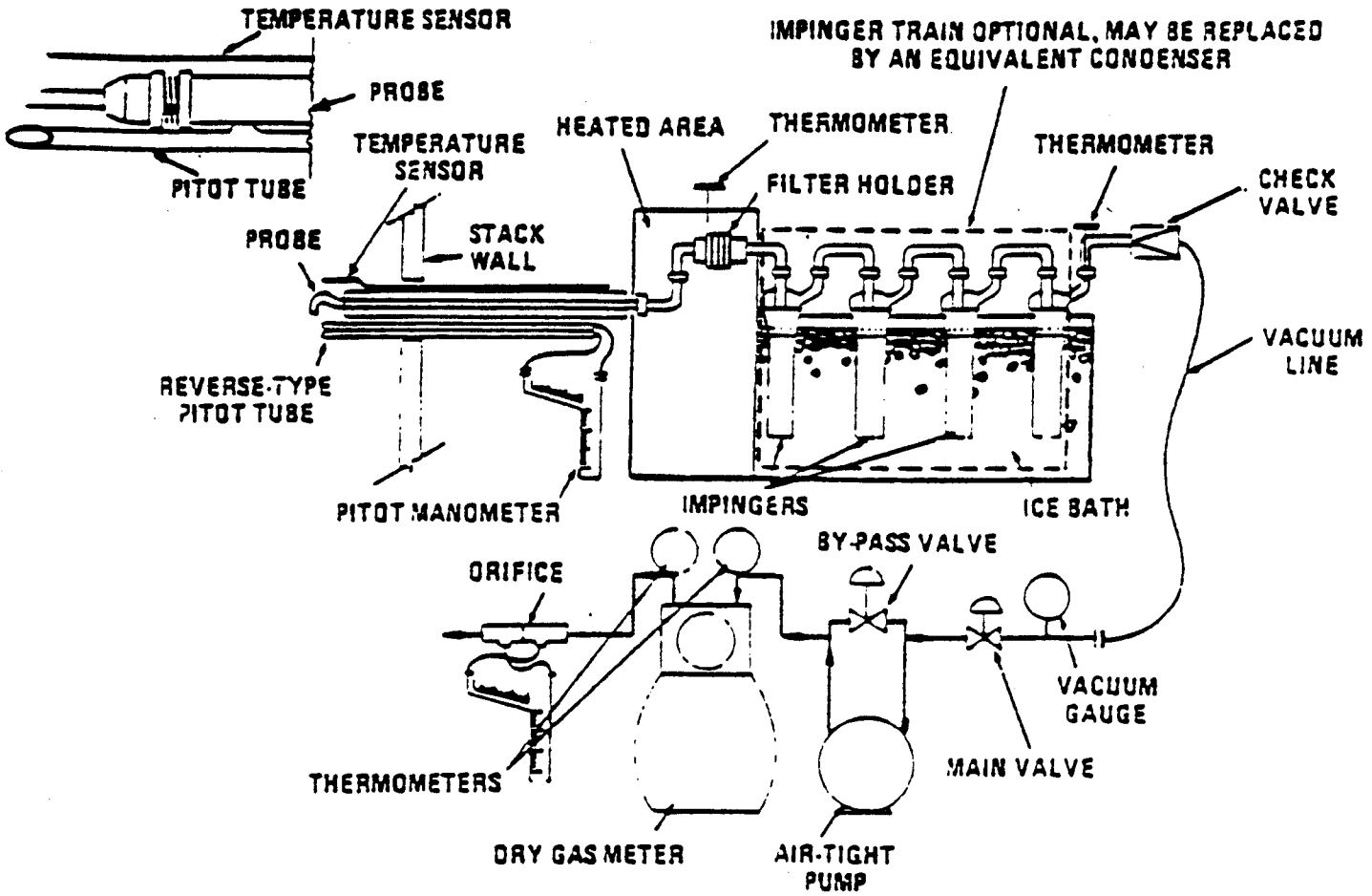


Fig. 9. EPA Method 5 Sampling Train

- The total amount of CCl_4 retained by the solids during a sampling run is believed to be negligible because the gas and liquid streams are at elevated temperatures and because CCl_4 has low solubility in water. At the proposed process conditions, residual CCl_4, if any, will tend to remain in the gas streams rather than be retained in the liquids or the small amount of accumulated solids.

- The filter media will probably contain radioactive particulates, complicating cartridge removal, recovery of accumulated solids, extraction and analysis of CCl_4. Removal of the air and liquid filter cartridges after each of the twelve sampling runs would cause extension of the test schedule and significantly increase trial burn costs.

All sample containers and organic sorbent traps for the above sampling program will be prepared by the laboratory having primary responsibility for analyzing all samples. At the test site a sample manager will be responsible for distributing sample containers and traps, monitoring sample collection, taking custody of samples from the sampling team, and preserving the samples. The sample manager will be responsible for shipping and for transferring sample custody to analysis coordinators in the primary and reference laboratories.

2. Sample Recovery Procedures

The laboratory analysis coordinators will inspect the samples as received and accept custody. Sample aliquots will be taken for the required analyses. Surrogate and/or reference compounds will be added to these samples before any preparation steps. The specific compounds and the amounts to be added will be as called for in the analytical procedures. Typically, the spike amounts will be near the analysis detection level. The laboratories will be responsible for implementing their own instrument calibration and QA/QC procedures.

The procedures for recovering compounds from the major sample groups are briefly summarized below.

<u>Organic Liquids</u> -- This group includes the fuel oil and the liquid waste blend samples. The fuel oil and liquid waste samples will be shaken to minimize stratification before removing aliquots for specific analyses.

For organic analyses, small aliquots will be diluted in hexane for direct analysis or processed through cleanup, as required by the analytical procedures identified in the next section.

Solids -- This group includes solid waste blanks, incinerator ash, and adsorber carbon. The samples will be dispersed in methanol or polyethylene glycol for analysis using purge and trap procedures (Attachment E).

Aqueous -- This sample group includes makeup water, blowdown water, alkaline solution and VOST condensate. Sample recovery procedures are not required for these samples because they will be direct injected according to procedures referenced in the next section for volatile organic analysis.

Sorbent Resins -- This sample group will include the VOST resin cartridges (Tenax® and Tenax-charcoal). Each pair of VOST resin cartridges will be thermally desorbed to an analytical trap according to the protocol detailed in EPA-600/8-84-007.

M5 Train Components -- The samples will be recovered from the M5 train as follows:

- Particulate filter -- Will be removed from holder, placed in a glass petri dish, wrapped in aluminum foil, placed in a plastic bag and sealed.

- Probe rinse -- The nozzle, probe, and front half of the filter holder and any connecting glassware will be brushed and rinsed with acetone followed by a rinse with hexane. The rinses will be placed in glass jars with Teflon-lined lids.

- Impinger water -- The contents of the impingers will be volumetrically measured and placed in a glass sample bottle with a Teflon-lined lid. The impingers will be rinsed with distilled water and the rinse added to the sample.

- Silica gel -- The cartridge will be returned to its original container and sealed.

Table 3. Analyses Planned for Trial Burn Samples

Sample Name	Analyses
	Tests 1 and 2 (Liquids)
Fuel oil	(Archive)[a]
Raw liquid waste	(Archive)[a]
Liquid waste blend	Density, heat content, ash content, elemental (C,H,N,O,S, organic Cl), matrix constituents, CCl_4
Incinerator ash	(Archive)[b]
Makeup water	CCl_4
Blowdown water	CCl_4, pH, total chlorides
Alkaline feed	CCl_4
Adsorber carbon	CCl_4
Stack gas VOST	CCl_4
Stack gas M5	Particulates, moisture, HCl, O_2, and CO_2
Combustion gas monitor	O_2
Absorber gas monitor	CO and CO_2
	Tests 3 and 4 (Solids)
Fuel oil	Density, heat contnt, ash content, elemental (C,H,N,O,S, organic Cl), CCl_4
Solids feed blank	Density, heat content, ash content, elemental (C,H,N,O,S, organic Cl), moisture, CCl_4
Incinerator ash	(Archive)[b]
Makeup water	CCl_4
Blowdown water	CCl_4, pH, total chlorides
Alkaline feed	CCl_4
Adsorber carbon	CCl_4
Stack gas VOST	CCl_4
	Tests 3 and 4 (solids) (Continued)
Stack gas M5	Particulate, moisture, HCl, O_2, and CO_2
Combustion gas monitor	O_2
Absorber gas monitor	CO and CO_2

[a]Retain for same analysis as liquid waste blend if needed.

[b]Retain for CCl_4 analysis if needed.

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Table 4. Summary of Analytical Procedures and Methods

Analysis	Sample Name	Test No.	Sample Matrix	No. of Samples	Procedure Description	Reference Methods[a]
ensity	Fuel oil	3,4	No. 2 fuel oil	6	Gravimetric/volumetric	
	Liquid waste blend	1,2	Fuel oil, CCl_4	6	Gravimetric/volumetric	
	Solids feed blank	3	Sawdust	1	Gravimetric/volumetric	
eat Content	Fuel oil	3,4	No. 2 fuel oil	6	Bomb calorimeter	A006, ASTM D240
	Liquid waste blend	1,2	Fuel oil, CCl_4	6	Bomb calorimeter	A006, ASTM D240
	Solids feed blank	3	Sawdust	1	Bomb calorimeter	A006, ASTM D2015
sh Content	Fuel oil	3,4	No. 2 fuel oil	6	Residue after combustion in muffle furnace	A001, ASTM D482
	Liquid waste blend	1,2	Fuel oil, CCl_4	6	Residue after combustion in muffle furnace	A001, ASTM D482
	Solids feed blank	3	Sawdust	1	Residue after combustion in muffle furnace	A001, ASTM D3174
lemental Composition (C, H, N, O)	Fuel oil	1,2	No. 2 fuel oil	6	Analyze combustion products and residue	A003, ASTM 3176
	Liquid waste blend	1,2	Fuel oil, CCl_4	6	Analyze combustion products and residue	A003, ASTM 3176
	Solids feed blank	3	Sawdust	1	Analyze combustion products and residue	A003, ASTM 3176
rganic Chlorine	Fuel oil	1,2	No. 2 fuel oil	6	Halide titration of combustion residue	A004, ASTM D2361
	Liquid waste blend	1,2	Fuel oil, CCl_4	6	Halide titration of combustion residue	A004, ASTM D2361
	Solids feed blank	3,4	Sawdust	1	Halide titration of combustion residue	A004, ASTM D2361
isture	Solids feed blank	3	Sawdust	1	Heating under controlled conditions	A001, ASTM D3173
tal suspended solids	Blowdown water	1,2,3,4	Water	12	Filtration residue	EPA M160.1
tal dissolved solids	Blowdown water	1,2,3,4	Water	12	Filtrate residue	EPA M160.2
tal organic carbon	Blowdown water	1,2,3,4	Water	12	Oxidation/IR detection	EPA M415.1

Table 4. (Continued)

Analysis	Sample Name	Test No.	Sample Matrix	No. of Samples	Procedure Description	Reference Methods[a]
Organics						
CCl_4	Fuel oil	3,4	No. 2 fuel oil	6	Dilution, purge and trap, GC/MS	A101, SW 8240
	Liquid waste blend	1,2	Fuel oil	6	Dilution, purge and trap, GC/MS	A101, SW 8240
	Solids feed blank	3	Sawdust	1	Extraction, purge and trap, GC/MS	A101c, A101
	Incinerator ash	1,2,3,4	Combustion residue	0-12	Extraction, concentration, GC/MS	A101c, A101
	Makeup water	1,2,3,4	Water	4	Purge and trap, GC/MS	A101a, A101
	Blowdown water	1,2,3,4	Water	12	Purge and trap, GC/MS	A101a, A101
	Alkaline solution	1,2,3,4	20% NaOH	1-4	Purge and trap, GC/MS	A101a, A101
	Adsorber carbon	1,2,3,4	Carbon	12	Purge and trap, GC/MS	A101a, A101
	Stack gas VOST	1,2,3,4	Sorbent resins	36	Thermal desorption, trap, GC/MS	A101a
		1,2,3,4	Condensate	12	Purge and trap, GC/MS	A101a, A101
HCl	Stack gas M5	1,2,3,4	Condensate H_2O combined with impinger NaOH solution	12	Ion specific electrode	Orion Manual
Particulates	Stack gas M5	1,2,3,4	Probe rinse residue, filter	12	Gravimetric	EPA Method 5
O_2, CO_2	Stack gas M5	1,2,3,4	Stack gas	-	Integrated bag samples for ORSAT analysis every 30 min	EPA Method 3
O_2	Secondary Chamber	1,2,3,4	Combustion gas	b	Gas analysis by electrochemical cell (Thermox WDG-III)	
CO_2, CO	Adsorber exit gas	1,2,3,4	Combustion gas	b	Gas analysis by IR detector (Foxboro-Wilks Miran II)	

[a]"A" refers to Sampling and Analysis Methods for Hazardous Waste Combustion, EPA-600/8-84-002, February 1984.
"ASTM" refers to American Society for Testing Material Standards.
"SW" refers to Test Methods for Evaluating Solid Waste, SW 846, Second Edition, July 1982.
"EPA" refers to New Source Performance Standards, Test Methods and Procedures, Appendix A, 40 CFR 60.
"EPA M" refers to Chemical Analysis of Water and Wastes, EPA-600/4-79-020.
[b]Continuous monitoring.

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3. Analytical Procedures

The analyses planned for each trial burn sample are listed in Table 3. The procedures and reference methods for these analyses are summarized in Table 4. The standard methods referenced for heat content, ash content, elemental composition, organic chlorine, and stack gas O_2, CO_2, and particulates are self-explanatory. Analysis of samples for CCl_4 will be by the methods referenced in EPA-600/8-84-002. These methods involve the use of standard purge-and-trap, gas chromatography (GC/MS) techniques for identification and quantification of volatile organics. Copies of referenced procedures are included as Attachment E.

4. Monitoring

Monitoring for CO will be done during the trial burn tests using a Foxboro-Wilks Miran II Infrared analyzer [See Section D-5b(2)(b)7].

D-5b(2)(d) Detailed Trial Burn Protocol

1. Waste Characterization

The CAI will be used to incinerate the Los Alamos laboratory waste. The laboratory wastes are a mixture of liquid and solid hazardous wastes composed of various organic solvents and liquids as well as chemically contaminated paper, wood, and plastics. The liquids are basically small quantity lab chemicals which will be transferred from lab size containers into larger containers and stored until ready to be incinerated. Laboratory liquids can contain either ignitable or U or P listed wastes containing Appendix VIII constituents.

Because the laboratory liquid wastes include numerous small bottles which are generated in a random fashion it is impossible to identify and quantify the Appendix VIII constituents by a sampling program. The POHC has therefore been selected based on an approach suggested by the EPA and discussed in the next section.

2. POHC Selection Rationale

In selecting the principal organic hazardous constituent (POHC) to be used in the CAI solids and liquids trial burn, several criteria were considered

important for various reasons. Trade-offs or constraints imposed by these criteria were carefully evaluated in selecting the compound.

Thermal stability of organic compounds must be considered in examining the behavior of organic compounds in a combustion unit. EPA's approach to trial burns is to specify POHCs of high thermal stability so that results can be extrapolated to compounds of similar or lower thermal stability. According to the EPA's Guidance Manual for Hazardous Waste Incinerator Permits, heat of combustion is the EPA's preferred indicator of thermal stability.[1] Accordingly, compounds with low heats of combustion (ΔHc) were given priority consideration in the POHC selection process. Since it is important to obtain as flexible a permit as possible, artificial wastes containing carbon tetrachloride (CCl_4) are proposed as the POHC during the trial burn. This option is suggested in the March 1983 draft of the EPA's Guidance Manual for Hazardous Waste Incinerator Permits. The Guidance Manual makes the following statement relative to the use of artificial wastes[2]:

> "Using an artificial waste feed has the advantage of simplifying the analytical procedures because interference by organics other than the POHCs is greatly reduced. This approach also allows the applicant to create waste feed that is very difficult to burn. A successful trial burn conducted with such a waste feed results in permit conditions allowing the operator to accept a wide variety of wastes for treatment, perhaps eliminating any future need for permit modifications and additional trial burns."

Carbon tetrachloride has a very high rank (fourth highest) on the EPA's ranking list of the incinerability of organic hazardous constituents on the basis of heats of combustion. Carbon tetrachloride has also been shown by the University of Dayton Research Institute to have a very high vapor phase thermal oxidation stability[3]. Therefore, CCl_4 is proposed for use as the POHC in both the solids and liquid trial burns.

Spiking the waste with CCl_4 will also provide a source of organic chlorine which will give maximum permit flexibility relative to the HCl performance standard. Los Alamos therefore recommends that CCl_4 be designated as the trial burn POHC.

The approximate composition and analytical parameters of the trial burn liquid and solid wastes are given in Tables 5 and 6. The values in Tables 5 and 6 are estimates.

3. Trial Burn Protocol and Operating Conditions
The trial burn will consist of four tests. Each trial burn will include triplicate sampling runs. A total of 12 sampling runs will be done. Table 7 presents the test protocol and schedule for each of these trial burn tests and 12 runs.

4. Waste Constituents

a. Liquid Wastes -- Trial burn tests 1 and 2 will involve the incineration of a liquid blend of fuel oil and carbon tetrachloride (CCl_4) as a suggested POHC in the primary chamber waste burner. The liquid blend will also be spiked with an ash surrogate which will generate particulate during incineration. The liquid waste will be spiked with an ash surrogate in order to obtain a more flexible RCRA liquid incineration permit relative to waste ash content. [See D-5b(2)(d) 8.] The viscosity of the liquid blend will be dependent on the characteristics of the blend of #2 fuel oil, CCL_4, and the ash surrogate. The ash surrogate may increase the viscosity of the blend substantially. Los Alamos will not burn material with a viscosity greater than 500 SSU at in injection temperature in order to ensure proper atomization. The approximate characteristics of the liquid waste blend are summarized in Table 5. The trial burn operating conditions are summarized in Table 8.

b. Solids Wastes -- Trial burn tests 3 and 4 will involve the incineration of sawdust and CCl_4. The CCl_4 was selected as a suggested POHC for the solids trial burn tests because of its commercial availability and high ranking on the EPA's heat of combustion hierachy. Because of CCl_4's high volatility, however, the CCl_4 will be fed to the incinerator in sealed containers. The sealed containers of CCl_4 and the sawdust will be placed in 1 foot X 1 foot X 2 foot cardboard boxes, weighed, and fed

Table 5. Approximate Estimated Composition of Trial Burn Waste Liquid[a]

	Wt%	
Composition		
Carbon tetrachloride	60-65	
Fuel oil	35-40	
Heat value		~7,000 Btu/lb
Organic chlorine content	55-60	
Ash content	2[b]	
Viscosity	< 500 SSU[c]	

[a]This is the CCl_4 spiked waste liquid which will be incinerated during the trial burn.

[b]An ash-producing material, aluminum stearate or other organometallic compound, will be added to the liquid waste blend as an ash surrogate.

[c]At injection temperature.

Table 6. Approximate Estimated Composition of Trial Burn Solid Waste

	Wt%
Composition	
Carbon tetrachloride	20-25
Sawdust	75-80
Organic chlorine content	20-25

Table 7. Test Protocol and Schedule

Trial Burn Test	Run No.	Sampling[a] Run Duration(hr)	Waste Feeds/POHCs Trial Burn Tests: Liquid[b] Waste	Solid[c] Waste	Natural[d] Gas	Stack Testing: DRE	Particulate	HCl
1	1 - 1	5 - 6	CCl_4		X	X	X	X
	1 - 2	5 - 6	CCl_4		X	X	X	X
	1 - 3	5 - 6	CCl_4		X	X	X	X
2	2 - 1	5 - 6	CCl_4		X	X	X	X
	2 - 2	5 - 6	CCl_4		X	X	X	X
	2 - 3	5 - 6	CCl_4		X	X	X	X
3	3 - 1	5 - 6		CCl_4	X	X	X	X
	3 - 2	5 - 6		CCl_4	X	X	X	X
	3 - 3	5 - 6		CCl_4	X	X	X	X
4	4 - 1	5 - 6		CCl_4	X	X	X	X
	4 - 2	5 - 6		CCl_4	X	X	X	X
	4 - 3	5 - 6		CCl_4	X	X	X	X

[a]Includes incinerator equilibration time and equipment change-over time between runs.

[b]Blend of fuel oil and CCl_4.

[c]Sawdust and CCl_4.

[d]As required to maintain primary and SCC temperatures.

Table 8. Trial Burn Operating Conditions[a]

Trial Burn Test	Physical Forms	Waste Feed Rates Solid (lb/hr)	Waste Feed Rates Liquid (lb/hr)	Heat Value (Btu/lb)	HCl (lb/hr)	Temperatures (°F) Primary	Temperatures (°F) SCC
1	Liquid		250-300	~ 7,000	150-185	1800 1,600	2000 1,800
2	Liquid		250-300	~ 7,000	150-185	1800 1,600	2200 2,000
3	Solid	250-300		-	60-75	" 1,600	2000 1,800
4	Solid	250-300		-	60-75	" 1,600	2200 2,000

[a]The values given in this table are estimates which may vary during actual operation.

to the incinerator by a ram feed or on a timed cycle. This is the present procedure for feeding most solid wastes to the CAI C [see Section D-5b(2)(b)10C]. The approximate composition of the solid waste in shown in Table 6. The trial burn operating conditions are shown in Table 8. The CCl_4 in plastic bottles simulates a lab solid waste which contains CCl_4 in a plastic bottle.

5. Combustion Temperature Ranges

The combustion temperatures for the tests will be 1600°F for the primary, and 1800 and 2000°F for the SCC as indicated in Table 8. Combustion temperatures are normally controlled to within 50°F. It is expected that this range will prevail for the trial burn.

6. Waste Feed Rates

The waste feed rates for trial burn test runs 1 through 4 are summarized in Table 8.

7. Combustion Gas Velocity

The measured indicator of combustion gas velocity during the trial burn will be the combustion gas flow through the Fluidics HHR flowmeter [See Section D-5b(2)(b)7C].

8. Waste Feed Ash Content

In order to obtain permit flexibility relative to the waste liquid ash content, an ash-producing material, aluminum stearate or other organo-metallic compound, will be added to the waste liquid before it is fed to the incinerator.

9. Auxiliary Fuel

Natural gas will be used as an auxiliary fuel as required to maintain temperatures, in both the primary and secondary combustion chambers.

10. Scrubber Water

Recycle water sumps will be sampled after each sampling test and will be flushed clean within practical limits before the next sampling test.

D-5b(2)(e) Trial Burn Schedule

1. Schedule

   The trial burn is planned to begin within 6 months of the time that Los Alamos receives EPA approval for the Part B Permit application. The schedule for the test is shown in Table 9.

2. Duration of Each Trial Burn Test

   Four trial burn tests are planned, each consisting of three replicate sampling runs. Each sampling run will last about 3 hours for a total of 9 hours per trial burn test. The incinerator will be fed test wastes for 2 to 3 hours before each sampling run for a total of 5 to 6 hours per test. This will establish steady operating at process test conditions. Sampling will be done 24 hours per day using two sampling shifts. Assuming minimal interruption of incinerator operation, the incinerator is therefore expected to operate on test waste feeds for 24 hours per day for about 3 days.

3. Quantity of Waste to Be Burned

   Test waste liquids and test waste solids will each be fed to the incinerator for an estimated 30 to 36 hours. Allowing a 25 percent safety factor the consumption of test wastes is expected to be about 1,250 gallons of waste liquid and 13,500 pounds of waste solids. The CAI will be operating on normal wastes under interim status prior to and following the tests. It is expected that the unit will be equilibrated at test conditions with normal waste or auxiliary fuel and switched to the test waste two to three hours before the start of each sampling run. A surplus of test waste will be prepared in case operational problems require a longer testing period. Unused waste will be incinerated at the conclusion of the tests. The amount of POHC (CCl_4) present in the liquid and solid wastes is expected to be about 12,150 pounds.

Table 9. Test Schedule

Test	Sampling Run No.[a]	Day
1	1-1	1
	1-2	1
	1-3	1
2	2-1	1
	2-2	2
	2-3	2
3	3-1	2
	3-2	2
	3-3	3
4	4-1	3
	4-2	3
	4-3	3

[a]Each sampling run will be about 3 hrs long, preceded by a 2 to 3 hr equilibration period and equipment change-over period.

D-5b(2)(f) Trial Burn Permit Objectives

If the RCRA DRE, particulate, and HCl performance standards (40 CFR 264.343) are achieved during the trial burn as outlined in Table 8, the RCRA incineration operating permit should allow the Controlled Air Incineration System to be used to incinerate RCRA hazardous solid and liquid wastes at the rates and conditions discussed in this section [D-5b(2)(f)].

The expected RCRA incineration permit conditions discussed in this section are based on the March 1983 "Guidance Manual for Hazardous Waste Incinerator Permits," prepared by the U.S. EPA's Office of Solid Waste.

The expected RCRA permit conditions are discussed in the following pages and summarized in Table 10.

1. Anticipated RCRA Permit Conditions for Solid Wastes
   The following expected permit conditions will be based on waste characteristics:

   a. Appendix VIII Constituents -- Since the solids in trial burn tests 3 and 4 will contain CCl_4, the system permit should allow the incineration of wastes containing CCl_4 and any other Appendix VIII Constituent lower on the EPA's Ranking of Incinerability List. Only three Appendix VIII Constituents at levels above 1000 ppm would not be allowed: $CFCl_3$, $CHBr_3$, and CF_2Cl_2.

   b. Minimum Heat Value -- There should be no permit requirement that specifies a maximum or minimum solids, sludge or slurry heat value. The minimum heat value concept, while relevant to organic liquid, is not relevant to low heat value solids such as contaminated soils. To quote the March 1983 Guidance Manual:

      "However, in the case of solids fed to rotary kilns, hearths and other solids handling incineration equipment, a different approach to specifying a heating value for waste is needed. Many solid wastes, by their very nature, are subject to wide variations in heating value, and rotary kiln, hearth, and similar incinerator designs attempt to deal with this problem. Such designs provide

Table 10. Summary of Expected Permit Conditions

Content/Physical Form	Type of RCRA Permit: Solid	Type of RCRA Permit: Liquid	Comments
POHCs	CCl_4	CCl_4	
Trial burn tests	3-4	1-2	
Appendix VIII constituents	CCl_4	CCl_4	NPC = Not permit condition
Minimum Btu/lb	NPC	7000	
Max. organic chlorine (lb/hr)	180[a]	180	Total for liquid/solid and aqueous wastes
Maximum ash content (wt%)	NPC	2	Total ash for liquid and aqueous
Temperature			
Primary (°F)	1550-1600	1550-1600	
SCC (°F)	1750-1800	1750-1800	
Maximum primary chamber thermal duty (MM Btu/hr)	2	2	
Maximum primary chamber natural gas (MM Btu/hr)	NPC	NPC	
Water injection rate	NPC	NPC	
Liquid feed rate	NPC	NPC	
Solid waste feed rate	NPC	NPC	

[a]- All numerical values are estimates which will be finalized by the trial burn results.

> for the volatiles in the solids to be vaporized and subsequently destroyed in an afterburner or secondary combustion chamber. Thus in specifying heating values for solid waste feeds, a lower heating value limit may not be required if the incinerator is equipped and operated to maintain sufficient temperature by addition of liquid waste or auxiliary fuel."

Since the CAI has auxiliary fuel firing capability in both the primary and SCC chambers, the CAI should not have a heat value permit condition for solids incineration.

c. Maximum Organic Chlorine Content of Waste -- The maximum permitted pounds per hour of waste organic chlorine should be based on the trial burn results. If the CAI's air pollution control system for example removes 185 pounds of HCl per hour, then the permit condition should allow the CAI to incinerate up to 180 pounds of organic chlorine per hour in the combined liquid and solid waste feeds. Since the source of the HCl is irrelevant to the performance of the air pollution control equipment, the permit should allow 180 pounds of organic chlorine per hour to be incinerated either as all liquid or solid or any combination of liquid and solid.

d. Maximum Ash Content of Waste -- There should be no solids ash content permit condition for the CAI. Particulate emissions will be measured during both solids trial burn tests. If the particulate emissions are at or below RCRA regulations, this testing should be considered as an acceptable particulate test for all solid wastes and sludges. When considering particulate emissions, it should be realized that for the CAI, the ash content of the liquid wastes is more important to particulate generation and emissions than is the ash content of the solid wastes being incinerated.

e. Physical Form -- The physical form given in the RCRA solid hazardous waste permit should specify solids, sludges, and slurries.

f. Incinerator Operating Permit Conditions -- The following permit conditions are anticipated to be based on the incinerator operating conditions during the trial burn tests:

- Temperature - Table 8 summarizes the temperature conditions for the solids trial burn tests.

- Maximum Thermal Duty - A maximum primary chamber thermal duty permit condition based on the trial burn results is desirable so that the permit will allow the incineration of any combination of aqueous, liquid, and solid/sludge wastes with a total thermal duty equal to the maximum permitted duty. The March 1983 version of the Guidance Manual covers this situation in Section 5, Example 2. On page 5-10, the Guidance Manual discusses a case in which 1MM Btu/hr of solid wastes and 1.2 MM Btu/hr of liquid wastes are successfully incinerated. The Guidance Manual then goes on to state that hazardous wastes containing more readily incinerated Appendix VIII Constituents than those tested may be fed in greater amounts, provided that the total thermal input is less than 2.2 MM Btu/hr and the other permit restrictions on waste composition are satisfied. Since no waste will be fired in the secondary combustion chamber (SCC), the maximum thermal duty should only apply to the primary chamber.

- Natural Gas Feed Rate - During the incineration of solid wastes, the only permit limit on natural gas feed rate should be the maximum thermal duty. Natural gas feed rate can vary from near zero up to the maximum permitted thermal duty. When incinerating solids, the rate of liquid fuel or liquid waste fired in the primary chamber is not the important criterion. What is important is the outlet temperature of the primary chamber combustion gas, which is controlled by a permit condition at a minimum level. This situation is covered on page 4-6 of the March 1983 Guidance Manual. The Manual states that the net effect of specifying the total thermal input is to permit the substitution of easily incinerated waste (higher waste heat value) for auxiliary fuel when specified operating conditions, such as combustion zone temperature and air feed rate, are maintained.

- Liquid Waste Feed Rate - As previously stated for the natural gas feed rate, the Guidance Manual states on page 4-6 that more easily incinerated wastes (constituents lower than CCl_4 and waste heat values greater than 7000 Btu/lb) can be permitted at rates up to the maximum permitted thermal duty of the primary chamber.

- Solid Waste Feed Rate - The only permit conditions related to the solid waste feed rate should be the maximum allowable primary chamber thermal duty and the primary chamber and SCC temperatures. As long as these

permit conditions are met, organic solid wastes should be destroyed at the DRE levels specified in the RCRA regulations.

g. Other Permit Conditions -- Other expected permit conditions such as stack carbon monoxide concentration and combustion gas velocity indicator are not discussed in this section. These conditions will be established when the results of the trial burn tests are evaluated.

2. Anticipated RCRA Permit Conditions for Liquid Wastes

The following anticipated permit conditions will be based on waste characteristics:

a. Appendix VIII Constituents -- Since the liquid waste trial burn tests 1 and 2 will contain CCl_4, the incineration system should be permitted to incinerate CCl_4 and all other Appendix VIII Constituents lower on the EPA's Ranking of Incinerability List. Only three Appendix VIII Constituents at levels above 1000 ppm would not be allowed: $CFCl_3$, $CHBr_3$, and CF_2Cl_2.

b. Minimum Heat Value -- A minimum heat value of about 7000 Btu/lb (see Table 10) for the liquid waste mixture is an anticipated permit condition.

c. Maximum Organic Chlorine Content of Waste -- The maximum permitted pounds/hour of waste organic chlorine should be based on the trial burn results. If the CAI's air pollution control system removes 185 pounds of HCl per hour, then the permit condition should allow the CAI to incinerate up to 180 pounds of organic chlorine per hour in the combined liquid and solid waste feeds. Since the source of the HCl is irrelevant to the performance of the air pollution control equipment, the permit should allow 180 pounds of organic chlorine per hour to be incinerated in either all liquid wastes or all solid wastes or any combination of liquid and solid wastes.

d. Maximum Ash Content of Waste -- The maximum permitted liquid waste ash content should be based on the ash content of the liquid wastes incinerated during trial burn tests 1 and 2.

e. Physical Form -- The physical form specified in the RCRA liquid hazardous waste permit should be liquid organic and aqueous wastes.

f. Incinerator Operating Permit Conditions -- The following anticipated permit conditions are based on the proposed incinerator operating conditions during the liquid trial burn tests:

- Temperature - Table 8 summarizes the temperature conditions for each liquid trial burn test.

- Maximum Thermal Duty - Los Alamos expects to obtain a maximum thermal duty permit condition based on the trial burn results that allows the incineration of any combination of liquid, aqueous, and solid/sludge wastes with a total thermal duty equal to the maximum permitted duty (see previous discussion on maximum thermal duty).

- Water Feed Rate - There should be no special permit restriction on the feeding of contaminated or non-contaminated water into the primary chamber. The previously quoted statement from page 4-6 of the Guidance Manual covers water injection. The statement " . . . specified operating conditions, such as combustion zone temperature and air feed rate, are maintained." indicates that as long as the total thermal duty and CAI combustion zone temperature are maintained, the water feed rate is irrelevant. When too much water is injected, it will be impossible, for example, to maintain combustion temperature at a specified thermal duty.

  Relative to the destruction of hazardous constituents in contaminated water, volatilization of CCl_4 from the solid waste in the primary chamber and volatilization of CCl_4 from a contaminated water are essentially equivalent processes. The CCl_4 that is volatilized from solid wastes or injected water would be subjected to essentially the same combustion temperature, gas mixing, and residence time in the SCC. Since CCl_4 volatilized from both matrices will be subjected to the same SCC combustion conditions, both the RCRA solid and RCRA liquid permits should allow the incineration of contaminated water that is injected into the primary chamber. Permit justification will be the successful

demonstration of the flameless oxidation of CCl_4 in the solids trial burn tests 3 and 4. Contaminated water means a liquid containing no less than 90 weight percent of water in which the organic contaminant, if any, is CCl_4 or falls below CCl_4 on the RCRA Ranking of Incinerability List.

- Natural Gas Feed Rate - During the incineration of liquid wastes, the only limit on natural gas feed rate should be the maximum thermal duty. Natural gas feed rate can range from zero to the maximum permitted thermal duty.

- Liquid Waste Feed Rate - As previously stated for the natural gas feed rate, the Guidance Manual states on page 4-6 that more easily incinerated wastes (constituents lower than CCl_4 and waste heat values greater than 7000 Btu/lb) can be permitted at rates up to the maximum permitted thermal duty of the primary chamber.

g. Other Permit Conditions -- Other expected permit conditions such as stack carbon monoxide concentration and combustion gas velocity indicator are not discussed in this section. These will be established when the results of the trial burn tests are evaluated.

D-5b(2)(g) Description and Planned Operating Conditions for the Emissions Control Equipment

The emissions control equipment is described in Section D-5b(2)(b)7. The operating condition ranges for normal operation and the trial burn are summarized in Table 11. During operation the system water flow rates and pressure drops typically fluctuate over a normal range, and these fluctuations are also expected to occur during the trial burn.

D-5b(2)(h) Shutdown Procedures

Procedures for shutting down the waste feed are described in Section D-5b(2)(b)(6).

These procedures will be in effect during trial burn tests 1 through 4 while feeding the waste liquid and solids.

D-5b(2)(i) Site Clean-Up

After the trial burn program is completed, all residual wastes or POHC that remain will be destroyed. Assuming that incineration operations went smoothly

based on on-site observations, and that preliminary analytical results are positive (e.g., as indicated by low CO values), Los Alamos will destroy any trial burn residual wastes in the CAI system. The unit will be operated at a primary temperature of 1600°F and a SCC of 1800°F during the incineration of any residual wastes.

D-5b(2)(j) Quality Assurance Plan

The Quality Assurance Project Plan is given in Attachment A.

D-5c Data in Lieu of Trial Burn

Los Alamos seeks an operating permit by way of an additional trial burn of a principal organic hazardous constituent with a high degree of difficulty of incineration, and will not submit results of earlier successful trial burns of hazardous wastes as justification for the permit.

D-5d Post Trial Burn Operation

The interim period between completion of the trial burn and receipt of final approval from EPA for full operating authority could be several months. During this time, Los Alamos intends to continue operating the incineration system on a full-time basis, operating under all state and federal requirements as per 40 CFR 265. All appropriate operating records will be maintained for documentation of operating conditions during this interim period.

D-5e Incinerator Inspection

The incinerator will be visually inspected daily during operation for fugitive emissions, leaks, and associated equipment, spills, and signs of tampering, as per 40 CFR 264.347(b).

D-5f Emergency Waste Feed Cut-Off Testing

During permitted operation the emergency waste feed cut-off system and associated alarms as described in D-5b(2)(b)6 will be tested, as per 40 CFR 264.347(c) on a monthly basis during periods of operation in order not to unduly restrict or upset operations. If the CAI is not routinely operating, the emergency waste feed cut-off system will be tested before start-up of the CAI, but not necessarily on a monthly basis.

Table 11. Planned Operating Conditions for the Emissions Control System During the Trial Burn

Equipment	ΔP Range (in. w.c.)
Quench chamber	0-2
Venturi	40-70
Packed bed	1-8

D-5g Record Keeping

A written operating log will be kept at the CAI facility as per Appendix I of 40 CFR Part 264 and 40 CFR 264.73(b).

D-5h Performance Test Determination

Trial burn results and determinations will be provided after they become available and have been displayed in a report format.

REFERENCES

1. Guidance Manual for Hazardous Waste Incinerator Permits, U.S. EPA, Office of Solid Waste, Washington, D.C., March 1983 Draft, page 2-15.

2. Ibid, pages 2-37 and 2-38.

3. Dellinger, B., J. Torres, W. Rubey, D. Hall, J. Graham, and R. Carnes, "Determination of the Thermal Stability of Selected Hazardous Organic Compounds," paper presented at the Ft. Mitchell, Kentucky Hazardous Waste Conference, April 1984.

APPENDIX J. QUALITY ASSURANCE PLAN

QUALITY ASSURANCE PROJECT PLAN

FOR A

CONTROLLED-AIR INCINERATOR TRIAL BURN

LOS ALAMOS NATIONAL LABORATORY

Los Alamos, New Mexico

March 1986

3.0 PROJECT DESCRIPTION

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

5.0 QUALITY ASSURANCE OBJECTIVES

6.0 SAMPLING PROCEDURES

7.0 SAMPLE CUSTODY

8.0 CALIBRATION PROCEDURES AND FREQUENCY

9.0 ANALYTICAL PROCEDURES

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

11.0 INTERNAL QUALITY CONTROL CHECKS

12.0 PERFORMANCE AND SYSTEM AUDITS

13.0 PREVENTIVE MAINTENANCE

14.0 PROCEDURES FOR ASSESSING DATA ACCURACY, PRECISION, AND COMPLETENESS

15.0 CORRECTIVE ACTION

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

3.0 PROJECT DESCRIPTION

Los Alamos National Laboratory will conduct a trial burn on a controlled air incineration (CAI) located in Los Alamos, New Mexico. The primary objective of the trial burn is to provide emissions testing, sampling, analysis, and evaluation directed toward obtaining the required operating permit for the facility. This Quality Assurance (QA) Plan describes the procedures for assuring the quality of data acquired during implementation of the trial burn plan. The incineration system, test waste feeds, incinerator test conditions, and sampling and analysis methods are described in Appendix J of the Los Alamos RCRA Part B permit application.

Four trial burn tests will be conducted, each consisting of three replicate sampling runs. Tests 1 and 3 will be conducted at a final combustion temperature of 1800°F, while Tests 2 and 4 will be conducted at a final combustion temperature of 2000°F. Tests 1 and 2 will be conducted using a mixture of commercial grade fuel oil, an organometallic additive, and carbon tetrachloride (CCl_4), with CCl_4 as the principal organic hazardous constituent (POHC). An organometallic additive will produce entrained particulate to test the particulate removal efficiency of the offgas cleaning system. Tests 3 and 4 will be conducted using a mixture of cellulosic sorbent and CCl_4, with CCl_4 as the POHC.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

This project will be conducted by Los Alamos National Laboratory personnel and/or contractor personnel who are experienced in the testing of hazardous waste incinerators.

The project organization and lines of communication and responsibility are shown in Figure 4-1. A Trial Burn Project Manager will be appointed and will be responsible for all aspects of the trial burn. Some of the responsibilities of the Trial Burn Project Manager include:

- planning and implementing the trial burn plan,
- implementing the QA project plan,
- designating individuals to assist in implementing the QA plan,
- coordinating incinerator operations with test activities, and
- directing the test team.

A QA Officer, who reports to Laboratory management, will also be appointed. Some of the responsibilities of the QA Officer include:

- providing independent data review, both operational and analytical,
- making recommendations to the Trial Burn Project Manager and Laboratory management if problems are detected, and
- ensuring that appropriate corrective actions are taken when problems are detected.

A Sampling Coordinator who reports to the Trial Burn Project Manager, with lines of communication to the QAO Officer, will be appointed. Some responsibilities of the Sampling Coordinator include:

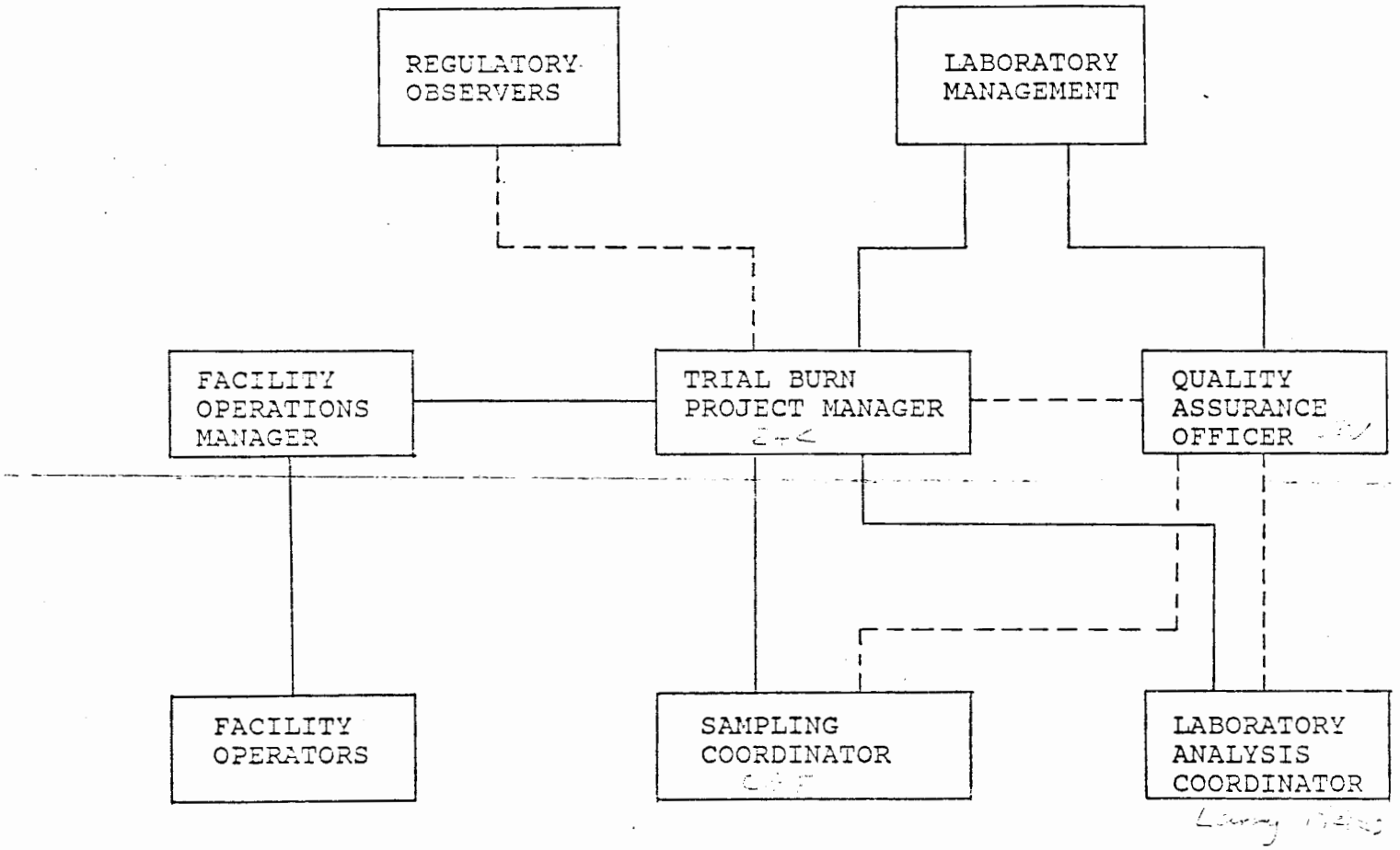
- preparing and shipping sampling equipment and containers to the test site,
- assigning and recording sample numbers,
- directing and/or participating in sampling activities,
- overseeing sample preservation in the field,
- documenting sampling activities in a field log book,
- preparing samples and shipping to the laboratory, and
- carrying out assigned QA duties.

A Laboratory Analysis Coordinator, who reports to the Trial Burn Project Manager, with lines of communication to the QAO Officer, will be appointed. Some responsibilities of the Laboratory Analysis Coordinator include:

- receiving, verifying, and documenting that incoming

field samples correspond to the chain of custody,

- maintaining records of incoming samples,
- tracking samples through processing, analysis, and disposal,
- Preparing quality control (QC) samples for analysis during the project,
- verifying that personnel are trained and qualified in specified laboratory QC and analytical procedures,
- verifying that laboratory QC and analytical procedures are being followed as specified in the QA plan,
- reviewing QC and sample data during analysis and determining if repeat samples or analyses are needed,
- submitting certified QC and sample analysis results to the project manager, and
- archive storage of analytical data.



---- Lines of Communication
____ Lines of Responsibility

Figure 4-1. Project Organization and Responsibility

5.0 QUALITY ASSURANCE OBJECTIVES

Quality assurance objectives for precision, accuracy, and completion are listed in Table 5-1. Precision, accuracy, and completion equations are defined in Section 14.0 of this document. The objective for all measurements is that at least 90 percent will be valid and meet the criteria set forth in Table 5-1.

In addition, a minimum of 10 percent of all analyses performed will be duplicate QC checks.

Table 5-1. Quality Assurance Objectives[a]

Sample Type	Measurement Parameter (Method)	Experimental Conditions	Precision (%)	Accuracy (%)	Completio (%)
Liquid mixture feed	CCl_4	Natural sample	<±20	>80	90
	Organic Cl	Natural sample	<±20	>80	90
	Density	Natural sample	<±20	>80	90
	Ash content	Natural sample	<±20	>80	90
	Heat value	Natural sample and SRM[b]	<±20	>80	90
Solid mixture feed	CCl_4	Natural sample	<±20	>80	90
	Organic Cl	Natural sample	<±20	>80	90
	Ash content	Natural sample	<±20	>80	90
	Heat value	Natural sample	<±20	>80	90
CCl_4 feed stock	CCl_4	Natural sample	<±20	>80	90
Fuel oil feed stock	CCl_4	Natural sample	<±20	>80	90
Organometallic feed stock	CCl_4	Natural sample	<±20	>80	90
Cellulosic sorbent feed stock	CCl^4	Natural sample	<±20	>80	90
Stack gas	CCl_4	Natural and spiked samples	<±20	>80	90
	Particulates	Natural sample	<±20	>80	90
	HCl	Natural sample	<±20	>80	90
	O_2	Natural sample	<±20	>80	90
	CO_2	Natural sample	<±20	>80	90
	CO	Zero + Span Gas	<±10	>90	
Scrubber discharge liquid	CCl_4	Natural sample	<±20	>80	90
Activated carbon, unused	CCl_4	Natural sample	<±20	>80	90
Activated carbon, spent	CCl_4	Natural sample	<±20	>80	90
HEPA filter medium, unused	CCl_4	Natural sample	<±20	>80	90
HEPA filter medium, spent	CCl_4	Natural sample	<±20	>80	90

[a]For reference methods see Table 4 of the Trial Burn Plan

[b]Standard reference material

6.0 SAMPLING PROCEDURES

Samples of the liquid feed mixture will be taken at 15-minute intervals during each test run as shown in Table 6-1. The liquid hazardous waste will be composited as specified using Method P001. The CCl_4 and fuel oil feed stocks will be sampled upon delivery and composited using Method P001.

Stack gas CO concentration will be monitored continuously using an on-line analyzer. The CO monitor will meet EPA Method 10 criteria. Stack gas velocity will be monitored continuously with an appropriate combustion gas velocity indicator.

An EPA Method 5 sampling train will be used to collect stack gas particulate and HCl samples. The Method 5 procedure includes measurement of the stack gas flow rate and temperature according to EPA Methods 1 and 2. Every 30 minutes, integrated samples of the stack gas will be collected in gas bags for O_2 and CO_2 determinations by an Orsat analyzer according to EPA Method 3. The Orsat sample will be drawn by a separate pump through a tube attached to the Method 5 sample probe. Moisture determinations will be made according to the procedure described in EPA Method 5.

A volatile organic sampling train (VOST) will be used to collect samples for POHC analysis to determine destruction and removal efficiency (DRE). The VOST will be operated at about 17 liters per minute for the duration of each test run (approximately 3 hours). This will result in the collection of approximately 3 M^3 of gas.

The sample containers to be used for retaining samples for shipment to the analytical laboratory are described in Table 6-2. All bottle caps will have Teflon liners.

Those samples requiring low temperature preservation will be placed on ice (0.4°C) in ice chests for shipment and will be stored at 4°C until analyzed. This will include all samples which contain volatile organics or which will be analyzed for volatiles.

Table c-1. Trial Burn Sampling and Analysis Schedule

Sample	Type	Equipment	Method	Frequency	Preparation	Method	Analysis
Liquid mixture feed	Grab	Amber bottle, VOA vial	SW-846	Every 20 minutes during run	Composite	FOD1	Organic Cl, CCl4, density, ash, heat value
Solid mixture feed	Grab	Amber bottle	SOD1, SW-846	From each container as delivered	Composite	FOD1	CCl4
CCl4 feed stock	Grab	Amber bottle	SOD1, SW-846	From each container as delivered	Composite	FOD1	CCl4
Fuel oil feed stock	Grab	Amber bottle	SOD1, SW-846	From each container as delivered	Composite	FOD1	CCl4
Organometallic feed stock	Grab	Amber bottle	SOD1, SW-846	From each container as delivered	Composite	FOD1	CCl4
Cellulosic feed stock	Grab	Amber bottle	SOD1, SW-846	From each container as delivered	Composite	FOD1	CCl4
Stack gas	Integrated	VOST	SW-846	Continuous/3 hour			CCl4
Stack gas	Integrated	M5 sampling train	EPA M5	Continuous/3 hour			Particulates, HCl, O2, CO2, moisture
Stack gas	Integrated	Instrument aspirator pump		Continuous			CO
Scrubber discharge liquid	Grab	Amber bottle		End of each run			CCl4
Activated carbon, unused	Grab	Amber bottle		From each container as delivered	Composite	FOD1	CCl4
Activated carbon, in-service	Grab	Amber bottle		End of each run			CCl4
HEPA filter media, unused	Grab	Amber bottle		From one typical filter			CCl4
HEPA filter media, spent	Grab	Amber bottle		From one filter at end of trial burn			CCl4

Table 6-2. Sample Containers

Sample Type	Container
VOST sorbent traps	Capped VOST cartridges, wrapped in aluminum foil, placed in sealed glass tubes
Method 5 nozzle, probe, and front half filter holder wash	Amber glass bottle[a]
Method 5 filter	Petri dish wrapped in aluminum foil
Method 5 condensate	Amber glass bottle
Liquid mixture feed	Amber glass bottle
CCl_4 feed stock	Amber glass bottle
Solid mixture feed	Amber glass bottle
Fuel oil feed stock	Amber glass bottle
Organometallic feed stock	Amber glass bottle
Cellulosic sorbic feed stock	Amber glass bottle
Scrubber discharge liquid	Amber glass bottle
Activated carbon, unused	Amber glass bottle
Activated carbon, spent	Amber glass bottle
HEPA filter medium, unused	Amber glass bottle
HEPA filter medium, spent	Amber glass bottle
Method 5 O_2 and CO_2	Plastic coated aluminum gas sample bag

[a]All bottle caps have Teflon lined lids.

7.0 SAMPLE CUSTODY

Sample custody will be the responsibility of Los Alamos National Laboratory personnel or contractor personnel from the time of sample collection until the samples are shipped to the analytical laboratory. Thereafter custody will be maintained by the analytical laboratory.

Samples will be kept in appropriate containers labeled so as to uniquely identify each sample. An example Field Sampling and Collection form, shown in Figure 7-1, will provide an inventory and field sampling record of each sample collected during field operations. Figure 7-2 shows an example Chain-of-Custody Record form, which will provide the formal custody record. Figure 7-3 shows an example Record of Analysis Report form, which documents analysis results for each sample.

Samples will be kept on ice as appropriate in an ice chest and will be shipped to the analytical laboratory in a secured chest. Chain-of-custody forms will be handled as follows:

- original form included with sample shipment,
- one copy retained by the sampling team,
- one copy sent separately to the analytical laboratory, and
- one copy sent to the project manager.

The laboratory custodian, after taking inventory of each shipment, will sign and date the original custody form. He will make a note on the custody form of any discrepancy in the samples and will also maintain a log in which all samples are recorded and described. The samples will be maintained in custody until one year after the final report is submitted.

FIELD SAMPLING AND COLLECTION FORM

LEADER	NAME OF SURVEY OR ACTIVITY	SHEET

DESCRIPTION OF SHIPMENT

TYPE OF SAMPLE

TOTAL NUMBER SAMPLE CONTAINERS

CONTENTS OF SHIPMENT

SAMPLE NO.	NO. OF CONTAINERS/FIELD NO.			ANALYSES REQUIRED - CHECK WERE APPROPRIATE							
	ORSAT BAG	GLASS	Blu	FORMIC ACID	DENSITY	ORGANIC Cl	ELEMENTAL COMPOSITION	TOC	ASH	TSS	TDS

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	RECEIVED BY	DATE	TIME	REASON
SEALED UNSEALED	SEALED UNSEALED			
RELINQUISHED BY	RECEIVED BY	DATE	TIME	REASON

Figure 7-1. Example Field Sampling and Collection Form

C/C Control No. 0000
R/A Control No. _____

CHAIN-OF-CUSTODY RECORD

PROJECT NAME _____ SAMPLE TEAM MEMBERS _____

PROJECT NUMBER _____ LAB DESTINATION _____

PROJECT MANAGER _____ CARRIER/WAYBILL NO. _____

Sample Number	Sample Location and Description	Date & Time Collected	Sample Type	Container Type	Condition On Receipt (Name & Date)

Special Instructions: _____

Possible Sample Hazards: _____

SIGNATURES: (Name, Company, Date & Time)

1. Relinquished By: _____
   Received By: _____
2. Relinquished By: _____
   Received By: _____
3. Relinquished By: _____
   Received By: _____
4. Relinquished By: _____
   Received By: _____

Authorization for Disposal: _____ Relinquished For Disposal: _____

Container No. _____ Transferred To: _____ Manifest No. _____

Figure 7-2. Example Chain-Of-Custody Record Form

R/A Control No. 0000
C/C Control No. ____

REQUEST FOR ANALYSIS

PROJECT NAME _____
PROJECT NUMBER _____
PROJECT MANAGER _____
BILL TO _____
_____
_____

PURCHASE ORDER NO. _____

DATE SAMPLES SHIPPED _____
LAB DESTINATION _____
LABORATORY CONTACT _____
SEND LAB REPORT TO _____
_____
_____
DATE REPORT REQUIRED _____
PROJECT CONTACT _____
PROJECT CONTACT PHONE NO. _____

Sample No.	Sample Type	Sample Volume	Preservative	Requested Testing Program	Special Instructions

TURNAROUND TIME REQUIRED: (Turnaround time must be arranged with lab prior to sample shipment.)

Normal_____ Rush_____ (Subject to rush surcharge)

POSSIBLE HAZARD IDENTIFICATION: (Please indicate if sample(s) are hazardous materials and/or suspected to contain high levels of hazardous substances)

Non hazardous_____ Flammable_____ Skin Irritant_____ Highly Toxic_____ Other_____
(Please Specify)

SAMPLE DISPOSAL: (Please indicate disposition of sample following analysis. Lab will charge for packing, shipping and disposal.)

Return to Client_____ Disposal by Lab_____

FOR LAB USE ONLY

Received By: _____ Date/Time: _____

Figure 7-3. Example Request for Analysis Form

INTERNATIONAL TECHNOLOGY CORPORATION

ANALYTICAL SERVICES

5815 Middlebrook Pike • Knoxville Tennessee 37921 • 615-588-6401

CERTIFICATE OF ANALYSIS

TO:

DATE REPORTED:
PROJECT CODE:
ORDER NUMBER:

Sample Description: _____

Parameter	Concentration (units)	Parameter	Concentratic (units)

Sworn to and subscribed before me this
day of
My commission expires

Notary Public

Approved by

Title

8.0 CALIBRATION PROCEDURES AND FREQUENCY

Calibration procedures for sampling and analysis instruments used in this project are given in the methods procedures documents that are referred to in the sections on sampling and analysis.

The Method 5 and Volatile Organic Sampling Trains will be calibrated as indicated by EPA's "Quality Assurance Handbook of Air Pollution Measurement Systems" (EPA-600/4-77-0276). The activity matrices for calibrating the equipment and apparatus are shown in Tables 8-1 and 8-2.

The CO monitor will be installed and calibrated in accordance with "Proposed Performance Specification 4, Appendix B, 40 CFR Part 60." The CO monitor will also be calibrated daily using a zero gas and three certified standard gases with different concentrations. The concentrations of the calibration gases used will be close to and will span the expected values in the gas stream. In addition, the CO monitor will have a zero and span calibration before and after each test and as requested during the trial burn by the regulatory representatives. The zero and span calibration will be considered a verification of the quality of data received from the CO monitor. If the zero and span shows a drift greater than 10 percent from the calibration curve, then a full calibration will be performed.

The laboratory analytical apparatus will be calibrated according to instructions in the method description at least once each day that analyses are to be done. In addition, a mid-range calibration standard will be analyzed after every tenth sample analysis.

Table 8-1. Activity Matrix for Calibration of Equipment

Apparatus	Acceptance Limits	Frequency and Method of Measurements	Action if Requirements Are not Met
Wet test meter	Capacity >3.4 m^3/hr (120 ft^3/hr); accuracy with ±1.0%	Calibrate initially, and then yearly by liquid displacement	Adjust until specifications are met, or return to manufacturer
Dry gas meter	$Y_i = Y \pm 0.02\ Y$	Calibrate vs. wet test meter initially, and when post-test check exceeds Y ±.05 Y	Repair, or place and then recalibrate
Thermometers	Impinger thermometer ±1°C (2°F); dry gas meter thermometer ±3°C (5.4°F) over range; stack temperature sensor ±1.5% of absolute temperature	Calibrate each initially as a separate component against a mercury-in-glass thermometer; then before each field trip compare each as part of the train with the mercury-in-glass thermometer	Adjust; determine a constant correction factor; or reject
Probe heating system	Capable of maintaining 120° ±14°C (248° ±25°F) at a flow rate of 21 L/min (0.71 ft^3/min)	Calibrate component initially by APTD-0576(11), if constructed by APTD-0581(10) or use published calibration curves	Repair, or replace, and then reverify the calibration
Barometer	±2.5 mm (0.1 in.) Hg of mercury-in-glass barometer	Calibrate initially vs. mercury-in-glass barometer; check before and after each field test	Adjust to agree with a certified barometer
Proble nozzle	Averge of three ID measurements of nozzle; difference between high and low <0.1 mm (0.004 in.)	Use a micrometer to measure to nearest 0.025 mm (0.001 in.)	Recalibrate, reshape, and sharpen when nozzle becomes nicked, dented or corroded
Analytical balance	± mg of Class-S weights	Check with Class-S weights upon receipt	Adjust or repair

Source: EPA-600/4-77-027b (23).

Table 8-2. Activity Matrix for Calibration of Apparatus

Apparatus	Acceptance Limits	Frequency and Method of Measurements	Requirements Are not Met
Type S pitot tube and/or probe assembly	All dimension specifications met	Calibrate initially and visually inspect after each field test	Use pitot tubes that meet face opening specifications; repair or replace as required
Stack gas temperature measurement	Capable of measuring within 1.5% of minimum stack temperature	Calibrate initially and after each field test	Adjust to agree with Hg bulb system thermometer, or construct a calibration curve to correct the readings
ırometer	Agrees within 2.5 mm (0.1 in.) Hg of mercury-in-glass barometer	Initially and after every field use, compare to a liquid-in-glass barometer	Adjust, repair, or discard
Differential pressure gauge (does not include inclined manometers)	Agree within ±5% of inclined manometers	Initially and after each field use	Reject test results, or consult administrator if post-test calibration is out of specification

Source: EPA-600/4-77=027b (23)

9.0 ANALYTICAL PROCEDURES

Standard methods will be employed for the analyses of all collected samples. These methods are described in the following documents:

- Sampling and Analysis Methods for Hazardous Waste Incineration, EPA 600/8-84-002,
- American Society for Testing and Materials, Annual Book of ASTM Standards, 1984,
- Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods, EPA Publication NO. SW-846, 1982,
- Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, and
- New Source Performance Standards, Test Methods and Procedures, Appendix A, 40 CFR 60.

10.0 DATA REDUCTION VALIDATION AND REPORTING

Reduction of data obtained from this trial burn will involve using the sampling and analysis results to calculate DRE according to equations given in 40 CFR 264.343.

The results of sample analysis will be reported in terms of mass/unit volume or total mass per sample and emission rates in mass per hour.

The initial step in the data validation will consist of a thorough check of all calculations involved in reduction of sampling and analysis data. Next, the data will be investigated for consistency of the results within and between tests. For example, comparisons will be made of stack gas flow rates, stack gas temperatures, and sampling system operating conditions. Analytical data will be reviewed to identify variations in composition from sample to sample among replicate runs. Where variations appear significant, calculations will again be checked for errors and the sample collection and analysis procedures will be reviewed to identify any causes for the inconsistencies. Any calculation errors will be corrected and anomalies in the sampling or analysis procedures will be documented and reported in the final project report.

Automatic data processing procedures will be used to calculate emission rates. These procedures will be checked manually at least once for each set of equations.

Treatment of Outlying Data and Measurements Below Detection Limits

All data collected in the study will be considered valid, with the following qualifications, and will be reported. If anomalous results are obtained, every effort will be made to identify any problems in the sample collection, sample preparation, and/or analysis which could have contributed to the anomaly. If any problems occurred, they will be reported, with the results in question, and may serve to qualify the significance of the result(s).

In instances where the analyte concentration in the analyzed sample is below the limit of detection, a "less than" value will be reported for the sample and for the emission level. Detection limits will vary with sample type and the level of interference in the sample.

All data accumulated during the project and final results will be recorded in permanently bound record books.

11.0 INTERNAL QUALITY CONTROL CHECKS

Blanks of all reagents and solvents used will be taken, as well as method blanks to assess possible laboratory contamination. A VOST cartridge will be opened and allowed to remain open as a field blank for the duration of each test. As the Method 5 Sampling Train procedures are inappropriate for field blank samples, none will be taken for the M5 stack gas tests. Process parameter measurements (temperatures, flows, etc.) will consist of reading the appropriate instrument (thermocouple readout, flow meter, etc.), which will be calibrated prior to the test.

Replicate samples are inappropriate for samples being composited before analysis, therefore they will not be taken. Instead, in order to provide quality control, a minimum of 10 percent of the composited samples from each test will have replicate analyses run with the other samples.

All stack gas samples for POHC will be spiked with a surrogate compound before preparation and analysis. The surrogate data will be used to calculate recovery of the surrogate as a measure of the accuracy of the sample preparation and analysis procedures. The surrogate compound will not be CCl_4.

For directed analysis of the POHC in the stack gas samples, one sample from each triplicate set will be spiked at a concentration corresponding to two times the target detection limit of DRE for stack gas samples.

12.0 PERFORMANCE AND SYSTEM AUDITS

Sampling performance audits will be accomplished through observation of the sampling operations by the regulatory agency representative(s), the QA Officer, and the Trial Burn Project Manager.

Analytical performance audits will consist of the replicate analysis and spiked sample procedures outlined in Section 9.0 of this document. If deemed necessary by the Trial Burn Project Manager and QA Officer, standard reference materials will be submitted for analysis as unknowns.

A system audit of laboratory activities involved in this trial burn will be performed by the Trial Burn Project Manager and/or QA Officer before any new experimental procedures are implemented. The audit will consist of an on-site inspection and review of the analytical operations and the associated quality assurance activities being employed. Additionally, the Trial Burn Project Manager and/or QA Officer will frequently review recent data to ensure that all required QC checks are being made and evaluation criteria followed.

13.0 PREVENTIVE MAINTENANCE

Preventive maintenance of sampling and analytical equipment used during the project will be performed according to the procedures and schedules set forth in manufacturers' maintenance manuals and as described in appropriate parts of standard methods.

All preventive maintenance performed will be recorded in a service record log for each instrument. If the performance of the instrument could have been affected by the maintenance procedure calibration, check samples, where appropriate, will be analyzed and the results recorded in the record notebook before any samples are analyzed. Whenever parts are replaced, the serial number (SN) of the new part (if available) or an assigned SN will be logged into the maintenance record notebook.

14.0 PROCEDURES FOR ASSESSING DATA ACCURACY, PRECISION, AND COMPLETENESS

The quality assurance activities implemented in this study will provide a basis for assessing the accuracy and precision of the analytical measurements. Table 5-1 shows the QA activity that will generate the accuracy and precision data for each sample type. The generalized form of the equations that will be used to calculate accuracy and precision are given below:

Accuracy

$$\text{Percent Accuracy} = \frac{(X-T)\ 100}{T} \qquad (14\text{-}1)$$

where X is the experimentally determined value and T is the true or reference value of the species being measured.

Precision

Precision will be calculated as a percent difference from the mean of duplicate measurements according to:

$$\text{Percent relative difference} = \frac{2\ (X_1 - X_2)}{X_1 + X_2} \qquad (14\text{-}2)$$

Where X_1 and X_2 are the results of duplicate measurements.

Completeness

Completeness in meeting the data recovery objectives will be assessed by the following equation:

$$\text{Completeness, \%} = \frac{D_r\ 100}{D_c} \qquad (14\text{-}3)$$

where D_r is the number of samples for which valid results are reported and D_c is the number of samples which are scheduled to be collected and analyzed during the study.

15.0 CORRECTIVE ACTION

The need for corrective action occurs when a circumstance arises that threatens the quality of the data output. In order for corrective action to be initiated, awareness of a problem must exist. In most instances, the personnel conducting the field work and the laboratory analysis are in the best position to recognize problems which will affect data quality. Keen awareness on their part can frequently detect minor instrument changes, drifts or malfunctions, which can be corrected, thus preventing a major breakdown of the system. If major problems arise, they are in the best position to decide upon the proper corrective action and initiate it immediately, thus minimizing data loss. Therefore, the field sampling and laboratory analysis personnel will have a prime responsibility for recognizing the need for corrective action. Decisions on whether to take corrective action and what action(s) to take will be made by the Trial Burn Project Manager, QA Officer, or Analytical Coordinator. Such decisions will be based on action limits discussed later in this section. When a corrective action is taken by any of the field or laboratory operations personnel, they will be responsible for notifying the project QA Officer so that he can, if deemed necessary, intensify QA surveillance of the affected sampling or analysis system.

A second level of recognition of the need for corrective action will be the project QA Officer, who will determine the need for corrective action from the results of the audits described in Section 12.0 and from review of the QA data generated during the study. The QA Officer will be responsible for initiating corrective action by immediately notifying the Trial Burn Project Manager. The Trial Burn Project Manager will then be responsible for instituting the appropriate corrective action.

Establishment of specific operating limits for all sampling and analysis systems beyond which corrective action will be triggered is not practical. Ultimately, the personnel performing and checking the sampling and analysis procedures and results must participate in such decisions. To reach the proper decision, each individual must understand the program objectives and data quality required to meet these objectives. Data quality objectives for this program are presented in Section 5.0. All personnel involved in the project will receive an approved copy of this QA Plan and thus will be informed of these objectives. Each individual will have a responsibility to notify the respective field sampling or laboratory operations supervisor whenever a measurement system is not yielding data within these objectives.

Problems requiring corrective action decisions are most likely to occur in the field during stack sampling tests and in the laboratory during the analysis.

If the situation arises requiring long-term corrective action, the following closed-loop corrective action system will be used:

- define the problem,
- assign responsibility for investigating the problem,
- investigate and determine the cause of the problem,
- determine corrective action course to eliminate the problem,
- assign responsibility for implementing the corrective action,
- determine the effectiveness of the corrective action and implement the correction, and
- verify that the corrective action has eliminated the problem.

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The Trial Burn Project Manager, QA Officer, and key staff responsible for sampling, analysis, and data management will review the Project Quality Assurance Program performance weekly while data are being generated. The results of the QA review will be summarized in a memorandum which will specifically identify any areas that may require corrective action and present the proposed corrective action. In addition, the memorandum will present the results of previous corrective actions. Documented copies of all QA reports will be submitted with the trial burn sampling and analysis results.

APPENDIX K.

REQUIREMENTS & SPECIFICATIONS FOR OFFGAS SAMPLING

REQUIREMENTS AND SPECIFICATIONS

FOR

OFFGAS SAMPLING

Los Alamos Controlled Air Incinerator
RCRA Part B Trial
Burn

(Revision 2, June 1986)

I. INTRODUCTION

This bid request solicits the services of a qualified sampling firm with experience in stationary source sampling. The responsibilities of the sampling firm will be to (1) conduct offgas sampling, (2) prepare collected samples for shipment to analytical laboratory, (3) provide quality assurance and quality control activities as required, and (4) prepare a comprehensive final report covering offgas sampling activities.

II. DESCRIPTION OF INCINERATION TEST

In compliance with the requirements of the Resource Conservation and Recovery Act (RCRA), the Department of Energy (DOE) has made application to the New Mexico Environmental Improvement Division (NMEID) for a Part B Permit for treatment and disposal of hazardous wastes at the Los Alamos National Laboratory. A part of this application is for the permitting of the Los Alamos controlled air incinerator (CAI) for the thermal destruction of RCRA regulated Laboratory wastes. This incineration test run is referred to as the trial burn. The primary objective of the trial burn is to provide emissions testing, sampling, analysis, and evaluation directed toward obtaining the required operating permit for the facility.

Four trial burn tests will be conducted, each consisting of three replicate sampling runs. Tests 1 and 3 will be conducted at a final combustion temperature of 2000°F, while Tests 2 and 4 will be conducted at a final combustion temperature of 2200°F. Tests 1 and 2 will be conducted using a mixture of commercial grade fuel oil, an organometallic additive, carbon tetrachloride (CCl_4), and hexachlorobenzene (HCB) with CCl_4 and HCB as the principal organic hazardous constituents (POHCs). The organometallic additive will produce entrained particulate during liquid mixture combustion to test the particulate removal

efficiency of the offgas cleaning system. Tests 3 and 4 will be conducted using a mixture of cellulosic sorbent, CCl_4, and HCB, with CCl_4 and HCB as POHCs.

The incinerator will be stabilized while feeding test wastes for 2 to 3 hours prior to each trial burn run (sampling period). Each sampling period will last about 3 hours resulting in a total time range of 15-18 hours for each of the four trial burn tests. Therefore the complete trial burn is expected to require 60-72 hours of contact time by the contract sampling firm at Los Alamos. Travel, setup, and packing time is in addition to this.

The sampling firm is requested to quote services for travel, setup, a fixed 60-hour sampling time, packing, and report preparation with the following two options.

Option 1 - Incineration and sampling operations conducted 24 hours per day. This option will require sufficient contract sampling personnel to complete the trial burn sampling needs in about 2.5 days of continuous operation. Los Alamos personnel would operate the incinerator using two 12-hour shifts per day with each shift staffed by a minimum of 5 qualified persons.

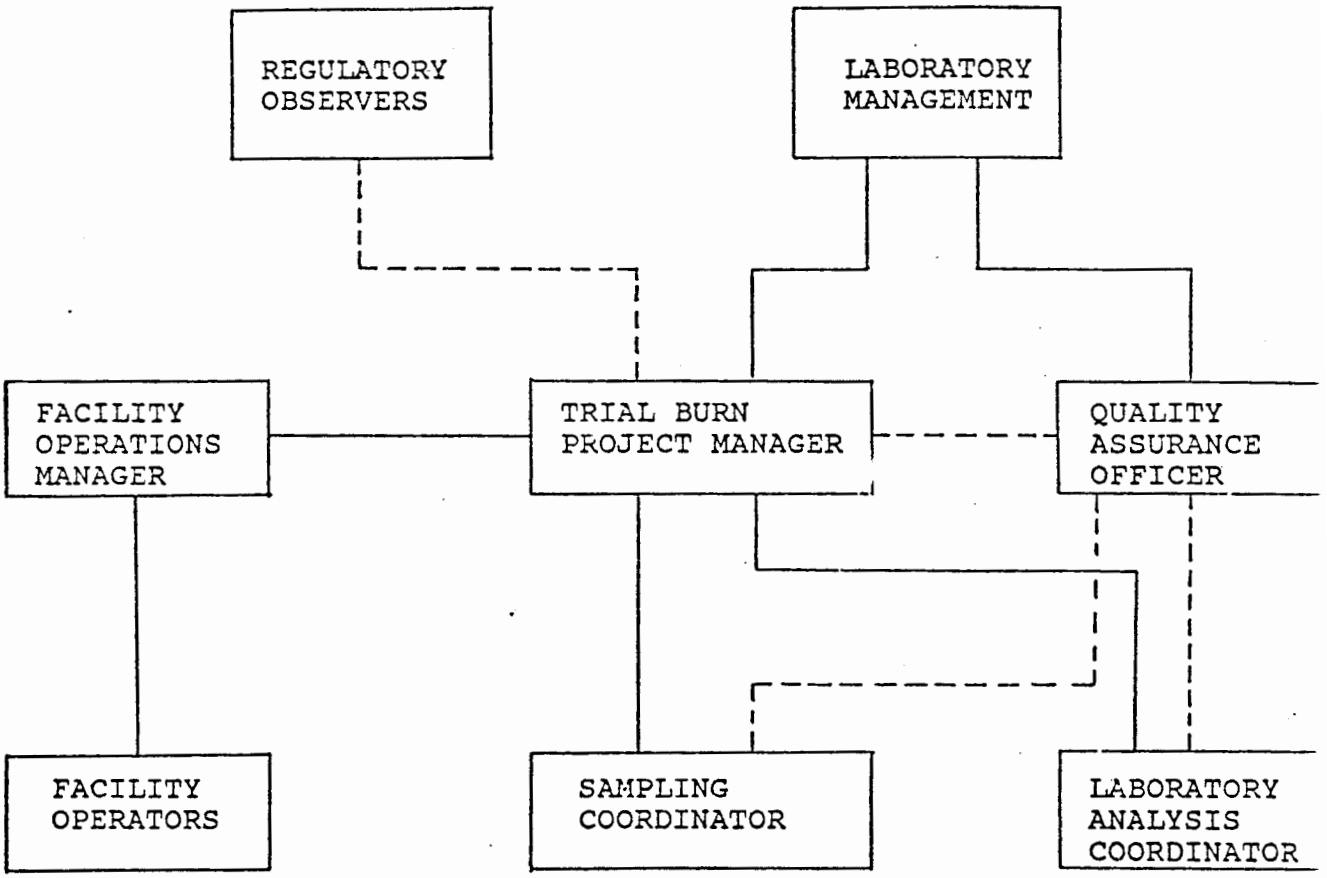
Option 2 - Incineration and sampling operations conducted 12 hours per day. This option will require sufficient contract sampling personnel to complete the trial burn sampling needs in about 5 days of intermittent sampling. Los Alamos personnel would operate the incinerator process continuously by using two 12-hour shifts per day with a sampling shift staffed by a minimum of 7 qualified persons.

Longer turnaround time and unanticipated problems associated with the incineration system could lengthen the trial burn. Accordingly, the sampling firm is requested to quote a fixed hourly rate for extension of sampling time past 60 hours.

III. SAMPLING COORDINATOR

A sampling coordinator will be appointed by the contract sampling firm. The sampling coordinator will report to the Los Alamos trial burn project manager, with lines of communication to the Los Alamos quality assurance officer, as indicated in Figure 1. Responsibilities of the sampling coordinator will include:

- preparing and shipping sampling equipment and containers to the trial burn site,
- assigning and recording sample numbers,



---- Lines of Communication
____ Lines of Responsibility

Figure 1. Project Organization and Responsibility

- directing and/or participating in sampling activities,
- overseeing sample preservation in the field,
- documenting sampling activities in a field log book,
- overseeing sample preparation for shipment to the analytical laboratory, and
- carrying out assigned quality assurance duties.

It is emphasized that it will be the responsibility of the sampling coordinator to ensure that all required samples indicated in this specification are collected properly and at the correct time.

IV. SAMPLING REQUIREMENTS

The locations from where solid, liquid, and offgas samples will be collected from the incineration system are shown in Figure 2. All of the materials supplied to the incineration process including fuel oil feed stock, CCl_4 feed stock, HCB feed stock, organometallic feed stock, cellulosic sorbent feed stock, liquid and solid mixture feeds, caustic solution, and makeup water are sampled at locations 1, 2, 4, 6, and 8. Samples of process secondary streams including incinerator ash, scrubber discharge liquid, and activated carbon are collected at locations 5, 7, and 13 respectively. O_2, CO_2, CO, CCl_4, HCB, HCl, and particulate emission samples are collected from the incineration system offgas (stack gas) at locations 10 and 11.

Required sampling equipment, procedures, frequency, and reference methods are summarized according to sample location in Table 1. Additional details regarding each required sample are discussed below.

A. Fuel Oil Feed Stock - A representative sample of fuel oil will be collected at location 1 before the start of the trial burn. An additional sample will be collected after any subsequent refilling of the fuel oil supply tank. The samples will be collected by a member of the contract sampling crew at the direction of the sampling coordinator. Operations personnel will alert the sampling coordinator to any refilling of the fuel oil supply tank.

B. CCl_4 Feed Stock - A representative sample of CCl_4 feed stock will be collected at location 2 from each bulk container as it is opened for use. The samples will be collected by a member of the contract sampling crew at the direction of the sampling coordinator. Operations

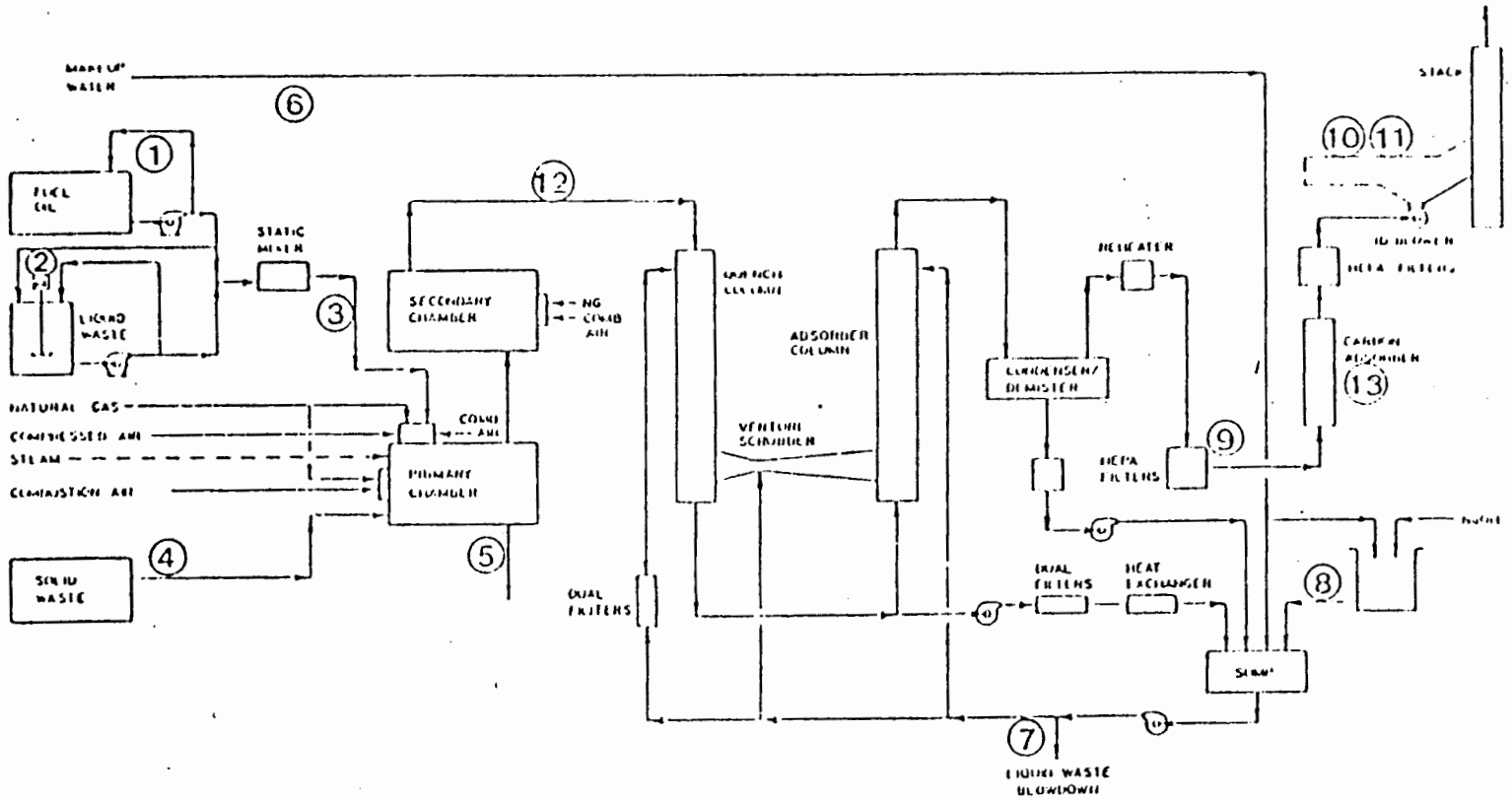


Fig. 2. Location of Sampling Points

Table 1. Trial Burn Sampling Schedule

Location	Description	Type	Equipment	Procedure/Frequency	Preparation
1	Fuel oil feed stock	Grab, tap	Amber bottle	From storage tank, beginning/refill	Composite total
2	CCl_4 feed stock	Grab	Amber bottle	From each container as opened for use	Composite total
2	HCB feed stock	Grab	Amber bottle	From each container as opened for use	Composite total
2	Organometallic feed stock	Grab	Amber bottle, wide mouth, scoop	From each container as opened for use	Composite total
2	Cellulosic feed stock	Grab	Amber bottle, wide mouth, scoop	From each container as opened for use	Composite total
3	Liquid mixture feed	Grab, tap	Amber bottle, VOA vial	Every 20 minutes during trial burn run	Composite run
2	Solid mixture feed	Grab	Amber bottle, wide mouth, scoop	From each container as prepared	
8	Caustic solution	Grab, tap	Teflon bottle	From each batch as prepared	Composite total
6	Makeup water	Grab, tap	Amber bottle	Beginning of each trial burn run	Composite total
5	Incinerator ash	Grab	Amber bottle, wide mouth, scoop	End of each trial burn run	
7	Scrubber discharge liquid	Grab, tap	Amber bottle	Two blanks before trial burn run	Composite
7	Scrubber discharge liquid	Grab, tap	Amber bottle	Hourly sample during trial burn run	Composite run
13	Activated carbon, unused	Grab, thief	Amber bottle, wide mouth	Beginning of trial burn	
13	Acivated carbon, used	Grab, thief	Amber bottle, wide mouth	End of each trial burn run	
10	Stack gas	Integrated	VOST	Continuous/about 3 hours	
11	Stack gas	Integrated	M5 sampling train	Continuous/about 3 hours	
11	Stack gas	Sample bag, integrated	Instrument aspirator pump	Continuous/sample every 30-minutes during trial burn run	

personnel will alert the sampling coordinator when each new container is opened for use.

C. HCB Feed Stock - A representative sample of HCB feed stock will be collected at location 2 from each bulk container as it is opened for use. The samples will be collected by a member of the contract sampling crew at the direction of the sampling coordinator. Operations personnel will alert the sampling coordinator when each new container is opened for use.

D. Organometallic Feed Stock - A representative sample of organometallic feed stock will be collected at location 2 from each bulk container as it is opened for use. The samples will be collected by a member of the contract sampling crew at the direction of the sampling coordinator. Operations personnel will alert the sampling coordinator when each new container is opened for use.

E. Cellulosic Sorbent Feed Stock - A representative sample of cellulosic sorbent feed stock will be collected at location 2 from each bulk container as it is opened for use. The samples will be collected by a member of the contract sampling crew at the direction of the sampling coordinator. Operations personnel will alert the sampling coordinator when each new container is opened for use.

F. Liquid Mixture Feed - The POHCs (CCl_4 and HCB) will be batch blended with fuel oil and organometallic additive in a liquid waste tank prior to feeding to the incinerator. Samples of the liquid mixture blend will be collected at location 3 by a member of the contract sampling crew at the direction of the sampling coordinator. Samples will be drawn at 20-minute intervals during a run and composited as a representative feed sample for that run.

G. Solid Mixture Feed - The POHCs (CCl_4 and HCB) will be absorbed in a cellulosic matrix. The total required solid feed material will be prepared by incinerator operations personnel before the trial burn and stored in sealed containers. Each sealed container will be labeled with a unique identifying number. A scoop will be used to collect equal size samples from each container of solid mixture feed before each container is sealed. These samples will be stored in amber glass bottles with Teflon-lined lids and will be marked with the same identifying number as the sampled container. Following a trial burn run, the sampling coordinator with prepare a composite of solid mixture feed from these collected samples that is representative of the actual material burned. The incinerator operations

personnel will notify the sampling coordinator of the identity of the sealed containers used in each trial burn run.

H. Caustic Solution - An caustic solution (NaOH in water) is fed to the recirculating offgas scrubber water as required to neutralize collected acids. Samples of the caustic solution will be collected from the storage tank, location 8, by a member of the contract sampling crew at the direction of the sampling coordinator. Operations personnel will alert the sampling coordinator when each new batch of caustic solution is prepared for use.

I. Makeup Water - At the beginning of each trial burn run, a sample of the system makeup water will be collected by by a member of the contract sampling crew at location 6 at the direction of the sampling coordinator.

J. Incinerator Ash - Small or possibly negligible amounts of ash are expected to be accumulated during each of the liquid feed test sampling runs. Larger quantities of ash are expected from combustion of the solid mixture feed test. Incinerator operations personnel will operate an ash collection and transportation mechanism at the end of each trial burn. Any ash collected will be sampled at the ash removal glovebox, location 5, by incinerator operations personnel at the direction of the sampling coordinator. The sampling coordinator will supply the sample container and reclaim the container once the sample is collected.

K. Scrubber Discharge Liquid - Samples of scrubber discharge liquid will be taken at location 7. Before each trial burn run two samples of blowdown water will be collected 30 minutes apart and composited to provide a blank sample. During each trial burn run, blowdown water samples shall be taken every 60 minutes and composited for that run. The samples will be collected by incinerator operations personnel at the direction of the sampling coordinator. The sampling coordinator will supply the sample container and reclaim the container once the sample is collected.

L. Activated Carbon, Unused - Prior to the trial burn, incinerator operations personnel will collect a sample of activated carbon from the adsorber bed, location 13, and place the sample in an amber glass bottle with a Teflon-lined lid. The container will be labeled with a unique identifying number. The sampling coordinator will claim the sample from the incinerations operations personnel.

M. Activated Carbon, Used - The incinerator operations personnel will collect a sample of the adsorber bed after each trial burn run at the direction of the sampling coordinator. The sampling coordinator will supply each sample container and reclaim the container once the sample is collected.

N. Stack Gas - Samples of the particulates, acid gases, and volatile organics in the process offgas will be collected from the exhaust duct at locations 10 and 11 as shown in Figure 3. This duct is outside the building and is approximately 11 feet above ground level. It is served by a steel grate work platform approximately 10.5 ft. by 21.5 feet, which is 8 feet above ground level. Access to the platform is via a 2-ft. wide 45° steel stairway.

VOST - A volatile organic sampling train (VOST), as illustrated in Figure 4, will be used at location 10 to collect CCl_4 and other volatile organics on sorbent resin. The VOST will be operated for approximately 3 hours during each trial burn run by members of the contract sampling crew at the direction of the sampling coordinator. A separate VOST cartridge will be opened and allowed to remain open as a field blank for the duration of each sampling run.

Modified Method 5 - An EPA Modified Method 5 sampling train as illustrated in Figure 5 will be used at location 11 for sampling of particulate, HCl acid gas, and HCB (and any other condensible organics present in the offgas). The sampling train will be operated by members of the contract sampling crew at the direction of the sampling coordinator. The Modified Method 5 procedure includes measurement of the stack gas flow rate and temperature according to EPA Methods 1 and 2. Moisture determinations will be made according to the procedure described in EPA Method 5. The Modified Method 5 train will be operated for approximately 3 hours to collect approximately 3.5 m^3 stack gas during each trial burn run. No method blank will be attempted with the Modified Method 5 train. Approximately every 30 minutes, integrated samples will be collected for O_2 and CO_2 determinations by an Orsat analyzer according to EPA Method 3. The Orsat sample will be drawn by a separate pump through a tube attached to the Modified Method 5 sample probe.

The contract sampler will furnish and prepare sufficient equipment and supplies (including VOST and Modified Method 5 trains) to conduct the above sampling operations with about 1.5 hour minimum turnaround time between sample periods. Sufficient overages of equipment and supplies should be

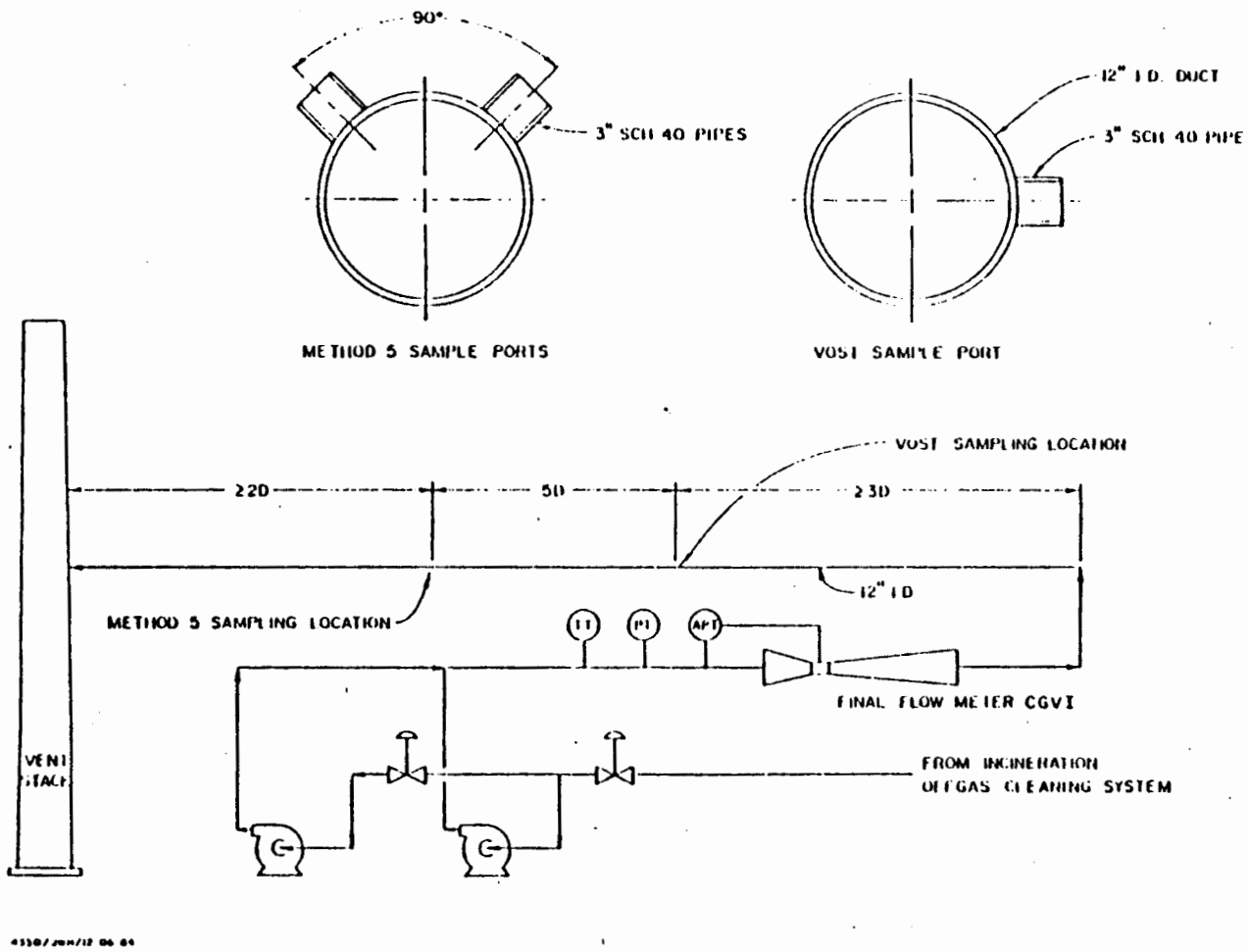
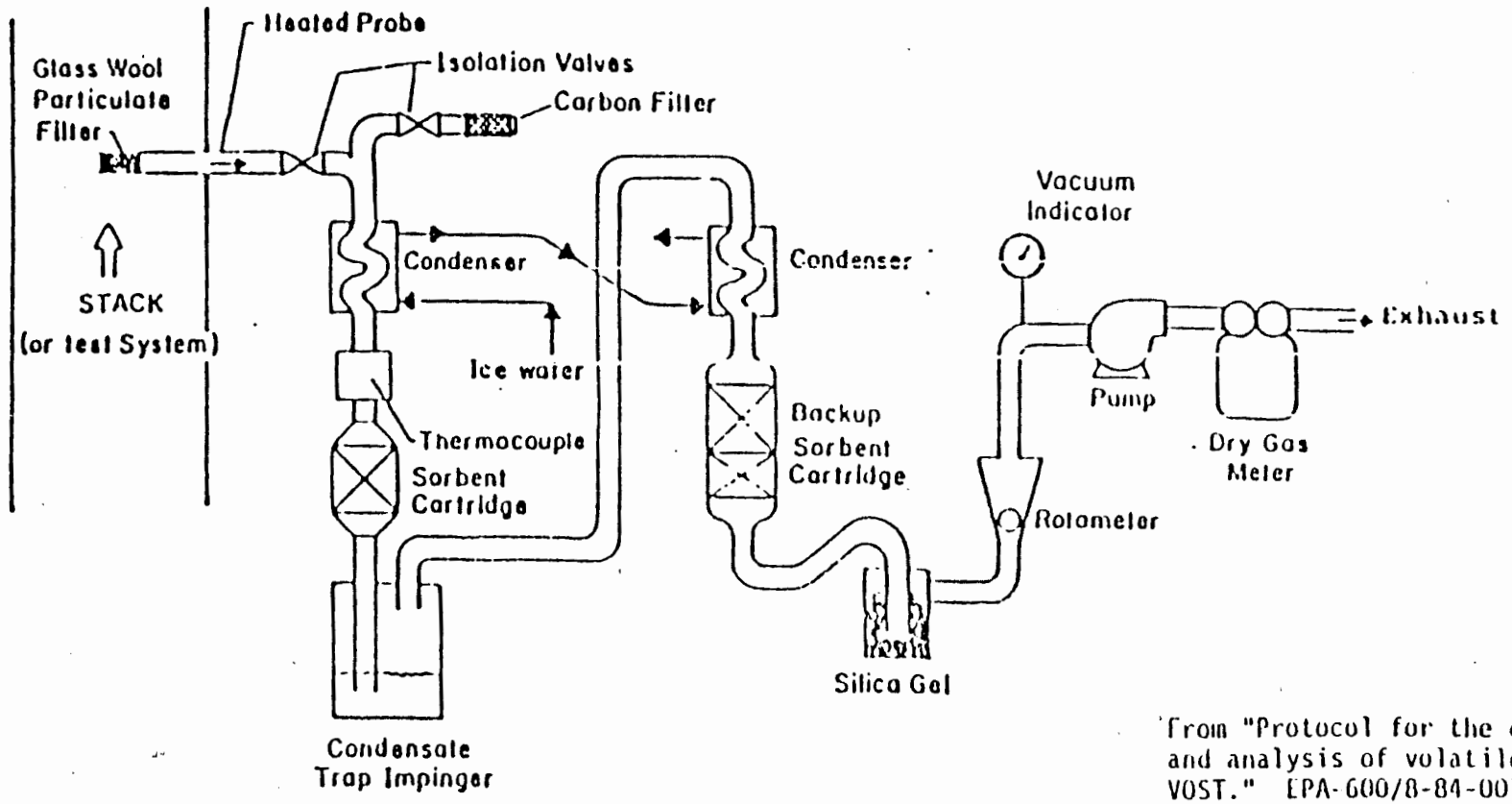


Fig. 3. Stack Gas Sampling Locations



From "Protocol for the collection and analysis of volatile POHC using VOST." EPA-600/8-84-007.

FIG. 4. Schematic of Volatile Organic Sampling Train (VOST)

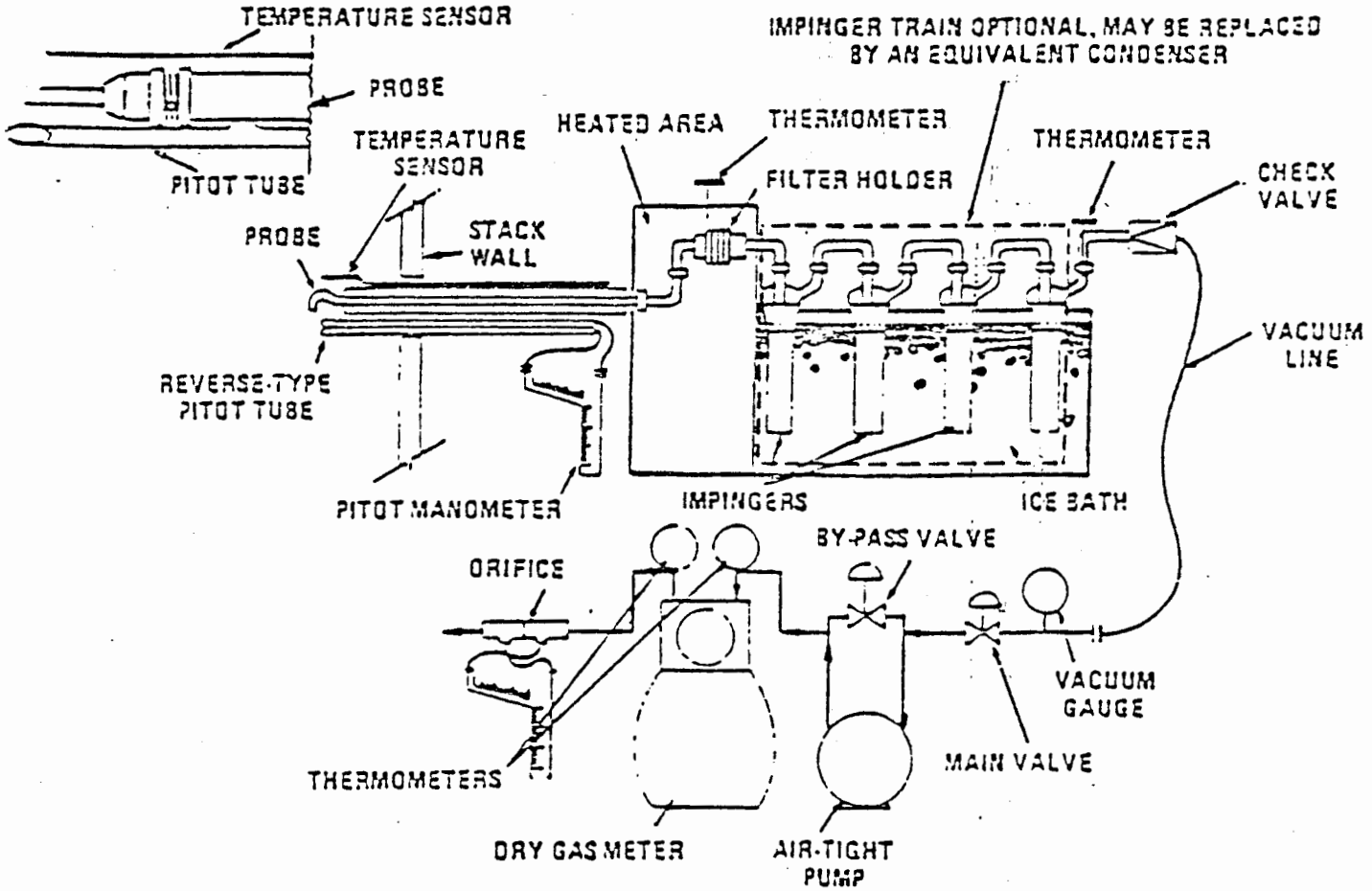


Fig. 5. EPA Method 5 Sampling Train

provided to ensure an adequate supply of all required sampling items.

All sample containers for the sampling program will be supplied and prepared by the contract sampler. Glass sample bottles and jars shall be amber and have Teflon-lined lids.

V. FACILITIES AND SERVICES AVAILABLE ON-SITE

The following resources are available to the sampling firm on-site at Los Alamos:

- chemical laboratory (11 ft x 24 ft. with 45 ft^2 of bench top space and chemical sink),
- two fume hoods,
- digital balance (0.1 mg sensitivity),
- ice making machine,
- chest-type freezer (27 ft^3 capacity), and
- large refrigerator, 21 ft^3 capacity.

The following plant utilities are available to the sampling firm on-site at Los Alamos:

- electrical power, 120 VAC, 60 Hz,
- plant air, 100 psig,
- instrument air, 60 psig,
- plant water, 40 psig,
- deionized water,
- distilled water, and
- waste drains.

VI. CALIBRATION PROCEDURES AND FREQUENCY

The VOST and Modified Method 5 trains are to be calibrated as indicated by EPA's "Quality Assurance Handbook of Air Pollution Measurement Systems" (EPA-600/4-77-027b). The required calibration activities are outlined in Tables 2 and 3.

Table 2. Activity Matrix for Calibration of Equipment

Apparatus	Acceptance Limits	Frequency and Method of Measurements	Action if Requirements Are not Met
Wet test meter	Capacity >3.4 m^3/hr (120 ft^3/hr); accuracy with ±1.0%	Calibrate initially, and then yearly by liquid displacement	Adjust until specifications are met, or return to manufacturer
Dry gas meter	$Y_i = Y \pm 0.02\ Y$	Calibrate vs. wet test meter initially, and when post-test check exceeds Y ±.05 Y	Repair, or place and then recalibrate
Thermometers	Impinger thermometer ±1°C (2°F); dry gas meter thermometer ±3°C (5.4°F) over range; stack temperature sensor ±1.5% of absolute temperature	Calibrate each initially as a separate component against a mercury-in-glass thermometer; then before each field trip compare each as part of the train with the mercury-in-glass thermometer	Adjust; determine a constant correction factor; or reject
Probe heating system	Capable of maintaining 120° ±14°C (248° ±25°F) at a flow rate of 21 L/min (0.71 ft^3/min)	Calibrate component initially by APTD-0576(11), if constructed by APTD-0581(10) or use published calibration curves	Repair, or replace, and then reverify the calibration
Barometer	±2.5 mm (0.1 in.) Hg of mercury-in-glass barometer	Calibrate initially vs. mercury-in-glass barometer; check before and after each field test	Adjust to agree with a certified barometer
Proble nozzle	Averge of three ID measurements of nozzle; difference between high and low <0.1 mm (0.004 in.)	Use a micrometer to measure to nearest 0.025 mm (0.001 in.)	Recalibrate, reshape, and sharpen when nozzle becomes nicked, dented or corroded
Analytical balance	± mg of Class-S weights	Check with Class-S weights upon receipt	Adjust or repair

Source: EPA-600/4-77-027b

Table 3. Activity Matrix for Calibration of Apparatus

Apparatus	Acceptance Limits	Frequency and Method of Measurements	Requirements Are not Met
Type S pitot tube and/or probe assembly	All dimension specifications met	Calibrate initially and visually inspect after each field test	Use pitot tubes that meet face opening specifications; repair or replace as required
Stack gas temperature measurement	Capable of measuring within 1.5% of minimum stack temperature	Calibrate initially and after each field test	Adjust to agree with Hg bulb system thermometer, or construct a calibration cu to correct the readings
Barometer	Agrees within 2.5 mm (0.1 in.) Hg of mercury-in-glass barometer	Initially and after every field use, compare to a liquid-in-glass barometer	Adjust, repair, or discard
Differential pressure gauge (does not include inclined manometers)	Agree within ±5% of inclined manometers	Initially and after each field use	Reject test results, or consult administrator if post-test calibration is out of specification

Source: EPA-600/4-77-027b

VII. SAMPLE PREPARATION PROCEDURES

The contract sampler will recover samples from the VOST and Modified Method 5 trains in accordance with prescribed EPA procedures.

All stack gas samples for POHCs (CCl_4 and HCB) will be spiked with a surrogate compound before preparation for shipment to the analytical laboratory. The surrogate data will be used to calculate recovery of the surrogate as a measure of the accuracy of the sample preparation and analysis procedures. The surrogate compound will be selected and supplied by Los Alamos prior to the trial burn.

For directed analysis of CCl_4 and HCB in the stack gas samples, one sample from each triplicate set will be spiked with a CCl_4/HCB concentration corresponding to two times the target detection limit of DRE for stack gas samples. After consultation with contract sampling personnel, Los Alamos will indicate prior to the trial burn the required CCl_4/HCB concentration in the spiked stack samples.

Replicate samples are inappropriate for individual samples being composited. Instead, in order to provide quality control, a minimum of 10 percent of the final composites associated with each trial burn run will be split and prepared for shipment for analysis.

Blank samples of all reagents, solvents, and spiking solutions used by the contract samplers will be collected and prepared for shipment to the analytical laboratory.

The sample containers to be used for retaining samples for shipment to the analytical laboratory are described in Table 4. All bottle caps will have Teflon liners. Those samples requiring low temperature preservation will be stored in a refrigerator at 4°C. This will include all samples which contain volatile organics or which will be analyzed for volatiles.

VIII. SAMPLE CUSTODY

Sample custody will be the responsibility of the trial burn project manager or the sampling coordinator from the time of sample collection until the samples are shipped to the analytical laboratory.

Samples will be kept in appropriate containers labeled so as to uniquely identify each sample. A form similar to Figure 6 is to be supplied and used by the sampling coordinator to provide an inventory and field sampling record of each sample collected.

The sampling coordinator is to provide and use a form similar to Figure 7 to provide a formal chain-of-custody record. Chain-of-custody forms will be handled as follows:

- original form retained at Los Alamos to include with sample shipment to the analytical laboratory,
- one copy sent separately to the analytical laboratory by the sampling coordinator,
- one copy retained by the sampling coordinator, and
- one copy sent to the trial burn project manager.

IX. REPORTS

Fifteen work days or more prior to the trial burn, the contract sampling firm will submit to Los Alamos for approval copies of all procedures and descriptions of all required equipment and supplies to be used.

A final sampling report including data sheets, calculations, calibrations, and any other pertinent information on the sampling effort is to be provided within 20 work days following the completion of the trial burn.

X. PRE-TEST MEETING

Personnel from the contract sampling firm shall attend a meeting at Los Alamos prior to the trial burn to discuss the sampling plans and to become familiar with the incinerator process. One person present from the sampling firm must be the designated sampling coordinator. Travel costs to Los Alamos for this meeting are to be included in the proposal.

XI. QUALITY ASSURANCE REQUIREMENTS

A quality assurance (QA) plan has been prepared by Los Alamos for the trial burn and a quality assurance officer has been appointed from the Los Alamos staff. The sampling contractor personnel will communicate with the quality assurance officer as shown in Figure 1. Elements of the QA plan as it pertains to sampling have been included in the requirements of the above sections of this specification. The proposal and any subsequent report to Los Alamos will be reviewed by the quality assurance officer for compatibility with the Los Alamos QA plan. During the trial burn, the quality assurance officer will work with the trial burn project manager and sampling coordinator to achieve the objectives of the QA plan.

C/C Control No. 0000
R/A Control No. _____

CHAIN-OF-CUSTODY RECORD

PROJECT NAME _____ SAMPLE TEAM MEMBERS _____
PROJECT NUMBER _____ LAB DESTINATION _____
PROJECT MANAGER _____ CARRIER/WAYBILL NO. _____

Sample Number	Sample Location and Description	Date & Time Collected	Sample Type	Container Type	Condition On Receipt (Name & Date)

Special Instructions: _____
Possible Sample Hazards: _____

SIGNATURES: (Name, Company, Date & Time)

1. Relinquished By: _____
   Received By: _____
2. Relinquished By: _____
   Received By: _____
3. Relinquished By: _____
   Received By: _____
4. Relinquished By: _____
   Received By: _____

Authorization for Disposal: _____ Relinquished For Disposal: _____
Container No. _____ Transferred To: _____ Manifest No. _____

Figure 7. Example Chain-Of-Custody Record Form

SUGGESTED SAMPLING FIRMS

ACUREX CORPORATION (415) 964-3200
Source Evaluation & Analysis Division
485 Clyde Avenue
Mountain View, CA 94042

CLEAN AIR ENGINEERING, INC. (312) 991-3300
209 North Woodwork Lane
Palatine, IL 66067

ENTROPY ENVIRONMENTALISTS, INC. (919) 781-3550
Department T
P. O. Box 12291
Research Triangle Park, NC 27709

ENVIROTECH CORPORATION (717) 272-2001
Buell Emission Control Division
200 North 7th Street
Lebanon, PA 17042

ENVISAGE ENVIRONMENTAL, INC. (216) 526-0990
P. O. Drawer 152
Richfield, OH 44286

KEMRON ENVIRONMENTAL SERVICES (304) 375-5800
902 Highland Avenue
Williamstown, WV 26187

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APPENDIX L. SAMPLING CONTRACTOR TEST PROTOCOL

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Clean Air Engineering

Clean Air Engineering, Inc.'s Test Protocol For Los Alamos National Laboratory Controlled Air Incinerator RCRA Part B Trial Burn

August 28, 1986

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Test Protocol for
Los Alamos National Laboratory
Controlled Air Incinerator
RCRA Part B Trial Burn

August 28, 1986

1.0 Introduction

Clean Air Engineering, Inc has been contracted by University of California (operators of Los Alamos National Laboratory) to provide sampling activities directed toward obtaining an operating permit for Los Alamos Controlled Air Incinerator (CAI).

The sampling is to be in compliance with the requirements or the Resource Conservation and Recovery Act (RCRA) for a Part B Permit for treatment and disposal or hazardous wastes. The trial burn will be conducted at four separate conditions incinerating specially prepared liquid and solid waste at two secondary chamber combustion temperatures. The principal organic hazardous constituents (POHC's) considered for the tests are Carbon Tetrachloride (CCl_4) and Trichloroethylene (TCE).

2.0 Objectives

The primary objective of the test program is to obtain hazardous waste incinerator operating and emission data for obtaining an operating permit for the facility.

The testing will document the destruction and removal efficiency (DRE) for the following POHC's using a volatile organic sampling train (VOST): Carbon Tetrachloride (CCl), Trichloroethylene (TCE).

Sampling of both the waste feed material and the stack effluent will be performed such that a DRE of at least 99.9999 percent (six 9's) may be determined.

Sampling will also be performed using an EPA Method 5 sampling train to document the particulate and hydrochloric acid concentration in the stack effluent.

Clean Air Engineering (CAE) will collect all required samples, composite as necessary, provide quality assurance and quality control and prepare a comprehensive final report covering all sampling activities.

3.0 Description of Installation and Process

The LANL controlled air incinerator (CAI) is a dual-chamber refractory lined incinerator. Liquid waste is introduced into the lower, or primary, combustion chamber through an atomizing nozzle where underfire air supports combustion at near stoichiometric conditions. (Solid waste is batch fed into the lower combustion through an appropriate mechanism). Unburned volatile compounds and entrained particulate exit the lower chamber through a connecting duct to the upper or secondary combustion chamber. Excess air is introduced at this location to promote complete combustion. The secondary chamber is designed to burn off volatiles with needed residence time and supplemental heat supplied as needed. Oxygen control is established by oxygen/combustibles analyzers at the exit of of each chamber with excess air controlled by adjustment of underfire air flow in the primary chamber and secondary air flow in the secondary chamber.

The offgas cleaning system consists of a quench tower, a high-energy variable throat venturi scrubber, a packed column absorber tower, a condenser, a mist eliminator, a reheater, a carbon absorber two series of two HEPA filters and two induced-draft blowers. Gas and particulate sampling ports are provided on the duct between the blowers and the stack.

Attachment I presents the proposed test matrix. Attachment II presents the proposed feed compositions for the test burn.

4.0 Sampling and Analytical Procedures

4.1 Sampling for POHC's will be conducted using the volatile organic sampling train (VOST). Operation will be in accordance with "Protocol for the Collection and Analysis of Volatile POHC's using VOST", EPA-600/8-84-007, dated March, 1984. It should be noted that this is a draft method that has not as yet been promulgated by the USEPA.

The VOST system, as shown in Figure I, consists of a sampling probe, a volatile collection system, and a gas metering system. The volatile collection system consists of condensers to cool the gas and two adsorbent traps in series. The first trap contains TENAX and the second trap contains a section of TENAX followed by a section of charcoal.

Each set (of two) traps will be exposed to twenty liters of effluent over a twenty minute period. The traps will than be charged and the sampling repeated until six (6) sets of traps are taken at each burn condition.

Each trap will be placed in its own transport tube and sealed by CAE for shipment to the analytical laboratory per the above protocol.

The aqueous condensate will be recovered at the end of each sampling condition. The sample will be archived but not analyzed because of the insolubility of the POHC's.

4.2 The following VOST blanks will be taken:

1 Set - laboratory blank - desorbed by lab, does not leave laboratory.

1 Set - trip blank - desorbed by lab, shipped to job site, returned to laboratory unopened.

4 Sets - field blanks - desorbed by lab, taken to sampling site, end caps are opened for approximately 5 minutes (time that it takes to change traps), recapped and returned to lab. One set taken for each burn condition.

4.3 Samples of the liquid and solid feeds, scrubber water, makeup water, ash and activated carbon will be taken at the location and frequency according to attachment III.

4.4 Particulate and HCl testing will be conducted using EPA Method 5 sampling procedures. The water in the impingers 5 sampling procedures. The water in the impingers may be may be replaced by 0.1 n sodium acetate if the expected chloride concentrations warrants it. The sampling train is shown in Fig II. Eight (8) traverse points will be sampled for eight minutes each for a total test time of 64 minutes. The sampling port locations and sampling points are shown in Figures III and IV respectively. Three (3) runs will be conducted at each of the four (4) burn conditions. Oxygen and carbon dioxide will be measured during each run using the intergrated procedure of EPA Method 3. Two (2) samples (bags) will be taken during each run.

4.5 Carbon monoxide will be monitored during each trial burn run using the continuous sampling train and non-dispersive intra-red analyzer procedure outlined in EPA Method 10.

4.6 Analysis of all of the samples taken will be performed by an analytical laboratory designated by Los Alamos National Laboratory. All samples will be sealed by Clean Air Engineering and logged on appropriate chain of custody forms for shipment to the laboratory. Spiked samples will be provide by LANL.

5.0 Manpower Responsibilities (Clean Air Engineering)

Sampling Coordinator
LANL - CAE Correspondence and interface
Shipment of sampling equipment to trial burn site
Assignment and recording sample numbers
Direction or sampling activities
Direction or sampling preservation/compositing/sealing/shipment
Documentation or sampling activities in field log
Run M10 carbon monoxide equipment
Quality assurance

Bulk Sampling Technician

Collect all liquid/solid samples at appropriate times - per sampling matrix.
Notify LANL personnel when appropriate to take samples.
Organize samples in secure area
Keep CAE sampling crews supplied with ice and expendables
Be present in incinerator building when sampling coordinator is absent to notify CAE crew if operation upset

Method 5 Sampling Technicians

Prepare M5 equipment
Weigh M5 filters and beakers
Run M5 equipment
Perform orsat analysis of M3 samples
Recover M5 samples
Assist VOST technician

VOST Sampling Technician

Prepare VOST equipment
Run VOST equipment
Change cartridges at appropriate times
Recover aqueous condensate at end of each condition
Assist M5 technician

APPENDIX

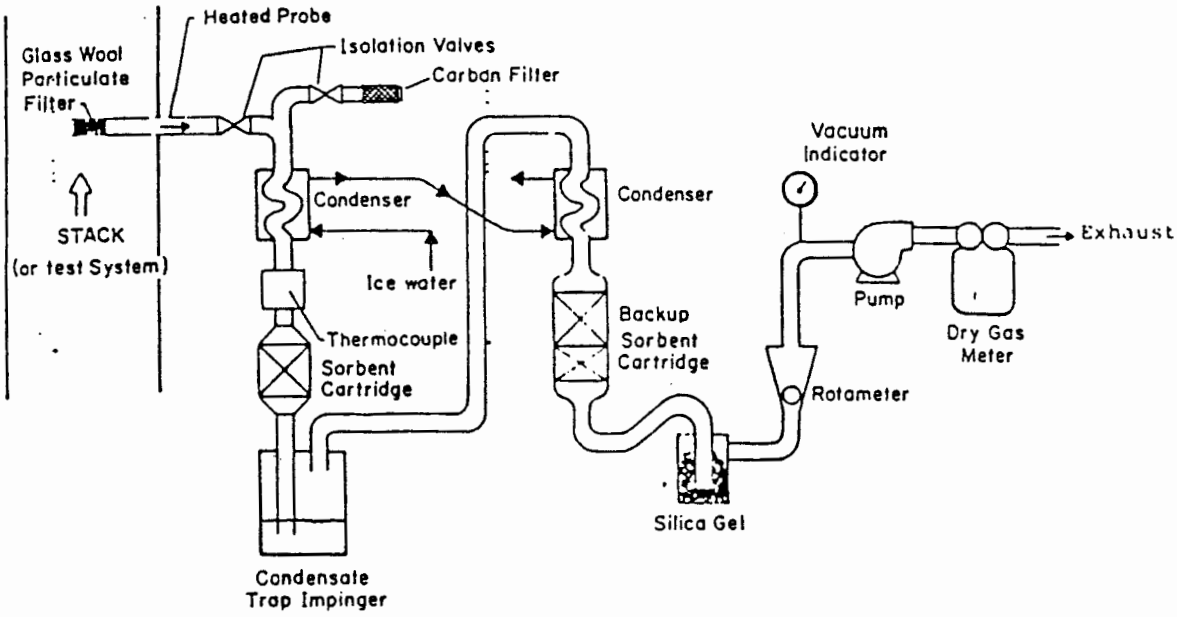


Figure I
VOST Sampling Train

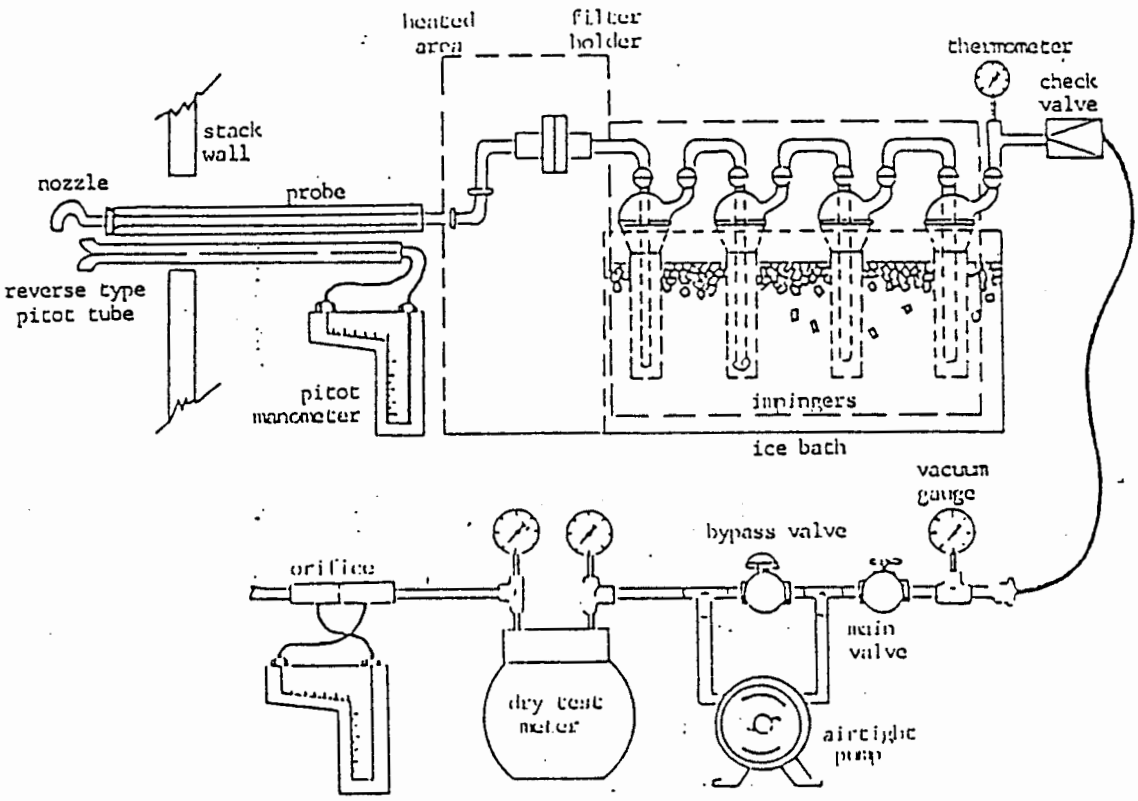


Figure II
Method 5 Sampling Train

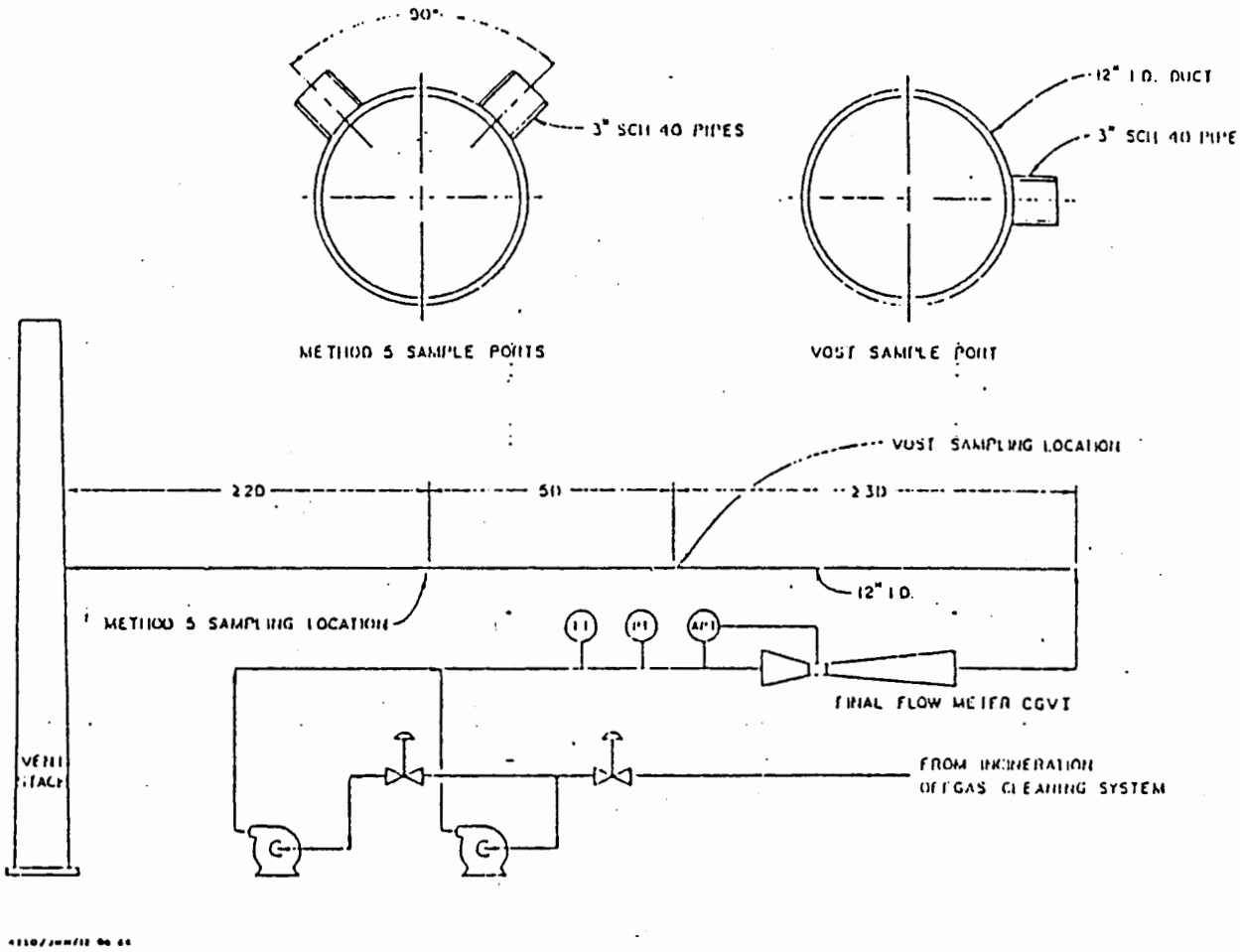
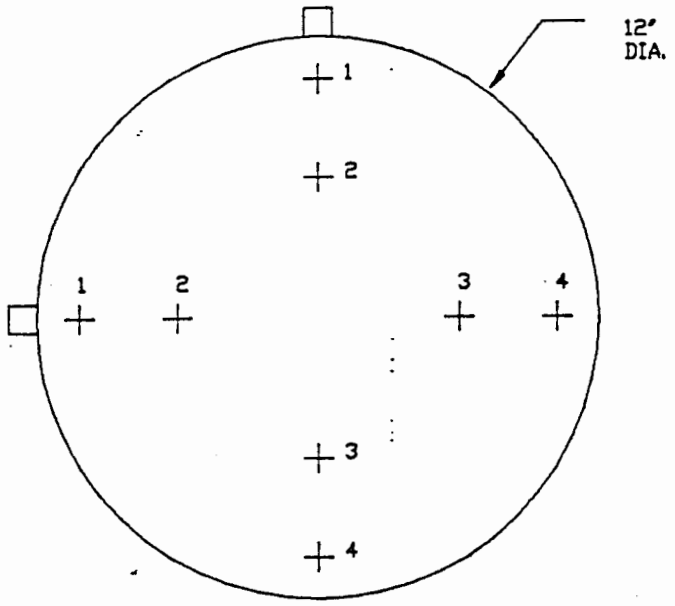


Figure III
Sample Port Locations



Traverse Point	% of Diameter to Point
1	6.7
2	25.0
3	75.0
4	93.3

Figure IV
Particulate Traverse Points

ATTACHMENT I

LOS ALAMOS CAI

RCRA TRIAL BURN

INCINERATION TEST CONDITIONS

Test #	Feed Type	Feed Rate (lb/h)	INCINERATOR CHAMBERS Primary Temp,F	Primary O_2,%	Secondary Temp,F	Secondary O_2,%	Time (h)
1A	liquid	150	1900	3-9	2200	3-9	1-3
1B	liquid	150	1900	3-9	2200	3-9	1-3
1C	liquid	150	1900	3-9	2200	3-9	1-3
2A	liquid	150	1900	3-9	2000	3-9	1-3
2B	liquid	150	1900	3-9	2000	3-9	1-3
2C	liquid	150	1900	3-9	2000	3-9	1-3
3A	solid	200	1900	3-9	2200	3-9	1-3
3B	solid	200	1900	3-9	2200	3-9	1-3
3C	solid	200	1900	3-9	2200	3-9	1-3
4A	solid	200	1900	3-9	2000	3-9	1-3
4B	solid	200	1900	3-9	2000	3-9	1-3
4C	solid	200	1900	3-9	2000	3-9	1-3

Notes:

1) The above primary chamber temperatures are estimates based on experience. The actual temperatures will be those obtained from burning the particular waste stream at the specified feed rate with the primary chamber natural gas burners on low fire.

2) The oxygen levels for both the primary and secondary chambers are given as a range because the actual level is that resulting from the temperature obtained and the specified feed conditions.

3) The time given is the sample period elapsed time only. The length of time that feed material will be fed to the incinerator between each sample period will range up to 3 hours. Hence, the maximum total elapsed time between the beginning of sample period 1A and the end of sample period 4C will be 72 hours.

ATTACHMENT II

LOS ALAMOS CAI
RCRA TRIAL BURN

FEED COMPOSITIONS

RCRA SOLID FEED
(4,676 Btu/lb)

Material	Weight %	Grams/box	Lbs/box
Pel-e-cel (corn cobs)	41.29	6936	15.28
Water	4.13	694	1.53
Plastic jug	5.54	930	2.05
Cardboard box	4.05	680	1.50
Carbon tetrachloride	30.00	5040	11.10
Trichloroethylene (TCE)	15.00	2520	5.55
	Total	16800	37.00

RCRA LIQUID FEED
(1400 lb batch, 7,542 Btu/lb)

Material	weight %	Lbs	Gal	Liters
Fuel oil	35	490	68.82	260.48
CCl_4	45	630	47.40	179.41
TCE	20	280	22.93	86.79
		1400	139.15	526.68

PHYSICAL PROPERTIES

Material	SpG	Density (lb/gal)	Heat content (Btu/lb)
Fuel oil	0.854	7.12	18,968
CCl_4	1.594	13.29	986
TCE	1.4642	12.21	2,301
Pel-e-cel	0.578	4.82	7,052
Cardboard	-----	-----	7,052
PE jug	----	-----	18,687
Water	1.00	8.34	------

LOS ALAMOS CONTROLLED AIR INCINERATOR
RCRA TRIAL BURN
SAMPLES FOR OFF-SITE ANALYSIS

Sample	Process Location	ANALYSES CCl_4	TCE	Cl^-	Partic.	pH	No. of samples	Procedure/Frequency
Fuel oil feed stock	1	x	x	x			1-2	each fuel oil tank reload (grab)
CCl_4 feed stock	2	x					2-4	every drum of CCl_4 (grab)
TCE feed stock	2		x				2-4	every drum of TCE (grab)
Cellulosic (Pel-e-cel) feed stock	4	x	x	x			1 E	one bag of Pel-e-cel (grab)
Liquid mixture feed	3	x	x	x	x		6	end of every sample period (grab)
Solid mixture feed	4	x	x	x			1 E	one box of mixed solid feed (grab)
Caustic solution	8			x			5-10	every batch prepared in caustic tank (grab)
Makeup water	6	x	x	x			12 E	end of every sample period (grab)
Incinerator ash	5	x	x	x		x	2 E	end of test #3C, end of test #4C (grab)
Scrubber discharge liquid	7	x	x	x		x	12 E	at beginning, middle, and end of each sample period, then composited (grabs)
Activated carbon (fresh)	13	x	x	x		x	1 E	before trial burn (grab)
Activated carbon (used)	13	x	x	x		x	~~12~~ E	end of each sample period (grab)
Stack gas (VOST)	10	x	x				24 ~~12~~ E	2 ~~3~~h during each sample period (continuous)
Stack gas blank (VOST)	10	x	x				6 2(?)E	3h (continuous)
Stack gas EPA M5	11			x	x		12	1 ~~6~~h during each sample period (continuous)
Stack gas blank EPA M5	11			x	x		2(?)	~~3h (continuous)~~
EPA QC VOST/M5 sample	10/11	x	x	x	x		?	before trial burn (continuous)
HEPA filter media (fresh)	9	x	x				1 E	before trial burn (grab)
HEPA filter media (spent)	9	x	x				1 E	after trial burn (grab)

Note: The "E" denotes those samples which will require extraction for one or more of the analyses.

ATTACHMENT IV

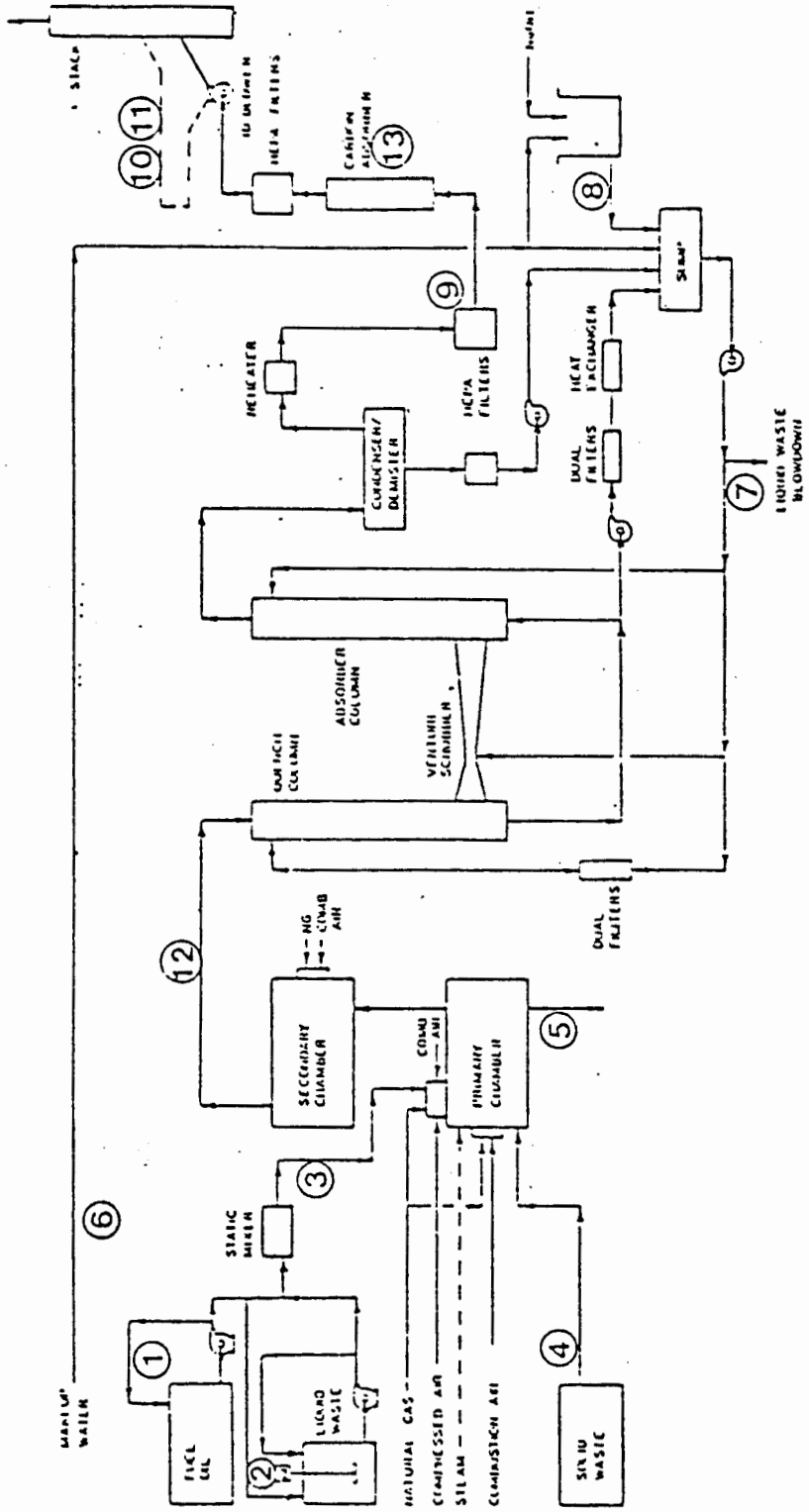


Fig. 5. Location of Sampling Points

CHAIN-OF-CUSTODY

CLIENT: _____ LOCATION: _____

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY

CARRIER: _____

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

Plant _____ Stack No. _____

Date _____ Probe No. _____

Location _____ VOST No. _____

Operator _____ Rotameter No. _____

Field Blank I.D.: Tenax _____ Dry Gas Meter No. _____

Tenax/Charcoal _____

Pair No.[b]	Leak Check	Cartridge I.D. Tenax	Cartridge I.D. Tenax/Charcoal	Rotameter Reading (l/min)	Time Initial	Time Final	Sampling Duration (min)	Probe Temp. (°C)	Barometric Pressure (in of Hg)	Condenser Outlet Temp. (°C)	Meter Temp. (Outlet)	Dry Gas Meter Initial	Dry Gas Meter Final	Gas Sample Volume (liters)	Comments

Condensate Samples:

Run No.	Sample I.D.	Comments

NOTES: [a]Reading should be tabulated at the beginning of a run and every five minutes thereafter.
[b]Refers to sample collection on one pair of Tenax and Tenax/charcoal traps.

VOST FIELD DATA SHEET

PARTICULATE TESTING
RAW DATA SET

Client/Owner _____
Plant _____
Unit# _____ Inlet/Outlet _____
Operator _____
Date _____
Run No. _____
Sample Box No. _____
Meter Box No. _____
Meter DH@ _____
K Factor _____
Pitot C_p _____ Pitot Leak Ck _____
Leak Rate Before _____ CFM @ _____ Hg
Leak Rate After _____ CFM @ _____ Hg
Static Press., In. H_2O (+/−) _____

Start Time
_____ : _____ AM / PM

Finish Time
_____ : _____ AM / PM

Meter Y_d
_____

SCHEMATIC OF TESTING LOCATION

Filter #'s
_____

Thimble #
_____

Beaker #
_____

Ambient Temperature, °F _____
Barometric Pressure, In. Hg _____
Assumed Moisture, % _____
Heater Box Setting _____
Probe Length, Ft. _____ No. _____
Nozzle Diameter, In. _____
Probe Heater Setting _____
% O_2 _____
% CO_2 _____
H_2O, ml _____
Silica Gel, gm _____
Total V_{lc} _____
Stack Area, Ft^2 _____
Pyrometer No. _____

TRAVERSE POINT NUMBER	MIN/PT _____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
TOTAL							AVG.	AVG.		
AVERAGE							AVG.			

Clean Air Engineering, Inc.

Page _____ of _____

ORSAT READINGS

Job: _____ Date: _____

_____

Test No.: _____

Time	% CO_2		% O_2		% CO	
Average						

BALANCE _____ CLIENT _____

OPERATOR _____ PLANT _____

DATE _____ UNIT _____

SHEET # _____ OF _____ RUN # _____

WEIGHT SHEET

RUN #	WT. #	FILTER # OR IDENTIFICATION	TFB	WASH ML	WASH CORR.	GROSS	TARE	
	1	BLANK	B		- - - -			
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							

APPENDIX M. ANALYTICAL LABORATORY QA/QC PLAN

CONTROLS FOR ENVIRONMENTAL POLLUTION, INC.

QUALITY CONTROL PROGRAM/QUALITY ASSURANCE PLAN

CONTROLS FOR ENVIRONMENTAL POLLUTION, INC.

QUALITY CONTROL PROGRAM

Copy No. _____

QUALITY ASSURANCE PLAN

Date	Rev#	Reviewed by	Approved by mgr. of Q.A.	Comments
1/2/74	0			
12/13/79	1			
12/21/81	2			
1/7/83	3	Barbara L Miller		
[illegible]	4	Barbara L Miller		[illegible]
12/12/83	5	Barbara Waters		

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CONTROLS FOR ENVIRONMENTAL POLLUTION, INC.
QUALITY CONTROL PROGRAM

QUALITY ASSURANCE PLAN
RADIOCHEMISTRY (ENVIRONMENTAL AND BIOASSAY), INORGANIC CHEMISTRY, ORGANIC CHEMISTRY, MICROBIOLOGY AND NUCLEAR MEASUREMENTS

1.0 Plan Description

1.1 Purpose

The purposes of this Quality Assurance Plan are to:

(a) define the nature and extent of Quality Assurance for Radiochemistry, Inorganic Chemistry, Organic Chemistry, Microbiology and Nuclear Measurements;

(b) set forth requirements for preparation of Quality Assurance and Quality Control procedures; and

(c) provide a general description of the Standard Operating Procedures used to carry out this Plan.

1.2 Scope

This outlines the Quality Assurance Plan and Quality Control procedures for all analytical activities practiced by Controls for Environmental Pollution, Inc. (CEP) in providing laboratory services to its clients.

1.3 Objectives

The overall objectives of this Quality Assurance Plan are to:

1.3.1 General Objectives

(a) assure that analytical procedures and practices are adequate to maintain required precision and accuracy of laboratory data;

(b) coordinate an in-house Quality Control program, independent of external programs, to assure that data generated by CEP is of the highest quality.

1.3.2 Specific Objectives

The specific objectives of this Quality Assurance Plan are to:

(a) assure that chemistry activities are documented and coordinated with

client specifications and regulatory requirements;

(b) assure that all chemistry procedures and practices are correct and adequate in terms of required accuracy and reproducibility of data;

(c) assure that procedures and practices conform to client specifications and regulatory requirements;

(d) assure that qualified laboratory personnel are provided with continued training, as necessary, for proper performance of analytical procedures;

(e) assure that records are completed and maintained for all samples and for each analysis conducted;

(f) assure that procedures contain adequate Quality Control measures and that such measures are practiced routinely; and

(g) assure that all equipment is maintained and calibrated on a scheduled basis as required.

2.0 Responsibilities

2.1 Director of Quality Control

The Director of Quality Control is responsible for:

(a) assuring that all Quality Assurance and Quality Control documents are reviewed and approved;

(b) reviewing and approving Quality Assurance Audits;

(c) reviewing and approving new analytical procedures; and

(d) issuing "stop work orders" for procedures which are not in compliance with the requirements of this plan.

2.2 Quality Control Officer

The Quality Control Officer is responsible for:

(a) developing and carrying out the approved Quality Assurance Program, and advising and assisting management in meeting these requirements;

(b) monitoring quality control activities of the laboratory to determine conformance with the Quality Control Program;

(c) performing Quality Assurance Audits, writing reports and providing follow-up action;

(d) recommending "stop work orders" when procedures are not in compliance of this plan;

(e) maintaining records on all anlytical data, calibration data and radioactive material inventory;

(f) providing clients with Quality Control data and Quality Assurance reports as requested;

(g) standardizing all radioactive quality control solutions; and

(h) introducing quality control samples, Environmental Protection Agency samples and other Environmental Protection Agency approved samples.

2.3 Laboratory Supervisor

The Laboratory Supervisor is reponsible for:

(a) monitoring laboratory personnel with respect to maintaining routine Quality Control practices;

(b) implementing new Quality Control procedures as directed by the Quality Control Officer;

(c) evaluating laboratory personnel in their Quality Control activities; and

(d) reviewing and signing analytical data.

3.0 Administration

Administrative activities associated with Radiochemistry, Inorganic Chemistry, Organic Chemistry, Microbiology and Nuclear Measurements, will be reviewed at Corporate Headquarters in Santa Fe, New Mexico.

Quality Assurance activities and audits will be performed at all CEP laboratory locations.

4.0 Schedule of Quality Control Activities

4.1 Radiochemistry

(a) Reagent blanks, duplicates and internal laboratory spikes will be analyzed at a frequency of ten percent.

(b) Quality control samples, unknown to laboratory personnel, will be issued by the Quality Control Officer, as appropriate: weekly, monthly, or quarterly .

(c) Samples provided by the Environmental Protection Agency, or other

Environmental Protection Agency approved supplier will be submitted as provided.

(d) Reagents and carriers which are in regular use and critical to proper results will be standardized monthly or prior to use, as appropriate.

(e) Radioactive quality control solutions will be calibrated as required.

4.2 Inorganic Chemistry

(a) Reagent blanks, duplicates and internal laboratory spikes will be analyzed at a frequency of ten percent.

(b) Quality control samples, unknown to laboratory personnel, will be submitted quarterly by the Quality Control Officer as follows:

Water Chemistry

Nitrate, Chloride, Fluoride, Sulfate, Total Dissolved Solids, Specific Conductance and Hardness.

Atomic Absorption Spectroscopy

Aluminum, Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Lithium, Mercury, Molybdenum, Potassium, Selenium, Silver and Sodium.

Inductively Coupled Plasma Spectroscopy

Beryllium, Boron, Calcium, Cobalt, Iron, Magnesium, Manganese, Nickel, Phosphorus, Silica, Strontium, Sulfur, Vanadium and Zinc.

Quality control samples not introduced into the laboratory will be documented on an Explanation Form (See Appendix A).

(c) Spiked samples provided by the Environmental Protection Agency as cross-check samples will be submitted at the frequency the samples are provided.

(d) Spiked samples certified by the Environmental Resources Associates or other Environmental Protection Agency approved supplier will be submitted at the frequency the samples are provided.

(e) Reagents which are critical to proper results will be standardized prior to use or as appropriate.

4.3 Organic Chemistry

(a) Reagent blanks will be analyzed at a frequency of ten percent.

(b) Duplicates will be analyzed at a ten percent frequency if sufficient sample is provided.

(c) Quality control samples, unknown to laboratory personnel, will be issued quarterly by the Quality Control Officer.

(d) Spiked samples provided by the Environmental Protection Agency as cross-check samples will be submitted quarterly, or as provided.

4.4 Microbiology

(a) Reagent blanks will be analyzed on each set of analysis.

(b) Duplicates or serial dilutions will be analyzed on all samples having adequate volume.

(c) Quality control samples. unknown to laboratory personnel, will be submitted quarterly, where applicable.

(d) Spike samples from the Environmental Protection Agency will be submitted at the frequency the samples are provided.

(e) Media for routine bacteriological procedures, when it is prepared, will be spiked with bacteria for verification of growth capacity.

4.5 Nuclear Measurements Instrumentation

(a) All nuclear measurements instrumentation and equipment shall be on a maintenance program, as appropriate for the nature and frequency of usage.

(b) Backgrounds on proportional counters and alpha spectrometers will be conducted with every twenty-five samples. Backgrounds for gamma spectrometry are determined automatically for all samples analyzed (computerized program).

(c) Instrumentation calibrations of proportional counters, gamma spectrometers and liquid scintillation systems shall be conducted on a weekly basis. Alpha spectrometers shall be calibrated on a quarterly basis. Less frequently used instruments will be calibrated prior to use. Standards used are to be traceable to National Bureau of Standards, when available.

(d) Self-absorption curves will be conducted on a quarterly basis.

4.6 Analytical Instrumentation and Equipment

(a) Atomic Absorption Spectrophotometer calibration curve shall be conducted for the particular method analyzed with certifed reference standards prior to use.

(b) Inductively Coupled Plasma Spectrophotometer calibration curve shall be conducted for the particular method analyzed with certified reference standards prior to use.

(c) Gas Chromatograph calibration curve shall be conducted for the particular method analyzed with certified reference standards prior to use.

(d) Ultraviolet/Visible Spectrophotometer calibration curve shall be conducted for the particular method analyzed with reference standards prior to use.

(e) pH Meters shall be calibrated with certified buffer solutions prior to use.

(f) Conductivity probe cell constant shall be determined prior to use.

(g) Biochemical Oxygen Demand Meter shall be calibrated monthly.

(h) Fluorometer calibration curve shall be conducted with certified reference standards traceable to National Bureau of Standards prior to use.

(i) Balances shall be calibrated monthly with class "S" weights having National Bureau of Standards specifications.

(j) Refrigerator temperatures will be checked daily.

(k) Incubator temperatures will be checked daily.

(l) Hoods will be monitored on a monthly basis.

(m) Microwave ovens will be monitored monthly.

(n) Glass thermometers will be calibrated annually and metal thermometers quarterly.

4.7 Instrument Maintainence

(a) Instruments and equipment shall be maintained on a schedule, as deemed necessary by the manufacturer. Electronic calibration shall be conducted as recommended in the manufacturer's manual.

4.8 Quality Assurance Audits

(a) Quality Assurance Audits shall be performed as deemed necessary by the Director of Quality Control.

5.0 Standard Operating Procedures

For all analytical methods used at CEP, Quality Control and Quality Assurance practices are built into the procedure. Since the sample is almost always consumed or altered during the analytical process, it is important that each step in the analytical process is correctly followed in order to yield valid data. In addition, Standard Operating Procedures are used to assure the following:

(a) use of standardized practices and equipment which have been demonstrated to be adequate for compliance with client requirements with regards to accuracy, sensitivity and reproducibility of data;

(b) that laboratory personnel are trained on the particular methods and equipment used; and

(c) that equipment, chemicals, samples and instrumentation are controlled at every step to assure accuracy and reliability.

5.1 Quality Control

(a) Standardization and qualification of procedures including:

1. Uniform step-by-step procedures; and
2. Training of personnel in use of procedures and equipment.

(b) uniform instructions for reagent preparation, control, storage, use and shelf-life (including appropriate labeling and dating);

(c) proper selection of glassware, plastic containers and other analytical equipment and supplies;

(d) regular calibration of equipment (against standards with traceability to National Bureau of Standards, where necessary and available);

(e) uniform and consistent procedures for taking, controlling, preserving and using samples (including identification labels with dates and time, type and amount of preservative, and control number for all record purposes);

(f) provisions for control of procurement, storage and use of all chemicals used in analytical procedures;

(g) provisions for analysis of duplicate samples, including standards and blanks where such procedures are appropriate;

(h) independent selective review and checking of calculations, curves or other data;

(i) standardized logs and analysis record sheets for recording sample identification, procedure used, data, and independent checks, where appropriate;

(j) introduction of quality control samples unknown to laboratory personnel;

(k) direct inspection of laboratory work and records; and

(l) corrective action:

1. When an analysis is consistently in the extreme upper or lower warning limit, predetermined by the procedure, an observation report will be submitted by the Quality Control Officer (see Appendix A).

2. When an analysis is beyond the predetermined limits for data acceptability, a corrective action report will be submitted by the Quality Control Officer (see Appendix A).

5.2 Analytical

The following analytical Standard Operating Procedures shall be used to accomplish the objectives of this Quality Assurance Plan.

5.2.1 Radiochemistry

(a) All Radiochemistry personnel shall follow approved methods by the Environmental Protection Agency, Environmental Measurements Laboratory or other methods approved by management to meet client specifications or regulatory requirements.

(b) All analytical data shall be recorded on approved forms after each analysis and signed by the laboratory supervisor.

(c) On a weekly, monthly or quarterly basis, quality control samples of unknown concentration in parameters commonly tested during the week, shall be introduced to the laboratory for routine analysis by the Quality Control Officer.

(d) All data shall be reviewed independently. When necessary, corrective action shall be recommended to the laboratory management, with a copy sent to the Director of Quality Control.

5.2.2 Inorganic Chemistry

(a) All Inorganic Chemistry personnel shall follow approved methods by the Environmental Protection Agency, current "Standard Methods for the Examination of Water and Wastewater," or other methods approved by management to meet client specifications or regulatory requirements.

(b) Analytical data shall be recorded on approved forms after each test and signed by the laboratory supervisor.

(c) On a quarterly basis, quality control samples of unknown

concentration in parameters commonly tested during the week, will be introduced into the laboratory for routine analysis by the Quality Control Officer.

(d) On a quarterly basis, additional samples of various concentrations and constituents shall be presented for analysis, from a source independent of CEP.

(e) All data shall be reviewed independently. When necessary, corrective action shall be recommended to laboratory management, with a copy sent to the Director of Quality Control.

5.2.3 Organic Chemistry

(a) All Organic Chemistry personnel shall follow methods approved by the Environmental Protection Agency, or other methods approved by management to meet client specifications or regulatory requirements.

(b) Analytical data shall be recorded on approved forms and signed by the laboratory supervisor.

(c) On a quarterly basis, quality control samples of unknown concentration in parameters commonly tested during the week, shall be introduced into the laboratory for routine analysis by the Quality Control Officer.

(d) On a quarterly basis, additional samples of various concentrations and constituents shall be presented for analysis, from a source independent of CEP.

(e) All data shall be reviewed independently. When necessary, corrective action shall be recommended to laboratory management, with a copy sent to the Director of Quality Control.

5.2.4 Microbiology

(a) All microbiology personnel shall follow methods approved by the Evironmental Protection Agency or other methods approved by management.

(b) Analytical data shall be recorded on approved forms and signed by the laboratory supervisor.

(c) On a quarterly basis, quality control samples of unknown concentration will be introduced into the laboratory for routine analysis by the Quality Control Officer, where applicable.

(d) On a quarterly basis, additional samples shall be presented for analysis, from a source independent of CEP.

(e) All data shall be reviewed independently. When necessary, corrective action shall be recommended to laboratory management, with a copy sent to the Director of Quality Control.

5.2.5 Nuclear Measurements

(a) All Nuclear Measurement personnel shall follow the Standard Operating Procedure Manual for each instrument.

(b) All instrument data shall be recorded on approved forms provided by the Quality Control Officer.

(c) Backgrounds on proportional counters and alpha spectrometers will be conducted with every twenty-five samples. Backgrounds for gamma spectrometry are determined automatically for all samples analyzed (computerized program). Standards traceable to National Bureau of Standards, when available, will be run on a weekly basis, or as appropriate for that instrument.

(d) All instrument data shall be reviewed promptly. When necessary, "stop work orders" shall be recommended to management, with a copy sent to the Director of Quality Control.

5.3 New Procedures

When a procedure is not available, requirements will be evaluated and a suitable analytical method established. After satisfactory verification that the procedure provides necessary sensitivity, accuracy and selectivity, a formal procedure will be approved by the Director of Quality Control.

5.4 Quality Assurance Audits

Quality Assurance Audits shall be performed using the following Standard Operating Procedures, with the number shown for record purposes.

CEP-QA-81 Quality Assurance Audit, Radiochemistry;

CEP-QA-82 Quality Assurance Audit, Inorganic Chemistry;

CEP-QA-83 Quality Assurance Audit, Organic Chemistry;

CEP-QA-84 Quality Assurance Audit, Microbiology; and

CEP-QA-85 Quality Assurance Audit, Nuclear Measurements.

Reports of these Quality Assurance Audit's shall describe:

(a) Particular activities audited;

(b) Basis and procedures for examination and evaluation of records;

(c) Procedures for verifying validity and consistency of data;

(d) Procedures for evaluating adequacy of Quality Control and Quality Assurance activities; and

(e) Deficiencies and the implementation of corrective actions with the review requirements.

5.5 Chain of Custody

Where samples may be needed for legal purposes a "Chain of Custody" form using the following Standard Operating Procedure will be incorporated:

(a) Identification of responsible party to act as sample custodian.

(b) Laboratory sample custody procedure for sample handling, storage and dispersement for analysis.

6.0 Reports and Record Requirements

6.1 Radiochemistry

(a) All analytical records and quarterly reports shall be retained as permanent record in accordance with CEP administrative requirements.

(b) Records and reports shall be formated as directed by CEP clients.

6.2 Inorganic Chemistry

(a) All records and reports of analytical data, including quantities and chemical constituency, shall be retained as permanent record in accordance with CEP's administrative requirements.

6.3 Organic Chemistry

(a) All records and reports shall be retained as permanent record in accordance with CEP's administrative requirements.

(b) Records of all certified reference standards and their correlation with analytical data, shall be retained for the time period established by the client.

6.4 Microbiology

(a) All records and reports shall be retained as permanent record in accordance with CEP's administrative requirements.

6.5 Nuclear Measurements

(a) Quality Assurance records shall consist of all logs, reports, results, deficiency reports and the like which are generated in the course of

carrying out requirements of the Quality Assurance Plan.

(b) All such records shall be retained as permanent record in accordance with CEP's administrative requirements.

7.0 Attachments

Refer to Appendix A and Appedix B, of this Quality Assurance document.

8.0 Review: Approval and Distribution

8.1 Quality Assurance Plan and Standard Operating Procedures

The draft of the completed Quality Assurance Plan and Standard Operating Procedure for Radiochemistry, Inorganic Chemistry, Organic Chemistry, Microbiology and Nuclear Measurements shall be distributed for review, comment and approval as follows:

President	1 Copy	(For review and comment)
All Laboratory Managerial Positions	1 Copy	(For review and comment))
Director of Quality Control	1 Copy	(For approval)

(a) A marked-up copy of Quality Assurance Plan and Standard Operating Procedures, or a comment letter incorporating all comments from reviewers, shall be returned to the issuer (Quality Control Officer) within ten to fifteen days.

(b) After resolution of all comments, and completion of signatures required on the signature sheet, the Director of Quality Control will approve the Quality Assurance Plan and Standard Operating Procedures and distribute copies to the controlled distribution.

QA - APPENDIX A

Quality Control/Quality Assurance Forms

CEP-QA-1
1/02/74
REV-3
1/07/83

Quality Assurance Department

Corrective Action Request*

Reference Document Pg. No./Para No.

INTRA DEPARTMENTAL ASSIGNMENT

Remarks

Description: _____

Recommended Corrective Action: _____

Respond by _____ Initiator _____ Date _____

Corrective Action Response _____

Complete Corrective Action Review: _____

Reviewed by _____ Date _____

CEP-QA-1
1/02/74
REV-3
1/07/83

Quality Assurance Department
Observation Report

Intra Departmental Assignment

Assigned To: Date:

Remarks:

Description:

Recommended Correction:

Respond by Initiator Date

Response

Technical Service Review Date

CONTROLS FOR ENVIRONMENTAL POLLUTION, INC. (CEP)

Quality Control/Quality Assurance Department

Explanation Form

This form supplements the regular Quality Assurance Audit and is to be completed when quality control samples, unknown, are not introduced per CEP Quality Control Progam/Quality Assurance Plan requirements.

Parameter	Reason	Date	Quality Assurance Approval

QA - APPENDIX B

Quality Assurance Plan Glossary

Glossary

Accuracy -	A bias measurement between a component measured and the known certified value.
Audit -	A systems check to determine the quality of activity performed. They are composed of two basic types; (a) performance audits in which the accuracy is measured; and (b) systems audit in which a direct inspection of laboratory work and records are reviewed.
Background -	Radiation present when there is no source under the detector, usually expressed as counts per minute.
Calibration Curve -	A standard reagent curve composed of a minimum of a reagent blank and three standards.
Duplicate -	Analysis of the same sample or samples by the same laboratory personnel within an analytical procedure.
Electronic Calibration -	An adjustment of the electronics or mechanism of an instrument.
Internal Laboratory Spike -	Known concentrations that are analyzed with a set of samples.
Precision -	The reproducibility of a method under controlled conditions.
Quality Assurance -	A system of activities whose purpose is to provide assurance that the overall Quality Control operation is in fact being done adequately.
Quality Control -	The overall system of activities whose purpose is to provide a quality service that meets the needs of the user.
Quality Control Samples (Unknown) -	Samples in which concentrations are unknown to laboratory personnel.
Reagent Blank -	A blank which undergoes the same procedural treatment as the sample.
Spike Sample -	A sample, usually distilled or deionized water, in which an addition of a known concentration(s) is added, unknown to the laboratory personnel performing the analyses.
Stop Work Order -	A discontinuation of an analysis or instrument until the problem is corrected.

QA MANUAL CHECKLIST

CEP-QA-1	Quality Assurance Program
CEP-QA-4A	Radiation Control Manual for Laboratory Personnel
CEP-QA-6	Standard Operating Procedure Inventory of Radioactive Material
CEP-QA-7	Quality Assurance Audit Checklist - Laboratory Area
CEP-QA-8	Standard Operating Procedure Quality Assurance Instrument and History Records
CEP-QA-9	Radionuclide Issuance Procedure
CEP-QA-10	Definition of Terms
CEP-QA-11	Counting Techniques and Data Handling
CEP-QA-12	Training Program for New Employees
CEP-QA-14	Nuclear Measurements Instrument Loading and Unloading Procedure
CEP-QA-21	Quality Control of Laboratory Services
CEP-QA-23	Instrument Calibration and Maintenance Procedure for Water Quality
CEP-QA-24	Water Quality Data Handling and Reporting
CEP-QA-26	Glossary of Terms used in Water Quality
CEP-QA-31	Personnel Bioassay Monitoring
CEP-QA-37	Quality Control of Glasswater in Water Chemistry
CEP-QA-38	Sampling and Preservation of water for compliance with National Interim Primary Drinking Water Regulation 40 CFR 141
CEP-QA-41	Quality Assurance Standard Operating Procedure for Recording Temp. of Freezer, Refrigerator, Ovens and Incubators
CEP-QA-42	Quality Assurance Standard Operating Procedure for Verification of Accuracy of Thermometers
CEP-QA-43	Quality Assurance Standard Operating Procedure for Verification of Accuracy of Mettler Analytical Balances
CEP-QA-44	Same as CEP-QA-43 but for Top Reader Loader
CEP-QA-45	Quality Assurance Standard Operating Procedure for the Calibration of Wide Beta Systems
CEP-QA-46	Quality Assurance Standard Operating Procedure for Determining Efficiences of Detectors for Wide Beta II and Low Beta II Systems

CEP-QA-47	Quality Assurance Standard Operating Procedure for Calibration of Low Beta II Systems
CEP-QA-52	Safety Records, Logs and Reports
CEP-QA-53	Training Program for Field Personnel
CEP-QA-56	Procedure for Analytical Performance of Radioanalytical Lab.
CEP-QA-58	Importance of Quality Control in Radioanalytical Laboratory
CEP-QA-59	Preparation of Precision Control Charts
CEP-QA-60	Preparation of Accuracy Control Charts
CEP-QA-81	Quality Assurance Audit, Radiochemistry
CEP-QA-82	Quality Assurance Audit, Inorganic Chemistry
CEP-QA-83	Quality Assurance Audit, Organic Chemistry
CEP-QA-84	Quality Assurance Audit, Microbiology
CEP-QA-85	Quality Assurance Audit, Nuclear Measurements
CEP-QA-86	Organizational Structure and Responsibilities of Personnel
CEP-QA-87	Personnel Qualifications
CEP-QA-88	Quality Assurance Standard Operating Procedures for Monitoring "Sterility of New Sample Bottles"
CEP-QA-89	Standard Operating Procedure Review of Radiochemical Data
CEP-QA-90	Standard Operating Procedure, Statistics Program
CEP-QA-91	Standard Operating Procedure, Storage of Spent Chemicals

APPENDIX N. CAI OPERATIONAL RUN PLAN

CAI RUN PLAN
for
RUN 21
RCRA TRIAL BURN

1.0 INTRODUCTION

The purpose of this test plan is to prescribe a procedure for a RCRA trial burn to be completed in the Los Alamos Controlled Air Incinerator (CAI). The purpose of this run is to demonstrate effective thermal destruction of the principal organic hazardous constituents (POHCs) carbon tetrachloride (CCl_4) and trichloroethylene (TCE) by achieving destruction and removal efficiencies (DREs) of 99.9999% or greater as required by the USEPA and NMEID.

2.0 OBJECTIVES

The objectives of this trial burn run are to demonstrate effective thermal destruction of CCl_4 and TCE by the Los Alamos CAI, and to provide emissions testing, sampling, analysis, and evaluation directed toward obtaining a RCRA operating permit allowing on-site incineration of Laboratory-generated RCRA wastes.

3.0 INCINERATOR FEED and TEST CONDITIONS

3.1 Feed Material

The incinerator will be operated with solid feed and liquid feed. Solid feed will consist of a mixture of carbon tetrachloride (CCl_4), trichloroethylene (TCE), and water absorbed on Pel-e-cel (shredded and pelletized corncobs). This mixture is contained in 5-gallon polyethylene containers in cardboard boxes. Liquid feed, consisting of a mixture of CCl_4, TCE, #2 fuel oil and Alumagel (aluminum stearate for particulate generation) will be fed to the incinerator via the liquid injection burner. Measurements of liquid feed viscosity will be taken and recorded for each batch prior to incineration. Compositions of both the solid and liquid feed materials are presented in Table I. Procedures for preparation of both liquid and solid feed materials are given in Section 9.

Table I
LOS ALAMOS CAI
RCRA TRIAL BURN
FEED COMPOSITIONS

RCRA SOLID FEED
(per package, 4,676 Btu/lb)

Material	Weight %	Grams/box	Lbs/box
Pel-e-cel (corn cobs)	41.29	6936	15.28
Water	4.13	694	1.53
Plastic jug	5.54	930	2.05
Cardboard box	4.05	680	1.50
Carbon tetrachloride	30.00	5040	11.10
Trichloroethylene (TCE)	15.00	2520	5.55
	Total	16800	37.00

RCRA LIQUID FEED
(1400 lb batch, 7,542 Btu/lb)

Material	weight %	Lbs	Gal	Liters
Alumagel	0.5	7	----	-----
Fuel oil	34.5	483	67.84	256.76
CCl_4	45	630	47.40	179.41
TCE	20	280	22.93	86.79
		1400	139.15	526.68

PHYSICAL PROPERTIES

Material	SpG	Density (lb/gal)	Heat content (Btu/lb)
Fuel oil	0.854	7.12	18,968
CCl_4	1.594	13.29	986
TCE	1.4642	12.21	2,301
Pel-e-cel	0.578	4.82	7,052
Cardboard	-----	-----	7,052
PE jug	----	-----	18,687
Water	1.00	8.34	------

3.2 Test Conditions

Four trial burn test periods will be conducted on each of four days (see Tables II and III). Liquid incineration will be tested in periods 1 and 2 while solid matrix incineration will be tested in periods 3 and 4. Periods 1 and 3 will be conducted at a secondary chamber temperature of 2200°F, while tests 2 and 4 will be conducted at a secondary chamber temperature of 2000°F. Oxygen concentrations will be maintained at 4-9% above stoichiometric. The stack sampling schedule for each test period is shown in Table IV. All sampling of the process will be directed by Clean Air Engineering (CAE).

TABLE II
INCINERATOR TARGET OPERATING CONDITIONS

Temperatures:	
Upper Chamber	2000-2200°F
Lower Chamber	Dependent on waste feed rate and excess O_2
Condenser Outlet	130°F
Superheater Outlet	160°F
Pressure and Pressure Drops:	
Lower Chamber Pressure	-2 in. WG
Venturi Pressure Drop	50 in. WG
Feed Nozzle Atomizing Medium	60 PSIG
Flows:	
Venturi Solution	8 GPM
Absorber Solution	10 GPM
Tempering Steam (when above 700°F)	>15 lbs/hr
Other:	
Secondary Chamber O_2*	4-9%
Primary Chamber O_2*	4-9%
Scrub Sump pH	5

*Upper and Lower Chamber Excess Oxygen will be maintained as close as possible to the same percentages.

Table III
LOS ALAMOS CAI
RCRA TRIAL BURN
INCINERATION TEST CONDITIONS

Test Period #	Feed Type	Feed Rate (lb/h)	INCINERATOR CHAMBERS Primary Temp,F	Primary O_2,%	Secondary Temp,F	Secondary O_2,%
1	Liquid	150	>1550	4-9	2200	4-9
2	Liquid	150	>1550	4-9	2000	4-9
3	Solid	200	>1550	4-9	2200	4-9
4	Solid	200	>1550	4-9	2000	4-9

Notes:

1) The actual primary chamber temperatures will be those obtained from burning the particular feed stream at the specified feed rate with the primary chamber natural gas burners on low fire. From experience, this temperature will remain above 1550 ^{o}F.

2) The oxygen levels for both the primary and secondary chambers are given as a range because the actual level is that resulting from the temperature obtained and the specified feed conditions.

Table IV
STACK GAS SAMPLING SCHEDULE
(for each test period above)

Sampling Method	Number of Sample Periods	Sample Period Duration, min	Changeout Time (approx), min
EPA M5	3	64	60-90
VOST	6	20	5-15

Note: Both EPA Method 5 and VOST stack sampling will be initiated concurrently at the beginning of each test period in Table III.

3.3 Operating Procedures

This run is being performed under the provisions of, and in accordance with, the following Los Alamos National Laboratory Standard Operating Procedures (SOPs):

"Solid Waste Receiving and Storage,"
"Liquid Waste Receiving and Storage,"
"Hazardous Liquid Waste Receiving, Storage and Disposal" (Draft)
"TDF Aqueous Liquid Transfer,"
"Caustic Solution Preparation and Use,"
"Respiratory Protection at the TDF."

4.0 SCHEDULE

Startup of the incinerator will begin at 0700 on Tuesday, September 2, 1986. Liquid matrix incineration testing will begin on Thursday morning, September 4. Waste feeding and sampling will take place only during the dayshift (0700-1900) with the incinerator to be placed in an idle mode firing on natural gas at night (1900-0700). Following completion of the test periods, approximately 24 hours cooldown time is required. Total length of the campaign is estimated to be 6 days (144 hours) from startup to shutdown. The proposed operating schedule is presented in Table V . The actual operating schedule may deviate markedly from this schedule.

TABLE V
TRIAL BURN OPERATING SCHEDULE

DATE/TIME	ACTIVITY
9/02 0700	Begin CAI startup. Heatup @ 100°F/hr using lower and upper gas burners to reach 1600°F in lower chamber and 1900°F in upper chamber.
9/03 0700	After reaching 1600°F in primary chamber, light liquid burner initially on natural gas at low fire. Shut off lower gas burner. Attain conditions for Test Period 1: (Primary: 1900°F, 4-9% O2, Secondary: 2200°F, 4-9% O_2).
9/03 1400	Prepare liquid batch no. 1 in the feed tank according to procedure in Section 9.
9/04 0700	Checkout system. Test emergency waste cutoff. Ensure proper operation of liquid feed system.
9/04 0800	Begin liquid feed (batch no. 1) @ 150 lb/h. Attain conditions for Test Period 1: secondary chamber temperature 2200°F, primary and secondary chamber oxygen levels 4-9%.
9/04 0900	Begin Test Period 1. Collect samples as

directed by Clean Air Engineering.

9/04 1700	End Test Period 1.
9/04 1800	Complete incineration of liquid batch no. 1 by feeding until feed tank is empty. Return liquid burner to natural gas firing. Remove liquid atomizer. Adjust upper chamber temperature to 2000°F. Place CAI in idle mode for night shift.
9/04 2000	Prepare liquid feed batch no. 2 in feed tank according to procedure in Section 9.
9/05 0700	Begin liquid feed (batch no. 2) @ 150 lb/h. Attain conditions for Test Period 2: secondary chamber temperature 2000°F, primary and secondary chamber oxygen levels 4-9%.
9/05 0800	Begin Test Period 2. Collect samples as directed by Clean Air Engineering.
9/05 1600	End Test Period 2.
9/05 1700	Complete incineration of liquid batch no. 2 by feeding until feed tank is empty. Shut down liquid burner. Flush feed tank with fuel oil spray using three separate rinses of 1-2 gallons each. Feed each "heel" in tank to incinerator prior to next rinse. Transfer 5 gallons fuel oil to feed tank and feed to incinerator until tank is empty. Shut down fuel oil and liquid feed systems. Remove liquid atomizer. Relight primary chamber natural gas burner. Adjust upper chamber temperature to 2000°F. Place CAI in idle mode for night shift. Ensure proper operation of solid feed system during night shift by cycling elevator, rams, guillotine door. Charge storage glovebox with first set of boxes.
9/06 0800	Begin solid feed at 200 lb/h (5 boxes/h). Attain conditions for Test Period 3: secondary chamber temperature 2200°F, primary and secondary chamber oxygen levels 4-9%.
9/06 0900	Begin Test Period 3. Collect samples as directed by Clean Air Engineering.
9/06 1700	End Test Period 3. Stop solid feed to incinerator.
9/07 0800	Begin solid feed at 200 lb/h (5 boxes/h). Attain conditions for Test Period 4: secondary chamber temperature 2000°F, primary and secondary chamber oxygen levels of 4-9%.
9/07 0900	Begin Test Period 4. Collect samples as directed by contract samplers.
9/07 1700	End Test Period 4. Continue to incinerate solid feed matrix boxes until all 92 prepared boxes have been incinerated.

9/07 2100 Begin cooldown @ 150°F/hr.

9/08 1900 CAI process shutdown.

5.0 DATA AND SAMPLING

5.1 Data

The data acquisition system (DAS) will not be required during this test burn. Control room process recording and manual data acquisition will be conducted to verify system performance. Manual data will be taken and entered on the appropriate data sheets every 4 hours during heatup and cooldown, and every 2 hours during solid and liquid feed operations.

5.2 Sampling (See Table VI and Figure 1)

All process stream samples will be taken and handled in accordance with the documents "Requirements and Specifications for Offgas Sampling,"[1] "Quality Assurance Project Plan for a Controlled-Air Incinerator Trial Burn,"[2] and The Los Alamos National Laboratory RCRA Part B Permit Application, Appendix J, "RCRA Trial Burn Plan,"[3] as amended. HSE-1 health physics personnel will monitor all samples (as possible) for presence of radioactive contamination prior to release.

Offgas Samples

Both EPA Method 5 sampling for particulates and HCl, and VOST sampling for CCl_4 and TCE will be performed by an independent sampling contractor, Clean Air Engineering (CAE), using EPA-approved and recommended methods.

Liquid Samples

Process liquid samples will be collected during periods of sample feed by TDF personnel under CAE direction and supervision and will then be presented to CAE for analysis by the analytical contractor. Samples of CCl_4 and TCE feedstocks, liquid feed mixture, makeup water, caustic solution, and process scrub solution will be withdrawn during each test period or batch as prepared (see Table VI) as requested by CAE.

Solid Samples

Process solid sample collection will be performed by TDF personnel under the direction and supervision of the sampling contractor. Samples of cellulosic feed stock (Pel-E-Cel), solid feed mixture, fresh and used activated carbon, and fresh and spent HEPA filter media will be taken as requested by the sampling contractor. Following completion of test periods, TDF personnel will cycle the gravity ash dropout system (GADOS) to

allow the ash to cool in the containment below the primary chamber. After sufficient time has elapsed for the ash to cool, the ash will be pneumatically transferred for collection and sampling. This process will be repeated following test periods 3 and 4.

TABLE VI
RCRA TRIAL BURN
SAMPLES FOR OFF-SITE ANALYSIS

Sample	Process Location	ANALYSES CCl_4	TCE	Cl^-	Partic.	pH	No. of samples
Fuel oil feed stock --each fuel oil tank reload (grab)	1	x	x	x			1-2
CCl_4 feed stock --every drum of CCl_4 (grab)	2	x					2-4
TCE feed stock --every drum of TCE (grab)	2		x				2-4
Cellulosic (Pel-E-Cel) feed stock --one bag of Pel-E-Cel (grab)	4	x	x	x			1 E
Liquid mixture feed --end of test period (grab)	3	x	x	x	x		6
Cardboard from box --one cardboard box (grab)	4	x	x	x	x		1 E
Polyethylene jug --one polyethylene 5 gal jug	4	x	x	x	x		1 E
Caustic solution --every batch prepared in caustic tank (grab)	8					x	4-6
Makeup water --end of every test period (grab)	6	x	x	x			12 E
Incinerator ash --end of test period 3, end of test period 4 (grab)	5	x	x	x		x	2 E
Scrubber discharge liquid --at beginning, middle, and end of each test period, then composited (grabs)	7	x	x	x		x	12 E

Sample	Process Location	ANALYSES CCl_4	TCE	Cl^-	Partic.	pH	No. of samples
Activated carbon (fresh) --before trial burn (grab)	13	x	x	x		x	1 E
Activated carbon (used) --end of each test period (grab)	13	x	x	x		x	12 E
Stack gas (VOST) --3h during each sample period (continuous)	10	x	x				36 E
Stack gas blank (VOST) --3h (continuous)	10	x	x				6 E
Stack gas EPA M5 --3h during each sample period (continuous)	11				x	x	12
Stack gas blank EPA M5 --3h (continuous)	11				x	x	2
EPA QC VOST/M5 sample --before trial burn (continuous)	10/11	x	x	x	x		?
HEPA filter media (fresh) --before trial burn (grab)	9	x	x				1 E
HEPA filter media (spent) --after trial burn (grab)	9	x	x				1 E

Note: The "E" denotes those samples which will require extraction for one or more of the analyses.

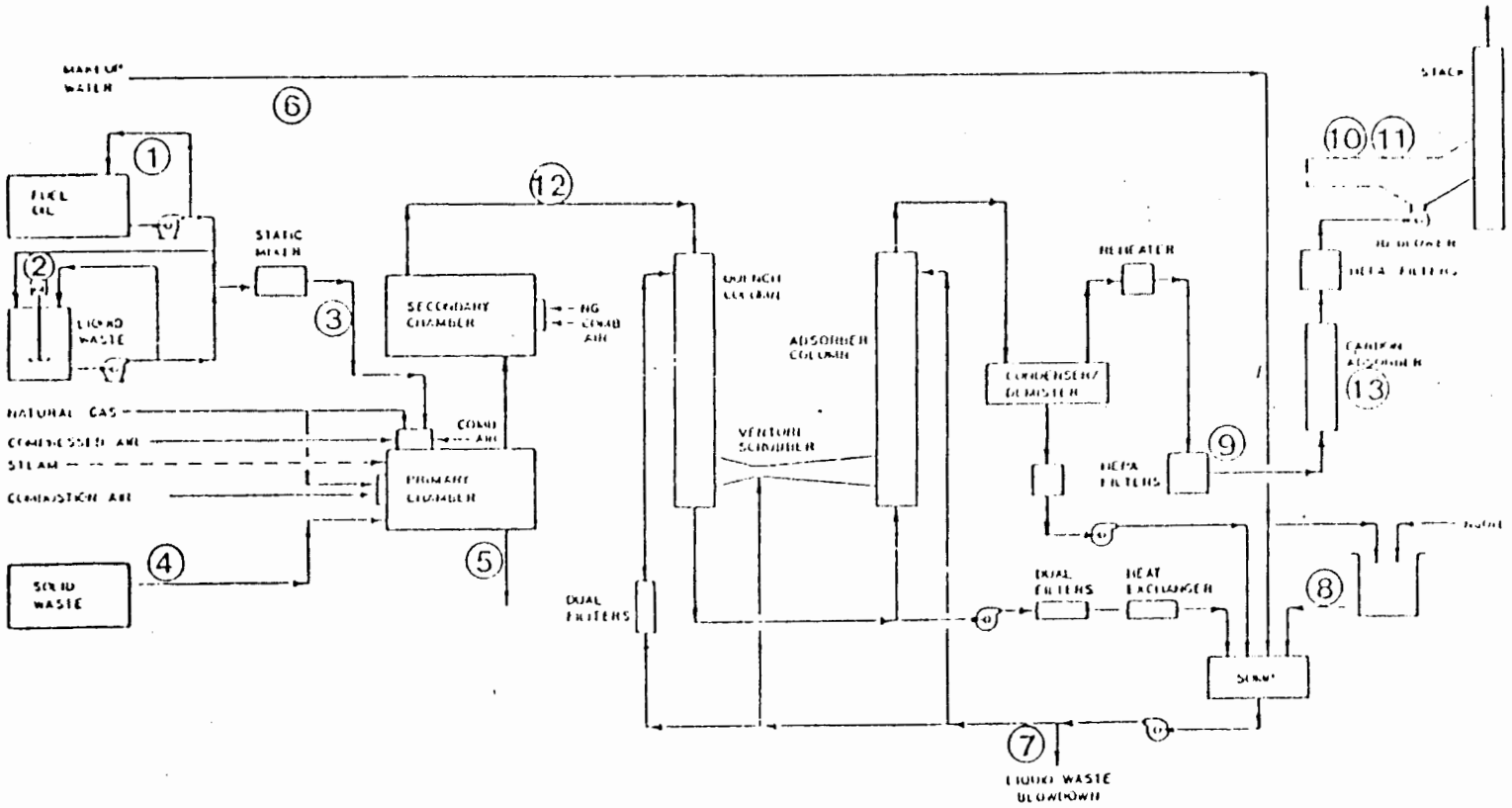

Fig. 1. Location of Sampling Points

6.0 ANALYTICAL REQUIREMENTS

Analysis of all samples will be carried out as per contract with the sampling and analytical contractors and in accordance with the documents "Requirements and Specifications for Offgas Sampling"[1], "Quality Assurance Project Plan for a Controlled-Air Incinerator Test Burn"[2], and The Los Alamos National Laboratory RCRA Part B Permit Application, Appendix J, "RCRA Trial Burn Plan"[3], as amended.

6.1 Quality Assurance/Control

Project responsibility for quality assurance and quality control and applicable procedures to be followed are outlined in the document "Quality Assurance Plan for a Controlled-Air Incinerator Trial Burn."[2] Responsible parties in the project organizational structure are:

Regulatory Observers	NMEID, USEPA
Laboratory Management	Ray Garde, Leon Borduin
Trial Burn Project Manager	Ralph Koenig
Quality Assurance Officer	John Vavruska
Laboratory Analysis Coordinator	Larry Fields
Sampling Coordinator	Clean Air Eng.
Facility Operations Manager	David Hutchins
Facility Operators	TDF Staff

6.2 Continuous Offgas Monitors

The O_2/combustibles monitors will be operational during this incinerator run. The CO/CO_2 and the NO/NO_x continuous offgas monitors will also be required during this run. Sampling contractor will provide a NDIR CO/CO_2 monitor to support and provide backup data to the FID CO/CO_2 monitor on site.

6.3 Calibration Requirements

For offgas monitors: zero and span settings calibrated before each test period and as requested by sampling personnel, NMEID and USEPA, as per trial burn plan.

Sampling and analysis test equipment: as per EPA-600/4-77-027b and reference #1.

7.0 CAI PROCESS LOG

A formal log book for the CAI process operations and equipment modifications or run plan changes and inter-shift communications will be maintained.

8.0 STAFFING ASSIGNMENTS

TABLE VII
OPERATIONS SHIFT ASSIGNMENT SCHEDULE

Day Shift 0700 to 1900 hours

R.A. Koenig, Shift Supervisor
D.A. Hutchins
J.S. Vavruska
C.L. Gilley
J.R. Rutten

Night Shift 1900 to 0700 hours

C.L. Warner, Shift Supervisor
W.E. Draper
D.L. Melton

9.0 FEED PREPARATION PROCEDURES

9.1 RCRA TRIAL BURN LIQUID MATRIX FEED PREPARATION PROCEDURE

Following is a step-by-step procedure for preparation of a batch of liquid matrix feed for the RCRA trial burn in the Los Alamos Controlled Air Incinerator. One 1400 lb batch of feed will be required for each of the two liquid feed test periods of the trial burn. It is emphasized that operations involving open drums of carbon tetrachloride (CCl_4) or trichloroethylene (TCE) require the use of a full-faced respirator equipped with an activated carbon canister. The operation of charging Alumagel powder to the feed tank through the opened lid requires the use of a self contained breathing apparatus (SCBA).

1. Transfer a drum of carbon tetrachloride (CCL_4) into the liquid feed room with the forklift, placing it on the scale and in the right hemispherical opening in the drum ventilation hood.

2. Verify that both ventilation blowers are on. Make sure the drum pump and convoluted teflon hose is attached to the bag filter and transfer header and that all valving is set to route liquid to feed tank #1. Record the gross weight of the CCl_4 drum in lbs.

3. FROM THIS POINT ON, A FULL FACE RESPIRATOR WITH ACTIVATED CARBON CANISTER MUST BE WORN. Remove the bung from the drum and insert the drum pump shaft into the bunghole until the end of the shaft rests on the bottom of the drum. Wrap a rag around the open area between the shaft and the bung to minimize release of vapors.

4. Begin transfer of CCl_4 to the feed tank #1 by pressing the air trigger on the drum pump. Note the loss in weight of the drum. The precise gross weight can be checked periodically by removing the shaft of the drum pump from the bunghole.

5. Stop transfer when 630 lbs of CCl_4 has been transferred to the feed tank. Record the reading in % on the tank liquid level meter. The reading should be approximately 27.5% which corresponds to 47.4 gallons.

6. Remove the CCl_4 drum from the scale and replace with a trichloroethylene (TCE) drum. Record the gross weight of the drum in lbs.

7. Begin transfer of TCE to the feed tank #1 by repeating steps 3 and 4 above using TCE rather than CCl_4.

8. Stop transfer when 280 lbs of TCE has been transferred to the feed tank. Record the reading in % on the tank liquid level meter. The reading should be approximately 43% which corresponds to a total of 70.3 gallons of liquid in the tank at this point.

9. Verify that valves are set up to route fuel oil to feed tank #1. Transfer fuel oil to tank #1 until a liquid level reading of 92% is attained. This corresponds to a total liquid volume of
139.15 gallons. The amount of fuel oil transferred should be 67.84 gal (483 lbs).

10. Turn on agitator in tank #1 and leave on for 10 minutes. Shut off agitator.

11. Wearing an SCBA, open the lid on feed tank #1 and charge 7 lbs of pre-weighed Alumagel to the tank. Close lid and secure with 3 C-clamps. All constituents are now in the feed tank.

12. Turn on the agitator and continue to blend the mixture for one hour. The feed batch is now ready to be fed to the incinerator.

9.2 RCRA TRIAL BURN SOLID MATRIX FEED PREPARATION PROCEDURE

Following is a step-by-step procedure for preparation of solid matrix feed material for the RCRA trial burn in the Los Alamos Controlled Air Incinerator. It is emphasized that steps 5 and 6 must be performed using a full face respirator equipped with an activated carbon canister.

1. Open the top lid on a box containing a 5 gal polyethylene jug. Unscrew the wide mouth cap and place on top of jug. Label the side of the box with an ID number.

2. Place the box/jug/cap on the digital balance and record the weight in lbs. Record the weight and punch the TR (tare) button on the balance.

3. Add the specified weight (15.28 lbs) of Pel-E-Cel (pelletized ground corn cobs) to the jug using a scoop and large polyethylene funnel supported on the ring stand. Record the actual weight of Pel-E-cel added to the jug. Punch the TR button on the balance. Note: For this operation, a dust mask must be worn.

4. Add the specified amount of water (1.53 lbs) to the jug through a separate funnel. Record the actual weight of water added to the jug.

5. Transfer a drum of carbon tetrachloride (CCl_4) into the liquid feed room with the forklift, placing it on the scale and in the right hemispherical opening in the drum ventilation hood. Verify that both ventilation blowers are on. Make sure the drum pump, transfer line and valve, and intermediate carboy assembly are ready for liquid transfer from the drum. FROM THIS POINT ON, A FULL FACE RESPIRATOR WITH ACTIVATED CARBON CANISTER MUST BE WORN. Remove the bung from the drum and insert the drum pump shaft into the bunghole until the end of the shaft rests on the bottom of the drum. Wrap a rag around the open area between the shaft and the bung to minimize release of vapors. Begin transfer of CCl_4 by pressing the air trigger on the drum pump. Release the trigger before the intermediate 5 gallon polyethylene carboy is full. Place a box/jug which has previously been loaded with Pel-E-Cel and water on the balance. Punch the TR button on the scale. Begin gravity transfer of CCl_4 from the intermediate carboy into the jug through the drain valve on the bottom of the carboy until the desired weight (11.10 lbs) has been reached. Record the actual weight of CCl_4 transferred and punch the TR button on the balance.

6. For addition of trichloroethylene (TCE) into the solid feed matrix, follow the exact procedure as outlined in step 5 above. The desired amount of TCE is 5.55 lbs. Record the actual weight of TCE added. Punch the TR button on the balance and record total weight of the solid matrix package. The desired total weight is 37.0 lbs. Replace cap tightly on polyethylene jug.

REFERENCES

1. "Requirements and Specifications for Offgas Sampling", Los Alamos Controlled Air Incinerator RCRA Part B Trial Burn (Revision 2, June 1986).

2. "Quality Assurance Project Plan for a Controlled-Air Incinerator Test Burn", Los Alamos National Laboratory, March 1986.

3. The Los Alamos National Laboratory RCRA Part B Permit Application, Appendix J, "RCRA Trial Burn Plan," 1985 (as amended).

APPENDIX O.

CLEAN AIR ENGINEERING, INC. SAMPLING AND ANALYSIS REPORT

CLEAN AIR ENGINEERING, INC
January 29, 1986

REPORT ON
CONTROLLED AIR INCINERATOR PERFORMANCE
DURING A RCRA TRIAL BURN

UNIVERSITY OF CALIFORNIA
LOS ALAMOS NATIONAL LABORATORY

Purchase Order No: 2-LFD-1415F-1
CAE Project No: 3770

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SUMMARY

TEST OBJECTIVES

The Los Alamos National Laboratory (LANL) contracted Clean Air Engineering, Inc to provide sampling activities directed toward obtaining an operating permit for the Los Alamos Controlled Air Incinerator (CAI).

The sampling was in compliance with the requirements of the Resource Conservation and Recovery Act (RCRA) for a Part B Permit for treatment and disposal of hazardous wastes. The trial burn was conducted at four separate test conditions. Specially prepared liquid and solid waste was incinerated at two secondary chamber combustion temperatures.

The testing and analyses were performed to:

1) Determine the destruction and removal efficiency (DRE) of principal organic hazardous constituents (POHC), carbon tetrachloride (CCl_4) and Trichloroethylene (TCE) using a a volatile sampling train (VOST);

2) Determine the particulate and gaseous chloride concentration in the stack effluent using an EPA Method 5 sampling train;

3) Monitor the carbon monoxide emissions during each trial burn run using an EPA Method 10 sampling train.

The testing took place at the Los Alamos CAI in Los Alamos, New Mexico on September 4 through 7, 1986. Coordinating the field testing were:

Ralph Koenig-Los Alamos National Laboratory
John Vavruska-Los Alamos National Laboratory
Phillip Schwindt, P.E.-U.S. Environmental Protection Agency, Region VI
G. Kelly Crossman-State of New Mexico Environmental Improvement Division
John Chapman-Clean Air Engineering, Inc.

SUMMARY OF TEST RESULTS

Destruction and Removal Efficiency of Carbon Tetrachloride

1) The DRE of CCl_4 during condition 1 averaged 99.9988 percent based on the inlet mass flow rate calculated from waste feed material and the outlet measured mass flow rate. This average was calculated from runs 2, 3 and 6.

2) The DRE of CCl_4 during condition 2 averaged 99.9994 percent based on the inlet mass flow rate calculated from waste feed material and the outlet measured mass flow rate. This average was calculated from runs 1, 4, 5 and 6.

3) The DRE of CCl_4 during condition 3 averaged 99.9992 percent based on the inlet mass flow rate calculated from waste feed material and the outlet measured mass flow rate. This average was calculated from runs 1 through 6.

4) The DRE of CCl_4 during condition 4 averaged 99.9987 percent based on the inlet mass flow rate calculated from waste feed material and the outlet measured mass flow rate. This average was calculated from runs 1 through 6.

Destruction and Removal Efficiency of Trichloroethylene

1) The DRE of TCE during condition 1 averaged 99.9999 percent based on the inlet mass flow rate calculated from waste feed material and the outlet measured mass flow rate. This average was calculated from runs 2, 3 and 6.

2) The DRE of TCE during condition 2 averaged 99.9999 percent based on the inlet mass flow rate calculated from waste feed material and the outlet measured mass flow rate. This average was calculated from runs 1, 3, 4, 5 and 6.

3) The DRE of TCE during condition 3 averaged 99.9998 percent based on the inlet mass flow rate calculated from waste feed material and the outlet measured mass flow rate. This average was calculated from runs 1 through 6.

4) The DRE of TCE during condition 4 averaged 99.9999 percent based on the inlet mass flow rate calculated from waste feed material and the outlet measured mass flow rate. This average was calculated from runs 1 through 6.

Particulate Emissions at the Stack

1) The particulate concentration (corrected to 7% O_2) during condition 1 averaged 0.0093 gr/dscf over three runs on September 4, 1986.

2) The particulate concentration (corrected to 7% O_2) during condition 2 averaged 0.0135 gr/dscf over three runs on September 5, 1986.

3) The particulate concentration (corrected to 7% O_2) during condition 3 averaged 0.0200 gr/dscf over three runs on September 6, 1986.

4) The particulate concentration (corrected to 7% O_2) during condition 4 averaged 0.0156 gr/dscf over three runs on September 7, 1986.

Carbon Monoxide Concentration at the Stack

1) The carbon monoxide concentration during condition 1 averaged 8 ppmv over three runs on September 4, 1986.

2) The carbon monoxide concentration during condition 2 averaged 6 ppmv over three runs on September 5, 1986.

3) The carbon monoxide concentration during condition 3 averaged 5 ppmv over runs 2 and 3 on September 6, 1986.

4) The carbon monoxide concentration during condition 4 averaged 6 ppmv over three runs on September 7, 1986.

Chloride Removal Efficiency

1) The chloride removal efficiency during condition 1 averaged >99.9% over three runs on September 4, 1986.

2) The chloride removal efficiency during condition 2 averaged >99.8% over three runs on September 5, 1986.

3) The chloride removal efficiency during condition 3 averaged 99.7% over three runs on September 6, 1986.

4) The chloride removal efficiency during condition 4 averaged 99.6% over three runs on September 7, 1986.

To the best of our knowledge, the data presented in this report is accurate and complete.

Respectfully submitted,

CLEAN AIR ENGINEERING, INC.

John Chapman
Vice President

Douglas D. Rhoades
Chemical Engineer

Reviewed By William I. Walker, P.E.

DESCRIPTION OF INSTALLATION

The LANL Controlled Air Incinerator is a dual chamber, refractory lined incinerator. An atomizing nozzle introduces liquid waste into the primary (lower) combustion chamber where underfire air supports combustion at near stoichiometric conditions. Solid waste is batch fed into the primary combustion chamber through an appropriate mechanism.

Unburned volatile compounds and entrained particulate exit the primary chamber through a connecting duct to the secondary (upper) combustion chamber. Excess air is introduced at this location to promote complete combustion.

The secondary chamber is designed to provide added residence time and supplemental heat where necessary to burn off certain volatiles. Oxygen/combustibles analyzers at the outlet of each chamber establish oxygen control. The excess air was controlled by the adustment of underfire air flow in the primary chamber and the secondary air flow in the secondary chamber.

The offgas cleaning system consists of a quench tower, a high-energy variable throat venturi scrubber, a packed column absorber tower, a condenser, a mist eliminator, a reheater, a carbon absorber, two series of two high-efficiency particulate air (HEPA) filters and an induced-draft blower.

Operating Conditions

Incinerator target operating conditions were as follows:

- Temperatures--
  - primary chamber- dependent on waste feed rate and excess O
  - secondary chamber- 2000-2200 F
  - condenser outlet- 130 F
  - reheater outlet- 160 F
- Pressures--
  - primary chamber- -2 in. H_2O
  - venturi pressure drop- 50 in. H_2O
  - feed nozzle atomizing medium- 60 psig
- Flows--
  - venturi solution- 8 gpm
  - absorber solution- 10 gpm
  - steam bleed- >15 lb/hr
- Other--
  - primary chamber O_2 - 4-9%
  - secondary chamber O_2 - 4-9%
  - scrub sump pH- 5

The primary and secondary chamber excess oxygen percentages were maintained at approximately the same level.

SUMMARY OF PROCEDURES

SAMPLING PROCEDURES

Methods

The sampling followed procedures outlined in U.S. Environmental Protection Agency (EPA) Methods 1, 2, 3, 5 and 10. These methods are titled:

- Method 1--"Sample and Velocity Traverses for Stationary Sources;"
- Method 2--"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube);"
- Method 3--"Gas Analysis for Carbon Dioxide, Oxygen, Excess Air and Dry Molecular Weight;"
- Method 5--"Determination of Particulate Emissions from Stationary Sources;"
- Method 10--"Determination of Carbon Monoxide Emissions from Stationary Sources."

These methods appear in detail in Title 40 of the Code of Federal Regulations (CFR), Part 60, Appendix A.

The metering equipment was designed and manufactured by the Research Appliance Co. and/or Nutech to meet U.S. EPA standards. All equipment was calibrated at the Clean Air Engineering, Inc. laboratory prior to shipment to the job site.

The sampling for POHC followed procedures outlined in "Protocol for the Collection and Analysis of Volatile POHC using VOST," EPA-600/8-84-007, dated March 1984. This is a draft method that has not yet been promulgated by the U.S. EPA.

The EPA Method 5 sampling apparatus is shown in Fig 1 on page 6-1. The VOST is shown in Fig 2 on page 6-2.

The EPA Method 10 sampling apparatus is shown in Fig 3 on page 6-3.

Gaseous chloride emissions were sampled by modifying EPA Method 5 sample train to collect gaseous chloride in the impinger solution. This was done by substituting 0.1 N NaOH in the first two impingers instead of H_2O.

Sampling Locations

The particulate emissions testing was performed at the stack of the controlled air incinerator. The stack had two ports, and four points were sampled per port. Three runs took place for each of the four test conditions. The sampling time per point was five minutes for a total sampling time of 80 minutes. The particulate emissions sampling locations are shown in Fig 4 on page 6-4.

The POHC testing was performed downstream of the particulate emissions testing at a single point in the duct. Six runs took place for each of the four test conditions. The total sampling time was 20 minutes for each run.

The carbon monoxide testing was also performed downstream of the particulate emissions testing at a single point in the duct. Three runs were performed coinciding with the particulate emission testing for each of the four test conditions.

Fuel Feed Conditions

Average fuel feed conditions are presented in the Appendix under Fuel Composition & Feed Rate.

ANALYTICAL PROCEDURES

Principal Organic Hazardous Constituents

The destruction and removal efficiency of POHC was determined using procedures outlined in "Protocol for the Collection and Analysis of Volatile POHC using VOST." The volatile collection system consisted of condensers to cool the gas and two adsorbent traps in series. The first trap contained a section of TENAX followed by a section of charcoal.

Each set of two traps were exposed to twenty liters of effluent over a twenty minute period. The traps were changed and the sampling repeated until six sets of traps were taken at each test condition.

Each trap was placed in its own transport tube and sealed by Clean Air Engineering, Inc. personnel for shipment to the analytical laboratory. The aqueous condensate was recovered at the end of each sampling condition. This sample was archived but not analyzed due to the insolubility of the POHC.

LANL contracted CEP laboratories to perform the POHC laboratory analyses. CAE delivered the samples directly to CEP in Santa Fe, New Mexico. The results are presented in the Appendix under Laboratory Data.

Destruction Removal Efficiency of POHC

The destruction removal efficiency of POHC was determined using inlet mass flow rates calculated from waste feed material and the outlet measured mass flow rates.

Particulate Emissions

The particulate emission rate was determined using procedures outlined in EPA Method 5. The particulate samples collected on glass fiber filters were analyzed gravimetrically. The probe and nozzles were washed with acetone. The wash was transferred to tared beakers and evaporated to dryness. This weight was also included in the analysis.

Carbon Monoxide Emissions

The carbon monoxide emission rate was determined using procedures outlined in EPA Method 10. A continuous gas sample was analyzed with a non-dispersion infrared analyzer.

QUALITY CONTROL PROCEDURES

Quality control procedures for all aspects of field sampling; sample preservation and holding time; reagent quality; analytical method; analyst training and safety; and instrument cleaning, calibration and safety were followed. These procedures are consistent with EPA guidelines documented in "Quality Assurance Manuals for Air Pollution Measurement Systems," Vol 3, "Stationary Source Specific Methods" (EPA-600/4-77-027b).

Audit samples were performed on VOST cartridges by CEP (Santa Fe). The results of these analyses are:

VOST Cartridge Analyses

Sample Number	Analytical Result Units (ng)	QC Result	% Recovery
First Set			
00.96770 (TCE)	1150	20280	6
00.96770 (CCl_4)	8	20	40
00.96771 (TCE)	499	10140	5
00.96771 (CCl_4)	6	10	60
00.96772 (TCE)	NR	40560	--
00.96772 (CCl_4)	NR	40	--
Second Set			
00.96586 (TCE)	240	280	86
00.96586 (CCl_4)	2900	4800	60
00.96787 (TCE)	4800	4500	106
00.96787 (CCl_4)	330	220	150
00.96588 (TCE)	2100	1100	190
00.96588 (CCl_4)	1440	800	180

NR = not reported

The average percent recovery for the first set of VOST cartridges containing QC spiked samples was 5.5% for TCE and 50% for CCl_4. The average percent recovery for the second set of VOST cartridges containing QC spiked samples was 127% for TCE and 130% for CCl_4. Further discussion of the audit samples is presented in the Appendix under Laboratory Data.

RESULTS

Principal Organic Hazardous Constituents

The test conditions and results of analysis for the destruction and removal efficiency of the principal organic hazardous constituents in the incinerator feed are presented in Tables 1 through 4 on pages 4-2 through 4-9.

Particulate Emissions

The test conditions and results of analysis for particulate emissions are presented in Tables 5 through 8 on pages 4-10 through 4-13.

Carbon Monoxide and Chloride Emissions

The test conditions and results of analysis for carbon monoxide and chloride emissions are presented along with the particulate emissions results in Tables 5 through 8 on pages 4-10 through 4-13.

Nomenclature, sample calculations, parameters, calibration data, weight sheets, field data and statistical analysis are provided in the Appendix.

Table 1A

Summary of Results
Principal Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 4, 1986
Condition 1

Run No.	1	2	3
Start time (approx.)	1:10 pm	2:00 pm	2:43 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	70.36	70.36	70.36
TCE (lb/hr)	30.42	30.42	30.42
Gas Conditions			
Temperature (F)	209	209	209
Moisture (volume %)	35.2	35.2	35.2
O_2 (volume %)	9.2	9.2	9.2
CO_2 (volume %)	8.6	8.6	8.6
Density (lb/ft^3)	0.0407	0.0407	0.0407
Excess Air (%)	73.60	73.60	73.60
Gas Flow Rates			
Volume Basis			
acfm	1476	1476	1476
dscfm	586	586	586
Mass Basis			
lb/hr	3604	3604	3604
Organic Emissions			
CCl_4 (ppbv)	[1]>1.88	65.14	56.18
CCl_4 (lb x 10^{-5}/hr)	[1]>2.64	91.4	78.9
TCE (ppbv)	[1]***	1.81	<0.13
TCE (lb x 10^{-5}/hr)	[1]***	2.17	<0.154
Destruction and Removal Efficiency			
CCl_4 (%)	[1]***	99.9987	99.9989
TCE (%)	[1]***	99.9999	>99.9999

[1]Analytical detector quenched and results possibly underestimated.

Table 1B

Summary of Results
Principal Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 4, 1986
Condition 1

Run No.	4	5	6
Start time (approx.)	3:25 pm	6:54 pm	7:38 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	70.36	76.92	76.92
TCE (lb/hr)	30.42	33.30	33.30
Gas Conditions			
Temperature (F)	209	213	213
Moisture (volume %)	35.2	36.5	36.5
O_2 (volume %)	9.2	9.2	9.2
CO_2 (volume %)	8.6	8.6	8.6
Density (lb/ft^3)	0.0407	0.0400	0.0400
Excess Air (%)	73.60	73.60	73.60
Gas Flow Rates			
Volume Basis			
acfm	1476	1521	1521
dscfm	586	585	585
Mass Basis			
lb/hr	3604	3654	3654
Organic Emissions			
CCl_4 (ppbv)	[1]>59.23	[1]>52.37	52.22
CCl_4 (lb x 10^{-5}/hr)	[1]>83.1	[1]>73.4	73.2
TCE (ppbv)	[1]***	[1]***	1.58
TCE (lb x 10^{-5}/hr)	[1]***	[1]***	1.89
Destruction and Removal Efficiency			
CCl_4 (%)	[1]***	[1]***	99.9989
TCE (%)	[1]***	[1]***	99.9999

[1] Analytical detector quenched and results possibly underestimated.

Table 2A

Summary of Results
Principal Organic Hazardous Constituents
Destruction and Removal Efficency
Volatile Organic Sampling Train
September 5, 1986
Condition 2

Run No.	1	2	3
Start time (approx.)	9:50 am	10:44 am	12:16 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	78.63	78.63	77.84
TCE (lb/hr)	33.17	33.17	32.78
Gas Conditions			
Temperature (F)	216	216	226
Moisture (volume %)	32.4	32.4	32.0
O_2 (volume %)	10.4	10.4	10.4
CO_2 (volume %)	8.0	8.0	8.0
Density (lb/ft^3)	0.0405	0.0405	0.0400
Excess Air (%)	93.33	93.33	93.33
Gas Flow Rates			
Volume Basis			
acfm	1351	1351	1356
dscfm	550	550	548
Mass Basis			
lb/hr	3283	3283	3255
Organic Emissions			
CCl_4 (ppbv)	0.62	[2]***	[1]***
CCl_4 (lb x 10^{-5}/hr)	0.816	[2]***	[1]***
TCE (ppbv)	<0.12	[2]***	<0.12
TCE (lb x 10^{-5}/hr)	<0.130	[2]***	<0.129
Destruction and Removal Efficiency			
CCl_4 (%)	99.9999	[2]***	[1]***
TCE (%)	>99.9999	[2]***	>99.9999

[1]Sample broken by analytical laboratory.
[2]Analytical detector quenched and results possibly underestimated.

Table 2B

Summary of Results
Principal Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 5, 1986
Condition 2

Run No.	4	5	6
Start time (approx.)	1:02 pm	2:48 pm	3:27 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	77.84	78.37	78.37
TCE (lb/hr)	32.78	33.04	33.04
Gas Conditions			
Temperature (F)	226	229	229
Moisture (volume %)	32.0	32.0	32.0
O_2 (volume %)	10.4	10.4	10.4
CO_2 (volume %)	8.0	8.0	8.0
Density (lb/ft^3)	0.0400	0.0398	0.0398
Excess Air (%)	93.33	93.33	93.33
Gas Flow Rates			
Volume Basis			
acfm	1356	1345	1345
dscfm	548	541	541
Mass Basis			
lb/hr	3255	3213	3213
Organic Emissions			
CCl_4 (ppbv)	11.98	44.98	62.91
CCl_4 (lb x 10^{-5}/hr)	15.7	58.3	81.5
TCE (ppbv)	1.93	1.32	1.43
TCE (lb x 10^{-5}/hr)	2.17	1.46	1.58
Destruction and Removal Efficiency			
CCl_4 (%)	99.9998	99.9992	99.9989
TCE (%)	99.9999	99.9999	99.9999

Table 3A

Summary of Results
Principal Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 6, 1986
Condition 3

Run No.	1	2	3
Start time (approx.)	10:36 am	11:17 am	5:09 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	49.30	49.30	55.77
TCE (lb/hr)	24.19	24.19	27.22
Gas Conditions			
Temperature (F)	225	225	216
Moisture (volume %)	35.4	35.4	39.5
O_2 (volume %)	10.1	10.1	10.0
CO_2 (volume %)	8.0	8.0	7.6
Density (lb/ft^3)	0.0396	0.0396	0.0391
Excess Air (%)	87.66	87.66	85.08
Gas Flow Rates			
Volume Basis			
acfm	1544	1544	1655
dscfm	596	596	603
Mass Basis			
lb/hr	3668	3668	3885
Organic Emissions			
CCl_4 (ppbv)	22.05	22.45	57.43
CCl_4 (lb x 10^{-5}/hr)	31.5	32.1	83.0
TCE (ppbv)	2.75	2.77	14.73
TCE (lb x 10^{-5}/hr)	3.35	3.38	18.2
Destruction and Removal Efficiency			
CCl_4 (%)	99.9994	99.9994	99.9985
TCE (%)	99.9999	99.9999	99.9997

Table 3B

Summary of Results
Principal Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 6, 1986
Condition 3

Run No.	4	5	6
Start time (approx.)	5:56 pm	7:24 pm	7:57 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	55.77	54.05	54.05
TCE (lb/hr)	27.22	26.17	26.17
Gas Conditions			
Temperature (F)	216	210	210
Moisture (volume %)	39.5	27.4	27.4
O_2 (volume %)	10.0	10.2	10.2
CO_2 (volume %)	7.6	7.6	7.6
Density (lb/ft^3)	0.0391	0.0417	0.0417
Excess Air (%)	85.08	88.69	88.69
Gas Flow Rates			
Volume Basis			
acfm	1655	1567	1567
dscfm	603	691	691
Mass Basis			
lb/hr	3885	3919	3919
Organic Emissions			
CCl_4 (ppbv)	45.81	2.40	29.02
CCl_4 (lb x 10^{-5}/hr)	66.2	3.97	48.0
TCE (ppbv)	6.56	0.07	0.09
TCE (lb x 10^{-5}/hr)	8.09	0.0924	0.128
Destruction and Removal Efficiency			
CCl_4 (%)	99.9988	99.9999	99.9991
TCE (%)	99.9998	99.9999	99.9999

Table 4A

Summary of Results
Principal Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 7, 1986
Condition 4

Run No.	1	2	3
Start time (approx.)	1:49 pm	2:30 pm	3:53 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	57.36	57.36	58.68
TCE (lb/hr)	28.28	28.28	28.41
Gas Conditions			
Temperature (F)	213	213	211
Moisture (volume %)	25.4	25.4	25.6
O_2 (volume %)	12.3	12.3	11.0
CO_2 (volume %)	5.9	5.9	7.0
Density (lb/ft^3)	0.0418	0.0418	0.0420
Excess Air (%)	132.33	132.33	103.31
Gas Flow Rates			
Volume Basis			
acfm	1469	1469	1540
dscfm	665	665	697
Mass Basis			
lb/hr	3684	3882	3882
Organic Emissions			
CCl_4 (ppbv)	54.73	5.96	27.23
CCl_4 (lb x 10^{-5}/hr)	87.2	94.9	45.5
TCE (ppbv)	0.59	<0.12	0.44
TCE (lb x 10^{-5}/hr)	0.809	<0.161	0.629
Destruction and Removal Efficiency			
CCl_4 (%)	99.9984	99.9998	99.9992
TCE (%)	99.9999	>99.9999	99.9999

Table 4B

Summary of Results
Principal Organic Hazardous Constituents
Destruction and Removal Efficiency
(Volatile Organic Sampling Train)
September 7, 1986
Condition 4

Run No.	4	5	6
Start time (approx.)	4:38 pm	6:09 pm	6:46 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	58.68	61.59	61.59
TCE (lb/hr)	28.41	30.13	30.13
Gas Conditions			
Temperature (F)	211	202	202
Moisture (volume %)	25.6	26.1	26.1
O_2 (volume %)	11.0	10.2	10.2
CO_2 (volume %)	7.0	8.0	8.0
Density (lb/ft^3)	0.0420	0.0426	0.0426
Excess Air (%)	102.31	89.51	89.51
Gas Flow Rates			
Volume Basis			
acfm	1540	1537	1537
dscfm	697	700	700
Mass Basis			
lb/hr	3882	3930	3930
Organic Emissions			
CCl_4 (ppbv)	61.56	59.04	49.30
CCl_4 (lb x 10^{-5}/hr)	103.0	99.0	82.7
TCE (ppbv)	2.91	1.81	1.37
TCE (lb x 10^{-5}/hr)	4.15	2.59	1.96
Destruction and Removal Efficiency			
CCl_4 (%)	99.9981	99.9982	99.9985
TCE (%)	99.9999	99.9999	99.9999

Table 5

Summary of Results
Particulate, CO and HCl Emissions
(EPA Method 5)
September 4, 1986
Condition 1

Run No.	1	2	3
Start time (approx.)	1:10 pm	6:52 pm	9:25 am
Organic Material Feed Rate			
CCl_4 (lb/hr)	70.36	76.92	76.92
TCE (lb/hr)	30.42	33.30	33.30
Total Chloride (as HCl) (lb/hr)	92.01	100.63	100.63
Gas Conditions			
Temperature (F)	209	213	212
Moisture (volume %)	35.2	36.5	36.6
O_2 (volume %)	9.2	9.2	9.2
CO_2 (volume %)	8.6	8.6	8.6
Density, (lb/ft^3)	0.0407	0.0400	0.0401
Excess air, (%)	73.60	73.60	73.60
Gas Flow Rates			
Volume Basis			
acfm	1476	1521	1467
dscfm	586	585	564
Mass Basis			
lb/hr	3604	3654	3528
Particulate Emissions			
gr/dscf	0.0093	0.0056	0.0087
gr/dscf (corr. to 7% O_2)	0.0110	0.0066	0.0103
lb/hr	0.0466	0.0280	0.0422
Carbon Monoxide Emissions			
ppmv	5	6	12
ppmv (corr. to 12% CO_2)	7	8	17
ppmv (corr. to 50% Excess air)	6	7	14
lb/hr	0.01	0.02	0.03
Chloride Emissions (as HCl)			
ppmv	<0.49	<0.49	<0.48
lb/hr	<0.0016	<0.0016	<0.0015
Chloride Removal Efficiency			
percent	>99.998	>99.998	>99.998

Table 6

Summary of Results
Particulate, CO and HCl Emissions
(EPA Method 5)
September 5, 1986
Condition 2

Run No.	1	2	3
Start time (approx.)	9:50 am	12:20 pm	2:40 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	78.63	77.84	78.37
TCE (lb/hr)	33.17	32.78	33.04
Total Chloride (as HCl) (lb/hr)	102.14	101.07	101.79
Gas Conditions			
Temperature (F)	216	226	229
Moisture (volume %)	32.5	32.0	32.0
O_2 (volume %)	10.4	10.4	10.4
CO_2 (volume %)	8.0	8.0	8.0
Density (lb/ft^3)	0.0405	0.0400	0.0398
Excess Air (%)	93.34	93.34	93.34
Gas Flow Rates			
Volume Basis			
acfm	1351	1356	1345
dscfm	550	548	541
Mass Basis			
lb/hr	3283	3255	3213
Particulate Emissions			
gr/dscf	0.0104	0.0086	0.0116
gr/dscf (corr. to 7% O_2)	0.0137	0.0114	0.0153
lb/hr	0.0488	0.0405	0.0537
Carbon Monoxide Emissions			
ppmv	5	6	7
ppmv (corr. to 12% CO_2)	8	9	11
ppmv (corr. to 50% Excess Air)	6	8	9
lb/hr	0.01	0.01	0.02
Chloride Emissions (as HCl)			
ppmv	<0.45	19.8	137.5
lb/hr	<0.0014	0.0616	0.4220
Chloride Removal Efficiency			
percent	>99.998	99.939	99.585

Table 7

Summary of Results
Particulate, CO and HCl Emissions
(EPA Method 5)
September 6, 1986
Condition 3

Run No.	1	2	3
Start time (approx.)	10:35 am	5:07 pm	7:27 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	49.30	55.77	54.05
TCE (lb/hr)	24.19	27.22	26.17
Total Chloride (as HCl) (lb/hr)	66.87	75.52	73.02
Gas Conditions			
Temperature (F)	225	216	210
Moisture (volume)	35.4	39.5	27.4
O_2 (volume %)	10.1	10.0	10.2
CO_2 (volume %)	8.0	7.6	7.6
Density (lb/ft^3)	0.0396	0.0391	0.0417
Excess air (%)	87.66	85.08	88.69
Gas Flow Rates			
Volume Basis			
acfm	1544	1655	1567
dscfm	596	603	691
Mass Basis			
lb/hr	3668	3885	3919
Particulate Emissions			
gr/dscf	0.0120	0.0165	0.0183
gr/dscf (corr. to 7% O_2)	0.0154	0.0210	0.0237
lb/hr	0.0611	0.0852	0.1085
Carbon Monoxide Emissions			
ppmv	[1]	5[2]	5
ppmv (corr. to 12% CO_2)	[1]	8	8
ppmv (corr. to 50% Excess air)	[1]	6	6
lb/hr	[1]	0.01	0.02
Chloride Emissions (as HCl)			
ppmv	74.7	33.0	50.4
lb/hr	0.2525	0.1130	0.1978
Chloride Removal Efficiency			
percent	99.622	99.850	99.729

[1] Data out of range of the upper limit.
[2] Two peaks noted at 70 and 63 pm during the middle of the run.

Table 8

Summary of Results
Particulate, CO and HCl Emissions
(EPA Method 5)
September 7, 1986
Condition 4

Run No.	1	2	3
Start time (approx.)	1:50 pm	3:57 pm	7:10 pm
Organic Material Feed Rate			
CCl_4 (lb/hr)	57.36	58.68	61.59
TCE (lb/hr)	28.28	28.41	30.13
Total Chloride (as HCl) (lb/hr)	77.91	79.27	83.46
Gas Conditions			
Temperature (F)	213	211	202
Moisture (volume %)	25.4	25.6	26.1
O_2 (volume %)	12.3	11.0	10.2
CO_2 (volume %)	5.9	7.0	8.0
Density (lb/ft^3)	0.0418	0.0420	0.0426
Excess Air (%)	132.33	103.31	89.51
Gas Flow Rates			
Volume Basis			
acfm	1469	1540	1537
dscfm	665	697	700
Mass Basis			
lb/hr	3684	3882	3930
Particulate Emissions			
gr/dscf	0.0055	0.0097	0.0188
gr/dscf (corr. to 7% O_2)	0.0089	0.0136	0.0244
lb/hr	0.0315	0.0582	0.1131
Carbon Monoxide Emissions			
ppmv	5	5	7
ppmv (corr. to 12% CO_2)	10	9	11
ppmv (corr. to 50% Excess air)	8	7	9
lb/hr	0.02	0.02	0.03
Chloride Emissions (as HCl)			
ppmv	13.0	71.2	82.0
lb/hr	0.0491	0.2819	0.3260
Chloride Removal Efficiency			
percent	99.937	99.644	99.609

DISCUSSION

Destruction and Removal Efficiency of Carbon Tetrachloride

During condition 1, only runs 2, 3, and 6 were used to calculate the emissions of carbon tetrachloride from the incinerator. This was because the samples obtained during runs 1, 4 and 5 quenched the flame in the analytical detector. This could be an indication of higher concentrations than reported in Table 1.

During condition 2, only runs 1, 4, 5 and 6 were used to calculate the emissions of carbon tetrachloride from the incinerator. The sample obtained from run 3 again quenched the flame in the analytical detector. The sample container used from run 2 was broken by the analytical laboratory resulting in the sample being lost.

During conditions 3 and 4 all samples were analyzed without any problems.

The accuracy of analysis for carbon tetrachloride was ± 10%.

Destruction and Removal Efficiency of Trichloroethylene

Only the emission rates calculated from runs 2, 3 and 6 were used to determine the average emission rate from the incinerator during condition 1. The samples obtained during runs 1, 4 and 5 quenched the flame in the analytical detector.

Only the emission rates calculated from runs 1, 3, 4, 5 and 6 were used to determine the average emission rate from the incinerator during condition 2. The sample container used from run 2 was broken by the analytical laboratory resulting in the sample being lost.

The average emission rates calculated for condition 3 and 4 were determined using all 6 runs during each condition. These samples were analyzed without any problems.

The accuracy of analysis for trichloroethylene was ± 10%.

No deviations from the U.S. EPA draft method were noted in sampling procedures for both carbon tetrachloride and trichloroethylene.

DISCUSSION (Continued)

Particulate Emissions at the Stack

The EPA Method 5 sample train was modified by replacing the water in the impingers with 0.1N sodium hydroxide to enhance the collection of chlorides from the gas stream. For this reason, the condensed moisture was measured gravimetrically and not volumetrically.

The first and last traverse points were adjusted to 1 in. away from the duct wall. The actual centroid of the sample area is 0.8 in. away from the wall. The volume of gas metered during run 1, condition 1, was adjusted by 0.12 ft^3 because of a leak check run on the sample train between points 1-1 and 1-2.

No deviations from standard U.S. EPA sampling procedures were noted.

Carbon Monoxide Concentrations at the Stack

During conditions 1, 2 and 4, the CO concentrations averaged 10 ppmv when corrected to 12% CO_2 in the stack gas. During run 1, condition 3, the carbon monoxide concentration went above the upper limit of the detector and chart recorder. The chart recorder system was calibrated so that the upper limit was approximately 500 ppmv CO. The CO concentration went back down to an average of about 10 ppmv when corrected to 12% CO_2 during runs two and three. During run two, two peaks were noted. At actual stack conditions, the first peak of 70 ppmv occured at 5:16 pm and the second peak of 63 ppmv occured at 5:29 pm.

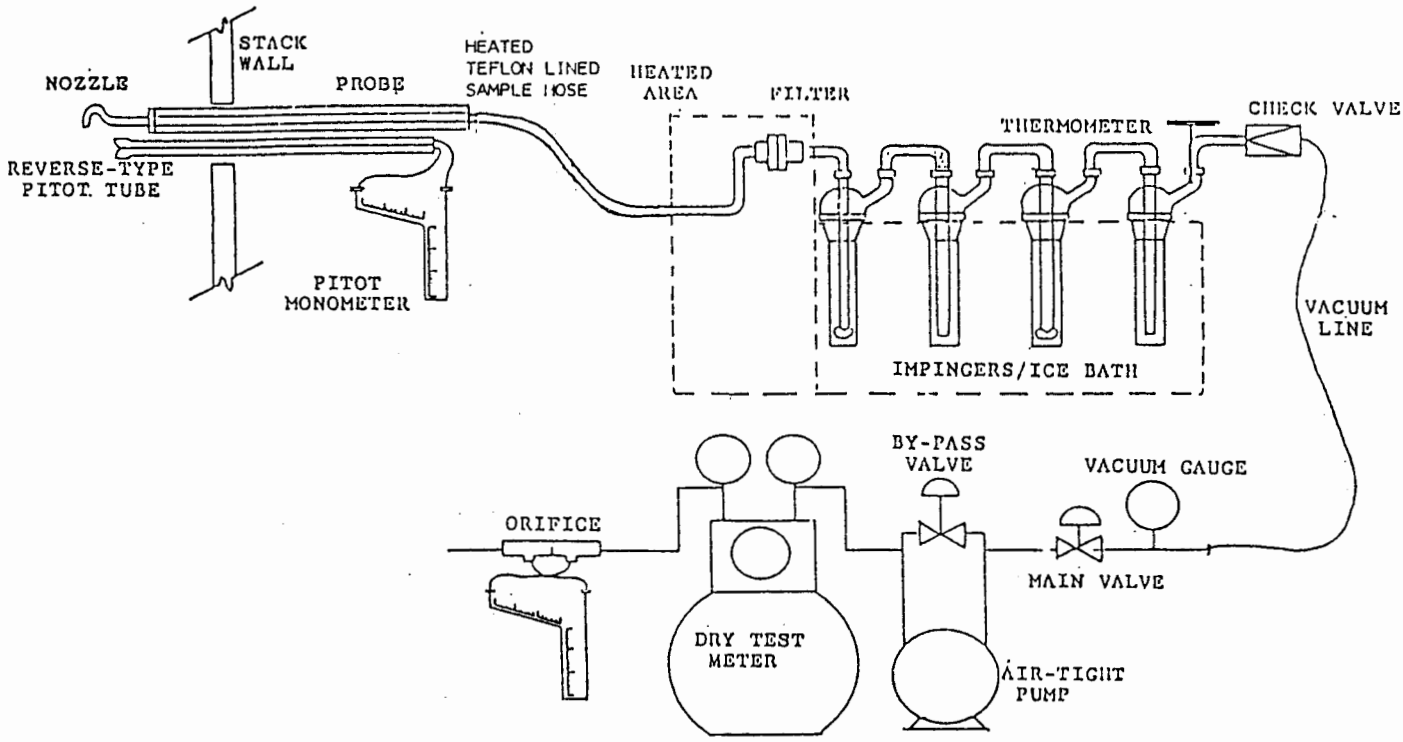
No deviations from standard U.S. EPA sampling procedures were noted.

Gaseous Chloride Emissions

During condition 1, the gaseous chloride concentrations were below the detectable limit of 0.5 ppmv. During condition 2, the gaseous chloride concentrations rose from <0.5 ppmv during run 1 to 137 ppmv during run 3.

During condition 3, the gaseous chloride concentrations averaged 53 ppmv over the three runs. During condition 4 the gaseous chloride concentrations went from 13 ppmv during run 1 to 82 ppmv during run 3.

FIGURES



Impingers Contain

1. 100 ml 0.1 N NaOH
2. 100 ml 0.1 N NaOH
3. Dry
4. 300 g silica gel

Fig 1. The EPA Method 5 sampling apparatus is shown.

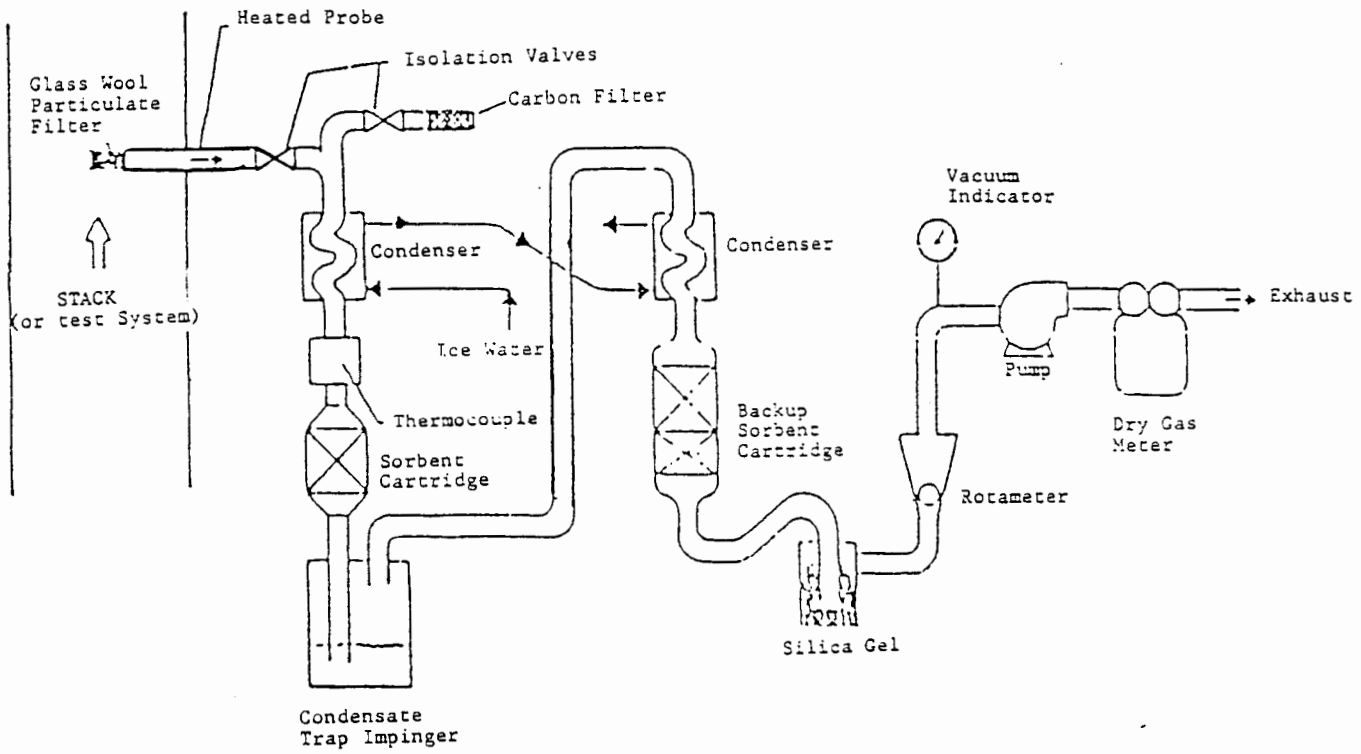


Fig 2. The VOST is shown.

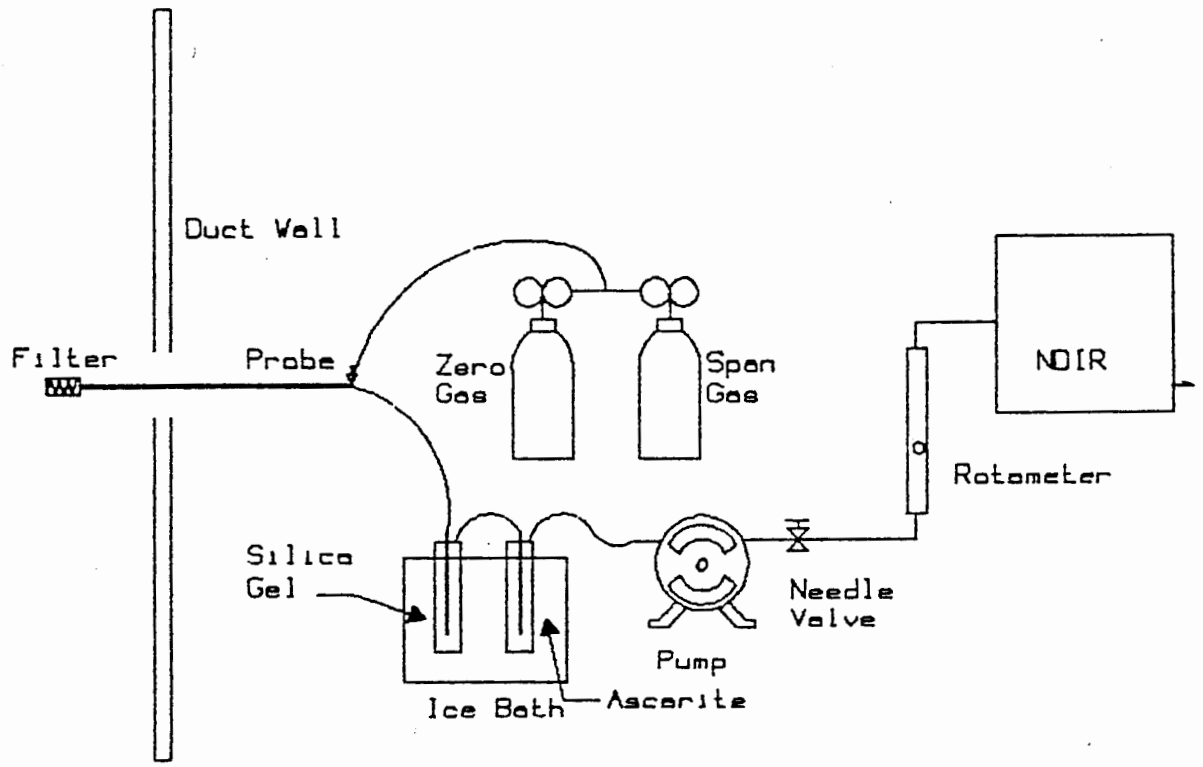
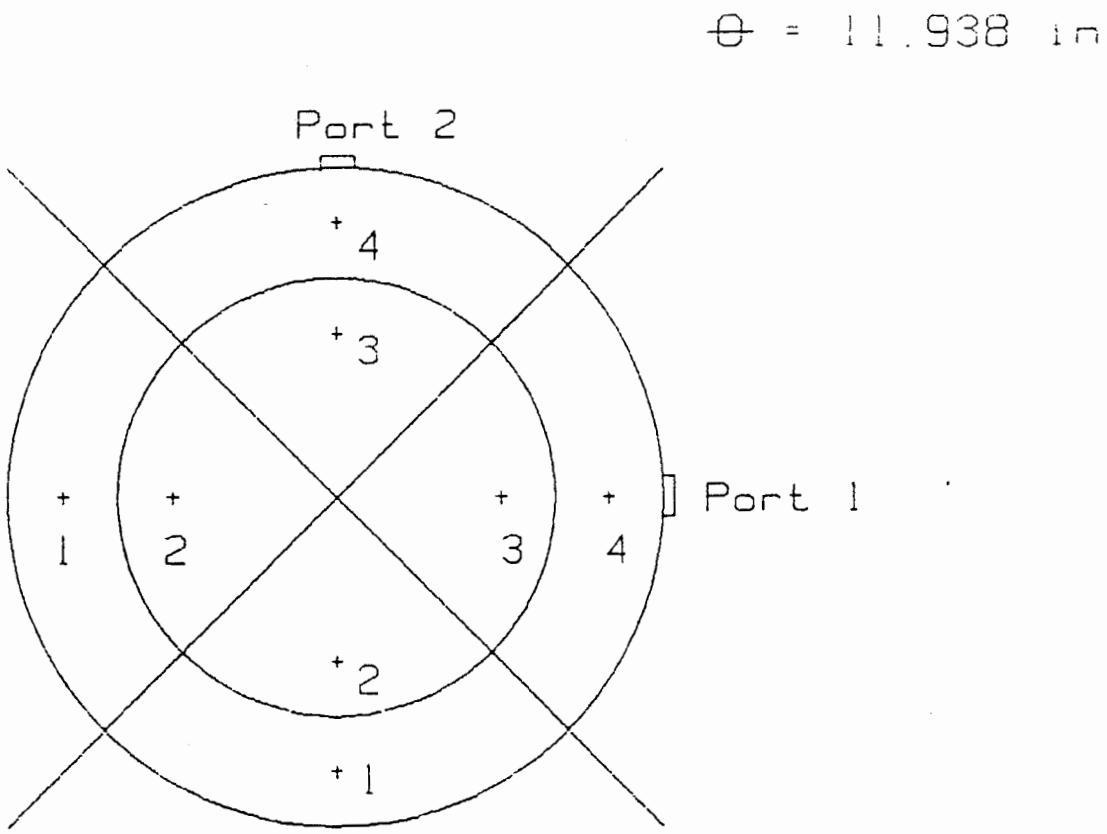


Fig 3. The carbon monoxide sampling apparatus is shown.



Traverse Point	Distance From Port to Point, (in.)
1	11.0
2	9.0
3	3.0
4	1.0

Fig 4. The particulate emissions sampling locations are shown.

APPENDIX

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NOMENCLATURE

SAMPLE CALCULATIONS

Nomenclature

A	-	absorbance
An	-	cross sectional area of nozzle (ft^2)
As	-	cross sectional area of stack (ft^2)
Bwo	-	proportion of water vapor in the gas stream by volume (%)
Cp	-	pitot tube coefficient (dimensionless)
Df	-	dilution factor
Fd	-	ratio of dry gas generated to gross calories (dcfm/MBtu)
Fc	-	ratio of gas generated to gross calories (dscf/MBtu)
GCV	-	gross calorific value of fuel (Btu/lb)
DH	-	average pressure drop across the meter box orifice (in. H_2O)
$\overline{(DP)^{1/2}}$	-	average of square roots of velocity heads of stack gas (in. H_2O)
DH@	-	meter orifice calibration coefficient (dimensionless)
%I	-	percent of isokinetic sampling (acceptable: $90\% \leq \%I \leq 110\%$)
Kp	-	$\frac{[(\text{lb/lb-mole})(\text{in. Hg})]^{1/2}}{[(^\circ R)(\text{in. } H_2O)]^{1/2}}$
Kc	-	spectrophotometer calibration factor
Md	-	dry molecular weight of stack gas (lb/lb-mole)
Ms	-	molecular weight of stack gas, wet basis (lb/lb-mole)
Mn	-	total amount of particulate matter collected (gm)
N	-	normality of titrant (meq/ml)
Pb	-	barometric pressure (in. Hg)
Pf	-	final absolute pressure of flask (in. Hg)
Pi	-	initial absolute pressure of flask (in. Hg)
Ps	-	absolute stack gas pressure (in. Hg)
Qa	-	volumetric flow rate, actual conditions
Qstd	-	volumetric flow rate, standard conditions, dry basis
std	-	standard conditions, 29.92 in. Hg 68°F
Tf	-	final absolute temperature of flask (°R)
Ti	-	initial absolute temperature of flask (°R)
Tm	-	average dry gas meter temperature (°F)
Ts	-	average stack temperature (°F)
Tstd	-	absolute temperature, standard conditions (528°R)
θ	-	total sampling time (min)
Va	-	volume of aliquot (ml)
Vf	-	volume of flask (ml)
Vlc	-	total volume of liquid collected in impingers and silica gel (ml)
Vm	-	volume of gas sample through the dry gas meter at meter conditions (ft^3)
Vmstd	-	volume of gas sample through the dry gas meter, standard conditions (ft^3)
Vstd	-	volume of flask sample, standard conditions (ml)
Vsoln	-	total volume of solution (ml)
Vt	-	volume of titrant used to titrate aliquot (ml)
Vtb	-	volume of titrant used to titrate blank (ml)
Vwstd	-	volume of water collected, standard conditions (ft^3)
Vs	-	stack gas velocity (ft/sec)
Yd	-	gas meter correction factor (dimensionless)

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SAMPLE CALCULATIONS - RUN #3 Condition 2
(Note: results are taken from computer analysis.)

1. Volume of water collected

$$V_{wstd} = (0.0471)(V_{1c})$$

$$= (\ .0471\ )\ (\ 300.6\ )$$

$$= 14.16 \text{ wscf}$$

2. Volume of gas metered, standard conditions

$$V_{mstd} = \frac{(\ 17.64\ )\ (\ V_m\ )\left[P_b + \frac{\overline{DH}}{13.6}\right]}{(\ 460 + T_m\ )}\ (\ Y_d\ )$$

$$= \frac{(\ 17.64\ )\ (\ 41.60\ )\left[23.05 + \frac{0.62}{13.6}\right]}{(\ 460 + 103\ )}\ (\ 0.9999\ )$$

$$= 30.10 \text{ dscf}$$

3. Moisture content

$$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$$

$$= \frac{14.16}{30.10 + 14.16}$$

$$= 0.3199$$

$$= 32.0\ \%$$

4. Molecular weight of dry gas stream

$$M_d = 0.44(\ \%CO_2) + 0.32(\ \%O_2) + 0.28(\ \%CO + \%N_2)$$

$$= 0.44(\ 8.0\ ) + 0.32(\ 10.4\ ) + 0.28(\ 81.6\ )$$

$$= 29.70$$

SAMPLE CALCULATIONS (Continued)

5. Molecular weight of stack gas

$$M_s = M_d (1 - B_{wo}) + 18 (B_{wo})$$

$$= 29.70 (1 - 0.3199) + 18 (0.3199)$$

$$= 25.95$$

6. Velocity of stack gas

$$V_s = K_p \; C_p \; \overline{(DP)}^{1/2} \; \frac{[\overline{T_s} + 460]^{1/2}}{[(M_s) (P_s)]^{1/2}}$$

$$= 85.49 (0.840) (0.375) \frac{[229 + 460]^{1/2}}{[(25.95) (23.09)]^{1/2}}$$

$$= 28.84 \text{ ft/sec}$$

7. Total volumetric flow of stack gas

$$Q_a = (60) (A_s) (V_s)$$

$$= (60) (0.7773) (28.84)$$

$$= 1345 \text{ acfm}$$

$$Q_{std} = \frac{Q_a \; P_s \; (17.64) (1 - B_{wo})}{\overline{T_s} + 460}$$

$$= \frac{(1345) (23.09) (17.64) (1 - 0.3199)}{229 + 460}$$

$$= 540.8 \text{ dscfm}$$

Sample Calculations (Continued)

8. Density of stack gas

$$= \frac{Ps\ (14.696)\ (144)\ Ms}{(29.921)\ (Ts + 460)\ (1545)}$$

$$= \frac{(23.09)\ (14.696)\ (144)\ (25.95)}{(29.921)\ (229 + 460)\ 1545}$$

$$= 0.0398\ lb/ft^3$$

9. Mass flow rate of stack gas

$$Q_m = (\quad)\ (Q_a)\ (60)$$

$$= (0.0398)\ (1367)\ (60)$$

$$= 3264\ lb/hr$$

10. Excess combustion air in stack gas

$$\%\ \text{Excess air} = \frac{\%\ O_2}{0.264\ (\%N_2) - (\%O_2)}(100)$$

$$= \frac{10.4}{(0.264)\ (81.6) - (10.4)}(100)$$

$$= 93.33$$

SAMPLE CALCULATIONS (Continued)

11. Percent isokinetic

$$\%I = \frac{(0.09450)\ (\overline{T_s} + 460)\ V_{mstd}}{P_s\ V_s\ A_n\ \theta\ (1 - B_{wo})}$$

$$= \frac{(0.09450)\ (229 + 460)\ (30.10)}{(23.09)(28.84)(0.000534)(80)(1 - 0.3199)}$$

$$= 101.2\ \%$$

12. Particulate concentration

$$\text{gr/dscf} = \frac{15.43\ (M_n)}{V_{mstd}}$$

$$= \frac{15.43\ (0.0226)}{(30.10)}$$

$$= 0.0116$$

gr/dscf corrected to 7% O_2

$$= (\text{gr/dscf})\ \frac{14}{(21 - \%O_2)}$$

$$= (0.0116)\ \frac{14}{(21 - 10.4)}$$

$$= 0.0153$$

$$\text{lb/hr} = \frac{(\text{gr/dscf})\ (Qstd)\ (60)}{7000}$$

$$= \frac{(0.0116)\ (549)\ (60)}{7000}$$

$$= 0.055$$

Sample Calculations (Continued)

13. Chloride emissions (as HCl)

$$\text{lb/dscf} = \frac{(\text{mg/l})\ (V_{soln}/1000)\ (36.45/35.45)}{(453{,}590)\ (V_{mstd})}$$

$$= \frac{(325 - 1)\ (533/1000)\ (36.45/35.45)}{(453{,}590)\ (30.10)}$$

$$= 1.301 \times 10^{-5}$$

$$\text{ppmv} = \frac{(\text{lb/dscf})\ (385.3)\ (10^6)}{(36.45)}$$

$$= \frac{(1.301 \times 10^{-5})\ (385.3)\ (10^6)}{36.45}$$

$$= 137.5$$

$$\text{lb/hrf} = (\text{lb/dscf})\ (\text{dscfm})\ (60)$$

$$= (1.301 \times 10^{-5})\ (549)\ (60)$$

$$= 0.428$$

14. Chloride entering incinerator, (as HCl)

from CCl_4 (71.834 lb/hr) $\left(0.9219\ \frac{\text{lb } Cl^-}{\text{lb } CCl_4}\right)$ = 66.2 lb/hr

from TCE (31.221 lb/hr) $\left(0.8095\ \frac{\text{lb } Cl^-}{\text{lb TCE}}\right)$ = 25.3 lb/hr

(as Cl^-) = 91.5 lb/hr

$$\text{as HCl} = (\text{ as } Cl^-)\ (36.45/35.45)$$

$$= (91.5)\ (36.45/35.45)$$

$$= 94.08 \text{ lb/hr}$$

Sample Calculations (Continued)

15. Chloride removal efficiency

$$\% \text{ Efficiency} = \frac{\text{inlet} - \text{outlet}}{\text{inlet}} (100)$$

$$= \frac{94.08 - 0.428}{(94.08)} (100)$$

$$= 99.55\%$$

16. Carbon monoxide emissions

ppmv corrected to 12% CO_2

$$= (\text{ppmv}) \frac{12}{\%CO_2}$$

$$= (7) \frac{12}{8.0}$$

$$= 10.5$$

ppmv corrected to 50% excess air

$$= (\text{ppmv}) \frac{100 + \%EA}{150}$$

$$= (7) \frac{100 + 93.33}{150}$$

$$= 9.0$$

$$\text{lb/hr} = \frac{(\text{ppmv})\ (28)\ (Qstd)\ (60)}{(385.3)\ (10^6)}$$

$$= \frac{(7)\ (28)\ (549)\ 60}{(385.3)\ (10^6)}$$

$$= 0.017$$

Sample Calculations (Continued)

17. Vost sample train gas metered at dry standard conditions.

$$V_{mstd} = (0.3858) \frac{(V_m)\ (P_b)\ (760/29.921)}{(Tm + 273)} (Y_d)$$

$$= \frac{(0.3858)\ (20.15)\ (23.13)\ (760)\ (1.0032)}{(34 + 273)\ (29.921)}$$

$$= 14.92\ l$$

18. POHC emissions (Condition 4, Run 3 CCl_4)

$$ug/m^3 = \frac{(ng\ CCl_4)}{(V_{mstd})}$$

$$= \frac{2600}{14.92}$$

$$= 174.2$$

$$ppbv = \frac{(ug/m^3)\ (24.04)}{(153.81)}$$

$$= 27.23$$

$$lb/hr = \frac{(ppbv)\ (153.81)\ (Qstd)\ (60)}{(10^8)\ (385.3)}$$

$$= \frac{(27.23)\ (153.81)\ (951)\ (60)}{(10^8)\ (385.3)}$$

$$= 6.20 \times 10^{-4}$$

Sample Calculations (Continued)

19. POHC emissions (Condition 4, Run 3 TCE)

$$ug/m^3 = \frac{ng\ TCE}{V_{mstd}}$$

$$= \frac{36}{14.92}$$

$$= 2.412$$

$$ppbv = \frac{(ug/m^3)\ (24.04)}{(131.378)}$$

$$= \frac{(2.412)\ (24.04)}{(131.378)}$$

$$= 0.442$$

$$lb/hr = \frac{(ppbv)\ (131.378)\ (Qstd)\ (60)}{(10^9)\ (385.3)}$$

$$= \frac{(0.442)\ (131.378)\ (951)\ (60)}{(10^9)\ (385.3)}$$

$$= 8.59 \times 10^{-6}$$

20. Destruction and removal efficiency of CCl_4

$$\%DRE = \frac{lb/hr\ in - lb/hr\ out}{lb/hr\ in}\ (100)$$

$$= \frac{55.500 - 6.20 \times 10^{-4}}{55.500}\ (100)$$

$$= 99.9989\%$$

Sample Calculations (Continued)

21. Destruction and removal efficiency of TCE

$$\%DRE = \frac{\text{lb/hr in} - \text{lb/hr out}}{\text{lb/hr in}} (100)$$

$$= \frac{27.750 - 8.59 \times 10^{-6}}{27.750} (100)$$

$$= 99.99997$$

PARAMETERS

Parameter Sheet
VOST

Condition 1

Run	1	2	3	4	5	6
Field Measurements						
Pb	23.17	23.17	23.17	23.17	23.17	23.17
Theta	20	20	20	20	20	20
Tm	32	31	30	39	30	27.5
Vm	20.91	21.71	18.91	20.82	21.48	21.36
Vmstd	15.62	16.27	14.22	15.20	16.15	16.19
Yd	1.0032	1.0032	1.0032	1.0032	1.0032	1.0032
dscfm	586	586	586	586	585	585
Organic Material Feed Rate						
CCl4, lb/hr	70.36	70.36	70.36	70.36	76.92	76.92
TCE, lb/hr	30.42	30.42	30.42	30.42	33.3	33.3
Laboratory Data						
CCl4, (ng)	>188	6780	5110	>5760	>5410	5410
Uncertainty	19	678	511	576	541	541
TCE, (ng)	***	161	<10	***	***	140
Uncertainty	***	16	1	***	***	14
Results, CCl4						
ug/m3	>12.04	416.80	359.47	>378.95	>335.04	334.14
ppbv, dry	>1.88	65.14	56.18	>59.23	>52.37	52.22
lbE-10/dscf	>7.51	260.06	224.28	>236.44	>209.04	208.48
lb/hr	>2.6E-05	9.14E-04	7.89E-04	>8.3E-04	>7.3E-04	7.32E-04
DRE, (%)	<99.9999	99.99870	99.99887	<99.9988	<99.9990	99.99904
Results, TCE						
ug/m3	***	9.90	<0.70	***	***	8.65
ppbv, dry	***	1.81	<0.13	***	***	1.58
lbE-10/dscf	***	6.18	<0.44	***	***	5.40
lb/hr	***	2.17E-05	<1.5E-06	***	***	1.89E-05
DRE, (%)	***	99.99996	>99.9999	***	***	99.99997

*** Detector Quenched or Sample Broken

Parameter Sheet
VOST

Condition 2

Run	1	2	3	4	5	6
Field Measurements						
Pb	23.05	23.05	23.05	23.05	23.05	23.05
Theta	20	20	20	20	20	20
Tm	21	24.5	38	36	40	48
Vm	20.62	21.68	21.82	21.17	21.98	19.92
Vmstd	15.89	16.51	15.90	15.52	15.91	14.06
Yd	1.0032	1.0032	1.0032	1.0032	1.0032	1.0032
dscfm	550	550	548	548	541	541
Organic Material Feed Rate						
CCl4, lb/hr	78.63	78.63	77.84	77.84	78.37	78.37
TCE, lb/hr	33.17	33.17	32.78	32.78	33.04	33.04
Laboratory Data						
CCl4, (ng)	63	***	***	1190	4580	5660
Uncertainty	6	***	***	119	458	566
TCE, (ng)	<10	***	<10	164	115	110
Uncertainty	1	***	1	16	12	11
Results, CCl4						
ug/m3	3.96	***	***	76.65	287.82	402.51
ppbv, dry	0.62	***	***	11.98	44.99	62.91
lbE-10/dscf	2.47	***	***	47.83	179.58	251.14
lb/hr	8.16E-06	***	***	1.57E-04	5.83E-04	8.15E-04
DRE, (%)	99.99998	***	***	99.99979	99.99925	99.99895
Results, TCE						
ug/m3	<0.63	***	<0.63	10.56	7.23	7.82
ppbv, dry	<0.10	***	<0.10	1.93	1.32	1.43
lbE-10/dscf	<0.39	***	<0.39	6.59	4.51	4.88
lb/hr	<1.3E-06	***	<1.3E-06	2.17E-05	1.46E-05	1.58E-05
DRE, (%)	>99.9999	***	>99.9999	99.99997	99.99998	99.99997

*** Detector Quenched or Sample Broken

Parameter Sheet
VOST

Condition 3

Run	1	2	3	4	5	6
Field Measurements						
Pb	23.15	23.15	23.15	23.15	23.15	23.15
Theta	20	20	20	20	20	20
Tm	25	33	33	33	25	24
Vm	20.14	20.87	20.71	20.37	21.99	21.04
Vmstd	15.38	15.52	15.40	15.15	16.79	16.12
Yd	1.0032	1.0032	1.0032	1.0032	1.0032	1.0032
dscfm	596	596	603	603	691	691
Organic Material Feed Rate						
CCl4, lb/hr	49.30	49.30	55.77	55.77	54.05	54.05
TCE, lb/hr	24.19	24.19	27.22	27.22	26.17	26.17
Laboratory Data						
CCl4, (ng)	2170	2230	5660	4440	258	2993
Uncertainty	217	223	566	444	26	299
TCE, (ng)	231	235	1240	543	6	8
Uncertainty	23	24	124	54	1	1
Results, CCl4						
ug/m3	141.08	143.67	367.47	293.07	15.36	185.64
ppbv, dry	22.05	22.46	57.43	45.81	2.40	29.02
lbE-10/dscf	88.03	89.64	229.27	182.86	9.59	115.83
lb/hr	3.15E-04	3.21E-04	8.30E-04	6.62E-04	3.97E-05	4.80E-04
DRE, (%)	99.99936	99.99934	99.99851	99.99881	99.99992	99.99911
Results, TCE						
ug/m3	15.02	15.14	80.51	35.84	0.36	0.50
ppbv, dry	2.75	2.77	14.73	6.56	0.07	0.09
lbE-10/dscf	9.37	9.45	50.23	22.36	0.22	0.31
lb/hr	3.35E-05	3.38E-05	1.82E-04	8.09E-05	9.24E-07	1.28E-06
DRE, (%)	99.99993	99.99993	99.99967	99.99985	99.99999	99.99999

*** Detector Quenched or Sample Broken

Parameter Sheet
VOST

Condition 4

Run	1	2	3	4	5	6
Field Measurements						
Pb	23.13	23.13	23.13	23.13	23.13	23.13
Theta	20	20	20	20	20	20
Tm	25	32	34	32	24	25
Vm	20.96	20.76	20.15	17.71	21.44	20.36
Vmstd	15.99	15.48	14.92	13.20	16.41	15.54
Yd	1.0032	1.0032	1.0032	1.0032	1.0032	1.0032
dscfm	665	665	697	697	700	700
Organic Material Feed Rate						
CCl4, lb/hr	57.36	57.36	58.68	58.68	61.59	61.59
TCE, lb/hr	28.28	28.28	28.41	28.41	30.13	30.13
Laboratory Data						
CCl4, (ng)	5600	590	2600	5200	6200	4900
Uncertainty	560	59	260	520	620	490
TCE, (ng)	52	<10	36	210	162	116
Uncertainty	5	1	4	21	16	12
Results, CCl4						
ug/m3	350.15	38.12	174.21	393.84	377.71	315.41
ppbv, dry	54.73	5.96	27.23	61.56	59.04	49.30
lbE-10/dscf	218.47	23.78	108.69	245.73	235.67	196.79
lb/hr	8.72E-04	9.49E-05	4.55E-04	1.03E-03	9.90E-04	8.27E-04
DRE, (%)	99.99848	99.99983	99.99922	99.99824	99.99839	99.99865
Results, TCE						
ug/m3	3.25	<0.65	2.41	15.91	9.87	7.47
ppbv, dry	0.59	<0.12	0.44	2.91	1.81	1.37
lbE-10/dscf	2.03	<0.40	1.51	9.92	6.16	4.66
lb/hr	8.09E-06	<1.6E-06	6.29E-06	4.15E-05	2.59E-05	1.96E-05
DRE, (%)	99.99998	>99.9999	99.99998	99.99992	99.99995	99.99996

*** Detector Quenched or Sample Broken

UNIVERSITY OF CALIFORNIA
CAE Project No: 3770

PARAMETERS

Particulate - Condition 1

Run No.	1	2	3
A_n	.000534	.000534	.000534
A_s	.7773	.7773	.7773
B_{wo}	.3520	.3652	.3660
$\%CO_2$	8.6	8.6	8.6
C_p	.840	.840	.840
$\overline{DH}$	.740	.740	.680
DH@	1.807	1.807	1.807
$\overline{(DP)^{1/2}}$	.415	.425	.410
%I	103.9	104.1	104.9
M_d	29.74	29.74	29.74
M_n	.0161	.0121	.0184
M_s	25.61	25.46	25.45
$\%O_2$	9.2	9.2	9.2
P_b	23.19	23.08	23.08
P_s	23.23	23.12	23.12
θ	64.0	80.0	80.0
$\overline{T_m}$	84	79	66
$\overline{T_s}$	209	213	212
V_{1c}	308.6	409	399
V_m	35.50	44.23	41.97
V_{mstd}	26.75	33.48	32.55
V_s	31.64	32.61	31.45
V_{wstd}	14.54	19.26	18.79
Y_d	.9999	.9999	.9999

UNIVERSITY OF CALIFORNIA
CAE Project No: 3770

PARAMETERS

Particulate - Condition 2

Run No.	1	2	3
A_n	.000534	.000534	.000534
A_s	.7773	.7773	.7773
B_{wo}	.3245	.3196	.3199
$\%CO_2$	8.0	8.0	8.0
C_p	.840	.840	.840
$\overline{DH}$	.570	.640	.620
DH@	1.807	1.807	1.807
$\overline{(DP)^{1/2}}$	.379	.378	.375
%I	98.5	102.2	101.2
M_d	29.70	29.70	29.70
M_n	.0200	.0172	.0226
M_s	25.90	25.96	25.95
$\%O_2$	10.4	10.4	10.4
P_b	23.05	23.05	23.05
P_s	23.09	23.09	23.09
θ	80.0	80.0	80.0
$\overline{T_m}$	71	92	103
$\overline{T_s}$	216	226	229
V_{1c}	303.8	307	300.6
V_m	38.84	41.71	41.60
V_{mstd}	29.79	30.78	30.10
V_s	28.97	29.08	28.84
V_{wstd}	14.31	14.46	14.16
Y_d	.9999	.9999	.9999

UNIVERSITY OF CALIFORNIA
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PARAMETERS

Particulate - Condition 3

Run No.	1	2	3
A_n	.000534	.000534	.000534
A_s	.7773	.7773	.7773
B_{wo}	.3540	.3947	.2736
$\%CO_2$	8.0	7.6	7.6
C_p	.840	.840	.840
$\overline{DH}$	.780	.840	.920
DH@	1.807	1.807	1.807
$\overline{(DP)^{1/2}}$	.429	.457	.446
%I	104.7	105.7	98.0
M_d	29.68	29.62	29.62
M_n	.0266	.0374	.0442
M_s	25.55	25.03	26.44
$\%O_2$	10.1	10.0	10.2
P_b	23.15	23.05	23.05
P_s	23.19	23.08	23.08
θ	80.0	80.0	80.0
$\overline{T_m}$	78	89	72
$\overline{T_s}$	225	216	210
V_{1c}	399	485.4	297.9
V_m	45.07	47.21	48.60
V_{mstd}	34.29	35.05	37.25
V_s	33.10	35.49	33.59
V_{wstd}	18.79	22.86	14.03
Y_d	.9999	.9999	.9999

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PARAMETERS

Particulate - Condition 4

Run No.	1	2	3
A_n	.000534	.000534	.000534
A_s	.7773	.7773	.7773
B_{wo}	.2537	.2559	.2607
$\%CO_2$	5.9	7.0	8.0
C_p	.840	.840	.840
$\overline{DH}$	.820	1.04	1.02
DH@	1.807	1.807	1.807
$\overline{(DP)^{1/2}}$	.419	.440	.443
%I	96.3	101.7	103.1
M_d	29.44	29.56	29.69
M_n	.0126	.0246	.0485
M_s	26.54	26.60	26.64
$\%O_2$	12.3	11.0	10.2
P_b	23.13	23.13	23.10
P_s	23.16	23.16	23.13
θ	80.0	80.0	80.0
$\overline{T_m}$	82	86	68
$\overline{T_s}$	213	211	202
V_{lc}	254.2	284.7	297.4
V_m	46.68	52.01	51.31
V_{mstd}	35.23	38.99	39.72
V_s	31.49	33.01	32.96
V_{wstd}	11.97	13.41	14.01
Y_d	.9999	.9999	.9999

Parameter Sheet
VOST

Audit Samples

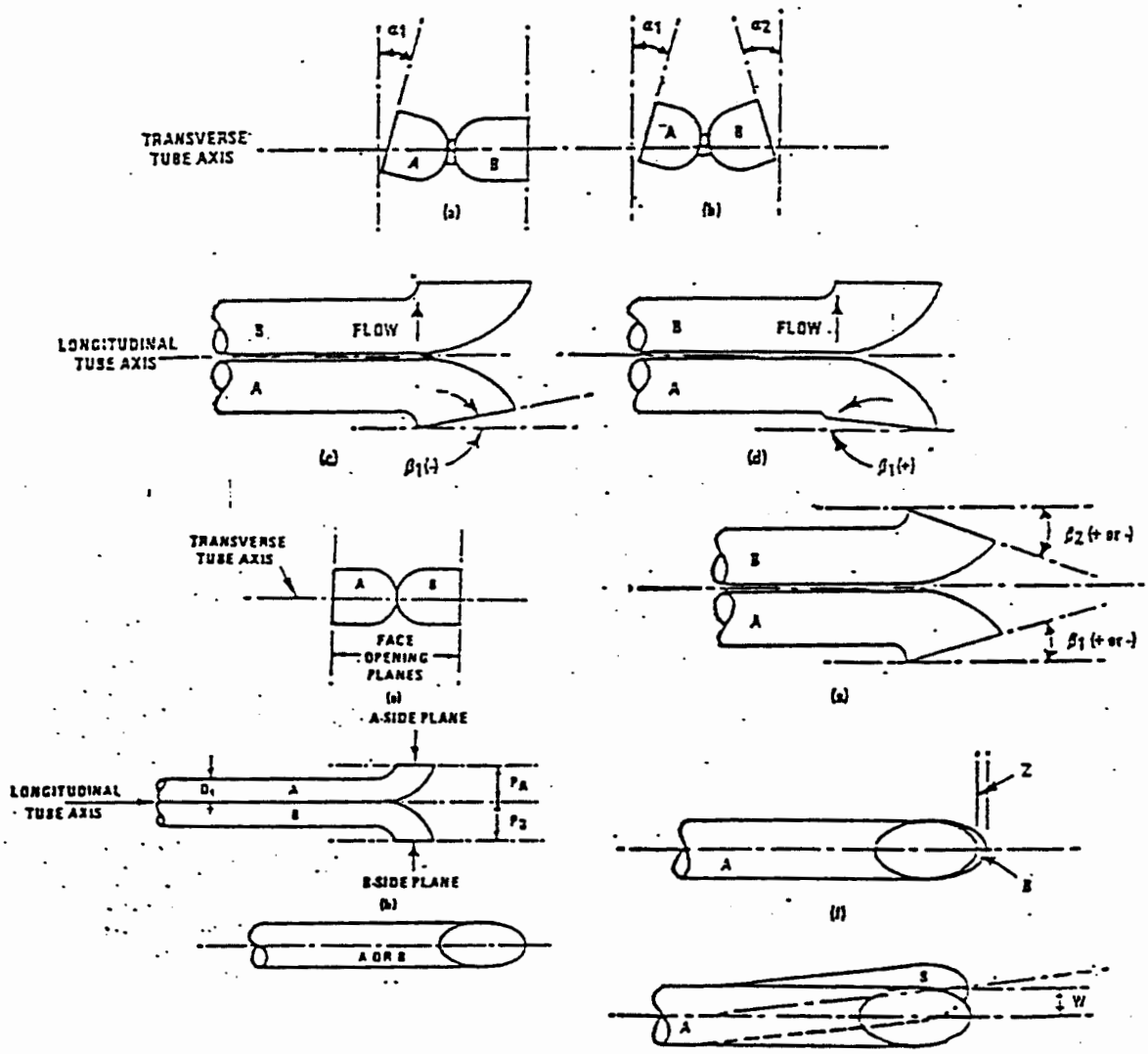
Run	1	2	3	4	5	6
Field Measurements						
Pb	23.05	23.05	23.05	23.05	23.05	23.05
Theta	20	20	20	20	20	20
Tm	27	29	31	22	25	27
Vm	9.93	11.39	10.91	10.12	10.28	10.6
Vmstd	7.50	8.55	8.13	7.77	7.82	8.01
Yd	1.0032	1.0032	1.0032	1.0032	1.0032	1.0032
Cylinder #	AAL12421	AAL12421	AAL12421	AAL11924	AAL11924	AAL11924
Laboratory Data						
CCl4, (ng)	<10	<10	<10	615	***	730
Uncertnty	1	1	1	62	***	73
TCE, (ng)	502	605	614	<10	***	<10
Uncertnty	50	61	61	1	***	1
Results CCl4						
ug/m3	<1.333	<1.170	<1.230	79.110	***	91.170
ppbv, dry	<0.21	<0.18	<0.19	12.36	***	14.25
lbE-10/dscf	<0.832	<0.730	<0.767	49.359	***	56.884
Results TCE						
ug/m3	66.933	70.793	75.504	<1.286	***	<1.249
ppbv, dry	12.25	12.95	13.82	<0.24	***	<0.23
lbE-10/dscf	41.762	44.170	47.109	<0.803	***	<0.779

*** Detector Quenched or Sample Broken

CALIBRATION DATA

Pitot Tube Calibration Data

All pitot tubes are constructed in-house. Prior to their initial usage, they are calibrated using EPA geometry standards. This involves verification of the alignment of the face openings as shown in the specifications illustrated in the figure below. The pitot tube is not used if it fails to meet these specifications.



Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of Cp so long as α_1 and $\alpha_2 < 10°$, β_1 and $\beta_2 < 5°$, z < 1/8 in. and w < 1/32 in. Also, 1.05 Dt < P < 1.50 Dt.

DATE: 7-18-85

OPERATOR: C. Fox

$\overline{Yd}$ .9999

$\overline{\Delta H@}$ 1.807

Meter Box: G6

BAROMETRIC PRESSURE (Pb): 29.28

Q	ΔH	ΔP	Yds	STANDARD METER GAS VOLUME (ft³) INITIAL	FINAL	Vds NET	METER BOX GAS VOLUME (ft³) INITIAL	FINAL	VD NET	STANDARD METER TEMP. (°F) IN	OUT	Tds AVG	METER BOX TEMP. (°F) IN	OUT	Td AVG	TIME (MIN) 0	Yd	C
.39	.5	-1.2	1.0000	0.000	5.000	5.000	312.400	317.576	5.176	76	76	76	106	103.5	105	18.44	1.0139	1.724
.39	.5	-1.2	1.0000	0.000	5.000	5.000	317.576	322.739	5.163	76	76	76	104	102.5	103	18.49	1.0129	
.65	1.5	-2.2	1.0000	00.000	10.013	10.013	322.739	333.131	10.392	76.5	76.5	76.5	104.5	101.5	103	14.87	1.0018	1.752 1.531
.65	1.5	-2.2	1.0000	00.000	10.000	10.000	333.131	343.487	10.356	76.5	76.5	76.5	101.5	100	101	14.91	1.0004	
.91	3.0	-3.9	1.0000	00.000	10.002	10.002	343.487	353.926	10.439	76.5	76.5	76.5	102	99	100.5	10.55	.9838	1.576 1.354
.91	3.0	-3.8	1.0000	00.000	10.000	10.000	353.926	364.373	10.447	77	77	77	106	99.5	103	10.62	.9865	

- Flow Rate (cfm)
- Orifice Pressure differential (in. H_2O)
- Standard Meter inlet pressure differential (in. H_2O)
- Standard Meter Correction Factor
- Meter Box Correction Factor

ΔH@ = Orifice pressure differential that gives 0.75 cfm at 70°F and 29.92" Hg (in. H_2O)

$$Yd = (Yds)\frac{Vds}{Vd}\;\frac{Td + 460}{Tds + 460}\;\frac{Pb + \Delta p/13.6}{Pb + \Delta H/13.6}$$

$$\Delta H@ = \frac{0.0317 \cdot \Delta H}{\quad}\left[\frac{(Tds + 460)\;\theta}{\quad}\right]^2$$

Clean Air
Engineering, Inc.

207 N. Woodwork Lane Palatine, Illinois 60067 312-991-3300

VACUUM GAUGE CALIBRATION SHEET

METER GG DATE 7-19-85

STANDARD (HG)	VACUUM GAUGE
27.6	28.0
24.8	25.0
19.9	20.0
14.6	15.0
9.4	10.0
4.1	5.0

CAE

PYROMETER CALIBRATION SHEET

PYROMETER # MeTeR 66 DATE 5-8-86

DIGIMITE	
50	48
100	102
150	157
200	210
250	263
300	318
350	369
400	422
450	474
500	528

CALIBRATED BY C. Fox

Clean Air Engineering, Inc.

METER BOX FULL TEST CALIBRATION

DATE: 9-2-86 METER BOX Yd: 1.0032 METER BOX: V I

OPERATOR: C. Fox METER BOX ΔH@: — BAROMETRIC PRESSURE (Pb): 29.34

Q	ΔH	ΔP	Yds	Standard Meter Gas Volume (ft³) Initial	Final	(Vds) Net	Meter Box Gas Volume (ft³) Meter Index in L/rev. Initial	Final	(Vd) Net	Standard Meter Temperature In	Out	Tds/Avg	Meter Box Temperature In	Out	Td/Avg	Time (Min.) θ	Yd	ΔH@
.0358	.5	-.1	1.0000	0.000	.500	.500			.5061	72	72	72	83.3	80.6	82.0	13.59	1.0050	—
.0356	.5	-.1	1.0000	0.000	1.000	1.000			1.0211	72.5	72.5	72.5	88.7	83.3	86.0	27.29	1.0027	—
.0355	.5	-.1	1.0000	0.000	.500	.500			.5124	73	73	73	90.5	86	88.0	13.69	1.0018	—

Q - Flow Rate (cfm)
ΔH - Orifice Pressure Differential (in. H O)
ΔP - Inlet Pressure Differential Standard Meter (in. H O)
Yds - Standard Meter Correction Factor (Unitless)
Yd - Meter Box Correction Factor (Unitless)
ΔH@ - Orifice Pressure Differential that gives 0.75 cfm of air at 70°F and 29.92" Hg (in. H O)

$$Yd = (Yds)\left(\frac{Vds}{Vd}\right)\left(\frac{Td + 460}{Tds + 460}\right)\left(\frac{Pb + \Delta P/13.6}{Pb + \Delta H/13.6}\right)$$

$$\Delta H@ = \frac{0.0317\ \Delta H}{Pb\ (T + 460)}\left[\frac{(Tds + 460)\ \theta}{Vds.\ Yds}\right]^2$$

$$Q = \frac{17.64 \cdot Vds \cdot Pb}{(Tds + 460)\ \theta}$$

POST TEST CALIBRATION CHECK

DATE: 1-10-87

OPERATOR: C. Fox

METER BOX VACUUM: 18"

METER BOX $\overline{Yd}$: 1.0032

RETURNED FROM: Univ. of Calif.

METER BOX: V1

BAROMETRIC PRESSURE (Pb): 29.26

Q	ΔH	ΔP	Yds	Standard Meter Gas Volume (ft^3) Initial	Final	(Vds) Net	Meter Box Gas Volume (~~ft^3~~ ℓ) Initial	Final	(Vd) Net	Standard Meter Temperature (°F) In	Out	Tds Avg.	Meter Box Temperature (°F) In	Out	Td Avg.	Time (Min.) θ	Yd	ΔH@
.041	1.4	-4.2	1.0000	0.000	1.076	1.076	548.000	578.387	30.387	65.5	65.5	65.5	87.8	84.2	86	26.04	1.0273	—
.039	1.3	-4.3	1.0000	0.000	1.000	1.000	578.387	606.565	28.178	66	66	66	88	85	86.5	25.36	1.0295	—
.038	1.3	-4.3	1.0000	0.000	1.000	1.000	606.565	634.856	28.291	66	66	66	88	86	87.	25.25	1.0264	—

Q - Flow Rate (cfm)
ΔH - Orifice Pressure Differential (in. H O)
ΔP - Inlet Pressure Differential Standard Meter (in. H O)
Yds - Standard Meter Correction Factor (Unitless)
Yd - Meter Box Correction Factor (Unitless)
ΔH@ - Orifice Pressure Differential that gives 0.75 cfm of air at 70°F and 29.92" Hg (in. H O)

$$Yd = (Yds)\left(\frac{Vds}{Vd}\right)\left(\frac{Td + 460}{Tds + 460}\right)\left(\frac{Pb + \Delta P/13}{Pb + \Delta H/13}\right)$$

$$\Delta H@ = \frac{0.0317\ \Delta H}{Pb\ (Td + 460)}\left[\frac{(Tds + 460)\ \theta}{Vds.\ Yds}\right]$$

FUEL COMPOSITION & FEED RATE

Liquid Feed Rate Data

Condition 1--9/4/86		Condition 2--9/5/86	
Alumagel	0.249 w/o	Alumagel	0.249
Fuel Oil	34.93 w/o	Fuel Oil	34.69 w/o
CCl_4	44.84 w/o	CCl_4	45.35 w/o
TCE	19.99 w/o (*19.39)	TCE	19.71 w/o (*19.12)

* TCE wt% corrected to 97% analysis of TCE feedstock

Sample Period and Time EPA M-5	VOST	Flowmeter/ Corrected lbm/min	Corrected Flowrate lbm/hr	PCHC Feed lbm/hr CCl_4	97% TCE
LA-1-M5-1 1310-1445	**LA-1-V-1** 1315-1335	2.26/2.45	147	65.91	28.50
	LA-1-V-2 1401-1421	2.59/2.78	166.8	74.80	32.34
	LA-1-V-3 1443-1503	2.59/2.78	166.8	74.80	32.34
	LA-1-V-4 1525-1545	2.62/2.84	170.4	76.39	33.04
LA-1-M5-2 1852-2015	**LA-1-V-5** 1824-1844	2.64/2.86	171.6	76.92	33.30
	LA-1-V-6 1938-1958	2.64/2.86	171.6	76.92	33.30
LA-1-M5-3 2125-2245		2.64/2.86	171.6	76.92	33.30
LA-2-M5-1 0950-1120	**LA-2-V-1** 0958-1018	2.67/2.89	173.4	78.63	33.17
	LA-2-V-2 1044-1104	2.67/2.89	173.4	78.63	33.17
LA-2-M5-2 1220-1340	**LA-2-V-3** 1216-1236	2.64/2.86	171.6	77.84	32.78
	LA-2-V-4 1302-1322	2.64/2.86	171.6	77.84	32.78
LA-2-M5-3 1440-1600	**LA-2-V-5** 1448-1508	2.66/2.88	172.8	78.37	33.04
	LA-2-V-6 1527-1547	2.66/2.88	172.8	78.37	33.04

Solid Feed Rate Data

Feedstocks: CCl_4 100%, TCE 97%

Condition 3--9/6/86 Condition 4--9/7/86

Sample Period & Time	Box #s Fed	Gross Wt. (lbs)	Times Fed	CCl_4 (lbs)	TCE (lbs)
LA-3-M5-1	21	37.20	1029	11.12	5.64
1035-1155	22	37.18	1040	11.06	5.62
	23	37.22	1050	11.10	5.60
LA-3-V-1	24	37.10	1104	11.12	5.54
1036-1056	25	37.20	1117	11.16	5.56
	28	37.28	1130	11.06	5.68
LA-3-V-2	29		1150		
1117-1137	Total	223.18	81 min	66.62	33.64
	Feedrates (lbm/hr) (corrected to 97% TCE)			49.30	24.19
		165.6 lbm/hr		29.85%	14.62%
LA-3-M5-2	34	37.28	1700	11.16	5.64
1707-1832	32	37.42	1713	11.24	5.60
	35	37.36	1725	11.26	5.54
LA-3-V-3	38	37.38	1737	11.12	5.64
1709-1729	36	37.32	1748	11.14	5.64
	40	37.16	1800	11.12	5.56
LA-3-V-4	42	36.58	1812	11.08	5.58
1756-1816	41	37.76	1824	11.10	5.58
	43		1836		
	Total	298.26	96 min	89.22	44.79
	Feedrates (lbm/hr) (corrected to 97% TCE)			55.77	27.22
		186.6 lbm/hr		29.91%	14.56%
LA-3-M5-3	45	36.82	1922	11.30	5.56
1927-2050	47	36.68	1934	11.10	5.58
	46	36.50	1946	11.08	5.54
LA-3-V-5	37	37.48	1959	11.40	5.56
1924-1944	50	36.58	2012	11.08	5.58
	81	36.70	2024	11.08	5.54
LA-3-V-6	87	36.98	2036	11.32	5.64
1957-2017	70		2049		
	Total	257.74	87 min	78.36	39.00
	Feedrates (lbm/hr) (corrected to 97% TCE)			54.05	26.17
		177.6 lbm/hr		30.40%	14.68%

LA-4-M5-1	54	37.20	1342	11.06	6.16
1350-1512	66	36.72	1352	11.16	5.58
	59	36.62	1407	11.10	5.52
LA-4-V-1	86	36.82	1415	11.08	5.58
1349-1409	92	37.12	1427	11.06	5.76
	89	37.04	1439	11.18	5.54
LA-4-V-2	57	36.62	1451	11.06	5.60
1430-1450	71	36.52	1503	11.12	5.52
	xx		1515		.
	Total	294.66	93 min	88.82	45.26
Feedrates (lbm/hr) (corrected to 97% TCE)				57.36	28.28
		190.2 lbm/hr		30.14%	14.90%
LA-4-M5-2	49	36.52	1555	11.06	5.56
1557-1718	65	36.64	1607	11.10	5.54
	82	36.62	1617	11.06	5.52
LA-4-V-3	55	36.60	1629	11.06	5.58
1558-1618	52	37.42	1641	11.26	5.54
	68	36.78	1653	11.10	5.62
LA-4-V-4	73	36.70	1702	11.12	5.56
1638-1658	85	36.74	1714	11.18	5.58
	74		1726		.
	Total	294.02	91 min	88.94	44.50
Feedrates (lbm/hr) (corrected to 97% TCE)				58.68	28.41
		193.8 lbm/hr		30.25%	14.68%
LA-4-V-5	63	36.50	1806	11.10	5.56
1809-1829	61	36.58	1818	11.08	5.58
	76	36.58	1830	11.10	5.56
LA-4-V-6	75	36.76	1840	11.10	5.54
1846-1906	91	36.88	1852	11.08	5.60
	64	36.92	1900	11.24	5.62
LA-4-M5-3	69	36.66	1912	11.10	5.62
1910-2030	83	36.82	1924	11.20	5.54
	88	36.70	1930	11.08	5.56
	56	36.66	1940	11.06	5.60
	79	37.26	1952	11.30	6.04
	53	37.10	2002	11.08	5.54
	80	36.56	2015	11.06	5.54
	6		2027		.
	Total	477.98	141 min	144.58	72.90
Feedrates (lbm/hr) (corrected to 97% TCE)				61.59	30.13
		203.4 lbm/hr		30.25%	14.79%

LOG SHEET NO. 6

LIQUID BURNER CONTROL PANEL

RUN NUMBER 21
START DATE 9/2/86
PAGE 1 OF ___

DATE	TIME	INIT.	FUEL OIL FLOW, ~~GPM~~ LB/min	~~FUEL OIL WASTE LIQUID FLOW, GPM~~ Totalizer, LB	MIXTURE FLOW, LB/MIN	MIXTURE TOTALIZER, LB	Liq Burner Air Rock 1 l/min	Liq. Burner Air Totalizer LB	Tank #1 Level %	Feed Pressure, psig	Atomizing Steam Flow lb/h		
							Rock 5						
9/3/86	1301	RA	not in operation →										
	2220	CLR	On	Natural Gas →									
9/4	0000	DM	On	Natural Gas →									
	0400	WD	"	"	"	—	5.5	—	—				
	0445	DMA					7.86	—	—				
	1300	BMA	—	~~17.7~~	2.26	42.17	14.2	—	88.9	47.3			
	1359	JSV	—	—	2.59	197.4	14.0		72.7	59.0	108		
	1534	JSV	—	—	2.62	447.3	14.0	—	49.5	59.0	112		
	1917	WD			2.64	690.4	16.0	—	30	51.2	107		
	2138	RA	—	—	2.64	1048	15.89	—	4.75	52.4	104		
9/5	0100	CLR	~~Gas~~ On	~~Natural Gas~~ Natural Gas	(on natural Gas) 0.00	1292.276	5.96	—		P.1 = 3.5* 36.2	102	Kerosene	
	1005	JSV	—	—	2.67	71.9	16.4		87.5	59.0	105		
	1320	RM	—	—	2.64	608	16.2	—	33.7	54	106		
	1530	JSV	—	—	2.66	931.8			11.0	64.9	98		

DATA POINT

LOS ALAMOS CAI
LIQUID FEED FLOWRATE CALIBRATION

Date 11/25/86 Liquid WATER @ 75°F Data Recorded by John S. Varnado

Flowmeter Type MICROMOTION MODEL C

Data Point No.	Pump Stroke Setting (%)	Micromotion Readout (lb/min)	Chart Reading (lb/min)	Measured Quantities H_2O Vol. (mL)	Measured Quantities Time (sec)	Calculated Flowrate (lb/min)
1	70	2.03	2.06	1218	74.01	2.18
2	70	2.03	2.06	1278	77.25	2.19
3	100	2.95	2.23	1515	62.56	3.20
4	100	2.95	2.23	1508	62.15	3.21
5	85	2.60	2.32	1300	61.87	2.78
6	85	2.58	2.32	1315	62.91	2.76
7	75	2.28	2.30	1441	77.60	2.46
8	75	2.28	2.30	1398	75.16	2.46
9	60	1.84	1.86	1248	84.06	1.96
10	60	1.82	1.85	1235	83.18	1.96
11	45	1.40	1.44	1040	93.56	1.47
12	45	1.41	1.44	896	80.04	1.48
13	30	0.95	0.97	840	113.87	0.98
14	30	0.94	0.97	998	135.17	0.98
15	15	0.44	0.45	830	261.80	0.42
16	15	0.43	0.45	759	265.15	0.41

LABORATORY DATA

Numbering system for samples taken at Los Alamos National Laboratories

```
LANL----- 1 ----V---- 1 --------T/C
                 Run #
                 -----
Condition/  Sample Train Type
---------   ----------------
            V   VOST
            M5  Method 5
```

Sample Description

- AC(F)--Activated Carbon, Fresh
- AC(U)--Activated Carbon, Used
- CCl4--CCl4 Feed Stock
- CS--Caustic Solution
- FOF--Fuel Oil Feed
- FO---Fuel Oil Feed Stock
- F-----Filter of M5 Train
- Imp--Impinger of M5 Train
- LMF--Liquid Mixture Feed
- MW--Make-up Water
- PW-Probe Wash of M5 Train
- SDL--Scrubber Discharge Liquid
- TCE--TCE Feed Stock
- T--Tenax
- T/C--Tenax/Charcoal

CCl4----Carbon tetrachloride
TCE-----triChloro ethylene

Analytical Report

Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

RECEIVED DEC 8 1986

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ——> Burn Test

Sample Sheet # 5425

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96591	46%CT	56235	CCl4	40	%	4
86.12412	LA-1-V-1-CCL4	56235	CCl4	100	%	5
86.12413	LA-1-V-1-TCE	79016	TCE	97	%	5
86.12414	LA-1-V-1-L.M.F.	56235	CCl4	32	%	2
		79016	TCE	16	%	1
		CL	Chloride	1	MG/L	.5
		SOLIDS,DIS	Disolved Solids	12350	MG/L	1235
86.12415	LA-1-V-2-L.M.F.	56235	CCl4	43	%	2
		79016	TCE	21	%	1
		CL	Chloride	8	MG/L	.5
		SOLIDS,DIS	Disolved Solids	5460	MG/L	546
86.12416	LA-1-V-3-L.M.F.	56235	CCl4	40	%	2
		79016	TCE	20	%	1
		CL	Chloride	3	MG/L	.5
		SOLIDS,DIS	Disolved Solids	2630	MG/L	263
86.12417	LA-2-V-1-L.M.F.	56235	CCl4	30	%	3
		79016	TCE	16	%	1
		CL	Chloride	5	MG/L	.5
		SOLIDS,DIS	Disolved Solids	6600	MG/L	660
86.12418	LA-2-V-2-L.M.F.	56235	CCl4	41	%	2
		79016	TCE	20	%	1
		CL	Chloride	3	MG/L	.5
		SOLIDS,DIS	Disolved Solids	5010	MG/L	501
86.12419	LA-2-V-3-L.M.F.	56235	CCl4	46	%	3
		79016	TCE	18	%	1
		CL	Chloride	4	MG/L	.5
		SOLIDS,DIS	Disolved Solids	10550	MG/L	1055

Date: 12/1/86
Approved, Contracting

mag 12-1-86
Date: 12/1/86
Approved, Quality Control

Analytical Report

Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ——> Burn Test

Sample Sheet # 5424

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
86.12400	LA-1-V-1-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.14	UG/L	.1
		CL	Chloride	14,000.000	MG/L	700.000
		PH	pH	10.300	PH UNITS	0.200
86.12401	LA-1-V-2-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	18,000.000	MG/L	900.000
		PH	pH	2.900	PH UNITS	0.200
86.12402	LA-1-V-3-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.21	UG/L	.1
		CL	Chloride	26,000.000	MG/L	1,300.000
		PH	pH	2.400	PH UNITS	0.200
86.12403	LA-2-V-1-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	13,000.000	MG/L	650.000
		PH	pH	2.200	PH UNITS	0.200
86.12404	LA-2-V-2-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.57	UG/L	.1
		CL	Chloride	25,000.000	MG/L	1,250.000
		PH	pH	1.800	PH UNITS	0.200
86.12405	LA-2-V-3-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.18	UG/L	.1
		CL	Chloride	28,000.000	MG/L	1,400.000
		PH	pH	1.600	PH UNITS	0.200
86.12406	LA-3-V-1-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.43	UG/L	.1
		CL	Chloride	20,000.000	MG/L	1,000.000
		PH	pH	1.000	PH UNITS	0.200
86.12407	LA-3-V-2-S.D.L.	56235	CCl4	.14	UG/L	.1
		79016	TCE	.64	UG/L	.1
		CL	Chloride	9,000.000	MG/L	450.000
		PH	pH	3.500	PH UNITS	0.200
86.12408	LA-3-V-3-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.59	UG/L	.1
		CL	Chloride	19,000.000	MG/L	950.000
		PH	pH	4.100	PH UNITS	0.200
86.12409	LA-4-V-1-S.D.L.	56235	CCl4	< .12	UG/L	.1
		79016	TCE	.43	UG/L	.1

		CL	Chloride		12,000.000	MG/L		600.000
		PH	pH		2.000	PH UNITS		0.200
86.12410	LA-4-V-2-S.D.L.	56235	CCl4	<	.12	UG/L	.1	
		79016	TCE		.57	UG/L	.1	
		CL	Chloride		18,000.000	MG/L		900.000
		PH	pH		207.000	PH UNITS		0.200
86.12411	LA-4-V-3-S.D.L.	56235	CCl4	<	.12	UG/L	.1	
		79016	TCE		.35	UG/L	.1	
		CL	Chloride		22,000.000	MG/L		550.000
		PH	pH		1.900	PH UNITS		0.200

Date: 12 / 1 / 86

Approved, Contracting

Date: 12 / 1 / 86

Approved, Quality Control

Analytical Report

Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ——> Burn Test

Sample Sheet # 5423

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96767	80.8 ppm	CL	Chloride	83.000	MG/L	1.000
86.10186	LA-1-V-1-C.S.	CL	Chloride	1,050.000	MG/L	1.000
86.10187	LA-2-V-1-C.S.	CL	Chloride	1,050.000	MG/L	1.000
86.10188	LA-2-V-3-C.S.	CL	Chloride	1,375.000	MG/L	1.000
86.10189	LA-3-V-1-C.S.	CL	Chloride	950.000	MG/L	1.000
86.10190	LA-3-V-2-C.S.	CL	Chloride	1,300.000	MG/L	1.000
86.10191	LA-4-V-123-C.S.	CL	Chloride	1,350.000	MG/L	1.000

Date: 12 / 1 / 86
Approved, Contracting

Date: 12 / 1 / 86
Approved, Quality Control

Analytical Report

Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ——> Burn Test

Sample Sheet # 5422

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96584	24ug/gCT,32 TCE	56235	CCl4	< 5	UG/L	2
		79016	TCE	< 5	UG/L	2
00.96585	33ug/gCT,25 TCE	56235	CCl4	< 5	UG/L	2
		79016	TCE	< 5	UG/L	2
00.96589	32ug/L CT,40TCE	56235	CCl4	25	UG/L	3
		79016	TCE	34	UG/L	4
00.96590	32ug/L CT,40TCE	56235	CCl4	21	UG/L	3
		79016	TCE	47	UG/L	5
00.96773	20ng/gCT20510TC	56235	CCl4	.1	UG/KG	.1
		79016	TCE	7.8	UG/KG	1
00.96774	38ng/gCT38494TE	56235	CCl4	.1	UG/KG	.1
		79016	TCE	.05	UG/KG	.1
00.96775	20ng/mlCT20280T	56235	CCl4	44	UG/L	4
		79016	TCE	8050	UG/L	805
00.96776	60ng/mlCT60840T	56235	CCl4	69	UG/L	7
		79016	TCE	44000	UG/L	4400
86.10192	LA-1-V-1-F.O.F.	56235	CCl4	< 1	MG/L	1
		79016	TCE	< 1	MG/L	1
		CL	Chloride	< 1.000	MG/L	1.000
86.10193	LA-2-M5-1-ALGL	56235	CCl4	27	UG/KG	3
		79016	TCE	1	UG/KG	1
		CL	Chloride	38.000	UG/G	2.000
86.10194	LA-1-M5-1-ALGL	56235	CCl4	510	UG/KG	51
		79016	TCE	628	UG/KG	63
		CL	Chloride	54.000	UG/G	2.000
86.10195	LA-3,4-V-123PEL	56235	CCl4	82	UG/KG	8
		79016	TCE	70	UG/KG	7
		CL	Chloride	2,610.000	UG/G	130.000
86.10196	LA-3-V-3-I.A.	56235	CCl4	168	UG/KG	16
		79016	TCE	150	UG/KG	15
		CL	Chloride	8,750.000	UG/G	435.000
		PH	pH	9.900	PH UNITS	0.200
86.10197	LA-4-M5-123-I.A	56235	CCl4	2000	UG/KG	200
		79016	TCE	600	UG/KG	60
		CL	Chloride	26,700.000	UG/G	1,335.000
		PH	pH	8.900	PH UNITS	0.200
86.10198	LA-1-V-1-HEPA	56235	CCl4	38	UG/KG	4
		79016	TCE	< 1	UG/KG	1

		CL	Chloride		9.000	UG/G	1.000
		PH	pH		8.300	PH UNITS	0.200
86.10199	LA-4-V-3-HEPA4	56235	CCl4	150		UG/KG	15
		79016	TCE	10		UG/KG	1
		CL	Chloride		87,700.000	UG/G	4,335.000
		PH	pH		5.900	PH UNITS	0.200

Date: 12/1/86

Approved, Contracting

Date: 12/1/86

Approved, Quality Control

Analytical Report

Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ——> Burn Test

Sample Sheet # 5421

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
86.10161	LANL-1-M5-1	AL	Al	5.300	MG/L	0.100
		FE	Fe	3.200	MG/L	0.100
		NA	Na	2.500	MG/L	0.100
86.10162	LANL-1-M5-2	AL	Al	6.700	MG/L	0.100
		FE	Fe	5.000	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
86.10163	LANL-1-M5-3	AL	Al	5.700	MG/L	0.100
		FE	Fe	2.500	MG/L	0.100
		NA	Na	2.100	MG/L	0.100
86.10164	LANL-2-M5-1	AL	Al	2.300	MG/L	0.100
		NA	Na	2.100	MG/L	0.100
86.10165	LANL-2-M5-2	AL	Al	3.500	MG/L	0.100
		FE	Fe	7.600	MG/L	0.100
		NA	Na	2.000	MG/L	0.100
86.10166	LANL-2-M5-3	AL	Al	3.600	MG/L	0.100
		FE	Fe	22.200	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
86.10167	LANL-3-M5-1	AL	Al	3.400	MG/L	0.100
		FE	Fe	26.200	MG/L	0.100
		NA	Na	2.200	MG/L	0.100
86.10168	LANL-3-M5-2	AL	Al	3.700	MG/L	0.100
		FE	Fe	31.100	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
86.10169	LANL-3-M5-3	AL	Al	3.100	MG/L	0.100
		FE	Fe	51.200	MG/L	0.100
		NA	Na	2.300	MG/L	0.100
86.10170	LANL-4-M5-1	AL	Al	4.100	MG/L	0.100
		FE	Fe	18.400	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
86.10171	LANL-4-M5-2	AL	Al	3.300	MG/L	0.100
		FE	Fe	29.300	MG/L	0.100
		NA	Na	2.400	MG/L	0.100
86.10172	LANL-4-M5-3	AL	Al	5.400	MG/L	0.100
		FE	Fe	65.600	MG/L	0.100
		NA	Na	2.200	MG/L	0.100
86.10173	BLANK	AL	Al	8.100	MG/L	0.100
		FE	Fe	0.600	MG/L	0.100
		NA	Na	1.700	MG/L	0.100

86.12484	Fe= 0.099 mg/L	AL	Al	<	0.100	MG/L	0.100
		FE	Fe		0.120	MG/L	0.100
		NA	Na		6.900	MG/L	0.100
86.12485	Fe=.08Al=.45mgL	AL	Al		0.500	MG/L	0.100
		FE	Fe		0.100	MG/L	0.100
		NA	Na		0.100	MG/L	0.100

Date: 12/1/86

Approved, Contracting

Date: 12/1/86

Approved, Quality Control

Analytical Report

Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ——> Burn Test

Sample Sheet # 5379

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96586	4800ngCT,280TCE	56235	CCl4	2900	NG	299
		79016	TCE	240	NG	24
00.96587	220ngCT,4500TCE	56235	CCl4	330	NG	33
		79016	TCE	4800	NG	488
00.96588	800ngCT,1100TCE	56235	CCl4	1440	NG	144
		79016	TCE	2100	NG	210
00.96770	20ngCT,20280TCE	56235	CCl4	8	NG	1
		79016	TCE	1150	NG	115
00.96771	10ngCT,10140TCE	56235	CCl4	5.6	NG	1
		79016	TCE	499	NG	50
00.96772	40ngCT,40560TCE	56235	CCl4	Broken	NG	
		79016	TCE		NG	
86.12449	1-V-1-T,TC	56235	CCl4	> 188	NG	19
		79016	TCE	Det Quenched	NG	
86.12450	1-V-2-T,TC	56235	CCl4	6780	NG	678
		79016	TCE	161	NG	16
86.12451	1-V-3-T,TC	56235	CCl4	5110	NG	511
		79016	TCE	< 10	NG	1
86.12452	1-V-4-T,TC	56235	CCl4	> 5760	NG	576
		79016	TCE	Det Quenched	NG	
86.12453	1-V-5-T,TC	56235	CCl4	> 5410	NG	541
		79016	TCE	Det Quenched	NG	
86.12454	1-V-6-T,TC	56235	CCl4	5410	NG	541
		79016	TCE	140	NG	14
86.12455	1-V-(1-6)-T,TC	56235	CCl4	< 10	NG	1
		79016	TCE	3	NG	1
86.12456	2-V-1-T,TC	56235	CCl4	63	NG	6
		79016	TCE	< 10	NG	1
86.12457	2-V-2-T,TC	56235	CCl4	Det Quenched	NG	
		79016	TCE		NG	
86.12458	2-V-3-T,TC	56235	CCl4	Broken	NG	
		79016	TCE	< 10	NG	1
86.12459	2-V-4-T,TC	56235	CCl4	1190	NG	119
		79016	TCE	164	NG	16
86.12460	2-V-5-T,TC	56235	CCl4	4580	NG	458
		79016	TCE	115	NG	12
86.12461	2-V-6-T,TC	56235	CCl4	5660	NG	566
		79016	TCE	110	NG	12

86.12462	2-V-(1-6)-T,TC	56235	CCl4		8	NG	1
		79016	TCE	<	10	NG	1
86.12463	3-V-1-T,TC	56235	CCl4		2170	NG	217
		79016	TCE		231	NG	23
86.12464	3-V-2-T,TC	56235	CCl4		2230	NG	223
		79016	TCE		235	NG	23
86.12465	3-V-3-T,TC	56235	CCl4		5660	NG	566
		79016	TCE		1240	NG	124
86.12466	3-V-4-T,TC	56235	CCl4		4440	NG	444
		79016	TCE		543	NG	54
86.12467	3-V-5-T,TC	56235	CCl4		258	NG	26
		79016	TCE		6	NG	1
86.12468	3-V-6-T,TC	56235	CCl4		2993	NG	300
		79016	TCE		8	NG	1
86.12469	3-V-(1-6)-T,TC	56235	CCl4	<	10	NG	1
		79016	TCE	<	10	NG	1
86.12470	4-V-1-T,TC	56235	CCl4		5600	NG	560
		79016	TCE		52	NG	5
86.12471	4-V-2-T,TC	56235	CCl4		590	NG	59
		79016	TCE	<	10	NG	1
86.12472	4-V-3-T,TC	56235	CCl4		2600	NG	260
		79016	TCE		36	NG	4
86.12473	4-V-4-T,TC	56235	CCl4		5200	NG	520
		79016	TCE		210	NG	21
86.12474	4-V-5-T,TC	56235	CCl4		6200	NG	620
		79016	TCE		162	NG	16
86.12475	4-V-6-T,TC	56235	CCl4		4900	NG	490
		79016	TCE		116	NG	12
86.12476	4-V-(1-6)-T,TC	56235	CCl4	<	10	NG	1
		79016	TCE	<	10	NG	1
86.12477	(1-4)-V-1-T,TCA	56235	CCl4	<	10	NG	1
		79016	TCE		502	NG	50
86.12478	(1-4)-V-2-T,TCA	56235	CCl4	<	10	NG	1
		79016	TCE		605	NG	61
86.12479	(1-4)-V-3-T,TCA	56235	CCl4	<	10	NG	1
		79016	TCE		614	NG	61
86.12480	(1-4)-V-4-T,TCA	56235	CCl4		615	NG	62
		79016	TCE	<	10	NG	1
86.12481	(1-4)-V-5-T,TCA	56235	CCl4			NG	
		79016	TCE		Broken	NG	
86.12482	(1-4)-V-6-T,TCA	56235	CCl4		730	NG	73
		79016	TCE	<	10	NG	1
86.12483	(1-4)V-ALL-T,TC	56235	CCl4	<	10	NG	1
		79016	TCE	<	10	NG	1

Date: 12/1/86

Approved, Contracting

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Date: 12/1/86

Approved, Quality Control

Analytical Report

Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ——> Burn Test

Sample Sheet # 5378

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result	Units	Uncertainty +/-
00.96764	6.4 ppm	CL	Chloride	7.000	MG/L	1.000
00.96765	3.2 ppm	CL	Chloride	3.600	MG/L	1.000
00.96766	12.9 ppm	CL	Chloride	14.500	MG/L	1.000
86.12433	LA-1-V-A.C.(F)	56235	CCl4	990	UG/KG	99
		79016	TCE	< 1	UG/KG	1
		CL	Chloride	2,300.000	UG/G	1.000
		PH	pH	9.900	PH UNITS	0.200
86.12434	LA-12V123-AC(U)	56235	CCl4	< 1	UG/KG	1
		79016	TCE	35	UG/KG	4
		CL	Chloride	9,780.000	UG/G	1.000
		PH	pH	5.700	PH UNITS	0.200
86.12435	LA-3-V-3-AC.(U)	56235	CCl4	1100	UG/KG	110
		79016	TCE	58	UG/KG	6
		CL	Chloride	30,100.000	UG/G	1.000
		PH	pH	6.000	PH UNITS	0.200
86.12436	LA-4-V-123-AC(U	56235	CCl4	620	UG/KG	62
		79016	TCE	110	UG/KG	11
		CL	Chloride	12,550.000	UG/G	1.000
		PH	pH	4.900	PH UNITS	0.200
86.12437	LA-1-V-1-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12438	LA-1-V-2-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12439	LA-1-V-3-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12440	LA-2-V-1-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12441	LA-2-V-2-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12442	LA-2-V-3-M.W.	56235	CCl4	< .1	UG/L	.1
		79016	TCE	< .12	UG/L	.1
		CL	Chloride	3.000	MG/L	1.000
86.12443	LA-3-V-1-M.W.	56235	CCl4	< .1	UG/L	.1

		79016	TCE	<	.12	UG/L	.1	
		CL	Chloride		3.000	MG/L		1.000
86.12444	LA-3-V-2-M.W.	56235	CCl4	<	.1	UG/L	.1	
		79016	TCE	<	.12	UG/L	.1	
		CL	Chloride		3.000	MG/L		1.000
86.12445	LA-3-V-3-M.W.	56235	CCl4	<	.1	UG/L	.1	
		79016	TCE	<	.12	UG/L	.1	
		CL	Chloride		3.000	MG/L		1.000
86.12446	LA-4-V-1-M.W.	56235	CCl4		.2	UG/L	.1	
		79016	TCE		.13	UG/L	.1	
		CL	Chloride		3.000	MG/L		1.000
86.12447	LA-4-V-2-M.W.	56235	CCl4		.2	UG/L	.1	
		79016	TCE		.13	UG/L	.1	
		CL	Chloride		3.000	MG/L		1.000
86.12448	LA-4-V-3-M.W.	56235	CCl4		.2	UG/L	.1	
		79016	TCE	<	.12	UG/L	.1	
		CL	Chloride		3.000	MG/L		1.000

Date: 12/1/86

Approved, Contracting

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Date: 12/1/86

Approved, Quality Control

Analytical Report

Date: 12/01/86

To: John Vavruska
MS - E 517
Tel. (505)-667-7391

From: Larry R. Field
HSE-9 / Contracting
MS - K484
Tel. (505)-667-5889

Source of Samples: ——> Burn Test

Sample Sheet # 5377

Sample No.	Other ID No.	Cas. Number	Analysis Type	Analytical Result		Units	Uncertainty +/-
00.96768	25.9 ppm	CL	Chloride		27.000	MG/L	1.000
00.96769	12.9 ppm	CL	Chloride		13.000	MG/L	1.000
86.12420	PA1234M5123IMPB	CL	Chloride	<	1.000	MG/L	1.000
86.12421	LA-1-M5-1-IMP	CL	Chloride	<	1.000	MG/L	1.000
86.12422	LA-1-M5-2-IMP	CL	Chloride	<	1.000	MG/L	1.000
86.12423	LA-1-M5-3-IMP	CL	Chloride	<	1.000	MG/L	1.000
86.12424	LA-2-M5-1-IMP	CL	Chloride	<	1.000	MG/L	1.000
86.12425	LA-2-M5-2-IMP	CL	Chloride		48.000	MG/L	1.000
86.12426	LA-2-M5-3-IMP	CL	Chloride		325.000	MG/L	1.000
86.12427	LA-3-M5-1-IMP	CL	Chloride		168.000	MG/L	1.000
86.12428	LA-3-M5-2-IMP	CL	Chloride		72.000	MG/L	1.000
86.12429	LA-3-M5-3-IMP	CL	Chloride		148.000	MG/L	1.000
86.12430	LA-4-M5-1-IMP	CL	Chloride		42.000	MG/L	1.000
86.12431	LA-4-M5-2-IMP	CL	Chloride		220.000	MG/L	1.000
86.12432	LA-4-M5-3-IMP	CL	Chloride		270.000	MG/L	1.000

Date: 12/1/86
Approved, Contracting

Date: 12/1/86
Approved, Quality Control

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

memorandum

TO Lee C. Borduin, HSE 7, E517 DATE November 26, 1986

FROM Larry R. Field, HSE-9, Contracting MAIL STOP/TELEPHONE K484/4086

SYMBOL HSE-9/86-555

SUBJECT Quality Assurance of Burn Test Analyses Performed By CEP (Santa Fe).

The results obtained from the Quality Control Samples submitted to CEP are given below. In addition a summary of analytical events is included at the end of this memorandum.

Chloride Analyses:

Sample Number	Analytical Result Units (ppm)	QC Result	% Recovery
00.96767	83.	81.	98.
00.96764	7.	6.4	91.
00.96765	3.6	3.2	113.
00.96766	14.5	12.9	112.
00.96768	27.	25.9	104.
00.96769	13.	12.9	100.

The average percent recovery for the chloride containing QC spiked samples was 103 % .

Inorganic Analyses (Na, Fe, & Al):

Sample Number	Analytical Result Units (mg/L)	QC Result	% Recovery
86.12484(Fe)	0.12	0.099	121.
86.12485(Fe)	0.1	0.08	125.
86.12485(Al)	0.5	0.45	111.

The average percent recovery for the Inorganic (Fe & Al) containing QC spiked samples was 119 % . Sodium (Na) was not in the QC sample.

Analyses of Liquid Mixture Feed:

Sample Number	Analytical Result Units (%)	QC Result	% Recovery
00.96591(CCl_4)	40.	46.	87.

The average percent recovery for the Liquid Feed Mixture containing QC spiked sample was 87 % .

Analyses of Volatile Organics in Soils:

Sample Number	Analytical Result Units (ug/kg)	QC Result	% Recovery
First Set			
00.96773(TCE)	7.8	20510.	0.03
00.96773(CCl_4)	0.1	20.	0.5
00.96774(TCE)	0.05	38494.	0.00
00.96774(CCl_4)	0.1	38.	0.2
Second Set			
00.96584(TCE)	ND	32.0	0.0
00.96584(CCl_4)	ND	24.3	0.0
00.96585(TCE)	ND	24.8	0.0
00.96585(CCl_4)	ND	32.7	0.0

The average percent recovery for the First Set of Volatile Organics in Soil containing QC spiked samples was 0.1 % .

The average percent recovery for the Second Set of Volatile Organics in Soil containing QC spiked samples was 0.0 % .

ND is not detected.

Analyses of Volatile Organics in Water:

Sample Number	Analytical Result Units (ug/L)	QC Result	% Recovery
First Set			
00.96775(TCE)	8050.	20280.	39.
00.96775(CCl_4)	44.	20.	220.
00.96776(TCE)	44000.	60840.	72.
00.96776(CCl_4)	69.	60.	115.
Second Set			
00.96589(TCE)	34.	32.	106.
00.96589(CCl_4)	25.	40.	63.
00.96590(TCE)	47.	32.	146.
00.96590(CCl_4)	21.	40.	53.

The average percent recovery for the First Set of Volatile Organics in Water containing QC spiked samples was 56. % for TCE and 167 % for CCl_4 .

The average percent recovery for the Second Set of Volatile Organics in Water containing QC spiked samples was 126. % for TCE and 58 % for CCl_4 .

Vost Cartridge Analyses:

Sample Number	Analytical Result Units (ng)	QC Result	% Recovery
First Set			
00.96770(TCE)	1150.	20280.	6.
00.96770(CCl_4)	8.	20.	40.
00.96771(TCE)	499.	10140.	5.
00.96771(CCl_4)	6.	10.	60.
00.96772(TCE)	NR	40560.	--
00.96772(CCl_4)	NR	40.	--

Second Set

00.96586(TCE)	240.	280.	86.
00.96586(CCl_4)	2900.	4800.	60.
00.96787(TCE)	4800.	4500.	106.
00.96787(CCl_4)	330.	220.	150.
00.96588(TCE)	2100.	1100.	190.
00.96588(CCl_4)	1440.	800.	180.

The average percent recovery for the First Set of Vost Cartridges containing QC spiked samples was 5.5 % for TCE and 50 % for CCl_4 .

The average percent recovery for the Second Set of Vost Cartridges containing QC spiked samples was 127. % for TCE and 130 % for CCl_4 .

NR is not reported.

Summary of Analytical Events:

Approximately 10 % of the analyses performed for this study were evaluated by the insertion of Quality Control Samples. The results obtained from the analyses of these samples are listed above.

Good analytical recoveries were achieved from the determinations of Chloride and the atomic species (Fe, Al, and Na) in spiked QC samples. However, such was not the case for the organic analyses of TCE and CCl_4 in various matrices i.e., air, water, and soil.

Inspection of the analytical data obtained from, and auditing of the analytical procedures used by, the contract analytical laboratory (CEP of Santa Fe) pointed out two distinct flaws. One was in the spiking of the QC samples themselves and the other was in the analytical technique used by CEP to analyze the liquid feed mixtures.

1.) The problem with the spiked QC samples was that the TCE was spiked at a 1000 fold excess of what it should be. The behavior of large amounts of these volatile organic materials on sorption media such as soils and Tenax is unknown and may account for the low recoveries observed for the first set of analyses. Thus, it was decided to resubmit additional QC samples to CEP for analyses, that contained organic materials spiked at levels more-in-line with what was found in the majority of the other samples. The recoveries on second set were better for the vost cartridges, but were erratic for the water samples.

2.)The improper analytical technique used by CEP for the analyses of the Liquid Feed mixtures was GC-ECD. The reason for this being improper is that calibration curves for the ECD are extremely non-linear at the high levels found in the samples we submitted. GC-FID on the other hand is the appropriate analytical technique for these analyses. Thus, it was decided to resubmit for analyses, all of the samples previously analyzed by GC-ECD along with new QC samples. The results obtained for the QC samples for the old vs new method are found in tabular form in this memorandum as First Set = old method(GC-ECD) and Second Set = new method(GC-FID). The average recoveries for these are listed at the bottom of each table.

It should be noted here that the poor recoveries observed for the soil samples, may result from dramatic differences in altitude between the sampling site and analytical laboratory. Further, the soil used to make these QC samples is not truly representative of the ash samples for which they were intended, so the low recoveries may not be an indication of the reliability of data obtained from the ash samples. Then again, it may.

cy: Peggy Gautier, QA/QC.

WEIGHT SHEETS

WEIGH SHEET # 1 AS ENTERED

R D S	R U N	W T #	IDENTIFIER	F B T	WASH ML	CORR.	GROSS	TARE	NET
		1	BLANK *	B	100	0.0000	67.5669	67.5622	.00080
01	1-1	2	B1	B	100	.0008	66.0277	66.0097	0.0172
02	2-1	3	B2	B	170	0.0014	68.9431	68.9268	0.0149
03	3-1	4	B3	B	170	0.0014	68.6401	68.6204	0.0183
04	1-2	5	B4	B	140	0.0011	68.4436	68.4208	0.0217
05	2-2	6	B5	B	147	0.0012	66.1587	66.1389	0.0186
06	3-2	7	B6	B	140	0.0011	64.0782	64.0557	0.0214
07	1-3	8	B7	B	150	0.0012	67.3314	67.3044	0.0258
08	2-3	9	B8	B	150	0.0012	66.1344	66.0979	0.0353
09	3-3	10	B9	B	140	0.0011	68.2562	68.2116	0.0435
10	1-4	11	B10	B	170	0.0014	67.0599	67.0461	0.0124
12	3-4	12	BM	B	175	0.0014	106.3878	106.3481	0.0383
11	2-4	13	B11	B	160	0.0013	65.3717	65.3469	0.0235
04	1-2	14	21517	F	----	------	3.8792	3.8809	-0.0017
12	3-4	15	21518	F	----	------	3.8817	3.8715	0.0102
01	1-1	16	21520	F	----	------	3.8832	3.8843	-0.0011
05	2-2	17	21507	F	----	------	3.7718	3.7732	-0.0014
06	3-2	18	21509	F	----	------	3.8015	3.8003	0.0012
10	1-4	19	21510	F	----	------	3.8133	3.8131	0.0002
02	2-1	20	21511	F	----	------	3.8233	3.8261	-0.0028

* NOTE: MAXIMUM ALLOWABLE CORRECTION IS .0008 GR/100ML

WEIGH SHEET # 1 SORTED

R D S	R U N	W T #	IDENTIFIER	F B T	WASH ML	CORR.	GROSS	TARE	NET
		1	BLANK *	B	100	0.0000	67.5669	67.5622	.00080
01	1-1	2	B1	B	100	.0008	66.0277	66.0097	0.0172
01	1-1	16	21520	F	----	------	3.8832	3.8843	-0.0011
02	2-1	3	B2	B	170	0.0014	68.9431	68.9268	0.0149
02	2-1	20	21511	F	----	------	3.8233	3.8261	-0.0028
03	3-1	4	B3	B	170	0.0014	68.6401	68.6204	0.0183
04	1-2	5	B4	B	140	0.0011	68.4436	68.4208	0.0217
04	1-2	14	21517	F	----	------	3.8792	3.8809	-0.0017
05	2-2	6	B5	B	147	0.0012	66.1587	66.1389	0.0186
05	2-2	17	21507	F	----	------	3.7718	3.7732	-0.0014
06	3-2	7	B6	B	140	0.0011	64.0782	64.0557	0.0214
06	3-2	18	21509	F	----	------	3.8015	3.8003	0.0012
07	1-3	8	B7	B	150	0.0012	67.3314	67.3044	0.0258
08	2-3	9	B8	B	150	0.0012	66.1344	66.0979	0.0353
09	3-3	10	B9	B	140	0.0011	68.2562	68.2116	0.0435
10	1-4	11	B10	B	170	0.0014	67.0599	67.0461	0.0124
10	1-4	19	21510	F	----	------	3.8133	3.8131	0.0002
11	2-4	13	B11	B	160	0.0013	65.3717	65.3469	0.0235
12	3-4	12	BM	B	175	0.0014	106.3878	106.3481	0.0383
12	3-4	15	21518	F	----	------	3.8817	3.8715	0.0102

* NOTE: MAXIMUM ALLOWABLE CORRECTION IS .0008 GR/100ML

WEIGH SHEET # 2 AS ENTERED

RDS	RUN	WT #	IDENTIFIER	FBT	WASH ML	CORR.	GROSS	TARE	NET
		1	BLANK	B	----	0.0000	--------	--------	-------
11	2-4	2	21512	F	----	------	3.8195	3.8184	0.0011
03	3-1	3	21513	F	----	------	3.8282	3.8281	0.0001
08	2-3	4	21514	F	----	------	3.8320	3.8299	0.0021
09	3-3	5	21556	F	----	------	3.9627	3.9620	0.0007
07	1-3	6	21557	F	----	------	3.9449	3.9441	0.0008
		7	END	-	----	------	--------	--------	-------
		8	--------	-	----	------	--------	--------	-------
		9	--------	-	----	------	--------	--------	-------
		10	--------	-	----	------	--------	--------	-------
		11	--------	-	----	------	--------	--------	-------
		12	--------	-	----	------	--------	--------	-------
		13	--------	-	----	------	--------	--------	-------
		14	--------	-	----	------	--------	--------	-------
		15	--------	-	----	------	--------	--------	-------
		16	--------	-	----	------	--------	--------	-------
		17	--------	-	----	------	--------	--------	-------
		18	--------	-	----	------	--------	--------	-------
		19	--------	-	----	------	--------	--------	-------
		20	--------	-	----	------	--------	--------	-------

WEIGH SHEET # 2 SORTED

RDS	RUN	WT #	IDENTIFIER	FBT	WASH ML	CORR.	GROSS	TARE	NET
		1	BLANK	B	----	0.0000	--------	--------	-------
11	2-4	2	21512	F	----	------	3.8195	3.8184	0.0011
03	3-1	3	21513	F	----	------	3.8282	3.8281	0.0001
08	2-3	4	21514	F	----	------	3.8320	3.8299	0.0021
09	3-3	5	21556	F	----	------	3.9627	3.9620	0.0007
07	1-3	6	21557	F	----	------	3.9449	3.9441	0.0008
		7	END	-	----	------	--------	--------	-------
		8	--------	-	----	------	--------	--------	-------
		9	--------	-	----	------	--------	--------	-------
		10	--------	-	----	------	--------	--------	-------
		11	--------	-	----	------	--------	--------	-------
		12	--------	-	----	------	--------	--------	-------
		13	--------	-	----	------	--------	--------	-------
		14	--------	-	----	------	--------	--------	-------
		15	--------	-	----	------	--------	--------	-------
		16	--------	-	----	------	--------	--------	-------
		17	--------	-	----	------	--------	--------	-------
		18	--------	-	----	------	--------	--------	-------
		19	--------	-	----	------	--------	--------	-------
		20	--------	-	----	------	--------	--------	-------

BALANCE _____ CLIENT LOS ALAMOS N-L

OPERATOR J. BALABUS ZICO PLANT WASTE MANAGEMENT

DATE 9/4/86 UNIT INCINERATOR

SHEET # 1 OF 1 ** 68-2562 * RUN # _____

WEIGHT SHEET * MORE ADD

RUN #	WT. #	FILTER # OR IDENTIFICATION	TFB	WASH ML	WASH CORR.	GROSS	TARE	NE
	1	BLANK	B		- - - -			
LANL-1-M5-1	2	1	B	100'	*	66.0268 66.0277	66.0088 66.0097 66.0091 *	.0186
LANL-1-M5-2	3	2	B	~~160~~ 170 FINAL VOL.	*	68.9425 68.9431	68.9265 68.9274 68.9268 *	.0163
LANL-1-M5-3	4	3	B	~~160~~ 170 FINAL VOL.	*	68.6394 68.6401	68.6203 68.6210 68.6204 *	.0197
LANL-2-M5-1	5	4	B	140	*	68.4429 68.4436	68.4205 68.4211 68.4208 *	.0228
LANL-2-M5-2	6	5	B	147	*	66.1594 66.1581 66.1587	66.1385 66.1395 66.1389 *	.0198
LANL-2-M5-3	7	6	B	140	*	64.0790 64.0777 64.0782	64.0548 64.0559 64.0557 *	.0225
LANL-3-M5-1	8	7	B	150	*	67.3312 67.3314	67.3049 67.3044 *	.0270
LANL-3-M5-2	9	8	B	150	*	66.1345 66.1344	66.0985 66.0979 *	.0365
LANL-3-M5-3	10	9	B	140	** *68.2562 *	68.2556 68.2576 68.2554	68.2117 68.2116 *	.0446 ~~44~~
LANL-4-M5-1	11	10	B	170		67.0595 67.0599	67.0451 67.0461 67.0461	

BALANCE _____ CLIENT LOS ALAMOS N.L.

OPERATOR J BMARUSZKO PLANT WASTE MANAGEMENT

DATE 9-4-86 UNIT INCINERATOR

SHEET # 1 OF 3 RUN # _____

WEIGHT SHEET

RUN #	WT. #	FILTER # OR IDENTIFICATION	TFB	WASH ML	WASH CORR.	GROSS	TARE	NE
	1	BLANK	B		- - - -			
	2	21548	F					
	3	21549	F					
	4	21550 lb	F					
	5	21551	F					
	6	21552	F					
	7	21553	F					
	8	21554	F					
	9	21555	F					
LANL-3-M5-3	10	21556	F			3.9628	3.9619	
						* 3.9628 JK	3.9620 *	.000
LANL 3-M5-1	11	21557	F			3.9448	3.9441	
						* 3.9449	3.9441 *	.000

CLEAR AIR ENGINEERING, INC

BALANCE _____ CLIENT _____

OPERATOR S. BALABUSZKO PLANT _____

DATE 9-4-86 UNIT _____

SHEET # 2 OF 3 RUN # _____

WEIGHT SHEET

RUN #	WT. #	FILTER # OR IDENTIFICATION	TFB	WASH ML	WASH CORR.	GROSS	TARE	NE
	1	BLANK	B		- - - -			
LANL 2-MS-2 (5)	2	21507	F			3.7718 * 3.7718	3.7732 3.7732 *	-.0014
BLANK	3	21508	F				3.7809 3.7807	
~~2-2~~ LANL 2-MS-3 (6)	4	21509	F			3.8012 ~~3.8013~~ * 3.8015 JB	3.8002 3.8003 *	.0012
LANL-4-MS-1	5	21510	F			3.8136 3.8133	3.8130 3.8131	
2 LANL-1-MS-2-F	6	21511	F			3.8234 * 3.8233	3.8260 3.8261 *	-.0028
LANL-4-MS-2	7	21512	F			3.8195 3.8195	3.8183 3.8184	
3 LANL-1-MS-3-E	8	21513	F			3.8285 ~~3.8270~~ * 3.8282	3.8282 3.8281 *	.0001
LANL 3-MS-2	9	21514	F			3.8321 * 3.8320	3.8299 3.8299 *	.002
BLANK	10	21515	F			~~3.9226~~	~~3.9222~~ 3.9223	
	11	21516	F				3.8482 3.8484	

BALANCE _____ CLIENT _____

OPERATOR J BALABUSZKO PLANT _____

DATE 9-4-86 UNIT _____

SHEET # 3 OF 3 RUN # _____

WEIGHT SHEET

RUN #	WT. #	FILTER # OR IDENTIFICATION	TFB	WASH ML	WASH CORR.	GROSS	TARE	N
	1	BLANK	B		- - - - JS			
LANL-M5-1 (4)	2	21517	F		3.8792	~~3.8792~~	3.8808	
						* 3.8792 JS	3.8809 *	-.001
LANL-4-M5-3	3	21518	F			3.8817	3.8714	
						3.8817	3.8715	
	4	21519	F					
#1 LANL-1-M5-1-F.	5	21520	F			3.8833	3.8842	
						* 3.8832	3.8843 * JS	-.00
LANL-4-M5-3	6	M	B	175		106.3859	106.3485	
						106.3878	106.3481	
						106.3878		
	7	11	B				2.9119	
	8	12	B				2.9157	
LANL-4-M5-2	9	11	B	160		65.3715	65.3460	
						65.3717	65.3472	
							65.3469	
blank	10	12	B	100 (.000047/ml)		67.5662	67.5617	
						* 67.5669	67.5626 *	.00
							67.5622 *	
2nd Acetone blank ~~LANL-AM5-3~~	11	AA	B	100		107.5203	107.5201	
						107.5205	107.5210	

FIELD DATA

ORSAT READINGS

Job: Los Alamos National Laboratories - Controlled Date: 9-4-86

Air Incinerator - Stack

Test No.: LANL-1-M5-1 (Condition 1 Run 1)
LANL-1-M5-2 (Condition 1 Run 2)
LANL-1-M5-3 (Condition 1 Run 3)

Time	% CO_2		% O_2		% CO	
LANL-1-M5-1 Bag 1	8.7		17.8	9.1		
Bag 1	8.6		17.8	9.2		
Bag 2	8.6		17.8	9.2		
Bag 2	8.6		17.8	9.2		
LANL-1-M5-2 Bag 1	8.6		17.8	9.2		
Bag 1	8.6		17.8	9.2		
Bag 2	8.6		17.7	9.1		
Bag 2	8.6		17.7	9.1		
LANL-1-M5-3 Bag 1	8.7		17.8	9.1		
Bag 1	8.6		17.8	9.2		
Bag 2	8.6		17.8	9.2		
Bag 2	8.6		17.8	9.2		
Average						

Engineering, Inc.

LANL-1-M5-1-ORSAT-MOISTURE

BAG 1			BAG 2		
CO_2+O_2	O_2	CO_2	CO_2+O_2	O_2	CO_2
17.8	9.1	8.7	17.8	9.2	8.6
17.8	9.2	8.6	17.8	9.2	8.6

Silica Gel gain - 12.6g. Impinger Water gain - 296 ml.

LANL-1-M5-2-ORSAT-MOISTURE

BAG 1			BAG 2		
CO_2+O_2	O_2	CO_2	CO_2+O_2	O_2	CO_2
17.8	9.2	8.6	17.7	9.1	8.5
17.8	9.2	8.6	17.7	9.1	8.6

Silica Gel gain - 14.0g Impinger Water Gain - 395

LANL-1-M5-3-ORSAT-MOISTURE

BAG 1			BAG 2		
CO_2+O_2	O_2	CO_2	CO_2+O_2	O_2	CO_2
17.8	9.1	8.7	17.8	9.2	8.6
17.8	9.2	8.6	17.8	9.2	8.6

Silica Gel Gain - 14.0 Impinger Water Gain - 385

ORSAT READINGS

Job: Los Alamos National Laboratories - Controlled Air Incinerator - Stack

Date: 9-5-86

Test No.: LANL-2-MS-1, LANL-2-MS-2, LANL-2-MS-3

Time	% CO_2		% O_2		% CO	
LANL-2-MS-1 Bag 1	8.0		18.4	10.4		
Bag 1	8.0		18.4	10.4		
Bag 2	8.0		18.4	10.4		
Bag 2	8.0		18.4	10.4		
	silica gel gain - 8.8 g		impinger water gain - 295 ml			
LANL-2-MS-2 Bag 1	8.0		18.4	10.4		
Bag 1	8.0		18.4	10.4		
Bag 2	8.0		18.4	10.4		
Bag 2	8.0		18.4	10.4		
	silicagel gain - 11.0		impinger H_2O gain - 296			
LANL-2-MS-3 Bag 1	8.0		18.4	10.4		
Bag 1	8.0		18.4	10.4		
Bag 2						
Bag 2						
	silica gel gain - 13.6		impinger H_2O gain - 287			
Average						

Engineering, Inc.

ORSAT READINGS

Job: Los Alamos National Laboratories - Controlled Air Incinerator - Stack sampling

Date: 9/6/86

Test No.: LANL-3-MS-1, LANL-3-MS-2, LANL-3-MS-3

Time	% CO_2		% O_2		% CO	
LANL-3-MS-1 Bag 1	8.0		18.1	10.1		
Bag 1	8.0		18.1	10.1		
Bag 2	8.0		18.1	10.1		
Bag 2	8.0		18.1	10.1		
	silica gel gain - 18		imp. H_2O gain - 387			
LANL-3-MS-2 Bag 1	7.6		17.6	10.0	silica gel gain - 18.4	
Bag 1	7.6		17.6	10.0	impinger H_2O gain - 416.7	
Bag 2	~~7~~.6		~~18.2~~ 17.7	10.0		
Bag 2	7.6 ~~8.0~~		17.6	10.0		
LANL-3-MS-3 Bag 1	7.6		17.8	10.2	silica gel gain - 17.9	
Bag 1	~~7.6~~ 7.6		17.8	10.2	impinger H_2O gain - 280	
Bag 2	7.6		17.8	10.2		
Bag 2	7.6		17.8	10.2		
Average						

Engineering, Inc.

ORSAT READINGS

Job: Los Alamos National Laboratories — Date: 9/7/86

Controlled Air Incinerators

Test No.: LANL-4-MS-1, LANL-4-MS-2, LANL-4-MS-3

Time	% CO_2		% O_2		% CO	
LANL-4-MS-1 Bag 1	5.8		18.2	12.4 Silica Gel Gain		11.6
Bag 1	5.8		18.2	12.4 H_2O	gain	-242.6
Bag 2	6.0		18.2	12.2		
Bag 2	6.0		18.2	12.2		
LANL-4-MS-2 Bag 1	7.0		18.3	~~12.7~~ 11.3		
Bag 1	7.0		17.8	11.1 silica	Gel	-13.8
Bag 1	7.0		18.1	11.1 H_2O	gain	-210.9
Bag 2	7.0		18.0	11.0		
Bag 2	7.0		18.2	11.0		
LANL-4-MS-3 Bag 1	8.0		18.2	10.2	silica gel	-18.4
Bag 1	8.0		18.2	10.2	H_2O gain	-279
~~Bag 2~~	~~6.4~~		~~18.6~~	~~12.2~~		
~~Bag 2~~	~~6.~~		~~18.4~~	~~12.2~~		
~~Bag 2~~	~~6.2~~		~~18.4~~	~~12.2~~		
Average						

Bag 2 not fully purged.

Engineering, Inc.

RAW DATA SET # 1

1) Plant	LANL	17) Heater Box Setting	250
2) Location	Outlet	18) Probe Length', ' Ft.	3
3) Operator	J. Balabuszko	19) Nozzle Diameter', 'In.	0.313
4) Date	9/4/86	20) Probe Heater Setting	250
5) Run No.	1	21) % O2	9.2
6) Sample Box No.		22) % CO2	8.6
7) Meter Box No.	GG	23) ML. H2O	296
8) Meter H@	1.807	24) GM. Silica Gel	12.6
9) K Factor	8.3	25) Total	305.6
10) Pitot Factor	0.84	26) Start Time	1:10 pm
11) Leak Rate Before	0.005@17	27) Finish Time	2:45 pm
12) Leak Rate After	0.000@12	28) Yd:	0.9999
13) Static Pres., in H2O	0.5	29) Stack Area	0.7773
14) Ambient Temperature	80	30) Sampling Time (MIN/PT)	4
15) Barometric Pressure	23.19	31) Initial Volume	95.76
16) Assumed Moisture, %	38	32) FILTER & BEAKER #'S	21520F
		B1B	

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						95.76				J.	Balabuszko
1 - 1	4	12	220	0.19	1.2	98.59	94	91	52	245	116.2 *
LEAK CK						98.71					
1 - 1	4	6.5	220	0.19	0.78	101.01	90	91	54	283	94.7
1 - 2	4	6	222	0.17	0.70	103.25	89	90	61	248	97.8
. - 2	4	6	222	0.17	0.70	105.35	89	90	63	254	91.7
1 - 3	4	7	214	0.19	0.78	107.64	90	89	60	282	94.0
1 - 3	4	9	208	0.24	0.98	110.17	89	89	58	256	92.1
1 - 4	4	9	197	0.23	0.94	112.64	86	87	58	274	91.5
1 - 4	4	8	182	0.20	0.82	115.02	82	84	59	237	94.1
2 - 1	4	6	216	0.16	0.66	117.10	81	81	64	278	94.6
2 - 1	4	7.5	218	0.20	0.82	119.43	80	81	58	250	95.1
2 - 2	4	7	219	0.17	0.70	121.64	80	81	56	258	97.9
2 - 2	4	6	220	0.15	0.62	123.72	80	80	56	262	98.2
2 - 3	4	8	219	0.17	0.70	125.83	80	79	57	298	93.6
2 - 3	4	5	200	0.12	0.53	127.74	80	79	57	278	99.4
2 - 4	4	4.5	191	0.11	0.45	129.51	79	78	58	260	95.7
2 - 4	4	5	181	0.13	0.53	131.38	79	78	58	246	92.3

64	209	.415	.74	35.5	84
Total	Avg.	Root	Avg.	Volume	Avg.

RAW DATA SET # 2

1)	Plant	LANL	17)	Heater Box Setting	250
2)	Location	Outlet	18)	Probe Length, Ft.	3
3)	Date	5/4/88	20)	Probe Heater Setting	250
5)	Run No.	2	21)	% O2	9.2
6)	Sample Box No.		22)	% CO2	8.6
7)	Meter Box No.	GG	23)	Ml. H2O	395
8)	Meter H@	1.807	24)	GM. Silica Gel	14
9)	K Factor	4.1	25)	Total	409
10)	Pitot Factor	0.84	26)	Start Time	6:52 pm
11)	Leak Rate Before	0.005@17	27)	Finish Time	8:15 pm
12)	Leak Rate After	0.000@7	28)	Yd.	0.9999
13)	Static Pres., in H2O	0.6	29)	Stack Area	0.7773
14)	Ambient Temperature		30)	Sampling Time (MIN/PT)	5
15)	Barometric Pressure	23.08	31)	Initial Volume	31.71
16)	Assumed Moisture, %		32)	FILTER & BEAKER #'S	21511F B2B

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						31.71				J. Balabuszko	
1 - 1	5	6.5	220	0.22	0.90	34.79	85	88	51	232	96.2
1 - 1	5	7	221	0.23	0.94	37.92	82	86	50	245	96.2
1 - 2	5	6	224	0.21	0.86	40.87	81	85	50	240	95.2
1 - 2	5	6	225	0.21	0.86	43.86	80	84	51	234	96.8
1 - 3	5	6	216	0.19	0.78	46.71	81	83	50	234	96.3
1 - 3	5	5.5	214	0.18	0.74	49.47	80	82	50	239	95.8
1 - 4	5	5	203	0.16	0.66	52.09	80	81	51	252	95.8
1 - 4	5	5	187	0.16	0.66	54.79	79	80	52	251	97.7
2 - 1	5	7	222	0.22	0.90	57.87	77	79	52	251	97.9
2 - 1	5	7	223	0.22	0.90	60.85	77	78	51	242	94.9
2 - 2	5	5	226	0.17	0.68	63.51	77	78	54	241	96.5
2 - 2	5	5	226	0.17	0.68	66.14	77	77	53	243	95.5
2 - 3	5	5.5	214	0.16	0.66	68.33	76	76	52	253	96.3
2 - 4	5	4	196	0.12	0.49	73.61	76	76	56	243	96.5
2 - 4	5	4.5	182	0.13	0.53	75.94	75	75	56	242	93.9
	80 Total		213 Avg.	.425 Root	.74 Avg.	44.23 Volume		79 Avg.			

RAW DATA SET # 3

1)	Plant	LANL	17)	Heater Box Setting	250
2)	Location	Outlet	18)	Probe Length', ' Ft.	3
3)	Operator	J. Balabuszko	19)	Nozzle Diameter', 'In.	0.313
4)	Date	9/4/86	20)	Probe Heater Setting	250
5)	Run No.	3	21)	% O2	9.2
6)	Sample Box No.		22)	% CO2	8.6
7)	Meter Box No.	GG	23)	ML. H2O	385
8)	Meter H@	1.807	24)	GM. Silica Gel	14
9)	K Factor	4.0	25)	Total	399
10)	Pitot Factor	0.84	26)	Start Time	9:25 pm
11)	Leak Rate Before	0.01@14	27)	Finish Time	10:45 pm
12)	Leak Rate After	0.01@15	28)	Yd.	0.9999
13)	Static Pres., in H2O	0.5	29)	Stack Area	0.7773
14)	Ambient Temperature	55	30)	Sampling Time (MIN/PT)	5
15)	Barometric Pressure	23.08	31)	Initial Volume	77.50
16)	Assumed Moisture, %		32)	FILTER & BEAKER #'S	21513F B3B

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						77.50				J. Balabuszko	
1 - 1	5	8	214	0.22	0.88	80.49	65	65	60	253	97.5
1 - 1	5	8	221	0.22	0.88	83.46	65	65	52	251	97.4
1 - 2	5	8	225	0.20	0.80	86.34	66	65	50	248	99.2
1 - 2	5	8	225	0.20	0.80	89.28	66	65	53	244	101.3
1 - 3	5	6	220	0.17	0.68	91.84	67	66	52	241	95.1
1 - 3	5	6	214	0.16	0.64	94.42	67	66	52	244	98.3
1 - 4	5	5	196	0.14	0.56	96.81	67	66	51	247	96.0
1 - 4	5	5	184	0.14	0.56	99.19	67	66	51	247	94.7
2 - 1	5	7	221	0.19	0.76	101.97	67	66	52	243	97.7
2 - 1	5	7	224	0.19	0.76	104.71	67	66	51	249	96.5
2 - 2	5	7	225	0.17	0.68	107.35	68	66	52	242	98.3
2 - 2	5	7	226	0.17	0.68	109.99	68	67	52	244	98.3
2 - 3	5	6	209	0.15	0.60	112.48	68	67	52	248	97.4
2 - 3	5	6	206	0.15	0.60	114.98	68	67	52	243	97.6
2 - 4	5	4	198	0.12	0.48	117.22	67	67	52	247	97.2
2 - 4	5	4	184	0.12	0.48	119.47	67	67	52	253	96.6

80	212	.41	.68	41.97	66
Total	Avg.	Root	Avg.	Volume	Avg.

RAW DATA SET # 4

1) Plant	LANL	17) Heater Box Setting	250
2) Location	Outlet	18) Probe Length', ' Ft.	3
3) Operator	J. Balabuszko	19) Nozzle Diameter', 'In.	0.313
4) Date	9/5/86	20) Probe Heater Setting	250
5) Run No.	1	21) % O2	10.4
6) Sample Box No.		22) % CO2	8.0
7) Meter Box No.	GG	23) Ml. H2O	295
8) Meter H@	1.807	24) GM. Silica Gel	8.8
9) K Factor	3.9	25) Total	303.8
10) Pitot Factor	0.84	26) Start Time	9:50 am
Finish Time	11:20 am		
12) Leak Rate After	0.01@17	28) Yd.	0.9999
13) Static Pres., in H2O	0.5	29) Stack Area	0.7773
14) Ambient Temperature		30) Sampling Time (MIN/PT)	5
15) Barometric Pressure	23.05	31) Initial Volume	19.71
16) Assumed Moisture, %		32) FILTER & BEAKER #'S	21517F 84B

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						19.71				J.	Balabuszko
1 - 1	5	4	220	0.19	0.74	22.47	65	64	46	241	92.7
1 - 1	5	4	222	0.19	0.74	25.22	66	64	42	244	92.4
1 - 2	5	4	225	0.17	0.66	27.81	68	65	42	255	91.9
1 - 2	5	4	226	0.16	0.62	30.32	70	66	42	252	91.6
1 - 3	5	4	221	0.14	0.55	32.69	71	67	43	249	92.0
1 - 3	5	4	218	0.14	0.55	35.09	71	68	44	251	92.8
1 - 4	5	3	206	0.11	0.43	37.22	72	69	46	243	91.9
1 - 4	5	3	186	0.10	0.39	39.27	73	70	47	251	91.2
2 - 1	5	5	221	0.19	0.74	42.04	72	71	51	258	91.9
2 - 1	5	5	226	0.18	0.70	44.73	75	72	46	252	91.7
2 - 2	5	5	228	0.15	0.59	47.22	76	73	48	246	92.9
2 - 2	5	4.5	228	0.14	0.55	49.64	76	73	50	253	93.4
2 - 3	5	4	217	0.13	0.51	51.97	76	73	51	254	92.6
2 - 3	5	4	218	0.13	0.51	54.30	77	74	51	254	92.5
2 - 4	5	4	203	0.10	0.39	56.40	77	74	52	257	93.9
2 - 4	5	4	198	0.11	0.43	58.55	78	75	53	245	91.2

80	216	.379	.57	38.84	71
Total	Avg.	Root	Avg.	Volume	Avg.

RAW DATA SET # 5

1)	Plant	LANL	17)	Heater Box Setting	250
2)	Location	Outlet	18)	Probe Length', ' Ft.	3
3)	Operator	J. Balabuszko	19)	Nozzle Diameter', 'In.	0.313
4)	Date	9/5/86	20)	Probe Heater Setting	250
5)	Run No.	2	21)	% O2	10.4
6)	Sample Box No.		22)	% CO2	8.0
7)	Meter Box No.	GG	23)	Ml. H2O	296
8)	Meter H@	1.807	24)	GM. Silica Gel	11.0
9)	K Factor	4.4	25)	Total	307
10)	Pitot Factor	0.84	26)	Start Time	12:20 pm
11)	Leak Rate Before	0.01@17	27)	Finish Time	1:40 pm
12)	Leak Rate After	0.01@6	28)	Yd.	0.9999
13)	Static Pres., in H2O	0.6	29)	Stack Area	0.7773
14)	Ambient Temperature		30)	Sampling Time (MIN/PT)	5
15)	Barometric Pressure	23.05	31)	Initial Volume	58.80
16)	Assumed Moisture, %		32)	FILTER & BEAKER #'S	21507F 85B

Pt. #	Ø	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						58.80				J. Balabuszko	
1 - 1	5	6	233	0.19	0.84	61.77	88	87	55	278	95.2
1 - 1	5	6	233	0.19	0.84	64.70	89	88	50	243	93.8
1 - 2	5	6	235	0.17	0.75	67.53	90	89	54	310	95.7
- 2	5	6	234	0.17	0.75	70.33	91	90	54	290	94.4
- 3	5	4.5	227	0.14	0.62	72.91	92	90	57	239	95.3
1 - 3	5	4.5	225	0.13	0.57	75.39	93	90	58	248	94.8
1 - 4	5	3.5	212	0.11	0.48	77.64	92	90	59	246	92.7
1 - 4	5	3.5	199	0.11	0.48	79.93	92	90	60	299	93.4
2 - 1	5	5.5	230	0.19	0.84	82.84	91	90	59	239	92.6
2 - 1	5	5.5	233	0.18	0.79	85.75	91	90	54	262	95.3
2 - 2	5	5	236	0.15	0.66	88.43	93	92	58	267	96.0
2 - 2	5	5	236	0.14	0.62	91.04	94	93	60	303	96.6
2 - 3	5	4.5	232	0.13	0.57	93.56	95	94	61	264	96.3
2 - 3	5	4	228	0.12	0.53	95.97	98	96	63	263	95.1
2 - 4	5	4	220	0.10	0.44	98.26	99	97	65	310	98.2
	80 Total		226 Avg.	.378 Root	.64 Avg.	41.71 Volume	92 Avg.				

RAW DATA SET # 6

1) Plant	LANL	17) Heater Box Setting	250
2) Location	Outlet	18) Probe Length', ' Ft.	3
3) Operator	J. Balabuszko	19) Nozzle Diameter', 'In.	0.313
4) Date	9/5/86	20) Probe Heater Setting	250
5) Run No.	3	21) % O2	10.4
6) Sample Box No.		22) % CO2	8.0
7) Meter Box No.	GG	23) Ml. H2O	287
8) Meter H@	1.807	24) GM. Silica Gel	13.6
9) K Factor		25) Total	300.6
10) Pitot Factor	0.84	26) Start Time	2:40 pm
11) Leak Rate Before	0.02@17	27) Finish Time	4:00 pm
12) Leak Rate After	0.02@17	28) Yd.	0.9999
13) Static Pres., in H2O	0.5	29) Stack Area	0.7773
14) Ambient Temperature		30) Sampling Time (MIN/PT)	5
15) Barometric Pressure	23.05	31) Initial Volume	2.72
16) Assumed Moisture, %		32) FILTER & BEAKER #'S	21509F
		BAR	

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0						2.72				J.	Balabuszko
1	5	5	232	0.18	0.79	5.68	99	99	68	299	95.0
1 - 1	5	5	235	0.19	0.84	8.67	98	99	68	280	93.7
1 - 2	5	4.5	236	0.18	0.79	11.55	98	98	63	240	92.9
1 - 2	5	4	239	0.16	0.70	14.31	99	98	64	283	94.5
1 - 3	5	4	234	0.13	0.57	16.82	103	100	60	247	94.5
1 - 3	5	4	232	0.12	0.53	19.27	104	102	58	201	95.6
1 - 4	5	3	212	0.09	0.40	21.43	105	103	56	276	95.7
1 - 4	5	3	205	0.10	0.44	23.68	105	104	57	276	94.0
2 - 1	5	4	235	0.17	0.75	26.47	106	104	63	200	91.4
2 - 1	5	4	239	0.17	0.75	29.31	105	103	56	249	93.5
2 - 2	5	4	240	0.15	0.66	31.97	106	105	58	228	93.0
2 - 2	5	4	239	0.14	0.62	34.59	106	107	60	291	94.5
2 - 3	5	3.5	232	0.13	0.57	37.10	107	107	61	255	93.4'
2 - 3	5	3.5	226	0.13	0.57	39.56	105	104	61	238	91.6
2 - 4	5	3.5	216	0.12	0.53	42.02	104	102	61	308	94.8
2 - 4	5	3.5	208	0.11	0.48	44.32	103	105	62	277	91.9

80	229	.375	.62	41.6	103
Total	Avg.	Root	Avg.	Volume	Avg.

RAW DATA SET # 7

1) Plant	LANL	17) Heater Box Setting	250
2) Location	Outlet	18) Probe Length', ' Ft.	3
3) Operator	J. Balabuszko	19) Nozzle Diameter', 'In.	0.313
4) Date	9/6/86	20) Probe Heater Setting	250
5) Run No.	1	21) % O2	10.1
6) Sample Box No.		22) % CO2	8.0
7) Meter Box No.	GG	23) Ml. H2O	381
8) Meter H@	1.807	24) GM. Silica Gel	18
9) K Factor	4.2	25) Total	399
10) Pitot Factor	0.84	26) Start Time	10:35 AM
11) Leak Rate Before	0.005@15	27) Finish Time	11:55 AM
12) Leak Rate After	0.01@15	28) Yd.	0.9999
13) Static Pres., in H2O	0.6	29) Stack Area	0.7773
14) Ambient Temperature		30) Sampling Time (MIN/PT)	5
15) Barometric Pressure	23.15	31) Initial Volume	45.48
16) Assumed Moisture, %		32) FILTER & BEAKER #'S	21557F B7B

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I	
0 - 0						45.48				J. Balabuszko		
1 - 1	5	7.5	225	0.24	1.0	48.72	72	71	41	253	99.0	
1 - 1	5	7.5	230	0.24	1.0	51.91	72	72	39	256	97.8	
1 - 2	5	8	233	0.23	0.97	55.06	73	72	43	249	98.7	
1 - 2	5	8	233	0.22	0.92	58.18	74	73	51	252	99.8	
1 - 3	5	5.5	227	0.16	0.67	60.83	75	73	58	261	98.8	
1 - 3	5	5.5	225	0.17	0.71	63.56	76	74	58	256	98.4	
1 - 4	5	5	214	0.14	0.59	66.05	78	75	57	256	97.8	
1 - 4	5	5	198	0.14	0.59	68.06	78	76	57	250	77.9	*
2 - 1	5	7.5	230	0.23	0.97	71.19	79	77	53	262	96.9	
2 - 1	5	7.5	234	0.22	0.92	74.30	80	77	50	274	98.6	
2 - 2	5	6	235	0.18	0.76	77.11	81	78	50	251	98.3	
2 - 2	5	6	235	0.18	0.76	79.94	83	80	50	330	98.7	
2 - 3	5	5.5	229	0.17	0.71	82.70	85	82	53	284	98.2	
2 - 3	5	5.5	227	0.17	0.71	85.44	86	84	51	253	97.1	
2 - 4	5	5	220	0.14	0.59	88.01	88	85	52	281	99.5	
2 - 4	5	5	209	0.14	0.59	90.55	90	87	54	251	97.2	
	80		225	.429	.78	45.07		78				
	Total		Avg.	Root	Avg.	Volume		Avg.				

RAW DATA SET # 8

1)	Plant	LANL	17)	Heater Box Setting	250
2)	Location	Outlet	18)	Probe Length', ' Ft.	3
3)	Operator	J. Balabuszko	19)	Nozzle Diameter', 'In.	0.313
4)	Date	9/6/86	20)	Probe Heater Setting	250
5)	Run No.	2	21)	% O2	10.0
6)	Sample Box No.		22)	% CO2	7.6
7)	Meter Box No.	GG	23)	ML. H2O	467
8)	Meter, HG	1.807	24)	GM. Silica Gel	18.4
9)	K Factor	4.0	25)	Total	485.4
10)	Pitot Factor	0.84	26)	Start Time	5:07 pm
11)	Leak Rate Before	0.01@17	27)	Finish Time	6:32 pm
12)	Leak Rate After	0.01@15	28)	Yd.	0.9999
13)	Static Pres., in H2O	0.4	29)	Stack Area	0.7773
14)	Ambient Temperature		30)	Sampling Time (MIN/PT)	5
15)	Barometric Pressure	23.05	31)	Initial Volume	90.77
16)	Assumed Moisture, %		32)	FILTER & BEAKER #'S	21514F
				BBB	

rt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						90.77				J.	Balabuszko
1 - 1	5	6	224	0.24	0.96	93.94	86	89	54	255	97.5
1 - 1	5	6	225	0.25	1.0	97.16	88	89	52	258	96.9
1 - 2	5	6	229	0.24	0.96	100.31	89	90	53	259	96.8
1 - 2	5	6	228	0.24	0.96	103.46	90	90	54	255	96.7
1 - 3	5	5.5	218	0.20	0.80	106.34	88	90	57	264	96.3
1 - 3	5	5.5	218	0.20	0.80	109.23	90	91	58	263	96.3
1 - 4	5	4.5	204	0.16	0.64	111.83	90	91	58	264	95.8
1 - 4	5	4.5	189	0.16	0.64	114.43	89	91	58	254	94.8
2 - 1	5	7	223	0.25	1.0	117.62	89	91	59	252	95.6
2 - 1	5	7	225	0.25	1.0	120.87	89	90	58	307	97.6
2 - 2	5	6	225	0.21	0.84	123.82	88	90	58	268	96.7
2 - 2	5	6	226	0.21	0.84	126.79	88	90	61	263	97.5
2 - 3	5	6	217	0.21	0.84	129.76	86	88	62	298	97.2
2 - 3	5	6	214	0.20	0.80	132.64	86	88	64	272	96.3
2 - 4	5	5	206	0.17	0.68	135.32	86	88	67	257	96.6
2 - 4	5	5	189	0.17	0.68	137.98	85	87	68	257	94.8

80	216	.457	.84	47.21	89
Total	Avg.	Root	Avg.	Volume	Avg.

RAW DATA SET # 9

1)	Plant	LANL	17)	Heater Box Setting	250
2)	Location	Outlet	18)	Probe Length', ' Ft.	3
3)	Operator	J. Balabuszko	19)	Nozzle Diameter', 'In.	0.313
4)	Date	9/6/86	20)	Probe Heater Setting	250
5)	Run No.	3	21)	% O2	10.2
6)	Sample Box No.		22)	% CO2	7.6
7)	Meter Box No.	GG	23)	ML. H2O	280
8)	Meter H@	1.807	24)	GM. Silica Gel	17.9
9)	K Factor	4.6	25)	Total	297.9
10)	Pitot Factor	0.84	26)	Start Time	7:27 pm
11)	Leak Rate Before	0.005@17	27)	Finish Time	8:50 pm
12)	Leak Rate After	0.01@16	28)	Yd.	0.9999
13)	Static Pres., in H2O	0.4	29)	Stack Area	0.7773
14)	Ambient Temperature		30)	Sampling Time (MIN/PT)	5
15)	Barometric Pressure	23.05	31)	Initial Volume	38.20
16)	Assumed Moisture, %		32)	FILTER & BEAKER #'S	21556F B9B

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm	in	Tmout	Tc	Tb	%I
0 - 0						38.20					J. Balabuszko	
1 - 1	5	6	218	0.22	1.0	41.39	73		74	55	246	93.0
1 - 1	5	6	220	0.22	1.0	44.57	73		74	50	244	92.8
1 - 2	5	6.5	221	0.21	0.97	47.69	72		73	51	252	93.4
1 - 2	5	6.5	222	0.22	1.0	50.88	73		73	57	253	93.3
1 - 3	5	5.5	213	0.19	0.87	53.85	73		72	61	252	92.9
1 - 3	5	5.5	211	0.19	0.87	56.80	72		72	63	256	92.3
1 - 4	5	5	200	0.16	0.74	59.56	72		72	61	256	93.2
2 - 1	5	7.5	218	0.26	1.2	65.90	71		71	54	248	91.4
2 - 1	5	7.5	220	0.26	1.2	69.11	72		71	51	256	92.0
2 - 2	5	6.5	221	0.21	0.97	72.27	71		71	50	242	94.9
2 - 2	5	6.5	221	0.21	0.97	75.40	71		71	50	250	94.0
2 - 3	5	6	209	0.20	0.92	78.43	70		71	50	259	92.5
2 - 3	5	6	203	0.20	0.92	81.48	71		70	50	258	92.7
2 - 4	5	5	191	0.15	0.69	84.14	70		70	51	260	92.5
2 - 4	5	5	182	0.15	0.69	86.80	70		69	52	254	92.0

80	210	.446	.92	48.6	72
Total	Avg.	Root	Avg.	Volume	Avg.

RAW DATA SET # 10

1)	Plant	LANL	17)	Heater Box Setting	250
2)	Location	Outlet	18)	Probe Length', ' Ft.	3
3)	Operator	J. Balabuszko	19)	Nozzle Diameter', 'In.	0.313
4)	Date	9/7/86	20)	Probe Heater Setting	250
5)	Run No.	1	21)	% O2	12.3
6)	Sample Box No.		22)	% CO2	5.9
7)	Meter Box No.	GG	23)	Ml. H2O	242.6
8)	K-Factor	[illegible]	24)	[illegible]	[illegible]
9)	[illegible]	[illegible]	25)	Total	254.2
10)	Pitot Factor	0.84	26)	Start Time	1:50 pm
11)	Leak Rate Before	0.015@17	27)	Finish Time	3:12 pm
12)	Leak Rate After	0.02@5	28)	Yd.	0.9999
13)	Static Pres., in H2O	0.4	29)	Stack Area	0.7773
14)	Ambient Temperature		30)	Sampling Time (MIN/PT)	5
15)	Barometric Pressure	23.13	31)	Initial Volume	88.16
16)	Assumed Moisture, %		32)	FILTER & BEAKER #'S	21510F B10B

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I	
0 - 0						88.16				J. Balabuszko		
1 - 1	5	5	217	0.22	1.0	91.38	75	77	56	241	91.3	
1 - 1	5	5	220	0.21	0.97	94.52	77	78	51	249	91.1	
1 - 2	5	4.5	223	0.20	0.92	97.60	78	79	48	259	91.5	
1 - 2	5	4.5	222	0.20	0.92	100.68	79	79	48	258	91.4	
1 - 3	5	3.5	223	0.15	0.69	103.40	81	81	52	248	92.9	
1 - 3	5	3.5	215	0.15	0.69	106.10	82	82	53	261	91.5	
1 - 4	5	3	196	0.12	0.55	108.54	82	83	53	259	91.0	
1 - 4	5	3.5	185	0.14	0.64	111.17	83	83	53	241	90.0	*
2 - 1	5	5	219	0.23	1.1	114.52	83	85	53	259	91.7	
2 - 1	5	5	222	0.24	1.1	117.93	84	85	50	248	91.5	
2 - 2	5	4.5	222	0.19	0.87	120.96	84	85	52	262	91.3	
2 - 2	5	4.5	222	0.19	0.87	123.98	84	85	53	248	91.0	
2 - 3	5	4	217	0.17	0.78	126.85	86	86	54	253	90.8	
2 - 3	5	4	211	0.17	0.78	129.74	85	86	53	272	91.1	
2 - 4	5	3	198	0.13	0.60	132.28	85	86	54	245	90.6	
2 - 4	5	3	192	0.13	0.60	134.84	85	86	55	297	90.9	

80	213	.419	.82	46.68	82
Total	Avg.	Root	Avg.	Volume	Avg.

RAW DATA SET # 11

1) Plant	LANL	17) Heater Box Setting	250
2) Location	Outlet	18) Probe Length', ' Ft.	3
3) Operator	J. Balabuszko	19) Nozzle Diameter', 'In.	0.313
4) Date	9/7/86	20) Probe Heater Setting	250
5) Run No.	2	21) % O2	11.0
6) Sample Box No.		22) % CO2	7.0
7) Meter Box No.	GG	23) Ml. H2O	270.9
8) Meter H@	1.807	24) GM. Silica Gel	13.8
9) K Factor	5.3	25) Total	284.7
10) Pitot Factor	0.84	26) Start Time	3:57 pm
11) Leak Rate Before	0.01@17	27) Finish Time	5:18 pm
12) Leak Rate After	0.01@8	28) Yd.	0.9999
13) Static Pres., in H2O	0.4	29) Stack Area	0.7773
14) Ambient Temperature		30) Sampling Time (MIN/PT)	5
15) Barometric Pressure	23.13	31) Initial Volume	35.40
16) Assumed Moisture, %		32) FILTER & BEAKER #'S	21512F B11B

Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						35.40				J. Balabuszko	
1 - 1	5	8.5	222	0.24	1.3	39.02	86	89	53	281	96.9
1 - 2	5	7.5	224	0.21	1.I	46.06	87	88	46	251	96.5
1 - 2	5	7.5	224	0.21	1.1	49.43	87	89	48	255	96.4
1 - 3	5	6	214	0.17	0.90	52.47	86	88	48	266	96.1
1 - 3	5	6	214	0.17	0.90	55.53	87	88	49	244	96.6
1 - 4	5	5	194	0.15	0.80	58.43	88	89	50	255	95.8
1 - 4	5	5	186	0.15	0.80	61.31	89	90	51	257	94.4
2 - 1	5	8	218	0.24	1.3	64.86	88	89	51	247	94.6
2 - 1	5	8	222	0.25	1.3	68.50	88	89	49	288	95.3
2 - 2	5	8	217	0.22	1.2	72.04	84	87	50	257	99.0
2 - 2	5	8	220	0.21	1.1	75.47	83	86	50	271	98.5
2 - 3	5	6.5	212	0.19	1.0	78.68	83	84	52	260	96.5
2 - 3	5	6.5	209	0.18	0.95	81.79	81	82	51	244	96.2
2 - 4	5	5.5	191	0.15	0.78	84.60	79	81	51	239	94.1
2 - 4	5	5.5	182	0.15	0.78	87.41	79	80	51	239	93.5

80	211	.44	1.04	52.01	86
Total	Avg.	Root	Avg.	Volume	Avg.

RAW DATA SET # 12

1)	Plant	LANL	17)	Heater Box Setting	250
2)	Location	Outlet	18)	Probe Length', ' Ft.	3
3)	Operator	J. Balabuszko	19)	Nozzle Diameter', 'In.	0.313
4)	Date	9/7/86	20)	Probe Heater Setting	250
5)	Run No.	3	21)	% O2	10.2
6)	Sample Box No.		22)	% CO2	8.0
8)	Meter H@	1.807	24)	GM. Silica Gel	18.4
9)	K Factor		25)	Total	297.4
10)	Pitot Factor	0.84	26)	Start Time	7:10 pm
11)	Leak Rate Before	0.02@6	27)	Finish Time	8:30 pm
12)	Leak Rate After	0.02@6	28)	Yd.	0.9999
13)	Static Pres., in H2O	0.4	29)	Stack Area	0.7773
14)	Ambient Temperature		30)	Sampling Time (MIN/PT)	5
15)	Barometric Pressure	23.10	31)	Initial Volume	9.34
16)	Assumed Moisture, %		32)	FILTER & BEAKER #'S BMB	2151BF

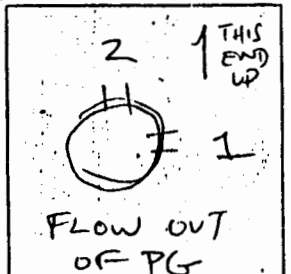
Pt. #	0	Vac.	Ts	DPs	DH	Vm	Tm in	Tmout	Tc	Tb	%I
0 - 0						9.34				J.	Balabuszko
1 - 1	5	5.5	217	0.24	1.2	12.90	73	73	59	281	98.6
1 - 1	5	5.5	218	0.24	1.2	16.47	73	73	59	278	99.0
1 - 2	5	5.5	221	0.21	1.1	19.81	74	73	59	272	99.1
1 - 2	5	5.5	221	0.21	1.1	23.04	73	72	58	264	96.0
1 - 3	5	5	212	0.19	0.99	26.20	72	72	53	262	98.1
1 - 3	5	5	210	0.19	0.99	29.42	72	71	53	264	99.9
1 - 4	5	4	183	0.15	0.78	32.19	69	70	53	258	95.1
1 - 4	5	4	175	0.15	0.78	35.00	69	68	53	253	96.0
2 - 1	5	6	209	0.24	1.2	38.47	66	66	53	256	96.8
2 - 1	5	6	210	0.24	1.2	41.90	66	66	53	251	95.8
2 - 2	5	6	210	0.21	1.1	45.32	66	65	55	250	102.2
2 - 2	5	6	207	0.21	1.1	48.67	64	64	53	254	100.1
2 - 3	5	5	196	0.19	0.99	51.84	63	63	52	247	98.9
2 - 3	5	5	193	0.19	0.99	54.98	63	63	53	247	97.8
2 - 4	5	5	189	0.15	0.78	58.65	64	63	53	258	97.2
	80		202	.443	1.02	51.31		68			
	Total		Avg.	Root	Avg.	Volume		Avg.			

K=8.3 T_m=110
T_s=220
B_{wo}=37 JB

PARTICULATE TESTING RAW DATA SET

Client/Owner LANL
Plant CAF
Unit# ____ Inlet/Outlet ____
Operator J. BRABUS 7140
Date 9/4/86
Run No. 1 4-1
Sample Box No. ____
Meter Box No. 66
Meter DH@ 1.807
K Factor ~~.9~~ 8.3
Pitot C_p .84 Pitot Leak Ck ✓
Leak Rate Before < .005 CFM @ 17 Hg
Leak Rate After ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−) .5

Start Time 13:10 AM ~~12:10~~ PM
Finish Time ____ : ____ AM PM
Meter Y_d 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s 21520
~~Thimble #~~ ____
Beaker # B1

Ambient Temperature, °F 80
Barometric Pressure, In. Hg 23.19
Assumed Moisture, % 38-39
Heater Box Setting 250°
Probe Length, Ft. 3' No. GLASS
Nozzle Diameter, In. .373 → .313
Probe Heater Setting 250°
% O_2 9.2
% CO_2 8.6
H_2O, ml 296
Silica Gel, gm 12.6
Total V_{lc} 308.6
Stack Area, Ft² 55/4 Θ = 12"
Pyrometer No. NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 95.76 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	P/HSL/F SAMPLE BOX TEMPERATURE T_p °F
1-1	4	12 *	220	.19	(1.58) 1.2	98.59 *	94	91	52	255/246/245 *
	8	6½	220	.19	.78	101.01	90	91	54	256/248/285
2	12	6	222	.17	.70	103.25	89	90	61	255/249/248
	16	6	222	.17	.70	105.35	89	90	63	256/248/254
3	20	7	214	.19	.78	107.64	90	89	60	255/249/282
	24	9	208	.24	.98	110.17	89	89	58	255/250/256
4	28	9	197	.23	.94	112.64	86	87	58	256/247/274
	32	8	182	.20	.82	115.02	82	84	59	259/250/237
							(84)			
TOTAL							AVG. -11	AVG. -9		
AVERAGE	(64)		(209)	(.4154)	(0.74)	(35.62)	AVG. 90 - 20/16	88.75		

NEW Iv. * Δ TO .313

98.71 NOZZLE 314 312 315 313 312 312 → 18 .313 K → 4.11

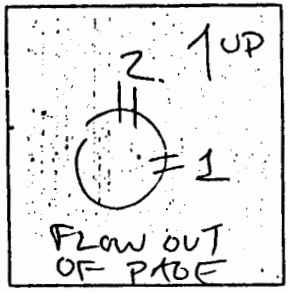
Clean Air Engineering, Inc.

Page 1 of 2

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF.
Unit#: ____ Inlet/Outlet
Operator: J. BALABUSZKO
Date: 9/4/86
Run No.: 1
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM/PM
Finish Time: ____ : ____ AM/PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: .3
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: 296
Silica Gel, gm: 12½
Total V_{lc}: 308½
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
2-1	(4) 36	6	216	.16	.66	117.10	81	81	64	259/253/278
	(8) 40	7½	218	.20	.82	119.43	80	81	58	259/255/250
2	(12) 44	7	219	.17	.70	121.64	80	81	56	260/254/258
	(16) 48	6	220	.15	.62	123.72	80	80	56	257/254/262
3	(20) 52	8	219	.17	.70	125.83	80	79	57	260/258/298
	(24) 56	5	200	.12	.53	127.74	80	79	57	260/259/278
4	(28) 60	4½	191	.11	.45	129.51	79	78	58	260/256/260
	(32) 64	5	181	.13	.53	131.38	79	78	58	261/253/246
TOTAL							AVG. −1	AVG. −3		
AVERAGE							AVG. 80 − 4/16 = 79.75			

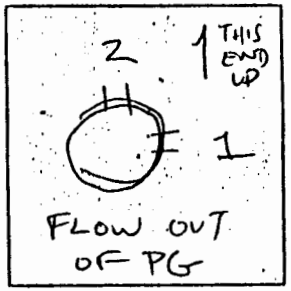
149/16 **Clean Air Engineering, Inc.**

16×5=80

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit #: _____ Inlet/Outlet
Operator: J. BRAUSZKO
Date: 9/4/86
Run No.: 2 9-2
Sample Box No.: _____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ~~.41~~ ~~1.40~~ 4.1 (OK)
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.005 CFM @ 17 Hg
Leak Rate After: _____ CFM @ _____ Hg
Static Press., in. H_2O (+/-): ~~0.6~~ 0.6

Start Time: 18:52 AM/PM
Finish Time: : AM/PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21511
Thimble #: _____
Beaker #: 32

Ambient Temperature, °F: _____
Barometric Pressure, in. Hg: 23.08
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: 61056
Nozzle Diameter, in.: .313
Probe Heater Setting: 250°
% O_2: 9.2
% CO_2: 8.6
H_2O, ml: 395
Silica Gel, gm: 14
Total V_{lc}: 409
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

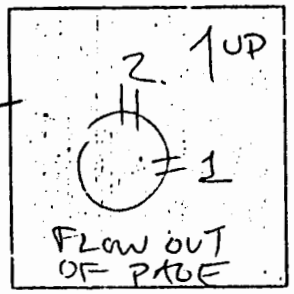
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM in. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, in. H_2O	Initial Volume: 31.71 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b, °F
1-1	~~5~~ 5	6 1/2	220	.22	.90	34.79	85	88	51	270/257/232
	~~8~~ 10	7	221	.23	.94	37.92	82	86	50	270/257/245
2	~~12~~ 15	6	224	.21	.86	40.87	81	85	50	254/258/240
	~~16~~ 20	6	225	.21	.86	43.86	80	84	51	259/258/234
3	~~20~~ 25	6	216	.19	.78	46.71	81	83	50	259/261/234
	~~24~~ 30	5 1/2	214	.18	.74	49.47	80	82	50	259/261/239
4	~~28~~ 35	5	203	.16	.66	52.09	80	81	51	259/260/252
	~~32~~ 40	5	187	.16	.66	54.79	~~80~~ 79	80	52	260/259/251
							8	29		
				.4066						
TOTAL					0.74		AVG.	AVG.		
AVERAGE	60		213.8	.4247	~~.8~~	44.23	AVG. ~~82~~ 3	79		

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAI.
Unit#: _____ Inlet/Outlet: _____
Operator: J. GALABUSZKO
Date: 9/4/86
Run No.: 2
Sample Box No.: _____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: _____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 6.005 CFM @ 15 Hg
Leak Rate After: _____ CFM @ _____ Hg
Static Press., In. H_2O (+/−): _____

Start Time: _____ : _____ AM / PM
Finish Time: 20:15 AM / ~~20:15~~ PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21517
Thimble #: _____
Beaker #: _____

Ambient Temperature, °F: _____
Barometric Pressure, In. Hg: 23.08
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: _____
Probe Heater Setting: 250°
% O_2: _____
% CO_2: _____
H_2O, ml: _____
Silica Gel, gm: _____
Total Vlc: _____
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

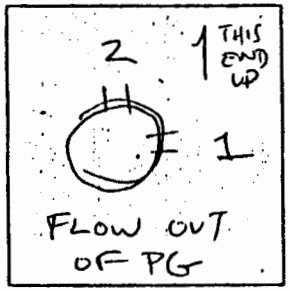
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s (135)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
2-1	~~(4)~~ 36	45	7	222	.22	.90	57.~~87~~53	77	79	52	264/260/257
	~~(8)~~ 40	50	7	223	.22	.90	60.85	77	78	51	260/260/242
2	~~(12)~~ 44	55	5	226	.17	.68	63.51	77	78	54	258/261/241
	~~(16)~~ 48	60	5	226	.17	.68	66.14	77	77	53	256/259/243
3	~~(20)~~ 52	65	5½	215	.16	.66	68.74	76	76	54	260/261/254
	~~(24)~~ 56	70	5½	214	.16	.66	71.33	76	76	56	260/262/253
4	~~(28)~~ 60	75	4	196	.12	.49	73.61	76	76	56	259/260/243
	~~(32)~~ 64	80	4½	182	.13	.53	75.94	75	75	56	260/261/242
TOTAL								AVG.	AVG.		
AVERAGE								AVG.			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet
Operator: J. Bannister
Date: 9/4/86
Run No.: 3 4-3
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: 40
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.01 CFM @ 17 Hg
Leak Rate After: <.01 CFM @ 15 Hg
Static Press., In. H_2O (+)(−): .5

Start Time: 21:25 AM PM
Finish Time: : AM PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21513
Thimble #: ____
Beaker #: B3

Ambient Temperature, °F: 55
Barometric Pressure, In. Hg: 23.06
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 9.2
% CO_2: 8.6
H_2O, ml: 385
Silica Gel, gm: 14
Total V_{lc}: 399
Stack Area, Ft²: π/4 · Θ = 12"
Pyrometer No.: NA

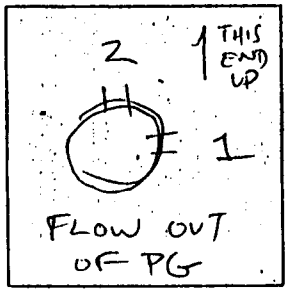
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 77.50 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	~~4~~ 5	8	214	.22	.88	80.49	65	65	60	260/265/253
	~~8~~ 10	8	221	.22	.88	83.46	65	65	52	260/266/251
2	~~12~~ 15	8	225	.20	.80	86.34	66	65	50	261/268/248
	~~16~~ 20	8	225	.20	.80	89.28	66	65	53	260/268/244
3	~~20~~ 25	6	220	.17	.68	91.84	67	66	52	261/268/241
	~~24~~ 30	6	214	.16	.64	94.42	67	66	52	257/262/244
4	~~28~~ 35	5	196	.14	.56	96.81	67	66	51	257/257/247
	~~32~~ 40	5	184	.14	.56	99.19	67	66	51	257/258/
TOTAL							AVG.	AVG.		
AVERAGE	30		212	0.4098	0.68	41.97	AVG. 66			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet: ____
Operator: J. BMARUSZKO
Date: 9/4/86
Run No.: 3
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ AM / PM
Finish Time: 22:45 (35) AM / PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total V_{lc}: ____
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³ (101.97 DDP)	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
1-1	~~4~~ 45	7	221	.19	.76	~~102~~ 97	67	56	52	256/258/243
	~~8~~ 50	7	224	.19	.76	104.71	67	66	51	257/259/249
2	~~12~~ 55	7	225	.17	.68	107.35	68	66	52	257/258/242
	~~16~~ 60	7	226	.17	.68	109.99	68	67	52	257/259/244
3	~~20~~ 65	6	209	.15	.60	112.48	68	67	52	258/259/248
	~~24~~ 70	6	206	.15	.60	114.98	68	67	52	259/260/243
4	~~28~~ 75	4	198	.12	.48	117.22	67	67	52	259/259/247
	~~32~~ 80	4	184	.12	.48	119.47	67	67	52	259/260/253
TOTAL							AVG.	AVG.		
AVERAGE							AVG.			

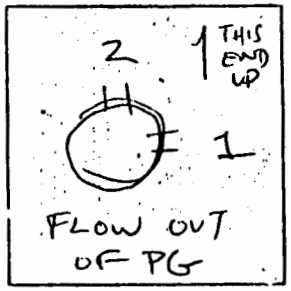
Clean Air Engineering, Inc.

4-1

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAI
Unit#: ____ Inlet/Outlet
Operator: J. BATA BUSTKO
Date: 9/5/86
Run No.: 1 (CONDITION 2)
Sample Box No.: ____
Meter Box No.: GG Ec1
Meter DH@: 1.807
K Factor: 3.9
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.01 CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/-): .5

Start Time: 9:50 AM/PM
Finish Time: 11:20 AM/PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21517
Thimble #: ____
Beaker #: BY

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: .313
Probe Heater Setting: 250°
% O_2: 10.4
% CO_2: 8.0
H_2O, ml: 595
Silica Gel, gm: 8.8
Total V_{lc}: 303.8
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

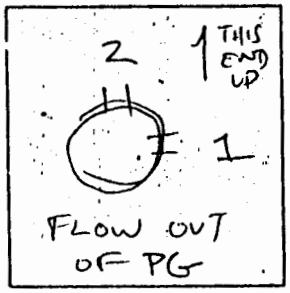
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 19.71 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	~~4~~ 5	4	220	.19	.74	22.47	65	64	46	261/255/241
	~~8~~ 10	4	222	.19	.74	25.22	66	64	42	260/256/244
2	~~12~~ 15	4	225	.17	.66	27.81	68	65	42	260/257/255
	~~16~~ 20	4	226	.16	.62	30.32	70	66	42	259/257/252
3	~~20~~ 25	4	221	.14	.55	32.69	71	67	43	258/256/249
	~~24~~ 30	4	218	.14	.55	35.09	71	68	44	259/256/251
4	~~28~~ 35	3	206	.11	.43	37.22	72	69	46	258/257/243
	~~32~~ 40	3	186	.10	.39	39.27	73	70	47	258/257/251
						~~44.~~				~~257/2~~
TOTAL			216	~~2850~~	0.57		AVG. 69.5	AVG. 66.6		
AVERAGE	80		~~215.5~~	.3794		38.84	AVG. 71			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: _____ Inlet/Outlet
Operator: J. BALASUSTKO
Date: 7/6/86
Run No.: 1 (CONDITION 2)
Sample Box No.: _____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: _____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: _____ CFM @ _____ Hg
Leak Rate After: <.01 CFM @ 17 Hg
Static Press., In. H_2O (+/−): _____

Start Time: _____ : _____ AM / PM
Finish Time: 11:20 AM / PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: _____
Thimble #: _____
Beaker #: _____

Ambient Temperature, °F: _____
Barometric Pressure, In. Hg: _____
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: _____
Probe Heater Setting: 250°
% O_2: _____
% CO_2: _____
H_2O, ml: _____
Silica Gel, gm: _____
Total V_{lc}: _____
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	~~4~~ 45	5	221	.19	.74	42.04	72	71	51	258/258/258
	~~8~~ 50	5	226	.18	.70	44.73	75	72	46	257/256/252
2	~~12~~ 55	5	228	.15	.59	47.22	76	73	48	257/252/246
	~~16~~ 60	4.5	228	.14	.55	49.64	76	73	50	257/256/253
3	~~20~~ 65	4	217	.13	.51	51.97	76	73	51	257/256/254
	~~24~~ 70	4	218	.13	.51	54.30	77	74	51	257/256/254
4	~~28~~ 75	4	203	.10 ~~.09~~	.39	56.40	77	74	52	256/256/257
	~~32~~ 80	4	198	.11	.43	58.55	78	75	53	255/255/245
						−19.71				
			-21							
				.3738						
TOTAL			217.4		0.57		AVG. 75.9	AVG. 73.1		
AVERAGE	80		216.4	.3794			AVG. 71.3			

Clean Air Engineering, Inc.

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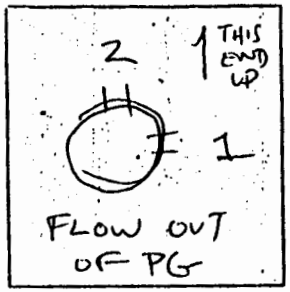
PARTICULATE TESTING RAW DATA SET

RUN 4, 21517
5

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet
Operator: J. BALDERAS
Date: 9/5/86
Run No.: 2 (CONDITION 2)
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 2.01 CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/-): 0.6

Start Time: 12:20 AM/PM
Finish Time: 1:40 AM/PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21507
Thimble #: ____
Beaker #: B5

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, In.: .313
Probe Heater Setting: 250°
% O_2: 8.0
% CO_2: 10.4
H_2O, ml: 296
Silica Gel, gm: 11.0
Total V_{lc}: 307
Stack Area, Ft^2: π/4 · Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 58.80 GAS SAMPLE VOLUME V_m, Ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	~~4~~ 5	6	233	.19	.84	61.77	88	87	55	254/261/278
	~~8~~ 10	6	233	.19	.84	64.70	89	88	50	252/261/243
2	~~12~~ 15	6	235	.17	.75	67.53	90 JB	89	54	253/263/310
	~~16~~ 20	6	234	.17	.75	70.33	~~90~~ 91	90	54	252/265/290
3	~~20~~ 25	4½	227	.14	.62	72.91	92	90	57	252/261/239
	~~24~~ 30	4½	225	.13	57 ~~.55~~ .58	75.39	93	90	58	252/260/248
4	~~28~~ 35	3½	212	.11	.48	77.64	92	90	59	251/260/246
	~~32~~ 40	3½	199	.11	.48	79.93	92	90	60	251/261/299
TOTAL			226	~~.3868~~ ✓			AVG. 90.875	AVG. 89.25		
AVERAGE	80		~~224~~	.3785	0.64	41.71	AVG. 92			

Clean Air Engineering, Inc.

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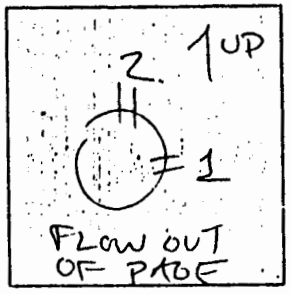
Client/Owner: LANL
Plant: CAT.
Unit#: _____ Inlet/Outlet
Operator: J. BALABUSZKO
Date: 9/5/86
Run No.: 2 (CONDITION 2)
Sample Box No.: _____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: 4.4
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 4.02 CFM @ 17 Hg
Leak Rate After: _____ CFM @ _____ Hg
Static Press., In. H_2O (+/−): _____

PARTICULATE TESTING RAW DATA SET

Start Time: _____ : _____ AM / PM

Finish Time: 1:40 AM / PM

Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: _____

Thimble #: _____

Beaker #: _____

Ambient Temperature, °F: _____
Barometric Pressure, In. Hg: _____
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: _____
Probe Heater Setting: 250°
% O_2: _____
% CO_2: _____
H_2O, ml: _____
Silica Gel, gm: _____
Total V_{lc}: _____
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

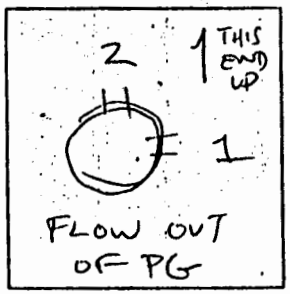
TRAVERSE POINT NUMBER	MIN/PT. ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
2-1	(4) ~~36~~	15	5 1/2	230	.19	82.84	91	90	59	251/260/239
	(8) ~~40~~	10	5 1/2	233	.18	85.75	91	90	54	252/264/262
2	(12) ~~44~~	15	5	236	.15	88.43	93	92	58	252/263/267
	(16) ~~48~~	10	5	236	.14	91.04	94	93	60	253/264/505
3	(20) ~~52~~	15	4 1/2	232	.13	93.56	95	94	61	253/265/264
	(24) ~~56~~	10	4	228	.12	95.97	98	96	63	249/264/263
4	(28) ~~60~~	15	4	220	.10	98.26	99	97	65	249/262/300
	(32) ~~64~~	10	4	210	.10	100.51	99	98	66	248/263/
			(228.125)	.3701						
TOTAL							AVG. 92.5	AVG. 93.75		
AVERAGE			226.1	.3785		41.71	AVG.	91.6		

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet: ____
Operator: J. BALABUSZKO
Date: 9/5/86
Run No.: 3 (CONDITION 2)
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: .02 CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): .5

Start Time: 14:40 AM/PM
Finish Time: 16:00 AM/PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21509
Thimble #: ____
Beaker #: B6

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 10.4
% CO_2: 8.0
H_2O, ml: 287
Silica Gel, gm: 13.6
Total V_{lc}: 300.6
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

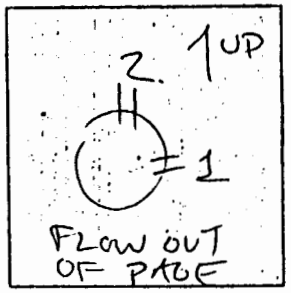
TRAVERSE POINT NUMBER	SAMPLING TIME θ, min. (MIN/PT ____)	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	GAS SAMPLE VOLUME V_m, Ft³ (Initial Volume: 2.72)	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER: OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T, °F
1-1	4 5	5	232	.18	.79	5.68	99	99	68	260/256/299
	8 10	5	235	.19	.84	8.67	98	99	68	260/261/280
2	12 15	4 1/2	236	.18	.79	11.55	98	98	63	260/255/240
	16 20	4	239	.16	.70	14.31	99	98	64	260/262/283
3	20 25	4	234	.13	.57	16.82	103	100	60	259/256/247
	24 30	4	232	.12	.53	19.27	104	102	58	259/258/261
4	28 35	3	212	.09	.40	21.43	105	103	56	262/256/276
	32 40	3	205	.10	.44	23.68	105	104	57	
			~~227~~							
			~~228~~	.3760						
TOTAL			229				AVG. 104	AVG. 100.4		
AVERAGE	80		~~228~~ 1	.3746	0.63	41.60	AVG. 103			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: _____ Inlet/Outlet: _____
Operator: J. BARAGUSAKO
Date: 9/5/86
Run No.: 3 (CONDITION 2)
Sample Box No.: _____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: _____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: _____ CFM @ _____ Hg
Leak Rate After: <.02 CFM @ 17 Hg
Static Press., In. H_2O (+/−): _____

Start Time: _____ : _____ AM / PM
Finish Time: 4:00 AM / PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: _____
Thimble #: _____
Beaker #: _____

Ambient Temperature, °F: _____
Barometric Pressure, In. Hg: _____
Assumed Moisture, %: _____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: _____
Probe Heater Setting: 250°
% O_2: _____
% CO_2: _____
H_2O, ml: _____
Silica Gel, gm: _____
Total V_{lc}: _____
Stack Area, Ft.²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
2-1	(4) 36	5 4	235	.17	.75	26.47	106	104	65	258/254/200
	(8) 40	4	239	.17	.75	29.31	105	103	56	257/254/249
2	(12) 44	5 4	240	.15	.66	31.97	106	105	58	259/255/228
	(16) 48	6 4	239	.14	.62	34.59	106	107	60	260/260/291
3	(20) 52	6 3½	232	.13	.57	37.10	107	107	61	256/257/255
	(24) 56	10 3½	226	.13	.57	39.56	105	104	61	258/249/258
4	(28) 60	16 3½	216	.12	.53	42.02	104	102	61	253/261/308
	(32) 64	80 3½	208	.11	.48	44.32	103	105	62	263/264/277
TOTAL			229.4	.3732			AVG. 105.3	AVG. 104.6		
AVERAGE			228.8	.3746			AVG. 102.9			

Clean Air Engineering, Inc.

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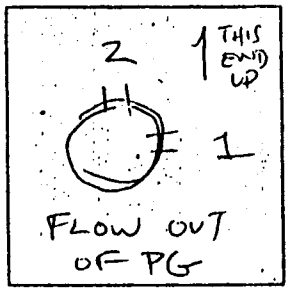
Client/Customer LANL
Plant CAI
Unit# _____ Inlet/Outlet _____
Operator S. RALABUS ZICC
Date 9/6/86
Run No. 1 CONDITION 3
Sample Box No. _____
Meter Box No. 66
Meter DH@ 1.807
K Factor 4.2
Pitot C_p .84 Pitot Leak Ck ✓
Leak Rate Before <.005 CFM @ 15 Hg
Leak Rate After <.01 CFM @ 15 Hg
Static Press., In. H_2O (+) -) 0.6

PARTICULATE TESTING RAW DATA SET

Start Time 10:35 AM PM
Finish Time _____ AM PM
Meter Y_d 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s 21557
Thimble # _____
Beaker # B7

Ambient Temperature, °F _____
Barometric Pressure, In. Hg 23.15
Assumed Moisture, % _____
Heater Box Setting 250°
Probe Length, Ft. 3' No. 61056
Nozzle Diameter, In. _____
Probe Heater Setting 250°
% O_2 10.1
% CO_2 8.0
H_2O, ml 381
Silica Gel, gm 18
Total V_{lc} 399
Stack Area, Ft² 55/4 Θ = 12"
Pyrometer No. NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume 45.48 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b °F
1-1	45	7½	225	.24	1.0	48.72	72	71	41	252/252/255
	~~8~~ 10	7½	230	.24	1.0	51.91	72	72	39	253/252/256
2	~~12~~ 15	8	233	.23	.97	~~54.35~~ 54.53	75	72	43	251/253/249
	~~16~~ 20	8	233	.22	.92	58.18	74	73	51	250/253/~~252~~ 252
3	~~20~~ 25	5½	227	.16	.67	60.83	75	75	58	251/252/261
	~~24~~ 30	5½	225	.17	.71	63.56	76	74	58	250/252/256
4	~~28~~ 35	5	214	.14	.59	66.05	78	75	57	250/253/256
	~~32~~ 40	5	198	.14	.59	68.06	78	76	57	254/253/250
			223.1	.4361 ✓	.81		74.8	73.5		
TOTAL							AVG.	AVG.		
AVERAGE	80		225	0.4287	0.78	45.07	AVG. 78			

Clean Air Engineering, Inc.

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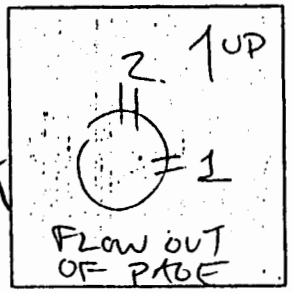
PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAI.
Unit#: ____ Inlet/Outlet
Operator: J. SALABUSZKO
Date: 9/6/86
Run No.: RUN 1 CONDITION 3
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before ____ CFM @ ____ Hg
Leak Rate After ____ CFM @ ____ Hg
Static Press., in. H_2O (+/−) ____

Start Time: ____ AM / PM
Finish Time: 11:55 ~~AM/PM~~ AM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, in. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, in.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total V_{lc}: ____
Stack Area, Ft²: ΠD/4 D = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM in. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, in. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
2-1	(4) 36	45	7½	230	.23	.97	71.19	79	77	53	250/252/262
	(8) 40	50	7½	234	.22	.92	74.30	80	77	50	249/251/274
2	(12) 44	55	6	235	.18	.76	77.11	81	78	50	250/253/251
	(16) 48	60	6	235	.18	.76	79.94	83	80	50	249/256/330
3	(20) 52	65	5½	229	.17	.71	82.70	85	82	53	247/255/284
	(24) 56	70	5½	227	.17	.71	85.44	86	84	51	248/250/253
4	(28) 60	75	5	220	.14	.59	88.01	88	85	52	247/252/281
	(32) 64	80	5	209	.14	.59	90.55	90	87	54	247/254/251
TOTAL								AVG.	AVG.		
AVERAGE								AVG.			

Clean Air Engineering, Inc.

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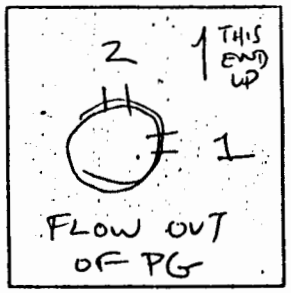
PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet: S. BALASUSZKO
Operator: ____
Date: 7/6/86
Run No.: 2 CONDITION 3
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: 4.0
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.01 CFM @ 17 Hg
Leak Rate After: <.01 CFM @ 15 Hg
Static Press., In. H_2O (+/−): 0.4

Start Time: 17:07 AM/PM
Finish Time: 18:32 AM/PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21514 (2)
Thimble #: ____
Beaker #: B8

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 15.0
% CO_2: 7.6
H_2O, ml: 467
Silica Gel, gm: 18.4
Total V_{lc}: 485.4
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 90.77 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	~~4~~ 5	6	224	.24	.96	93.94	86	89	54	255/248/255
	8 10	6	225	.25	1.0	97.16	88	89	52	254/250/258
2	18 15	6	229	.24	.96	100.31	89	90	53	252/250/259
	16 20	6	228	.24	.96	103.46	90	90	54	242/257/255
3	20 25	5 1/2	218	.20	.80	106.34	88	90	57	253/251/264
	24 30	5 1/2	218	.20	.80	109.23	90	91	58	253/254/263
4	28 35	4 1/2	204	.16	.64	111.83	90	91	58	253/248/264
	32 40	4 1/2	189	.16	.64	114.43	89	91	58	253/251/259
			216.9	.4580 ✓	.85					
							88.8	~~89.1~~ 90.1		
TOTAL							AVG.	AVG.		
AVERAGE	80		216	.4569	.84	117.21	AVG. 89			

Clean Air Engineering, Inc.

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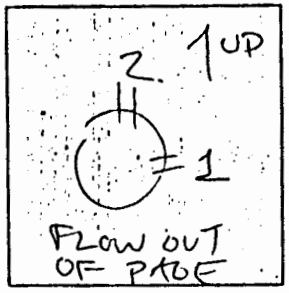
PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAT.
Unit #: ____ Inlet/Outlet: 3
Operator: RAJABUSZKO
Date: 9/6/86
Run No.: 2 CONDITION 3
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM PM
Finish Time: ____ : ____ AM PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total V_{lc}: ____
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
2-1	(4) 36	45 / 7	223	.25	1.0	117.62	89	91	59	254/252/252
	(8) 40	50 / 7	225	.25	1.0	120.87	89	90	58	253/252/307
2	(12) 44	55 / 6	225	.21	.84	123.82	88	90	58	253/252/268
	(16) 48	60 / 6	226	.21	.84	126.79	88	90	61	255/252/263
3	(20) 52	65 / 6	217	.21	.84	129.76	86	88	62	254/251/288
	(24) 56	70 / 6	214	.20	.80	132.64	86	88	64	254/255/272
4	(28) 60	75 / 5	206	.17	.68	135.32	86	88	67	254/252/257
	(32) 64	80 / 5	189	.17	.68	137.98	85	87	68	255/252/257
			215.6		.84					
				.4558						
TOTAL							AVG. 87.1	AVG. 89		
AVERAGE			216.3	.4569	.84		AVG. 88.8			

Clean Air Engineering, Inc.

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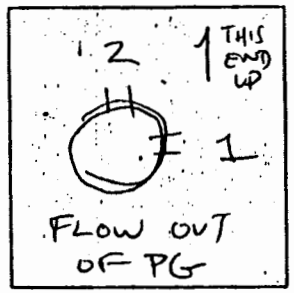
PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAI
Unit#: ____ Inlet/Outlet: ____
Operator: S. BALABUS
Date: 9/6/86
Run No.: 3 CONDITION 3
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: 4.6
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: <.005 CFM @ 17 Hg
Leak Rate After: <.01 CFM @ 16 Hg
Static Press., In. H_2O (+) (−): .4

Start Time: 19:27 AM PM
Finish Time: : AM PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21556
Thimble #: ____
Beaker #: B9

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.05
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ~~10.6~~ 10.2
% CO_2: ~~10.6~~ 7.6
H_2O, ml: 280
Silica Gel, gm: 17.9
Total V_{lc}: 297.9
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	SAMPLING TIME θ, min. (MIN/PT ____)	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	GAS SAMPLE VOLUME V_m, Ft³ (Initial Volume: 38.20)	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
1-1	4 5	6	218	.22	1.0	41.39	73	74	55	256/256/246
	8 10	6	220	.22	1.0	44.57	73	74	50	256/257/244
2	12 15	6½	221	.21	.97	47.69	72	73	51	253/257/252
	16 20	6½	222	.22	1.0	50.88	73	73	57	252/255/253
3	20 25	5½	213	.19	.87	53.85	73	72	61	253/252/252
	24 30	5½	211	.19	.87	56.80	72	72	63	253/256/256
4	28 35	5	200	.16	.74	59.56	72	72	61	252/257/256
	32 40	5	183	.16	.74	62.31	72	72	59	252/258/255
			211		.90		72.5	72.8		
TOTAL							AVG.	AVG.		
AVERAGE	80		210	0.4464	0.92	48.60	AVG. 72			

Clean Air Engineering, Inc.

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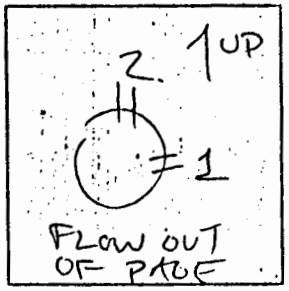
PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: C-AT
Unit #: ____ Inlet/Outlet: ____
Operator: S. BARABUSZKO
Date: 9/6/86
Run No.: 3 CONDITION 3
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM PM
Finish Time: ____ : ____ AM PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total V_{lc}: ____
Stack Area, Ft²: JJ/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b °F
2-1	(4) 36	45	7½	218	.26	1.2	65.70	71	71	54	253/255/248
	(8) 40	50	7½	220	.26	1.2	69.11	72	71	51	253/246/256
2	(12) 44	55	6½	221	.21	.97	72.27	71	71	50	253/257/242
	(16) 48	60	6½	221	.21	.97	75.40	71	71	50	253/255/250
3	(20) 52	65	6	209	.20	.92	78.43	70	71	50	253/257/259
	(24) 56	70	6	203	.20	.92	81.48	71	70	50	252/257/258
4	(28) 60	75	5	191	.15	.69	84.14	70	70	51	253/256/260
	(32) 64	80	5	182	.15	.69	86.80	70	69	52	253/258/259
				208.1		.95		70.8	70.5		
TOTAL								AVG.	AVG.		
AVERAGE				209.6		.93		AVG.	71.7		

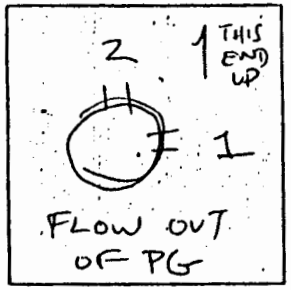
Clean Air Engineering, Inc.

10-1

PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit#: ____ Inlet/Outlet
Operator: S. BARBUSZELO
Date: 4/7/86
Run No.: 1 CONDITION 4
Sample Box No.: ____
Meter Box No.: GG
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 2.015 CFM @ 17 Hg
Leak Rate After: .03 CFM @ 5 Hg
Static Press., In. H_2O (+/-): 0.4

Start Time: 13:50 AM/PM
Finish Time: 15:12 AM/PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21510
Thimble #: ____
Beaker #: B10

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.13
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: 61056
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 12.3
% CO_2: 5.9
H_2O, ml: 242.6
Silica Gel, gm: 11.6
Total V_{lc}: 254.2
Stack Area, Ft²: π/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 88.16 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b, °F
1-1	5	5	217	.22	1.0	91.38	75	77	56	252/253/241
	10	5	220	.21	.97	94.52	77	78	51	251/247/249
2	15	4½	223	.20	.92	97.60	78	79	48	251/254/259
	20	4½	222	.20	.92 gm	100.68	79	79	48	251/255/258
3	25	3½	223	.15	~~.69~~	103.40	81	81	52	254/256/248
	30	3½	215	.15	.69	106.10	82	82	53	249/258/261
4	35	3	196	.12	.55	108.54	82	83	53	250/254/259
	40	3½	185	.14 JB	.64	111.17	83	83	53	250/253/241
				.0146 ✓						
			212.6		.80		~~89.6~~	~~90.3~~		
TOTAL							AVG.	AVG.		
AVERAGE	80		212	0.4190	0.82	46.68	AVG. 82			

Clean Air Engineering, Inc.

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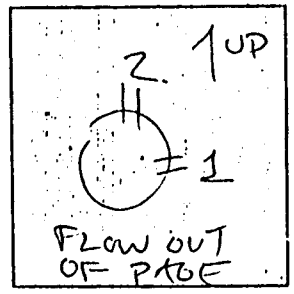
PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAT.
Unit#: Inlet/Outlet
Operator: J-BALAGUSTRO
Date: 9/7/86
Run No.: 1 CONDITION 4
Sample Box No.:
Meter Box No.: 66
Meter DH@: 1.807
K Factor:
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: CFM @ Hg
Leak Rate After: CFM @ 17 Hg
Static Press., In. H_2O (+/−):

Start Time: AM / PM
Finish Time: 15:12 AM / PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s:
Thimble #:
Beaker #:

Ambient Temperature, °F:
Barometric Pressure, In. Hg:
Assumed Moisture, %:
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: Glass
Nozzle Diameter, In.:
Probe Heater Setting: 250°
% O_2:
% CO_2:
H_2O, ml:
Silica Gel, gm:
Total V_{lc}:
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

MIN/PT: 5

TRAVERSE POINT NUMBER	SAMPLING TIME θ, min.	VACUUM In. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
2-1	(4) 36	45	5	219	.23	1.1	114.52	83	85	53	251/256/259
	(8) 40	50	5	222	.24	1.1	117.93	84	85	50	250/257/248
2	(12) 44	55	4½	222	.19	.87	120.96	84	85	52	251/256/262
	(16) 48	60	4½	222	.19	.87	123.98	84	85	53	252/255/248
3	(20) 52	65	4	217	.17	.78	126.85	86	86	54	249/258/253
	(24) 56	70	4	211	.17	.78	129.74	85	86	53	252/255/272
4	(28) 60	75	3	198	.13	.60	132.28	85	86	54	251/258/245
	(32) 64	80	3	192	.13	.60	134.84	85	86	55	250/257/297
				212.9		.84					
TOTAL					.4234			AVG. 84.5	AVG. 85.5		
AVERAGE				212.8	.4190	.82		AVG.			

Clean Air Engineering, Inc. 87.5

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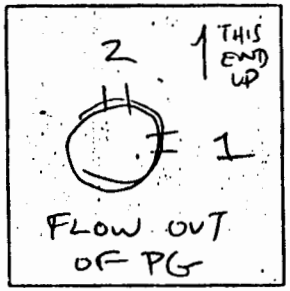
PARTICULATE TESTING RAW DATA SET

Client/Owner: LANL
Plant: CAF
Unit #: ____ Inlet/Outlet: ____
Operator: J. RAMBUSCH
Date: 9/7/86
Run No.: 2 CONDITION 4
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: 5.3
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 6.01 CFM @ 17 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+) (−): 0.4

Start Time: 15:57 AM PM
Finish Time: 17:16 AM PM
Meter Yd: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 21512
Thimble #: ____
Beaker #: B11

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.13
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: 270.9
Silica Gel, gm: 13.8
Total V_{lc}: 284.7
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

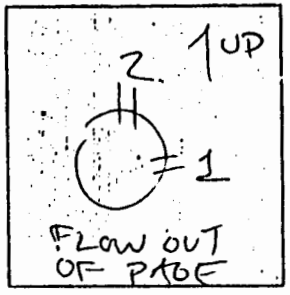
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: 35.40 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p, °F
1-1	4 5	8 1/2	227	.24	1.3	39.02	86	89	53	259/262/281
	8 10	8 1/2	223	.24	1.3	42.69	87	88	46	259/264/252
2	12 15	7 1/2	224	.21	1.1	46.06	87	88	46	258/259/251
	16 20	7 1/2	224	.21	1.1	49.43	87	89	48	256/259/255
3	20 25	6	214	.17	.90	52.47	86	88	48	256/259/266
	24 30	6	214	.17	.90	55.53	87	88	49	254/258/244
4	28 35	5	194	.15	.80	58.43	88	89	50	255/258/255
	32 40	5	186	.15	.80	61.31	89	90	51	254/258/257
			~~.193~~							
			~~.189~~	.1369						
					1.0		87.3	88.6		
TOTAL			212.6				AVG.	AVG.		
AVERAGE	80		211	.1405	1.04	52.01	AVG. 86			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF.
Unit#: ____ Inlet/Outlet: ____
Operator: J. CATASUSAN
Date: 9/7/86
Run No.: 2 CONDITION 4
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: ____ CFM @ ____ Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): ____

Start Time: ____ : ____ AM/PM
Finish Time: 17:20 AM/PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: ____
Thimble #: ____
Beaker #: ____

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: ____
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: ____
% CO_2: ____
H_2O, ml: ____
Silica Gel, gm: ____
Total Vlc: ____
Stack Area, Ft²: JJ/4 Θ = 12"
Pyrometer No.: NA

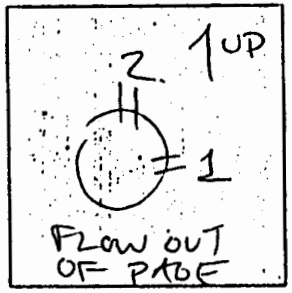
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
2-1	(4) 36	45 8	218	.24	1.3	64.86	88	89	51	255/256/247
	(8) 40	50 8	222	.25	1.3	68.50	88	89	49	253/260/288
2	(12) 44	55 8	217	.22	1.2	72.04	84	87	50	255/249/257
	(16) 48	60 8	220	.21	1.1	75.47	83	86	50	254/258/271
3	(20) 52	65 6½	212	.19	1.0	78.68	83	84	52	254/255/260
	(24) 56	70 6½	209	.18	.95	81.79	81	82	51	258/256/244
4	(28) 60	75 5½	191	.15	.78	84.60	79	81	51	255/259/259
	(32) 64	80	182	.15	.78	87.41	79	80	51	
			2089	.4440			83.1	84.8		
TOTAL					1.1		AVG.	AVG.		
AVERAGE			210.7	.4405	1.1		AVG. 85.9			

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAT.
Unit#: ____ Inlet/Outlet: ____
Operator: J. SALABUSZKO
Date: 9/7/86
Run No.: 3 CONDITION 4
Sample Box No.: ____
Meter Box No.: 66
Meter DH@: 1.807
K Factor: ____
Pitot C_p: .84 Pitot Leak Ck: ✓
Leak Rate Before: 2.02 CFM @ 6 Hg
Leak Rate After: ____ CFM @ ____ Hg
Static Press., In. H_2O (+/−): 0.4

Start Time: 19:10 AM PM
Finish Time: : AM PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s: 2151 8
Thimble #: ____
Beaker #: BM

Ambient Temperature, °F: ____
Barometric Pressure, In. Hg: 23.10
Assumed Moisture, %: ____
Heater Box Setting: 250°
Probe Length, Ft.: 3 No.: Glass
Nozzle Diameter, In.: ____
Probe Heater Setting: 250°
% O_2: 10.2
% CO_2: 8.0
H_2O, ml: 279
Silica Gel, gm: 18.4
Total V_{lc}: 297.4
Stack Area, Ft²: 55/4 Θ = 12"
Pyrometer No.: NA

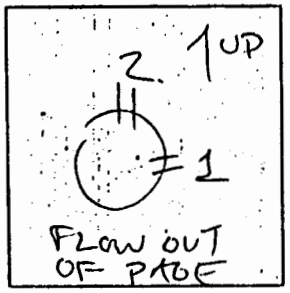
TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM in. Hg		STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, in. H_2O	Initial Volume: 9.34 GAS SAMPLE VOLUME V_m, Ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET T_m in, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_b, °F
2-1	(4) 36	5	5½	217	.24	1.2	12.90	73	73	59	257/268/281
	(8) 40	10	5½	218	.24	1.2	16.47	73	73	59	257/252/278
2	(12) 44	15	5½	221	.21	1.1	19.81	74	73	59	256/254/272
	(16) 48	20	5½	221	.21	1.1	23.04	73	72	58	256/261/264
3	(20) 52	25	5	212	.19	.99	26.20	72	72	53	257/262/262
	(24) 56	30	5	210	.19	.99	29.42	72	71	53	257/265/264
4	(28) 60	35	4	183	.15	.78	32.19	69	70	53	259/265/258
	(32) 64	40	4	175	.15	.78	35.00	69	68	53	257/268/253
TOTAL								AVG.	AVG.		
AVERAGE		80		202	.4428	1.02	51.31	AVG.	68		

Clean Air Engineering, Inc.

PARTICULATE TESTING
RAW DATA SET

Client/Owner: LANL
Plant: CAF.
Unit#: ' Inlet/Outlet
Operator: J. BATAKUS + KO
Date: 9/7/86
Run No.: 3 CONDITION 4
Sample Box No.:
Meter Box No.: 66
Meter DH@: 1.807
K Factor:
Pitot C_p: .84 Pitot Leak Ck ✓
Leak Rate Before: CFM @ Hg
Leak Rate After: CFM @ Hg
Static Press., In. H_2O (+/−):

Start Time: AM / PM
Finish Time: 20:30 AM / PM
Meter Y_d: 0.9999



SCHEMATIC OF TESTING LOCATION

Filter #'s:
Thimble #:
Beaker #:

Ambient Temperature, °F:
Barometric Pressure, In. Hg: 2
Assumed Moisture, %:
Heater Box Setting: 250°
Probe Length, Ft.: 3' No.: GLASS
Nozzle Diameter, In.:
Probe Heater Setting: 250°
% O_2:
% CO_2:
H_2O, ml: ~~479~~ 279
Silica Gel, gm: ~~18~~
Total Vlc: ~~497~~
Stack Area, Ft.: 55/4 Θ = 12"
Pyrometer No.: NA

TRAVERSE POINT NUMBER	MIN/PT ____ SAMPLING TIME θ, min.	VACUUM In. Hg	STACK TEMPERATURE T_s, °F	VELOCITY HEAD DP_s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER DH, In. H_2O	Initial Volume: GAS SAMPLE VOLUME V_m, Ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET T_m In, °F	OUTLET T_m out, °F	TEMP. OF GAS LEAVING CONDENSER OR LAST IMPINGER T_c, °F	SAMPLE BOX TEMPERATURE T_p °F
2-1	(4) 36	6	209	.24	1.2	38.47	66	66	53	257/266/256
	(8) 40	6	210	.24	1.2	41.90	66	66	53	256/267/259
2	(12) 44	6	210	.21	1.1	45.32	66	65	55	257/266/250
	(16) 48	6	207	.21	1.1	48.67	64	64	53	255/268/254
3	(20) 52	5	196	.19	.99	51.84	63	63	52	258/265/247
	(24) 56	5	~~193~~ 193	.19	.99	54.98	63	63	53	" " "
4	(28) 60	5	~~181~~ 173	.15	.78	57.82	64	63	53	255/262/251
	(32) 64	5	169	.15	.78	60.65	64	63	53	254/261/258
TOTAL							AVG.	AVG.		
AVERAGE							AVG.			

Clean Air Engineering, Inc.

48.67

VOST FIELD DATA SHEET
DATA SET # 1

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 16"
LEAK CHECK AFTER <0.1" Hg/min @ 17.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI outlet stack
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~V-1~~ 4
METER BOX NO. V1
Yd 1.0032
Bp 23.17

condition 1

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 170.00	ΔH	COMMENTS:	Vac
5	~1	70	138	12	12	20	33	32	175.2	1.0	start Time	5
10	~1	70	133	12	12	23	33	31	180.2	1.0	1315	6
15	~1	75	132	12	12	23	32	31	185.35	1.0		7
20		75	132	13	13	23	32	32	19~~0.91~~	1.0		7
									190.91			
Avg/total							32		20.91	1.0		

CONDENSATE SAMPLES: ~~NA~~ LANL-1-V-1

SAMPLE I.D.: _____ COMMENTS: _____

condition 1

Frosted glass outlet of trap

VOST FIELD DATA SHEET
DATA SET # 2

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 2
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE < 0.1" Hg/min @ 17.5"
LEAK CHECK AFTER < 0.1" Hg/min @ 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~V~~ 4
METER BOX NO. VI
Yd 1.0032
Bp 23.17

Diagram of sample location

Start Time 1401

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 19 ~~209~~.01	ΔH	COMMENTS: Vac "Hg	
5	~1	75	133	16	12	20	32	30	204.6	1.0	6	
10	~1	75	135	14	11	21	32	31	210.1	1.0	5	
15	~1	75	132	14	11	21	32	31	215.2	1.0	5	
20	~1	75	130	14	12	20	32	31	220.72	1.0	6	
Avg/total								31	21.71	1.0		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

Condition 1

VOST FIELD DATA SHEET
DATA SET # 3

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 19"
LEAK CHECK AFTER <0.1" Hg/min. @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ≤14
METER BOX NO. V1
Yd 1.0032
Bp 23.17

Diagram of sample location

Start Time 1443

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 223.01	ΔH	COMMENTS: Vac
5	~1	85	128	17	13	20	31	29	227.8	1.0	13
10	~1	70	135	15	12	21	31	29	232.6	1.0	14
15	~1	65	138	16	13	21	31	30	237.2	1.0	14
20	~1	65	142	18	14	23	31	31	241.92	1.0	14
Avg/Total								30		1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

Condition 1

High vaccuum during sampling - one of the trapps packed tightly

Final leak check was conducted at the maximum vaccuum the pump could pull

VOST FIELD DATA SHEET
DATA SET # 4

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE < 0.1" Hg/Min @ 19"
LEAK CHECK AFTER < .01/Min @ 19"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET 4
METER BOX NO. V
Yd 1.0032
Bp 23.17

Diagram of sample location Start Time 1525

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 245.24	ΔH	COMMENTS: Vac
5	~1	75	138	22	21	27	37	38	250.6	1.0	7
10	~1	75	137	21	19	27	38	39	—	1.0	8
15	~1	73	130	20	18	25	39	40	261.1	1.0	8
20	~1	70	137	20	19	27	40	41	266.06	1.0	8
Avg/Add								39	20.82	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

condition 1

VOST FIELD DATA SHEET
DATA SET # 5

PLANT LANL
LOCATION CA1
OPERATOR Kaufmann
DATE 9/4/86
RUN # 5
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 19"
LEAK CHECK AFTER <0.1" Hg/min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CA1 outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~NA~~ 4
METER BOX NO. V1
Yd 1.0032
Bp ~~23.17~~ 23.08

Diagram of sample location Start Time 1854

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters 270.52 INITIAL: ~~270.74~~	ΔH	COMMENTS: VOC
5	~1	75	127	16	18	21	31	30	275.9	~~1.0~~ 1.2	10
10	~1	75	128	15	17	20	31	31	281.0	~~1.0~~ 1.2	10
15	~1	75	132	15	13	20	30	30	286.2	~~1.0~~ 1.2	10
20	~1	70	136	14	12	20	31	29	292.00	~~1.0~~ 1.2	11
Avg/Total								30	21.48	1.2 ~~1.0~~	

CONDENSATE SAMPLES:

SAMPLE I.D.: condition 1

COMMENTS: stop after 20.7 min.

VOST FIELD DATA SHEET
DATA SET # 6

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/4/86
RUN # 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 19"
LEAK CHECK AFTER <0.1" Hg/min @ 19.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~14
METER BOX NO. V1
Yd 1.0032
Bp 23.08

Diagram of sample location

Start Time 1938

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 294.32	ΔH	COMMENTS: Vac
5	~1	75	133	15	13	19	29	27	299.8	1.2	7
10	~1	75	141	13	13	19	28	27	304.95	1.2	8
15	~1	75	140	10	13	19	28	27	—	1.2	9
20	~1	75	133	11	13	19	28	27	315.68	1.2	9
								27.5	21.36	1.2	

CONDENSATE SAMPLES:

SAMPLE I.D.: condition 1

COMMENTS:

VOST FIELD DATA SHEET
DATA SET # 7

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21"
LEAK CHECK AFTER <0.1" Hg/min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3.5
METER BOX NO. V I
Yd 1.0032
Bp 23.05

condition 2

Diagram of sample location

Start Time 0958

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: ~~[illegible]~~ 0.00	ΔH	Vac	COMMENTS:
5	~1	75	129	11	14	17	19	21	5.42	1.03	10	
10	~1	75	133	9	11	17	20	21	10.60	1.03	10	
15	~1	73	141	9	11	18	21	22	15.60	1.03	10	
20	~1	70	136	10	11	18	21	22	20.62	1.03	10	
Avg/Total								21	20.62	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-1

Frosted area of trap is the gas outlet side

VOST FIELD DATA SHEET
DATA SET # 8

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 2
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21"
LEAK CHECK AFTER <0.1" Hg/Min @ 20"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET
METER BOX NO. V1
Yd 1.0032
Bp 23.05

condition 2

Diagram of sample location

Start Time 1044

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 21.49	ΔH	Vac	COMMENTS:
5	~1	75	137	9	13	19	24	24	26.81	1.03	8	
10	~1	75	139	9	12	19	25	24	32.15	1.03	8	
15	~1	75	139	9	12	20	24	25	37.68	1.03	9	
20	~1	75	140	8	12	19	25	25	43.17	1.03	9	
Avg/Total								24.5	21.68	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-2

VOST FIELD DATA SHEET
DATA SET # 9

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 20.5"
LEAK CHECK AFTER <0.1" Hg/min @ 19"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~2~~ 3
METER BOX NO. VI
Yd 1.0032
Bp 23.09

condition 2

Diagram of sample location

Start Time 1216

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 43.78	ΔH	Vac	COMMENTS:
5	~1	75	138	9	12	20	37	38	49.50	1.03	7	
10	~1	70	138	8	11	21	38	38	54.68	1.03	7	
15	~1	75	147	9	10	20	38	37	60.15	1.03	8	
20	~1	75	144	8	10	20	40	39	65.60	1.03	8	
Avg/Total								38	21.82	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-3

VOST FIELD DATA SHEET
DATA SET # 10

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # ~~3~~ 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1 "Hg/Min @ 21"
LEAK CHECK AFTER <0.1 "Hg/Min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3.5
METER BOX NO. VI
Yd 1.0032
Bp 23.05

condition 2

Diagram of sample location

Start Time 1302

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 66.30	ΔH	Vac	COMMENTS:
5	~1	.70	143	13	15	24	38	36	71.51	1.03	10	
10	~1	.75	146	10	12	20	37	34	76.95	1.03	11	
15	~1	.75	146	10	14	22	37	35	82.30	1.03	11	
20	~1	.75	145	10	12	21	35	33	87.47	1.03	11	
Avg/Total								36	21.17	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-4

VOST FIELD DATA SHEET
DATA SET # 11

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 5
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21"
LEAK CHECK AFTER <0.1" Hg/Min @ 18"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~1.1~~ 2.5
METER BOX NO. V I
Yd 1.0032
Bp 23.09

condition 2

Diagram of sample location

Start Time 1448

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 87.98	ΔH	Vac	COMMENTS:
5	~1	75	149	12	12	21	38	37	93.50	1.03	7	
10	~1	75	141	12	13	22	39	38	98.75	1.03	7	
15	~1	75	139	13	15	24	40	41	104.22	1.03	7	
20	~1	75	139	14	15	25	41	43	109.96	1.03	8	
Avg/Total								40	21.98	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-5

VOST FIELD DATA SHEET
DATA SET # 12

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/5/86
RUN # 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1 "Hg/min @ 21"
LEAK CHECK AFTER <0.1 "Hg/min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET
METER BOX NO. V1
Yd 1.0032
Bp

condition 2

Diagram of sample location

Start Time 1527

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 110.67	ΔH	Vac	COMMENTS:
5	~1	75	136	15	16	26	46	49	116.00	1.03	6	
10	~1	70	133	13	13	24	47	48	120.90	1.03	7	
15	~1	70	130	11	13	25	48	48	125.82	1.03	8	
20	~1	65	137	13	14	25	49	48	130.59	1.03	8	
Avg/Total							48		19.92	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-2-V-6

VOST FIELD DATA SHEET
DATA SET # 13

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/MM @ 21"
LEAK CHECK AFTER <0.1" Hg/Min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3.5
METER BOX NO. VI
Yd 1.0032
Bp 23.15

condition 3

Diagram of sample location

Start Time 1036

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 0.00	ΔH	Vac	COMMENTS:
5	~1	75	130	15	13	18	24	25	5.00	1.03	9	
10	~1	75	132	13	12	18	24	25	10.00	1.03	10	
15	~1	70	133	12	11	18	24	26	15.07	1.03	11	
20	~1	70	132	14	12	19	25	26	20.14	1.03	11	
Avg/Total								25	20.14	1.03		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-3-V-1

VOST FIELD DATA SHEET
DATA SET # 15

PLANT LANL
LOCATION CAI
OPERATOR Kautmann
DATE 9/6/86
RUN # 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE < 0.1" Hg/min @ 21.5"
LEAK CHECK AFTER < 0.1" Hg/min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3
METER BOX NO. V I
Yd 1.0032
Bp 23.05

condition 3

Diagram of sample location

Start Time 1709

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 45.71	ΔH	COMMENTS: Vac
5	~1	75	124	20	20	23	32	32	—	1.02	11
10	~1	75	131	20	20	25	33	33	56.12	1.02	11
15	~1	70	131	20	19	25	33	33	61.19	1.02	12
20	~1	70	129	19	20	24	34	33	66.42	1.02	12
Avg/Total								33	20.71	1.02	

CONDENSATE SAMPLES:

SAMPLE I.D.:

COMMENTS: Traps loaded in train ~ 5 hrs. before sampling

LANL-3-V-3

VOST FIELD DATA SHEET
DATA SET # 16

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21"
LEAK CHECK AFTER <0.1" Hg/Min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~
METER BOX NO. V 1
Yd 1.0032
Bp 23.05

condition 4

Diagram of sample location

Start Time 1756

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 66.83	ΔH	COMMENTS: Vac	
5	~1	75	128	20	20	23	34	32	72.03	1.02	9	
10	~1	70	128	18	18	23	34	32	77.10	1.02	12	
15	~1	70	132	18	18	[illegible]	33	32	82.20	1.02	12	
20	~1	70	133	18	17	22	33	32	87.20	1.02		
Avg/Total								33	20.37	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-3-V-4

VOST FIELD DATA SHEET
DATA SET # 17

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 5
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/Min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3
METER BOX NO. V I
Yd 1.0032
Bp 23.05

condition 3

Diagram of sample location

Start Time 1924

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 87.75	ΔH	Vac	COMMENTS:
5	~1	75	132	19/14	13	18	26	25	93.32	1.02	14	
10	~1	75	134	15	14	18	25	25	98.81	1.02	13	
15	~1	75	131	15	14	18	25	25	104.30	1.02	13	
20	~1	75	133	14	13	18	25	24	109.74	1.02	13	
Avg/Total								25	21.99	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-3-V-5

VOST FIELD DATA SHEET
DATA SET # 18

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/6/86
RUN # 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/MM @ 21.5"
LEAK CHECK AFTER <0.1" Hg/M @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3
METER BOX NO. V1
Yd 1.0032
Bp 23.05

condition 3

Diagram of sample location

Start Time 1957

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 10.42	ΔH	COMMENTS: Vac
5	~1	75	127	15	14	17	25	23	15.73	1.03	7
10	~1	70	131	15	13	18	25	24	20.97	1.03	9
15	~1	75	133	15	13	18	25	24	26.20	1.03	10
20	~1	70	135	14	14	18	25	24	31.46	1.03	10
Avg/Total								24	21.04	1.03	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-3-V-6

VOST FIELD DATA SHEET
DATA SET # 19

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 21"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3.5
METER BOX NO. VI
Yd 1.0032
Bp 23.13

condition 4

Diagram of sample location

Start Time 1349

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 33.02	ΔH	Vac	COMMENTS:
5	~1	75	126	13	16	18	23	24	38.54	1.02	11	
10	~1	75	130	12	15	19	24	25	43.80	1.02	11	
15	~1	75	132	12	~~12~~ 15	20	25	27	49.00	1.02	11	
20	~1	70	131	~~14~~ 12	14 ~~20~~	20 ~~26~~	~~28~~ 26	28	53.98	1.02	11	
Avg/Total								25	20.96	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-1

VOST FIELD DATA SHEET
DATA SET # 20

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 2
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA 3.5
PROBE HEATER SET ~~NA~~
METER BOX NO. V1
Yd 1.0032
Bp 23.13

condition 4

Diagram of sample location

Start Time 1430

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 54.66	ΔH	COMMENTS: Vac	
5	~1	75	133	11	14	19	31	32	59.75	1.02	5	
10	~1	75	133	10	13	19	31	32	64.86	1.02	6	
15	~1	70	131	9	11	19	31	32	70.08	1.02	6	
20	~1	75	130	9	11	19	32	32	75.42	1.02	6	
Avg/Total								32	20.76	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-2

VOST FIELD DATA SHEET
DATA SET # 21

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3.5
METER BOX NO. V 1
Yd 1.0032
Bp 23.13

condition 4

Diagram of sample location

Start Time 1558

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 75.96	ΔH	Vac	COMMENTS:
5	~1	70	134	11	12	20	33	33	~~80.00~~ 81.00	1.02	6	
10	~1	70	133	13	13	20	34	34	~~89.95~~ 89.95	1.02	6	
15	~1	70	141	10	11	18	34	34	91.03	1.02	6	
20	~1	70	140	10	11	19	34	34	96.11	1.02	6	
Avg/Total								34	20.15	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-3

VOST FIELD DATA SHEET
DATA SET # 22

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/min @ 21.5"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET ~~[illegible]~~ 3.0
METER BOX NO. VI
Yd 1.0032
Bp 23.13

condition 4

Diagram of sample location

Start Time 1638

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 96.74	ΔH	Vac	COMMENTS:
5	~1	65	125	12	13	19	34	33	101.45	1.0	17	
10	~1	65	129	11	12	18	33	32	106.00	1.0	17	
15	~1	63	131	11	12	18	33	31	110.22	1.0	17	
20	~1	55	134	12	11	18	32	31	114.45	1.0	17	
Avg/Total								32	17.71	1.0		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-4

VOST FIELD DATA SHEET
DATA SET # 23

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/Min @ 18"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST 1
VOST NO.
FILTER I.D. NA
PROBE HEATER SET
METER BOX NO. VI
Yd 1.0032
Bp 23.5

condition 4

Diagram of sample location

Start Time 1309

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 15.12	ΔH	Vac	COMMENTS:
5	~1	75	136	11	13	19	24	23	20.35	1.02	7	
10	~1	75	137	10	11	19	24	23	—	1.02	6	
15	~1	75	137	10	13	18	24	23	31.40	1.02	6	
20	~1	75	131	11	11	19	25	24	36.56	1.02	6	
Avg/Total								24	21.44	1.02		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-5

VOST FIELD DATA SHEET
DATA SET # 24

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 21"
LEAK CHECK AFTER <0.1" Hg/min @ 20"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. CAI Outlet
PROBE NO. VOST I
VOST NO.
FILTER I.D. NA
PROBE HEATER SET
METER BOX NO. V I
Yd 1.0032
Bp 22.10

condition 4

Diagram of sample location

Start Time 1846

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 37.01	ΔH	COMMENTS: Vac
5	~1	70	129	11	11	18	25	25	—	1.02	6
10	~1	70	134	10	11	17	25	25	47.20	1.02	8
15	~1	70	134	11	11	18	26	25	52.42	1.02	8
20	~1	70	128	10	11	18	26	26	~~53.~~	1.02	8
									57.37		
Avg/Total								25	20.36	1.02	

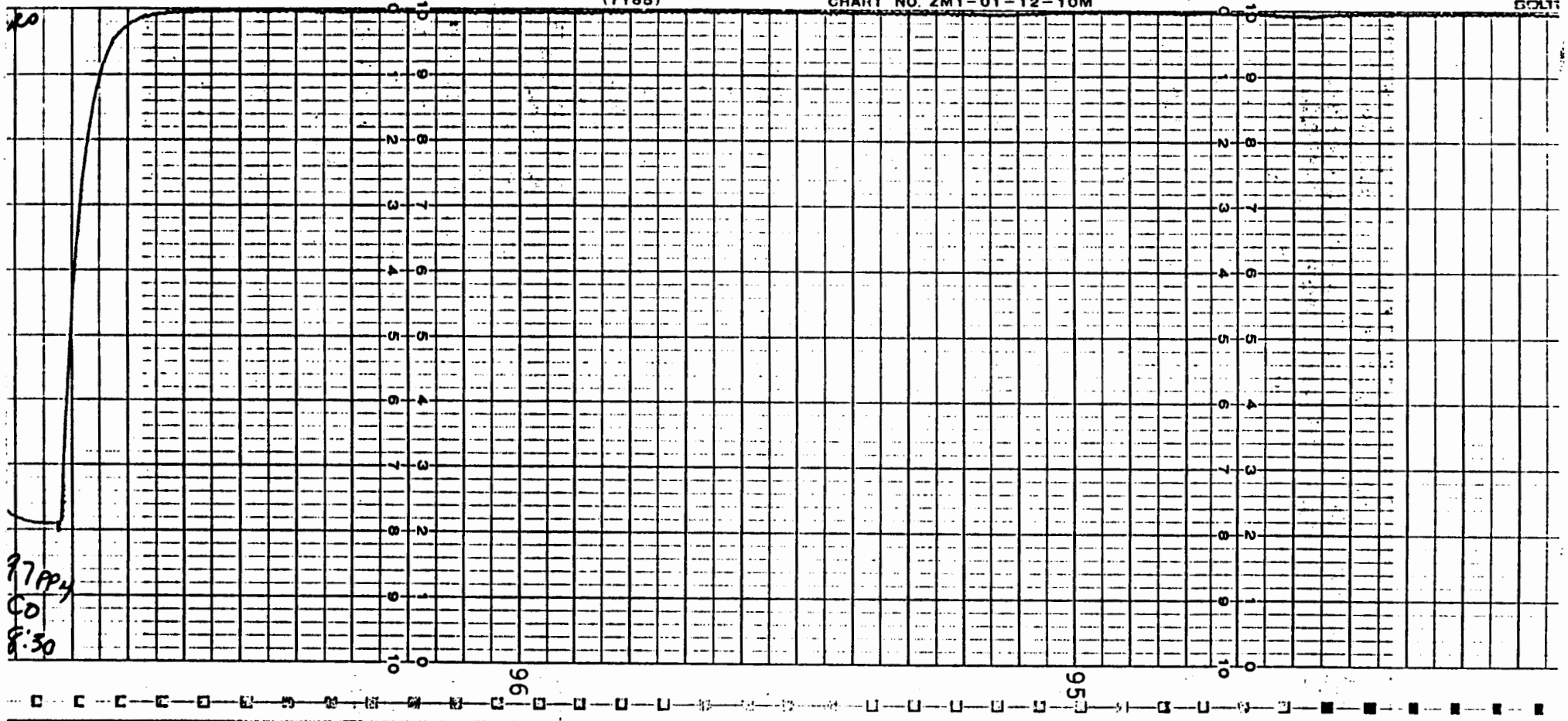
CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-4-V-6

97
98
99
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10
SOLTEC
CHART NO. ZM1-01-1
10M
(Z105)
PRIMELINE
A SOLTEC PRODUCT
CHART NO. ZM1-01-12-10M

(7165) CHART NO. ZM1-01-12-10M



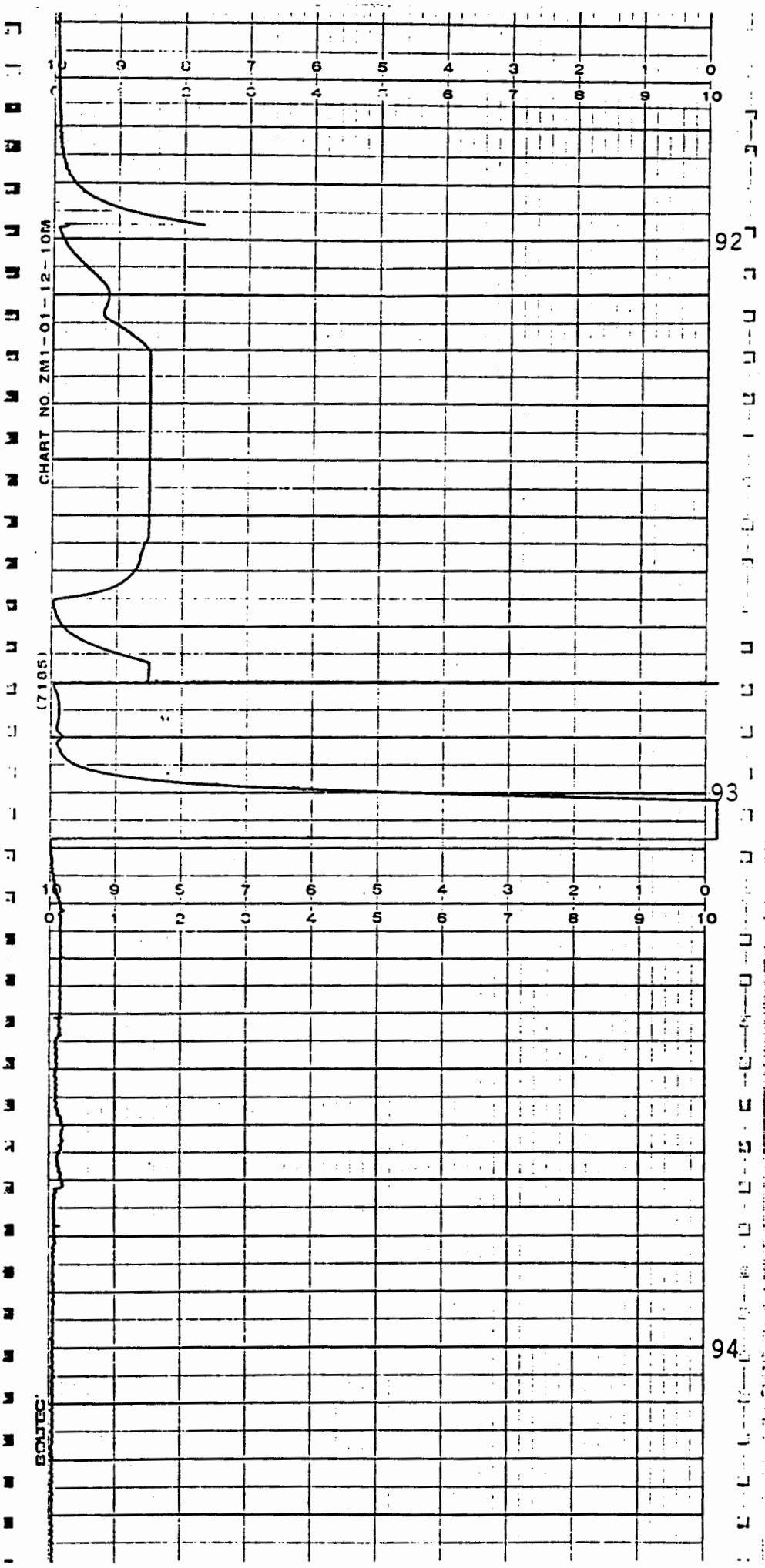


CHART NO. ZM1-01-12-10M
(7105)
BOLTEC
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10
92
93
94

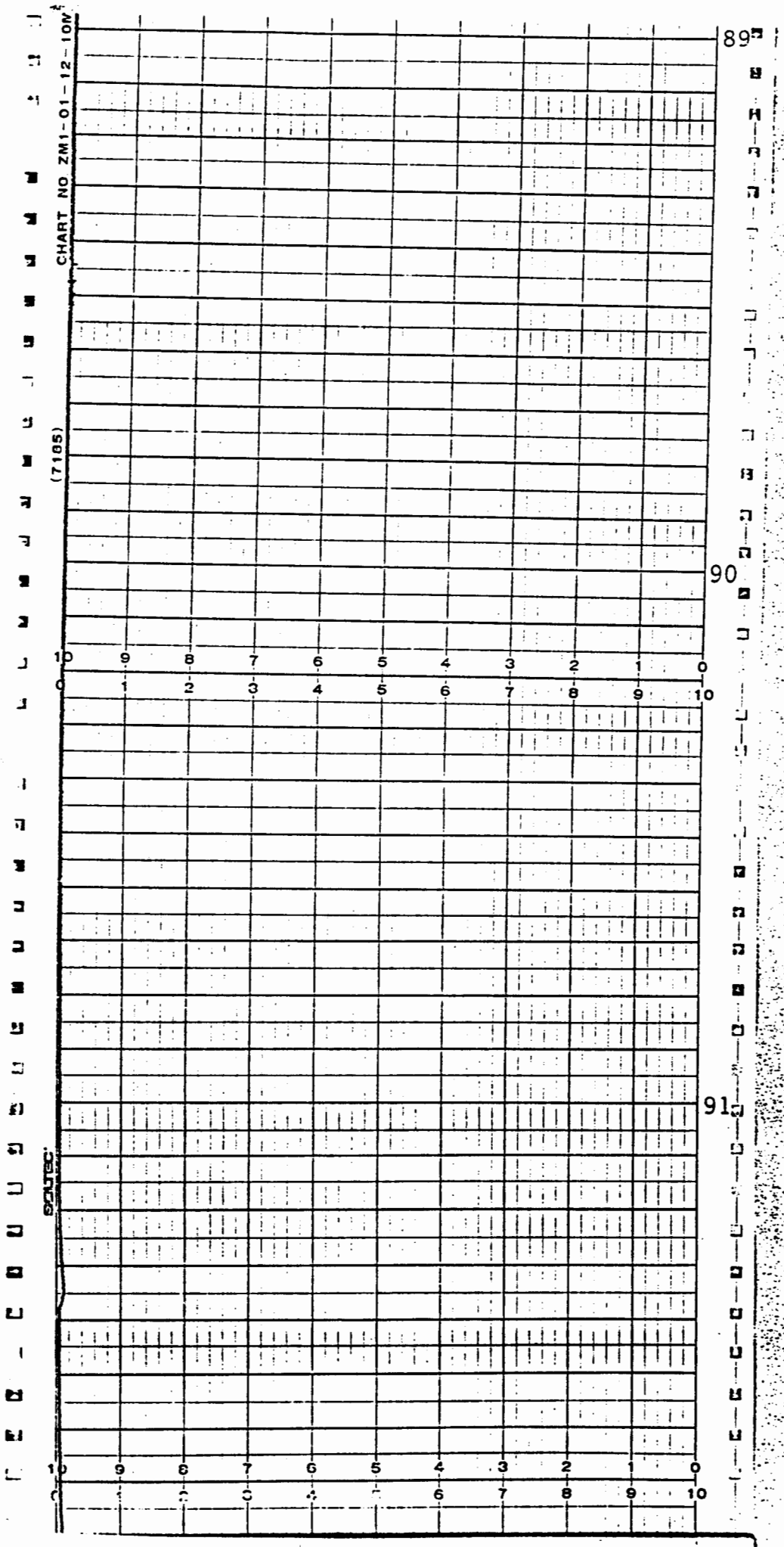
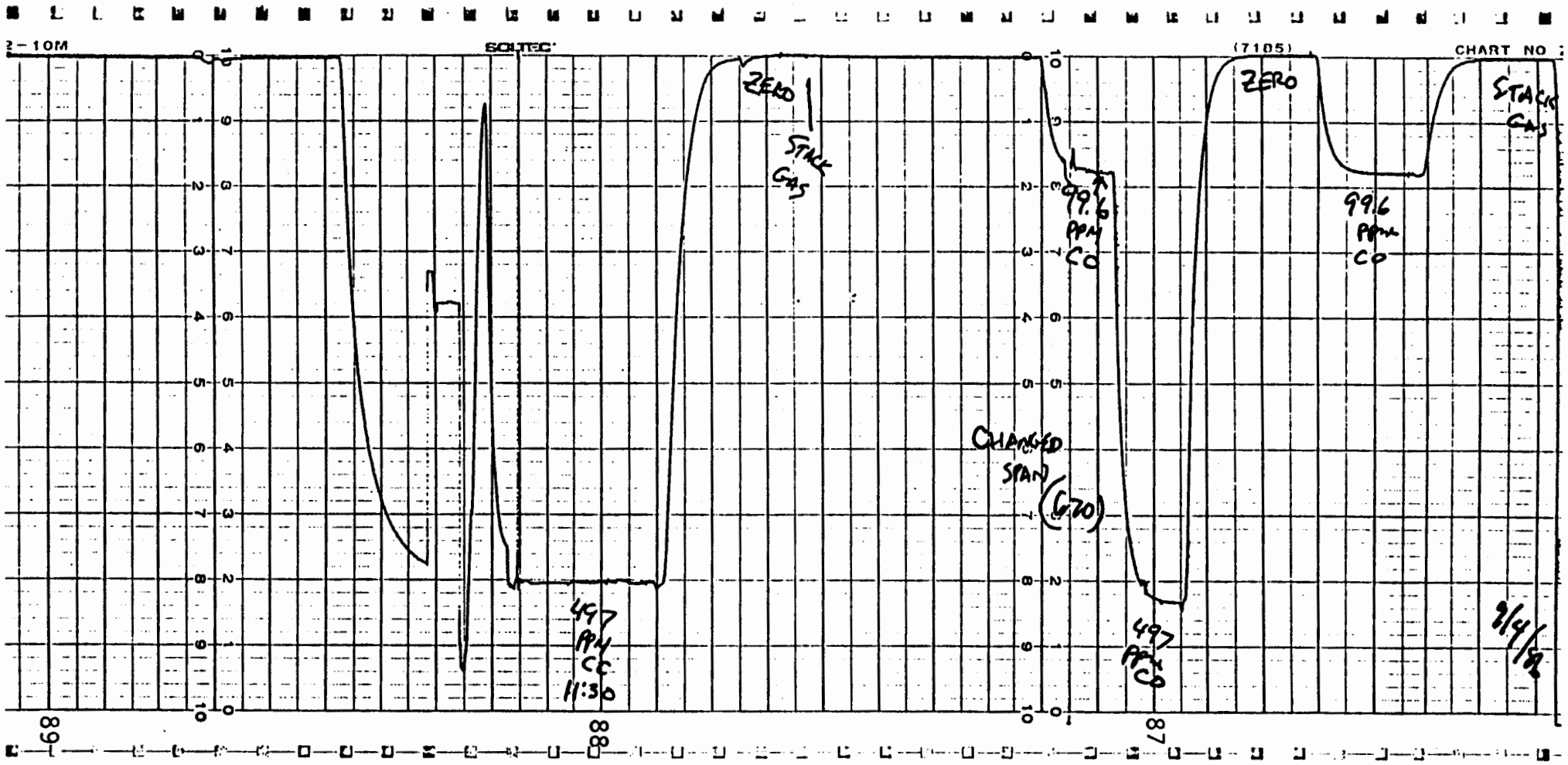
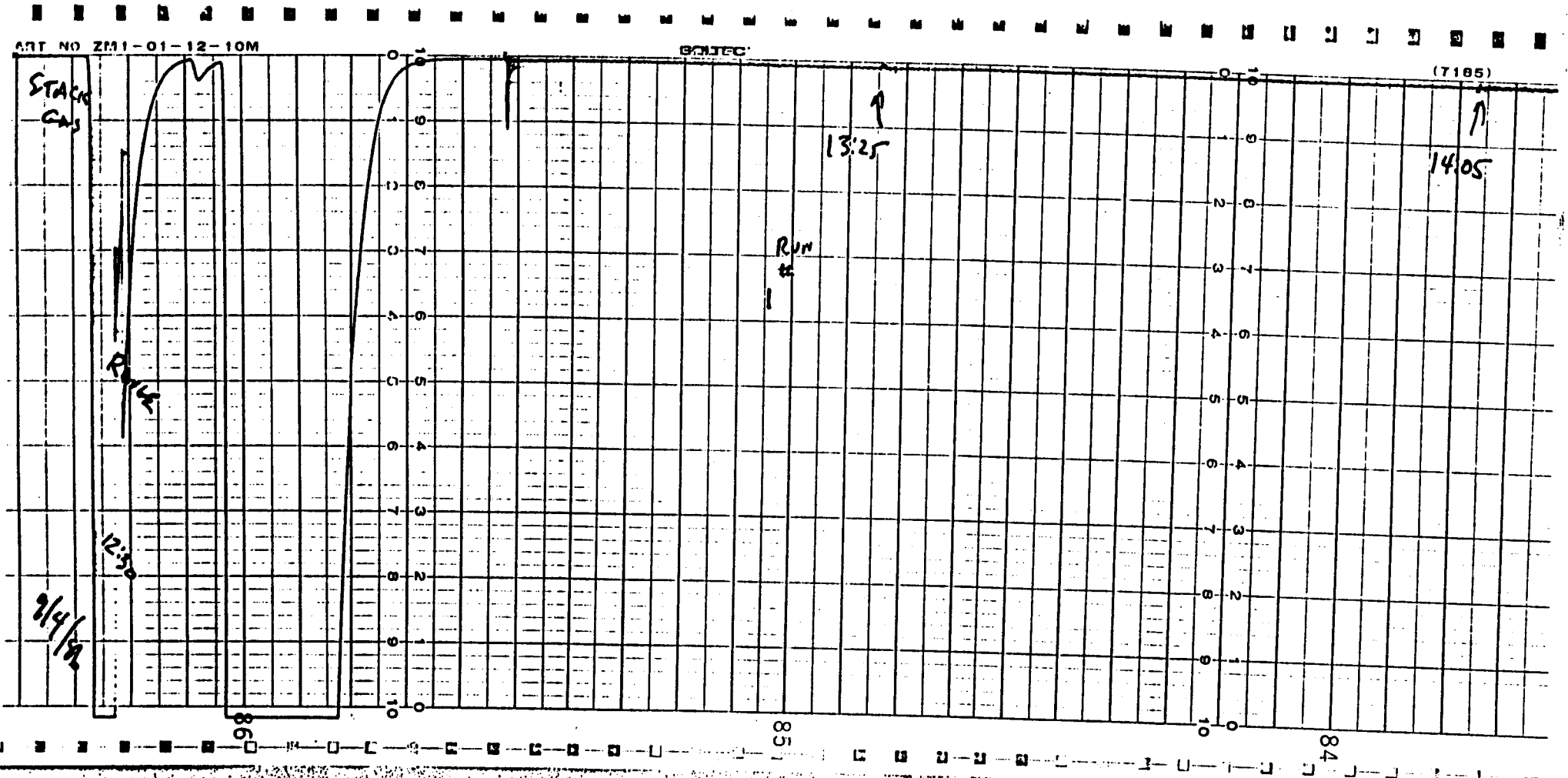


CHART NO ZM1-01-12-10M
(7185)
89
90
91
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10


2-10M
SOLTEC
(7105)
CHART NO
ZERO
STACK GAS
99.6 PPM CO
CHANGED SPAN (670)
497 PPM CO
11:30
ZERO
99.6 PPM CO
STACK GAS
497 PPM CO
9/4/82
89
88
87


ART NO ZM1-01-12-10M
(7185)
STACK GAS
12:30
2/4/92
13:25
14:05
RUN #1
86
85
84

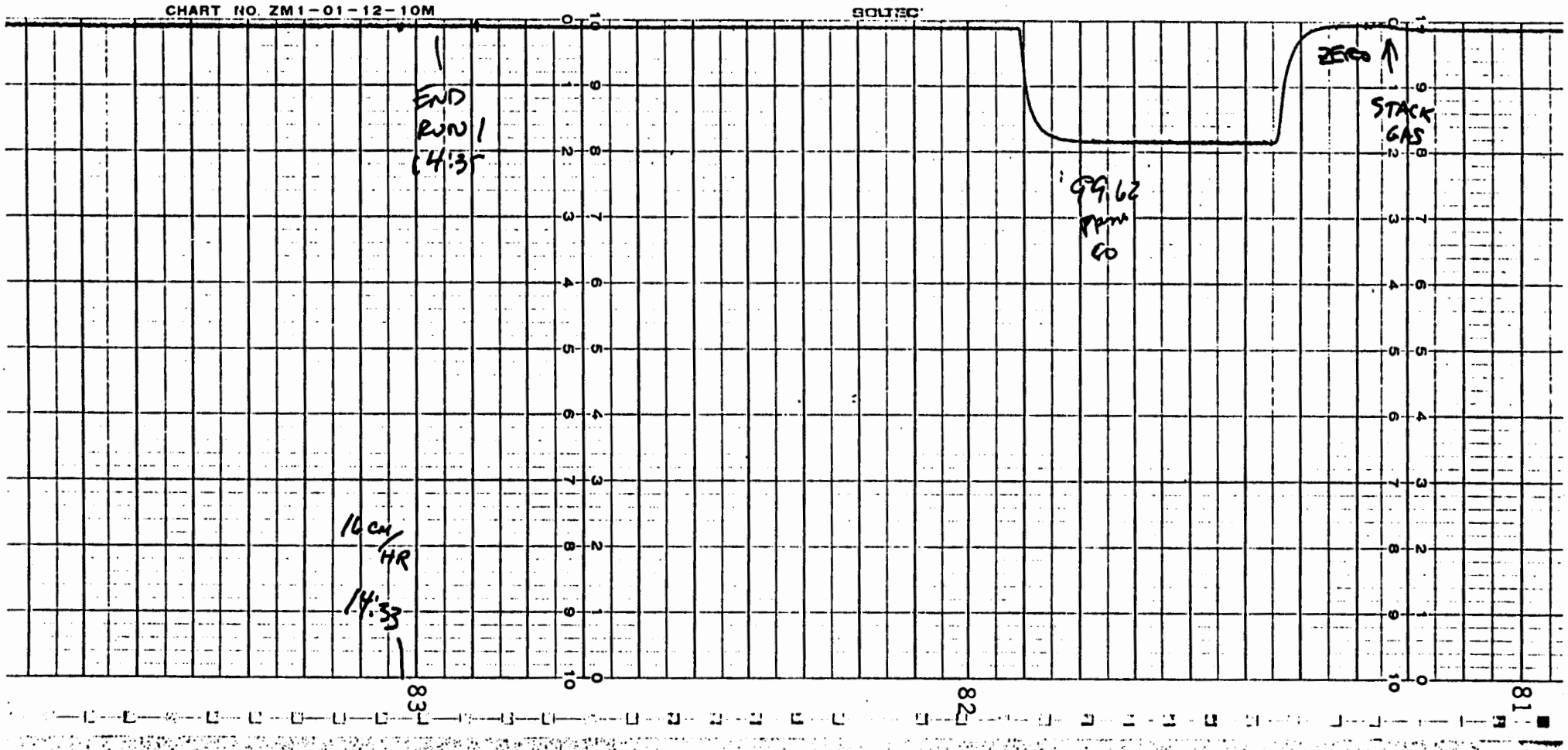
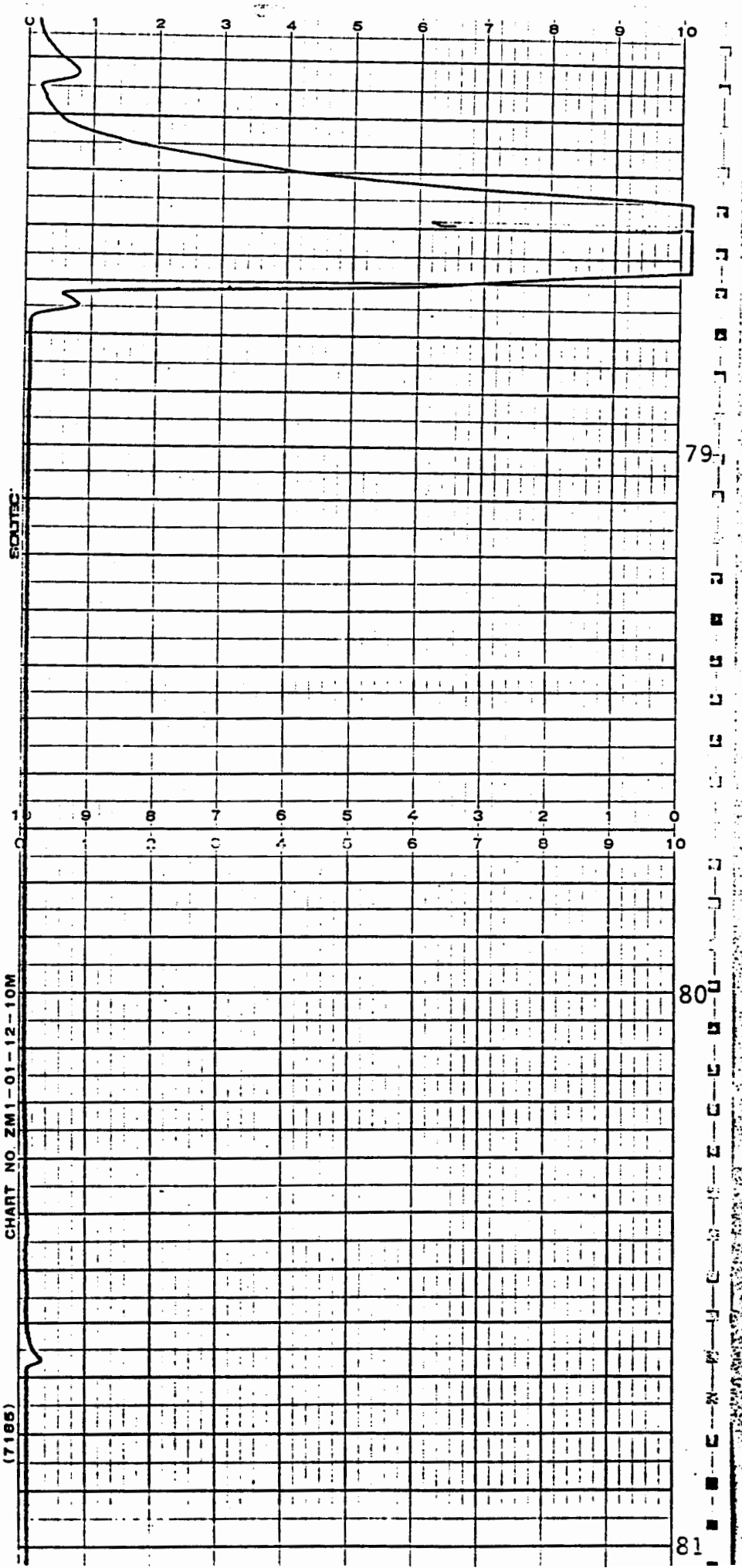
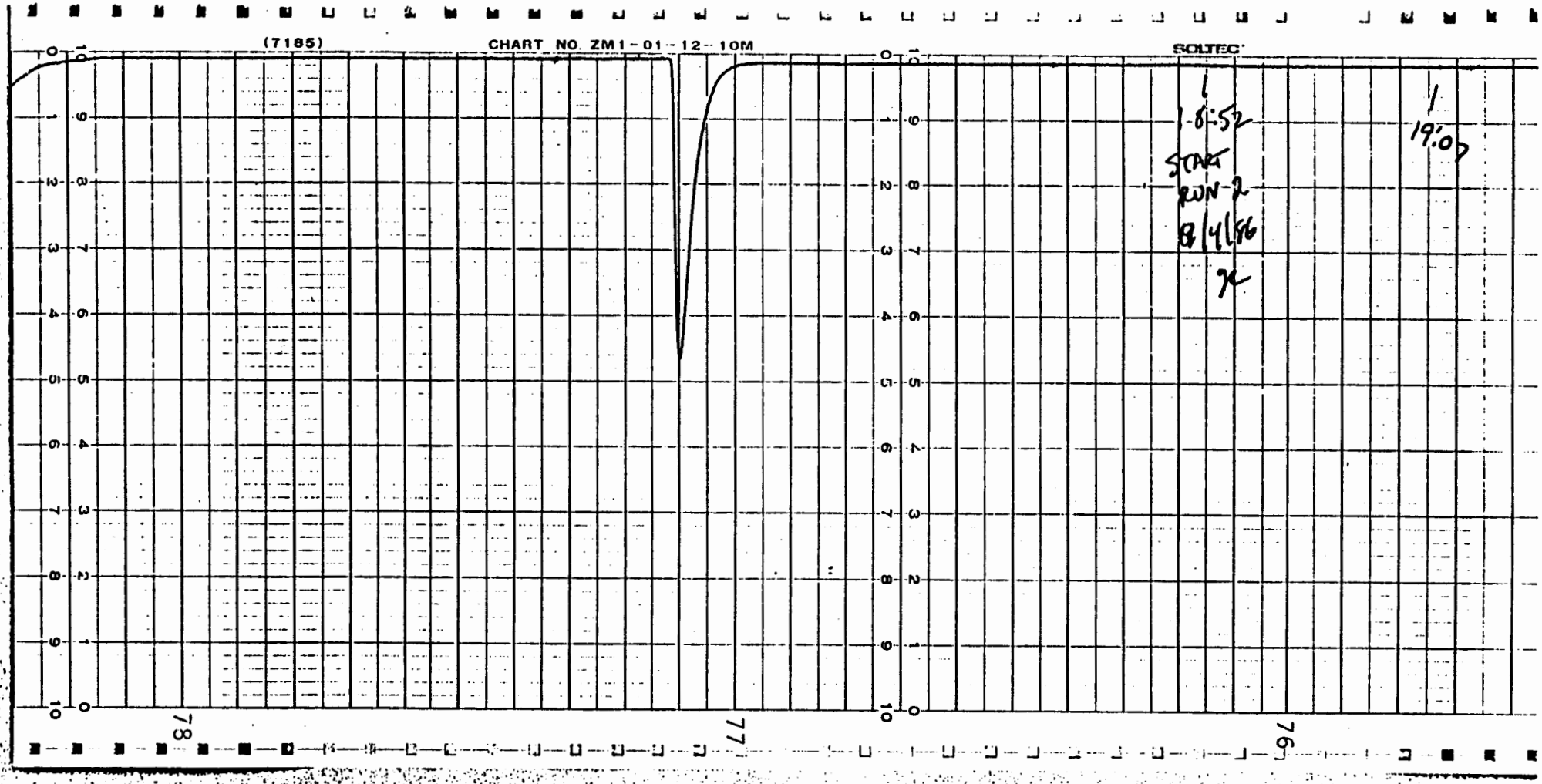
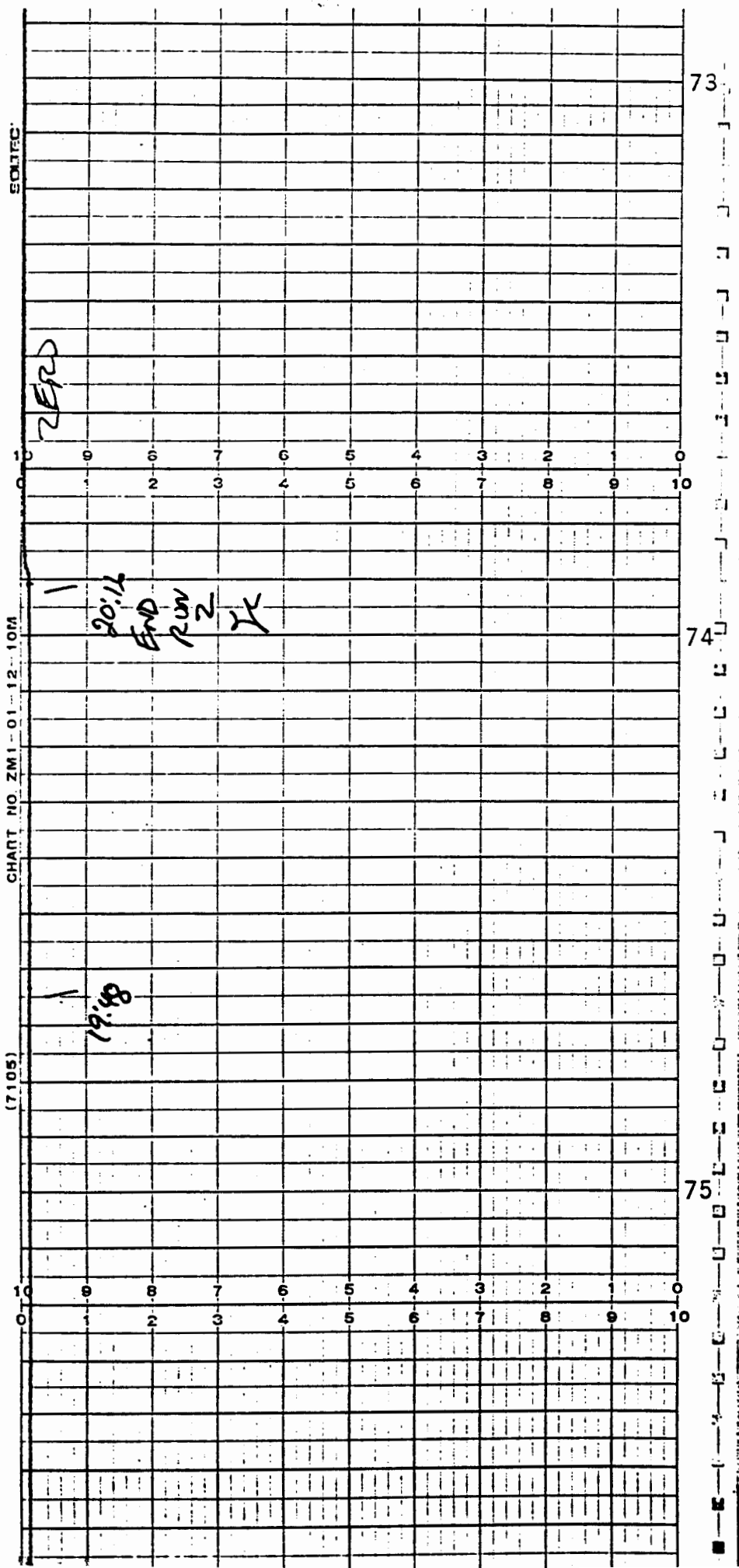
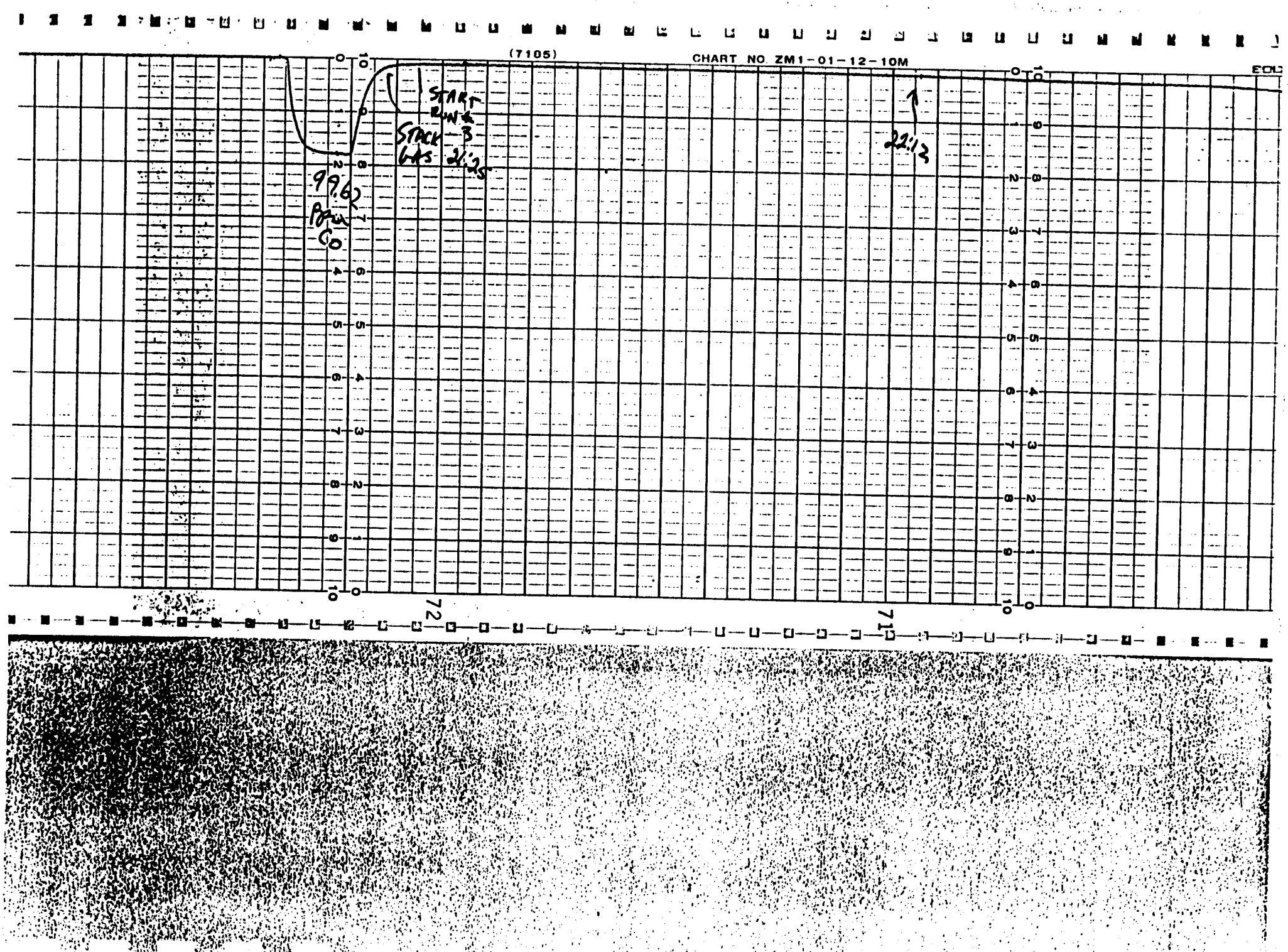


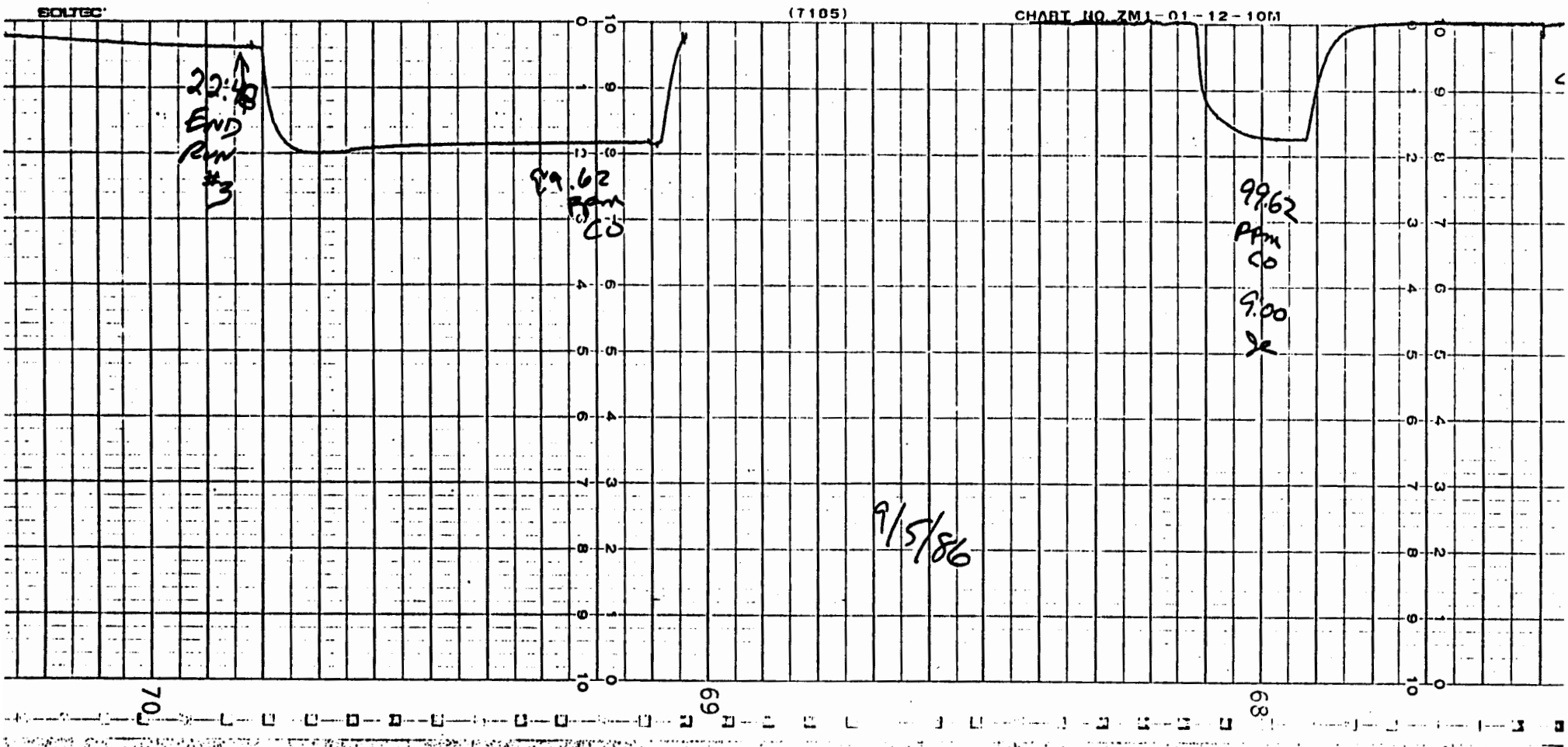
CHART NO. ZM1-01-12-10M
SOLTEC
END RUN 1 14:35
16 cm/HR
14:33
99.62 ppm CO
ZERO
STACK GAS
83
82
81

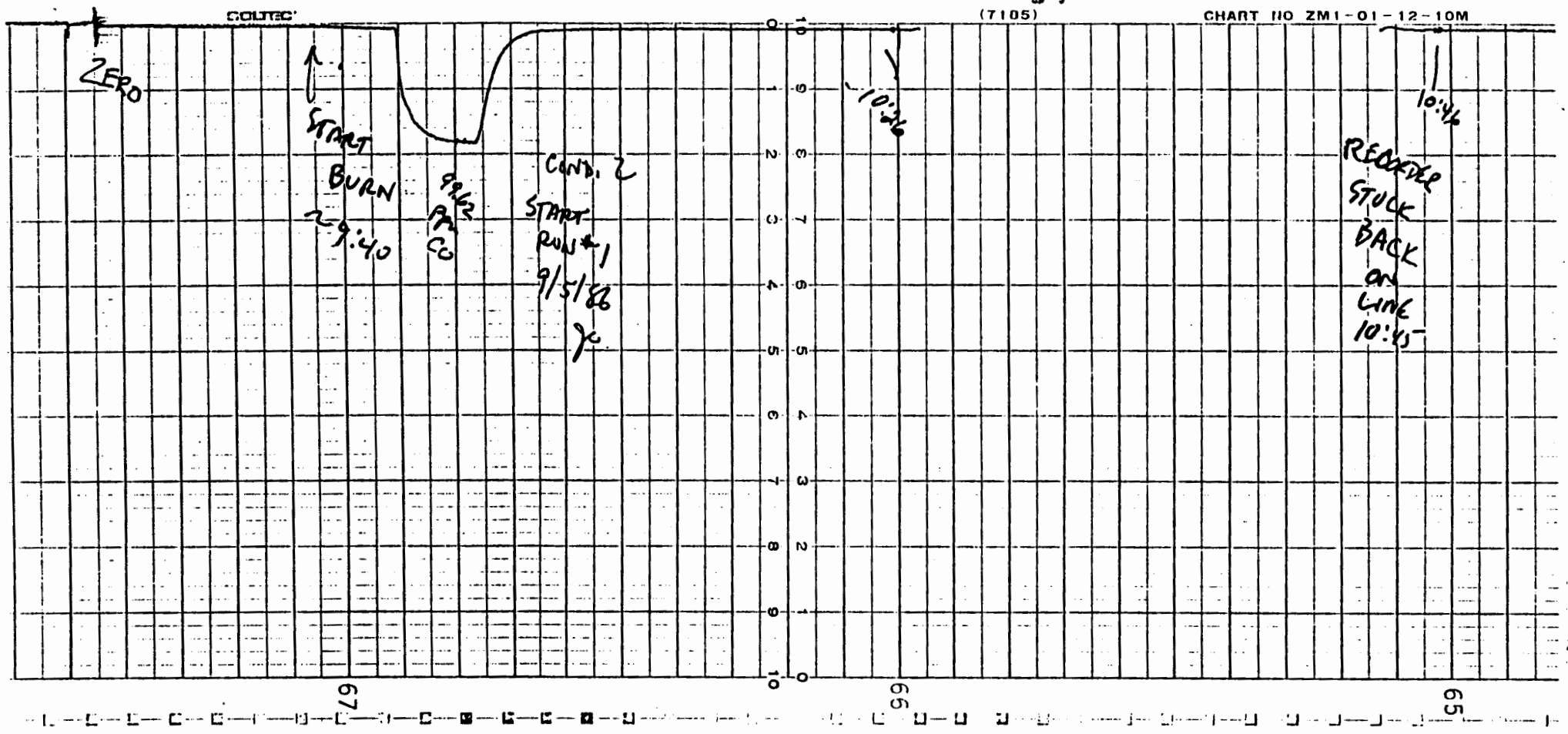

0 1 2 3 4 5 6 7 8 9 10
79
SOLTEC
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10
80
CHART NO. ZM1-01-12-10M
(7185)
81

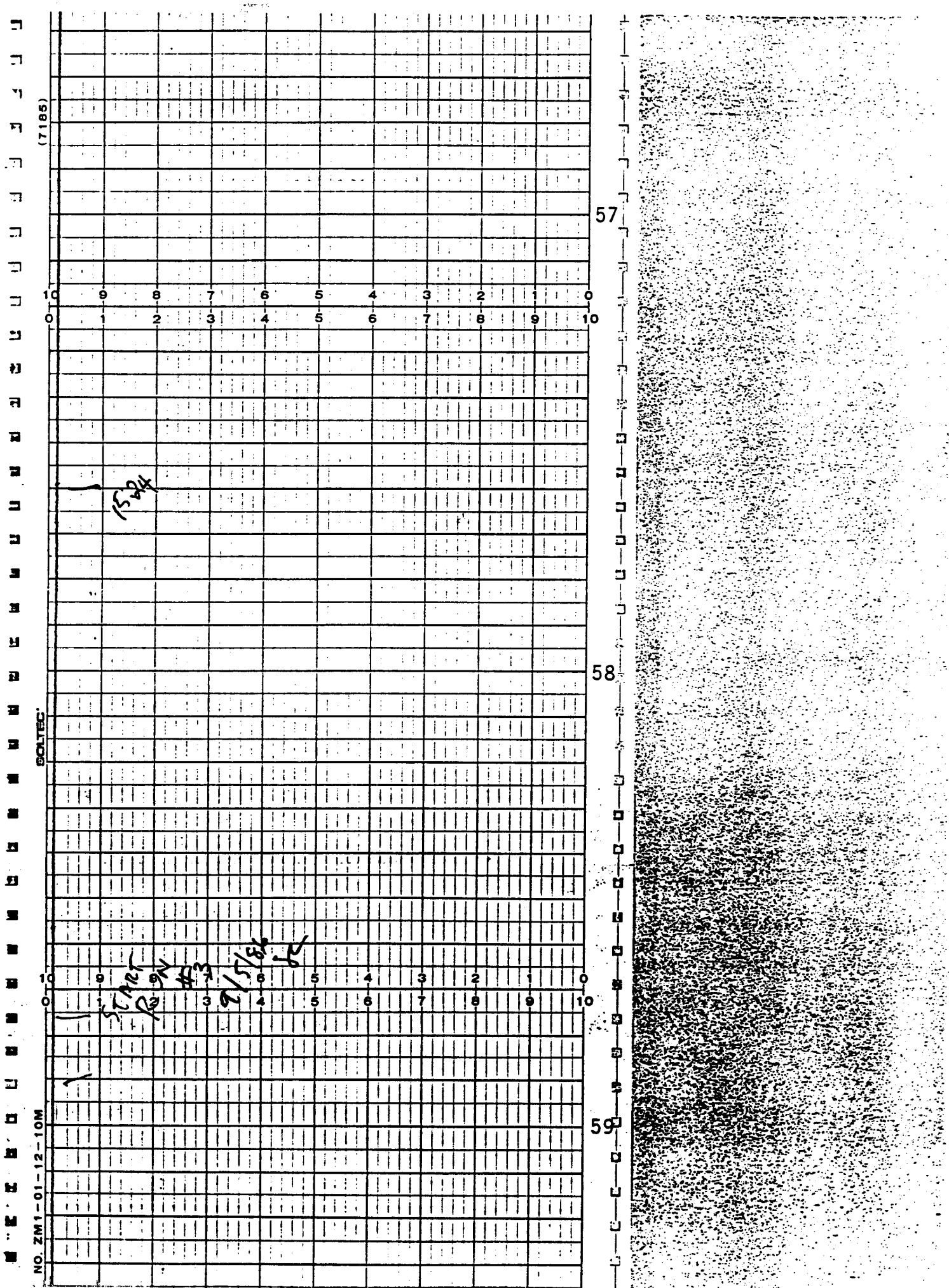

(7185)
CHART NO. ZM1-01-12-10M
SOLTEC
18:52
START
RUN 2
8/4/86
19:00
78
77
76


SOLTEC
CHART NO. ZM1-01-12-10M
(7105)
ZERO
20:12
END
RUN
2
19:48
73
74
75
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10


(7105)
CHART NO ZM1-01-12-10M
START RUN 3
STACK WAS 21.25
99.6
22.13
72
71


SOLTEC
(7105)
CHART NO. ZM1-01-12-10M
22:48
END
Run
#3
99.62
ppm
CO
99.62
ppm
CO
9:00
9/5/86
70
69
68


COLTEC
(7105)
CHART NO ZM1-01-12-10M
ZERO
START BURN ~9:40
9:42 AM CO
COND. 2
START RUN #1 9/5/86
10:46
10:46
RECORDER STUCK BACK ON LINE 10:45
67
66
65


(7185)
57
58
59
GOLTEC
NO. ZM1-01-12-10M
15 DAY
START RUN #3 9/5/86

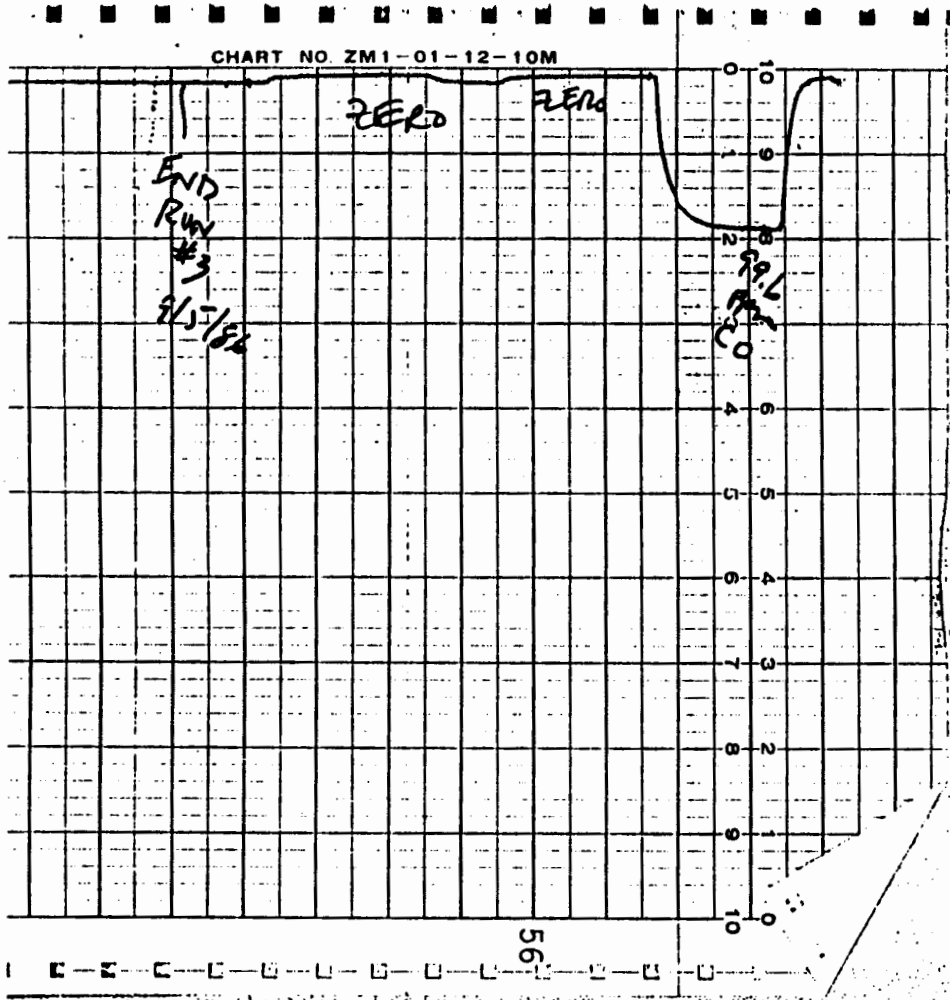
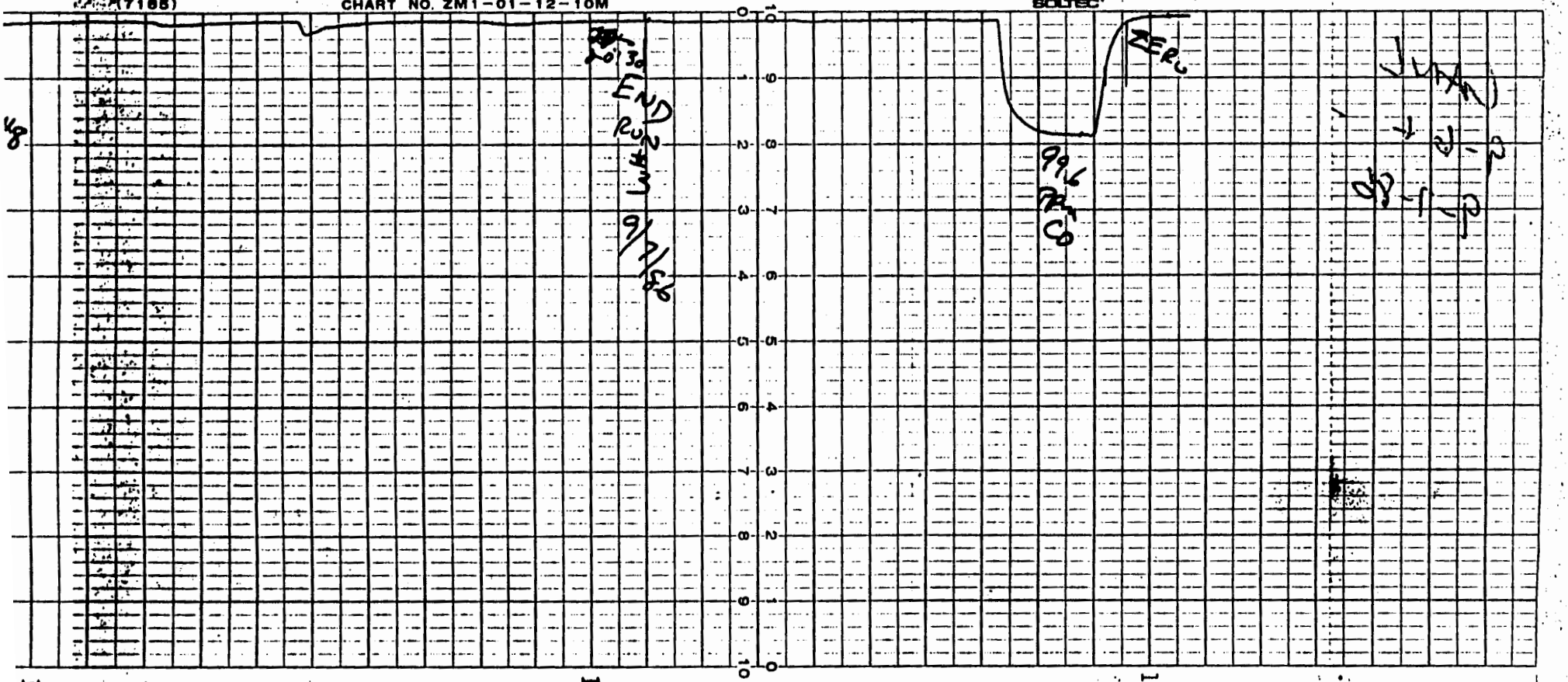


CHART NO. ZM1-01-12-10M
ZERO
ZERO
END RUN #3 8/31/82
8.9 PPM CO

(7165) CHART NO. ZM1-01-12-10M SOLTEC



15 14 13

5)

CHART NO. ZM1-01-12-10M

SOLTEC

18:12
START
RUN #
3
9/7/86

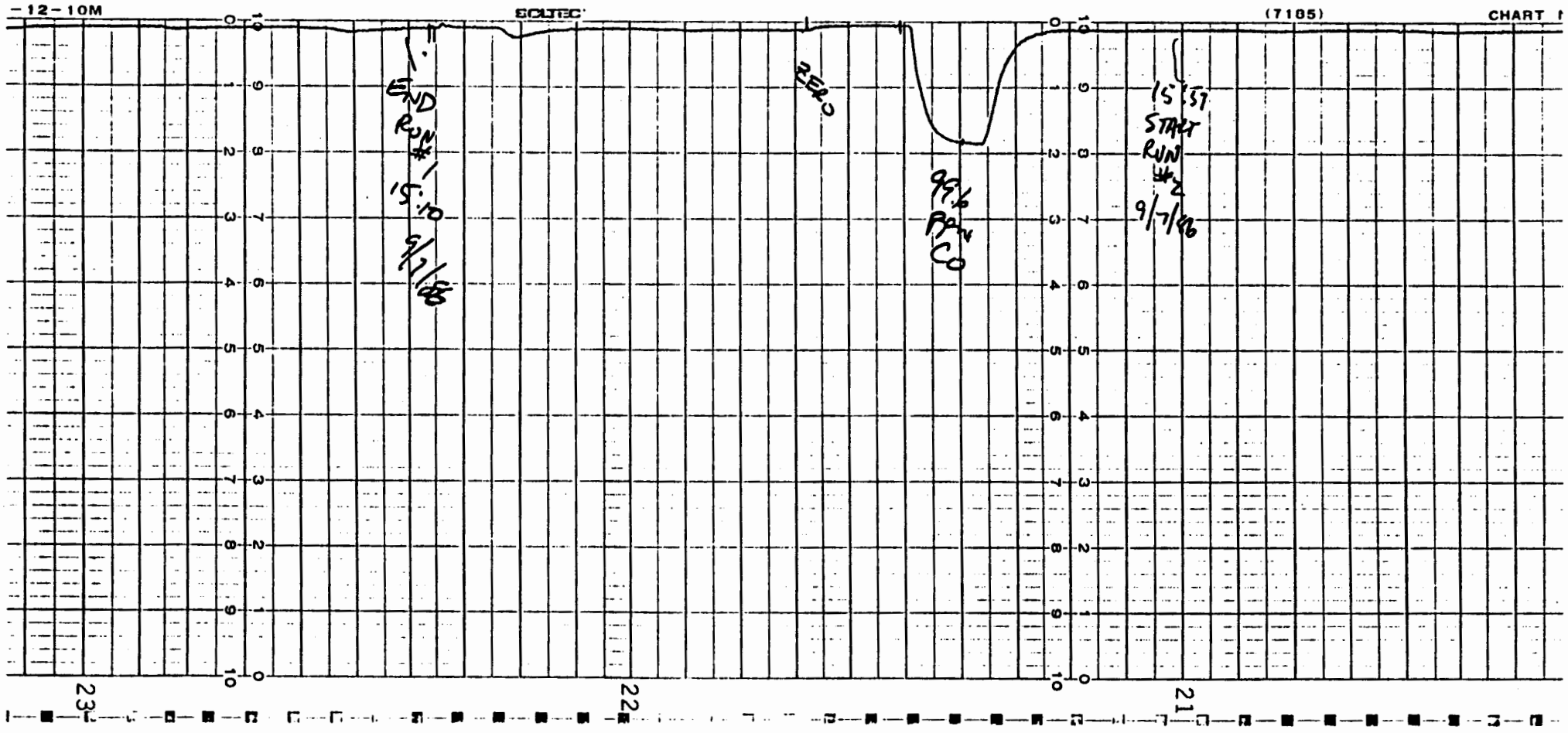
19:48

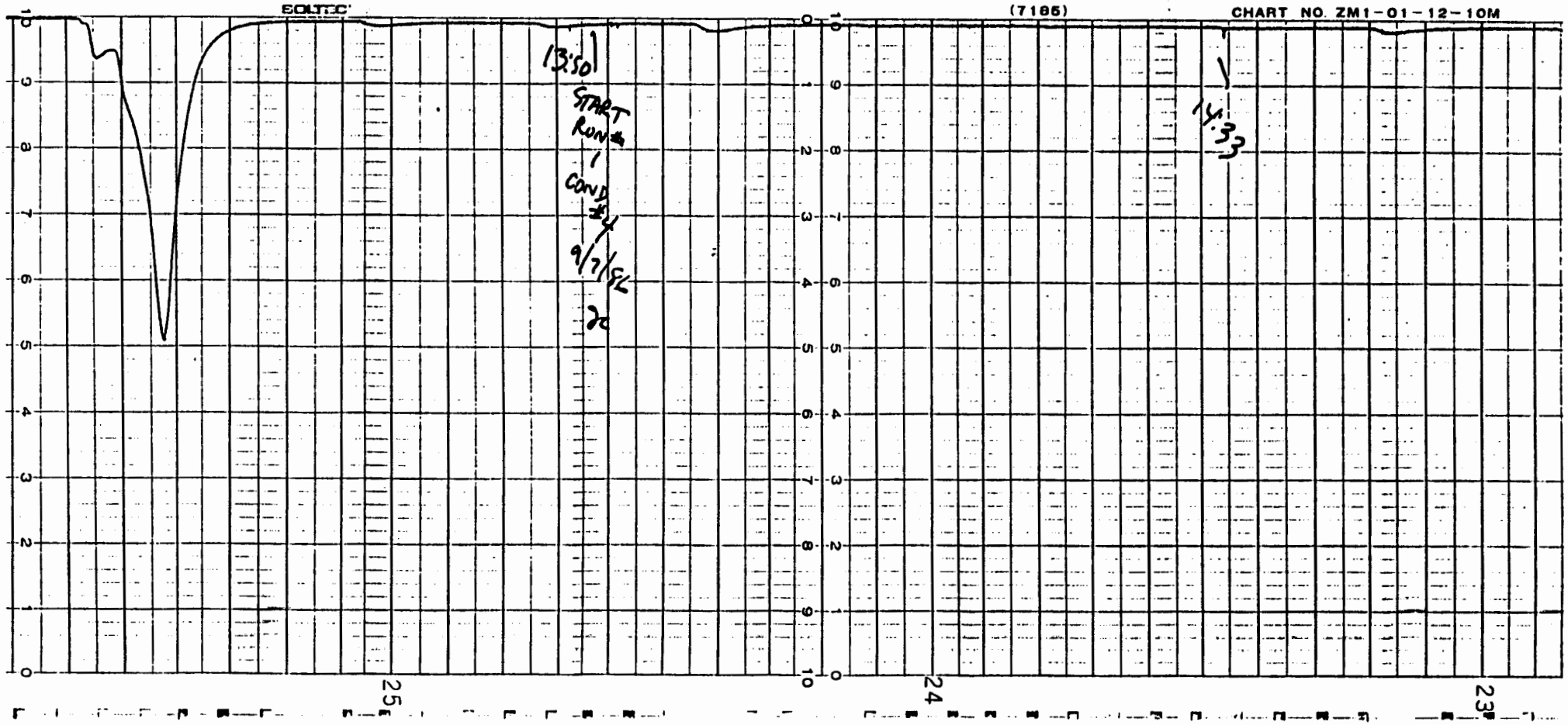
17

16

15

CHART NO. ZM1-01-12-10M
SOLTEC
(7185)
18
19
20
Peak Pt CO
12:00
17:18
End Point #2 Calibr
16:44


-12-10M
SOLTEC
(7185)
CHART
END RUN #1 15:10 9/7/86
ZERO
99% RANGE CO
15:59 START RUN #2 9/7/86
23
22
21


SOLTEC
(7185)
CHART NO. ZM1-01-12-10M
13:50
START
RUN #
1
COND
#4
9/7/82
2c
14:33
25
24
23

SOLTEC

(7185)

CHART NO. ZM1-01-12-10M

28

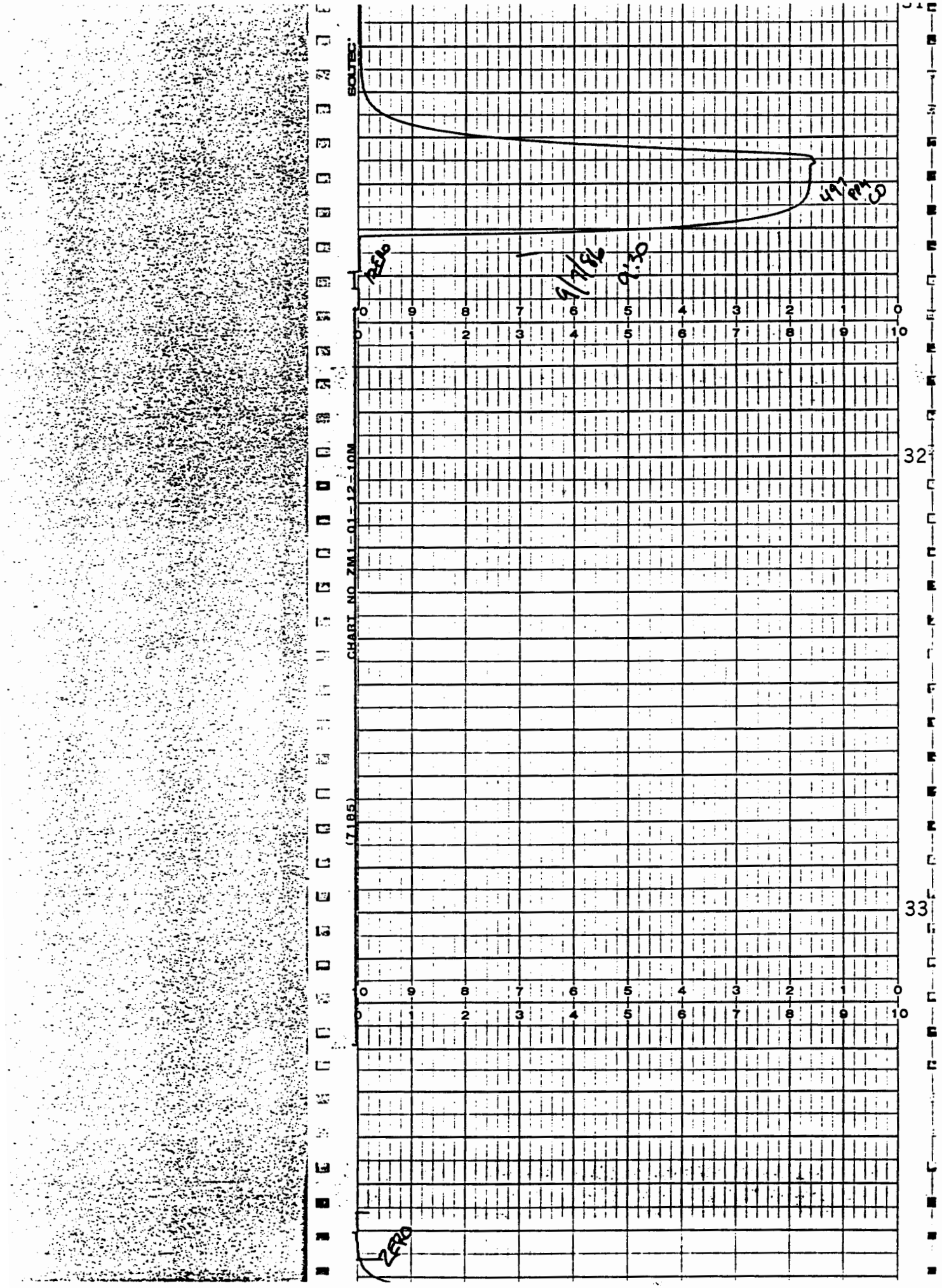
27

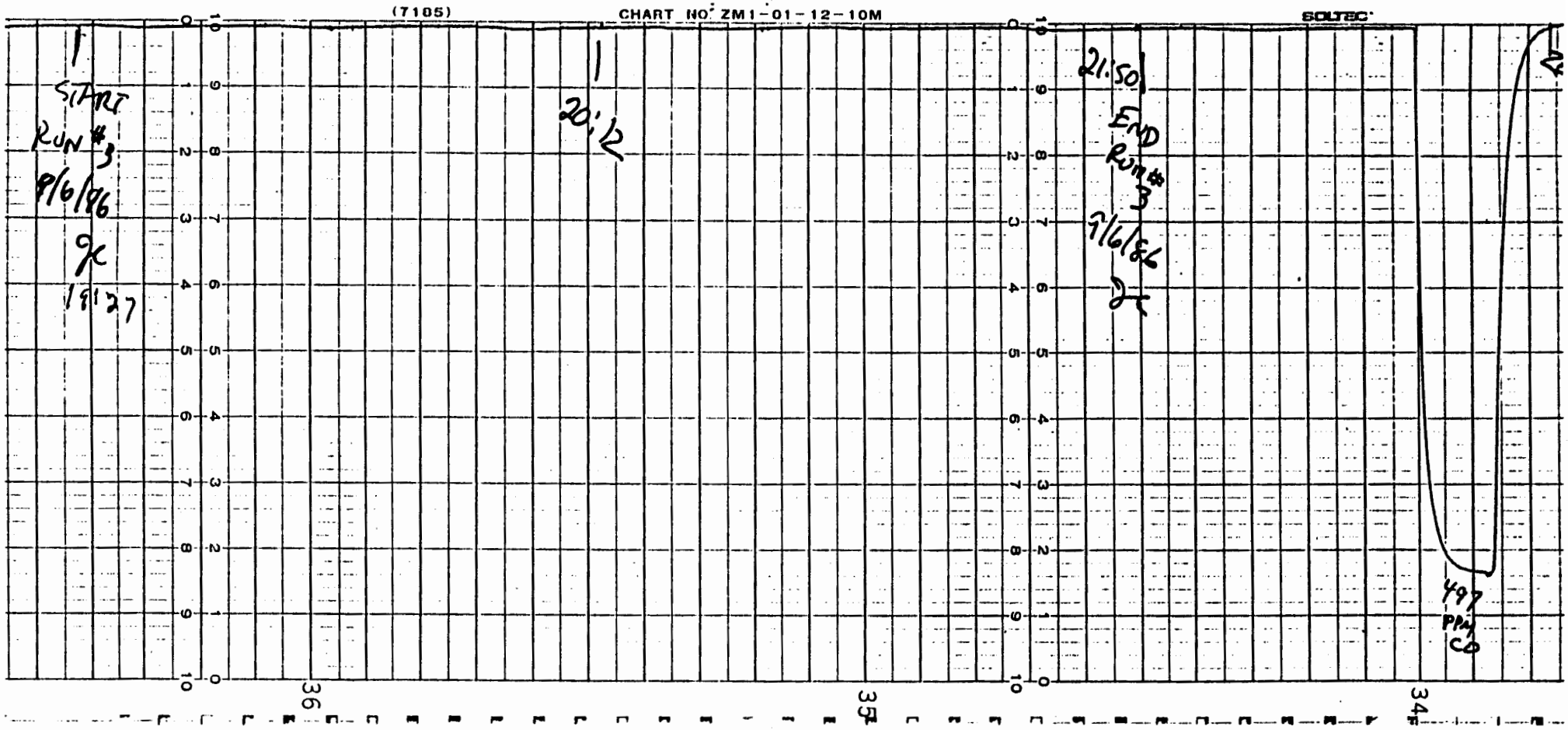
26

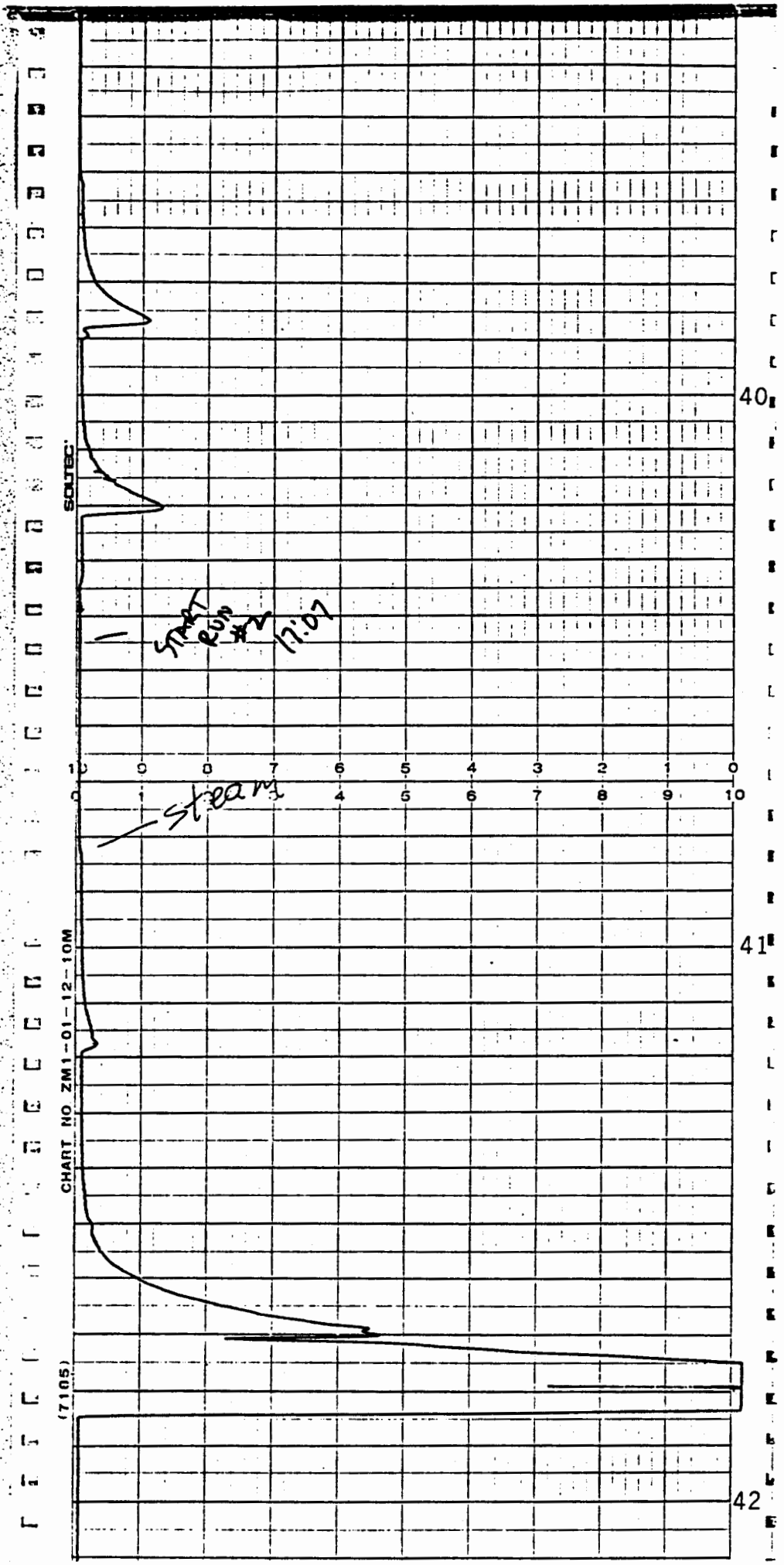
(7105) CHART NO. ZM1-01-12-10M

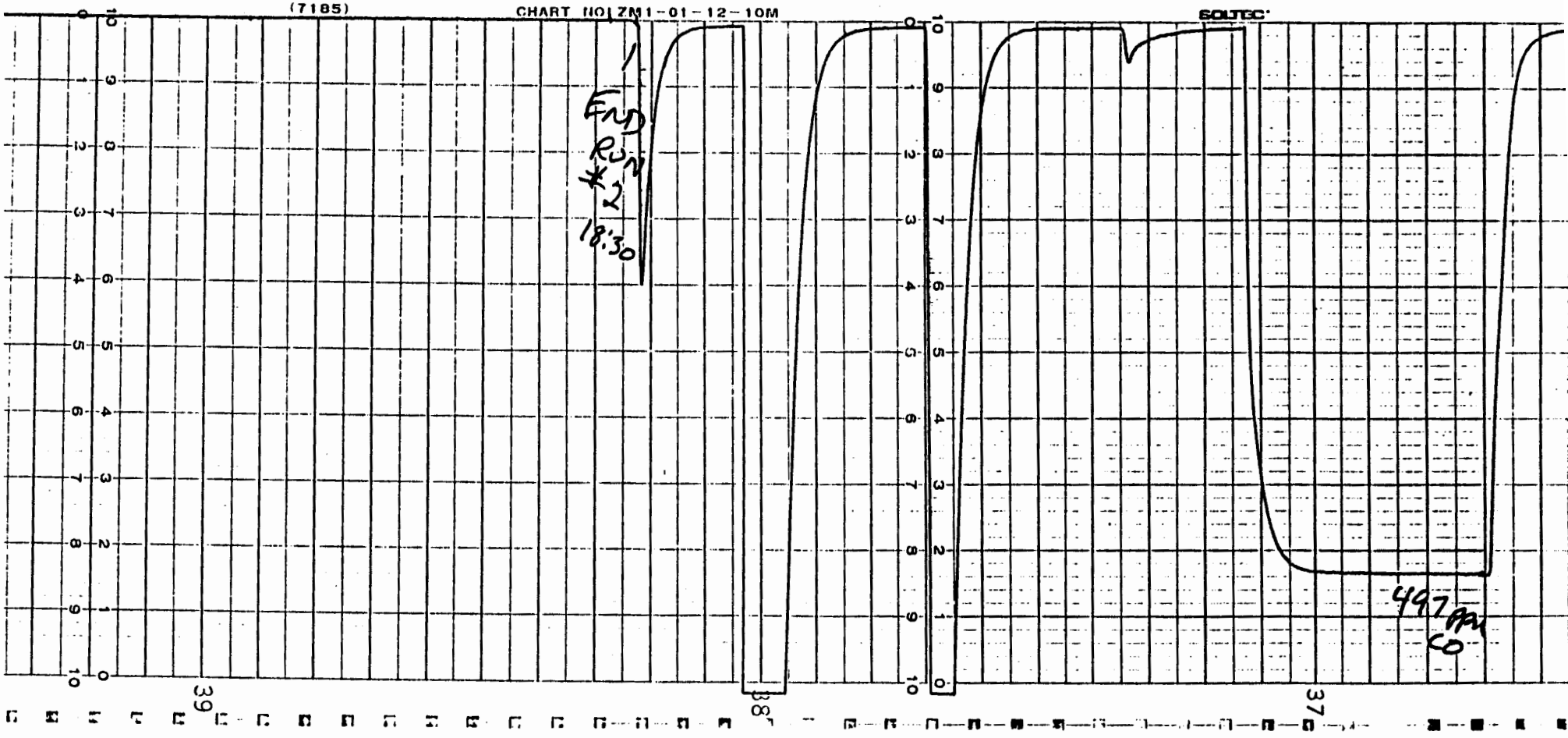
(ZERO)

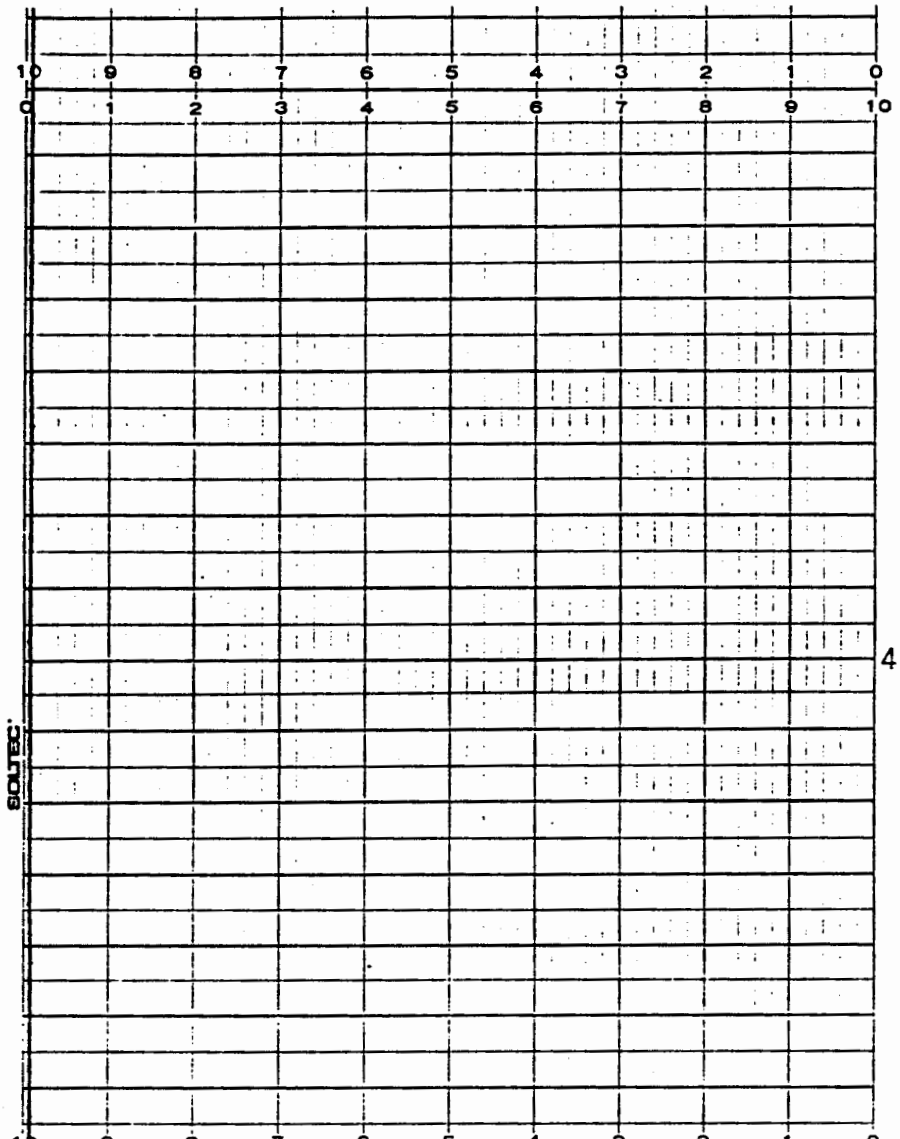
31 30 29


SOLTEC
CHART NO. ZM1-01-12-10M
(7185)
497 RPM
30
9/7/86
0:30
ZERO
32
33

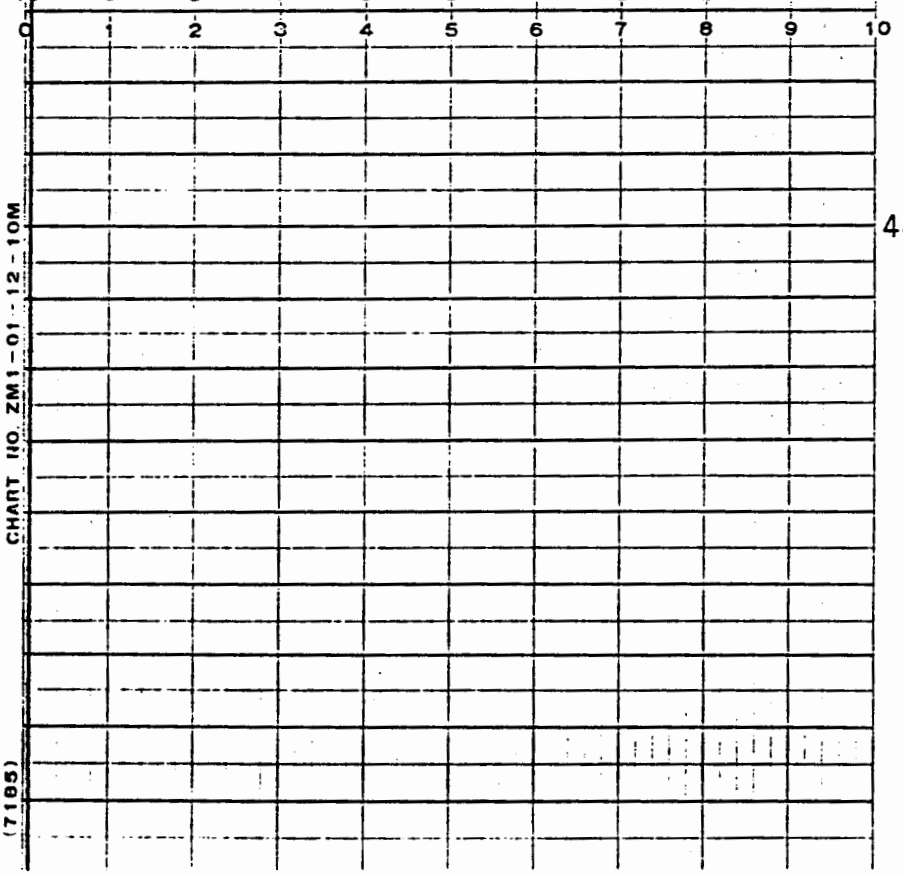

(7185)
CHART NO. ZM1-01-12-10M
SOLTEC
START
RUN #3
9/6/86
JK
19:27
20:12
21:50
END
RUN #3
9/6/86
JK
497
PPM
CO
36
35
34


SOLTEC
START RUN #2 17:07
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10
steam
CHART NO. ZM1-01-12-10M
(7105)
40
41
42

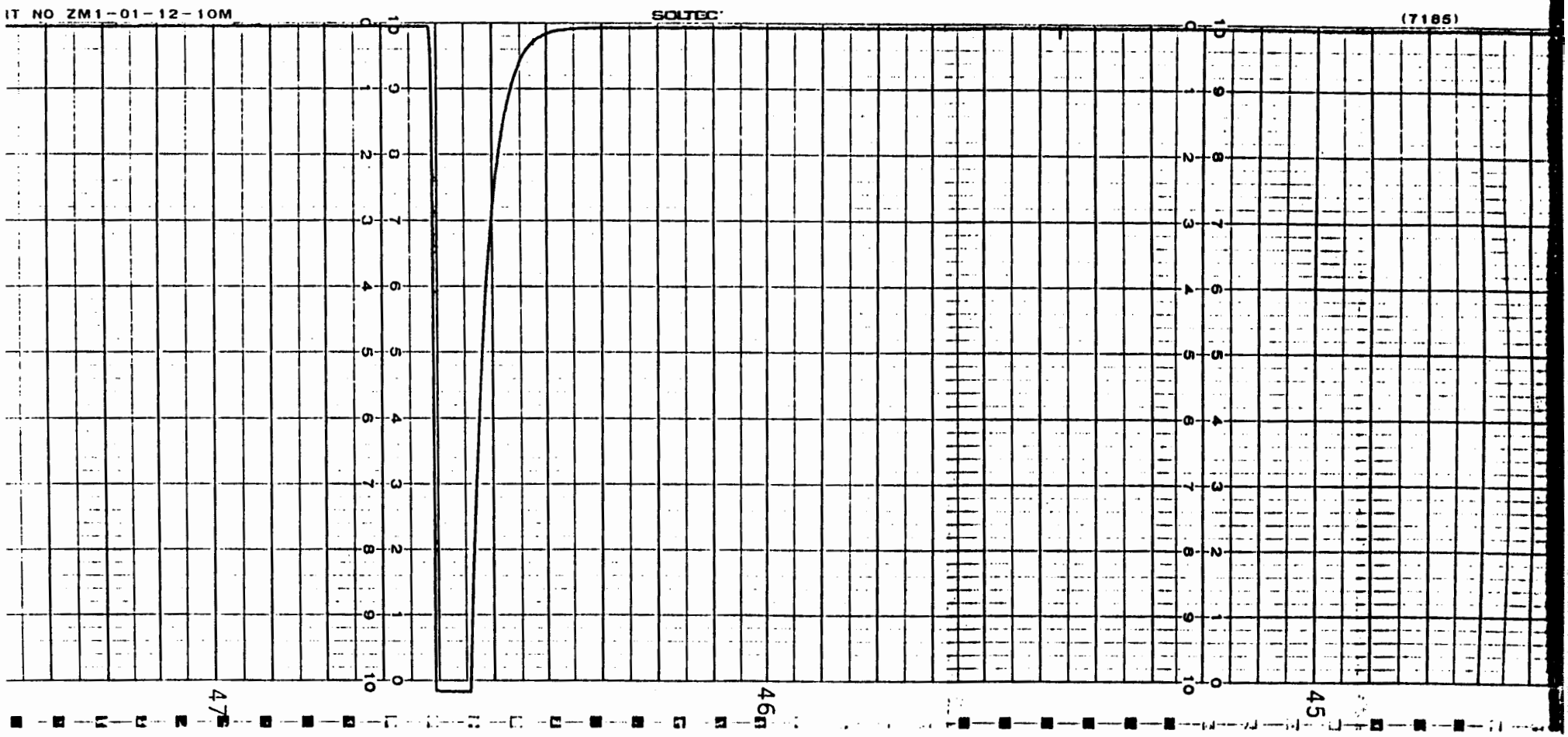

(7185)
CHART NO.ZM1-01-12-10M
SOLTEC
END RUN #2 18:30
497 ppm CO
39
38
37

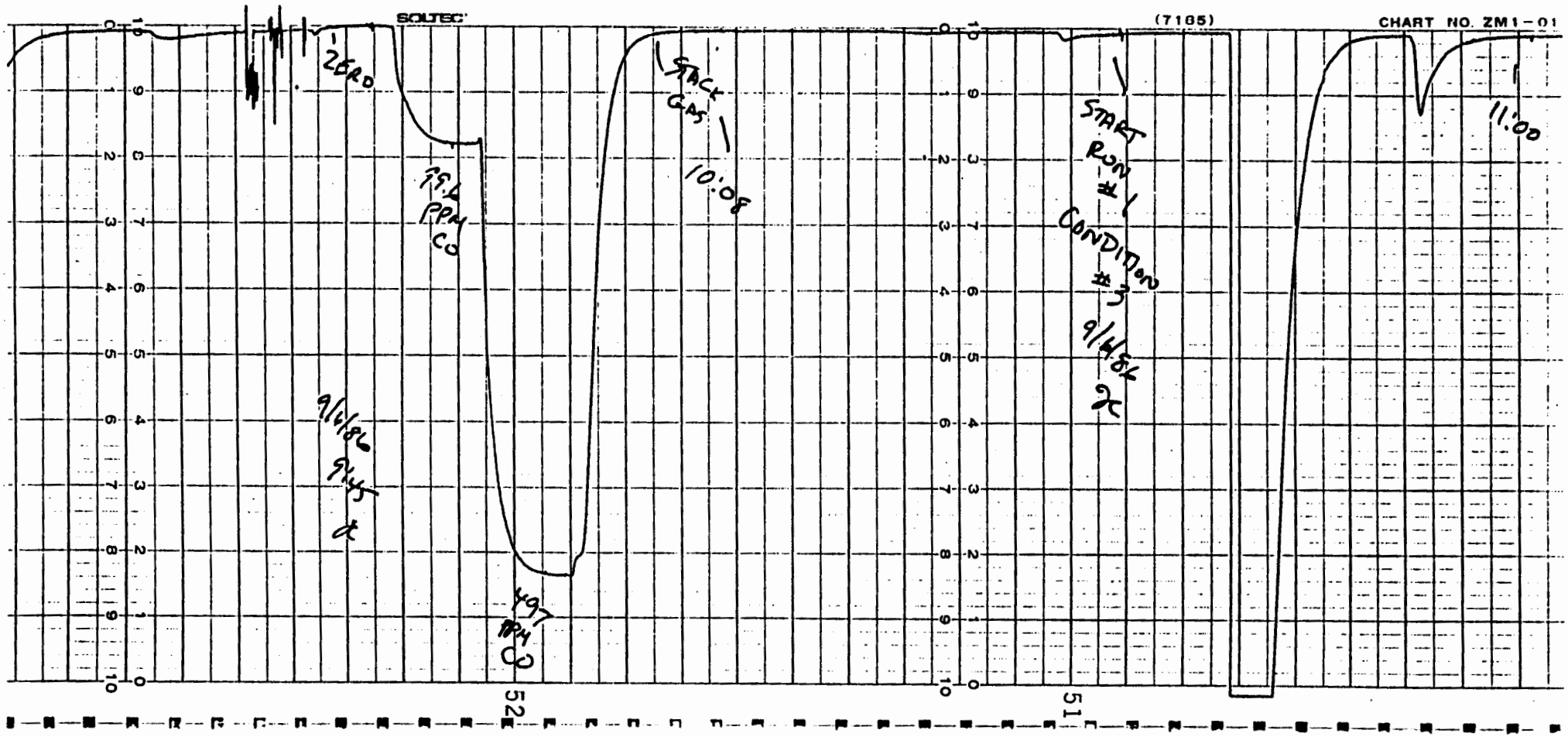

10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10
SOLTEC

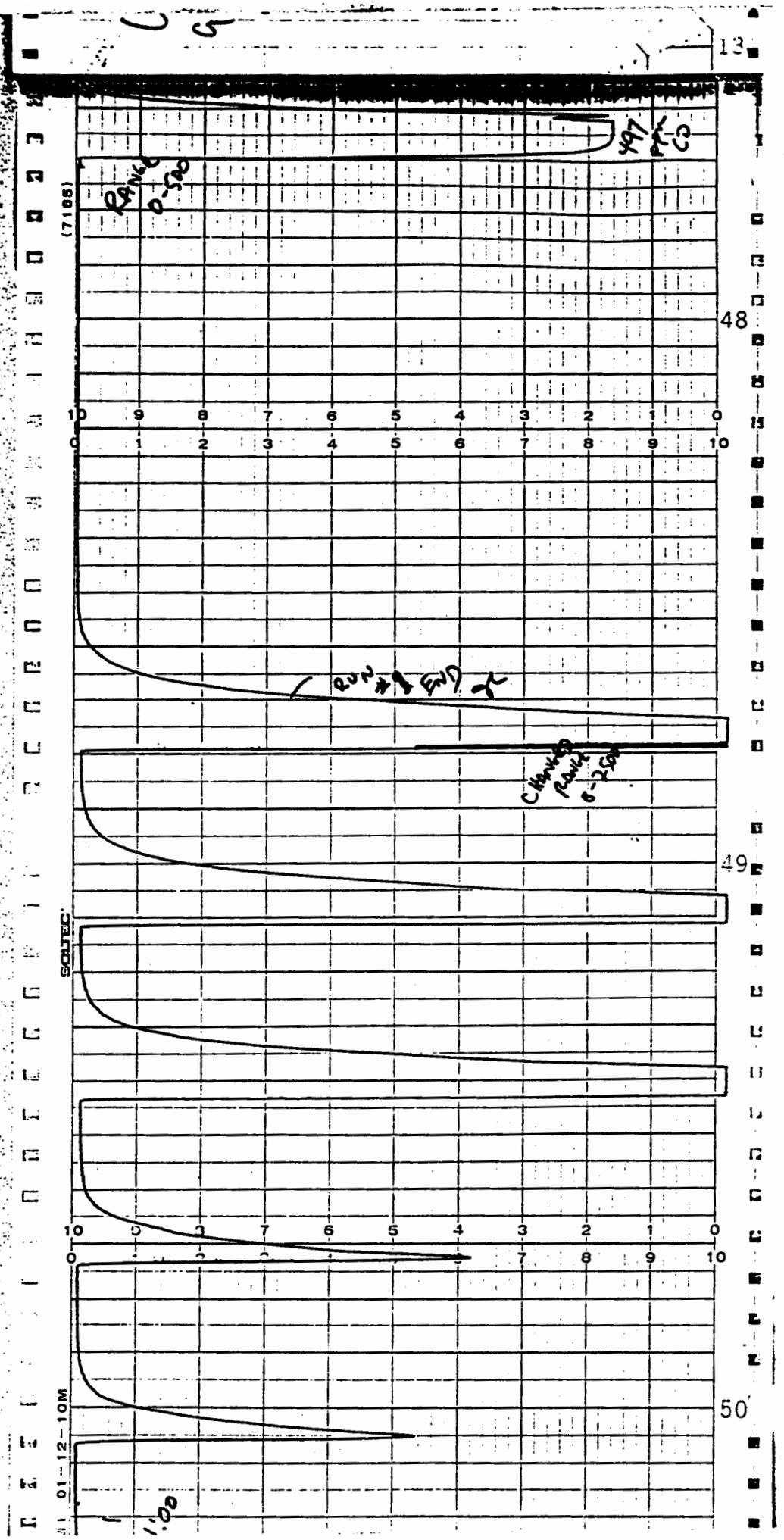
43

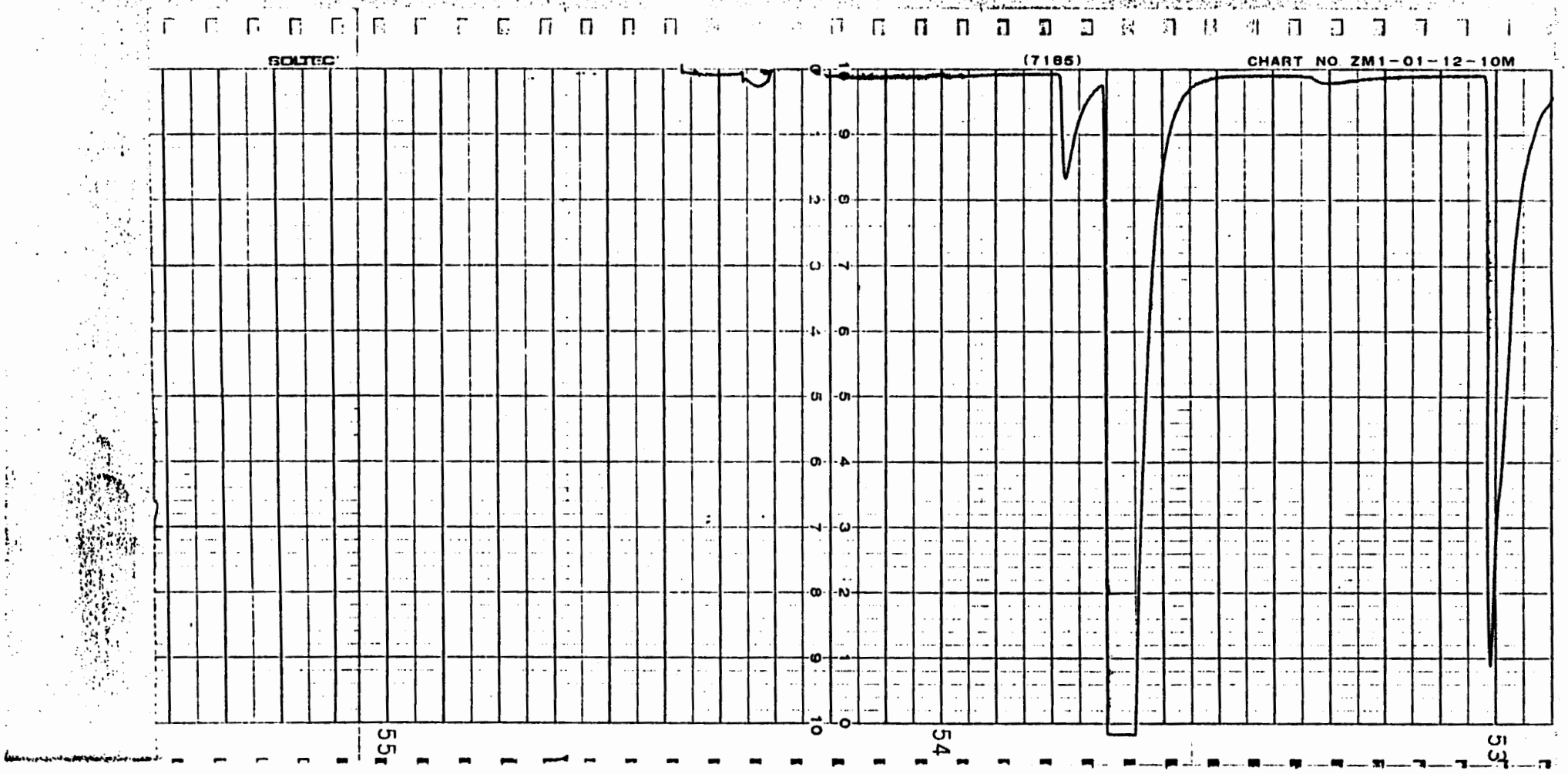

10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10
CHART NO. ZM1-01-12-10M
(7185)

44


IT NO ZM1-01-12-10M
SOLTEC
(7185)
47
46
45


SOLTEC
(7165)
CHART NO. ZM1-01
ZERO
9/4/86
9:45
x
99.6
PPM
CO
497
PPM
CO
STACK
GAS
10:08
START
RUN
#1
CONDITION
#3
9/4/86
x
11:00


13
48
49
50
RANGE 0-500
497 PPM CO
RUN #8 END
CHANGED RANGE 0-2500
SOLTEC
(7185)
01-12-10M
1:00


SOLTEC
(7185)
CHART NO. ZM1-01-12-10M
55
54
53

STATISTICAL ANALYSIS

LOCATION - Outlet

RUN	DATE OF RUN	AVERAGE SQ. RT. VEL PRES	AVERAGE TEMP	STANDARD DEVIATION SQ. RT. VEL PRES	STANDARD DEVIATION TEMP	VARIANCE SQ. RT. VEL PRES	VARIANCE TEMP	RMS DEVIATION SQ. RT. VEL PRES	RMS DEVIATION TEMP
1	9/4/86	0.415	209.3	0.044	14.4	0.002	207.8	10.558	6.9
2	9/4/86	0.425	213.4	0.040	14.0	0.002	195.7	9.466	6.6
3	9/4/86	0.410	212.0	0.039	14.5	0.002	209.7	9.527	6.8
1-	9/5/86	0.379	216.4	0.042	12.0	0.002	144.7	11.088	5.6
2-	9/5/86	0.378	226.4	0.043	10.8	0.002	117.6	11.469	4.8
3-	9/5/86	0.375	228.8	0.041	11.8	0.002	138.5	10.960	5.1
1-	9/6/86	0.429	225.3	0.044	10.4	0.002	107.5	10.335	4.6
2-	9/6/86	0.457	216.3	0.036	12.9	0.001	165.5	7.905	5.9
3-	9/6/86	0.446	209.6	0.038	13.8	0.001	191.1	8.496	6.6
1-	9/7/86	0.419	212.8	0.046	12.6	0.002	159.1	10.870	5.9
2-	9/7/86	0.440	210.8	0.041	14.3	0.002	204.5	9.429	6.8
3-	9/7/86	0.443	201.8	0.039	17.2	0.001	296.0	8.712	8.5

CHAIN OF CUSTODY

CHAIN-OF-CUSTODY

CLIENT: LOS ALAMOS NATIONAL LABS. LOCATION: LOS ALAMOS, NM.

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
LANL-1-MS-1	1	9-4-86	J. Balabuszko
LANL-1-MS-2	2	9-4-86	J. Balabuszko
LANL-1-MS-3	3	9-4-86	J. Balabuszko
LANL-2-MS-1	4	9-5-86	J. Balabuszko
LANL-2-MS-2	5	9-5-86	J. Balabuszko
LANL-2-MS-3	6	9-5-86	J. Balabuszko
LANL-3-MS-1	7	9-6-86	J. Balabuszko
LANL-3-MS-2	8	9-6-86	J. Balabuszko
LANL-3-MS-3	9	9-6-86	J. Balabuszko
LANL-4-MS-1	10	9-7-86	J. Balabuszko
LANL-4-MS-2	11	9-7-86	J. Balabuszko
LANL-4-MS-3	M	9-7-86	J. Balabuszko
BLANK	AA	9-7-86	J. Balabuszko
			(J. BALABUSZKO)

ANALYSIS REQUIRED: DIGESTION, Al, Na, Fe

CARRIER: Beth Dowe

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY
			9-8-86	ANALYSIS

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
① Fuel Oil Feed Stock - Conditions 1,2,3,+4	LANL-1-V-1-F.O.F.	9/4/86	LANL-CAI personnel
② Alumagel Feed Stock - Condition 2	LANL-2-M5-1-ALGL	9/5/86	LANL-CAI
Alumagel Feed Stock - Condition 1	LANL-1-M5-1-ALGL	9/4/86	LANL-CAI
③ Cellulosic (Pel-E-Cel) feedstock - Conditions 3 + 4	LANL-3,4,-V-1,2,3,-PEL	9/6/86	d.b. CAE
④ Incinerator Ash-post Condition 3	LANL-3-V-3-I.A	9/6/86	LANL-CAI
Incinerator Ash-post Condition 4	LANL-4-M5-1,2,3-I.A.	9/7/86	"
HEPA filter (fresh)	LANL-1-V-1-HEPA	9/4/86	"
HEPA filter (used)	LANL-4-V-3-HEPA(4)	9/8/86	"

ANALYSIS REQUIRED: (① CCl_4, TCE, Cl^-) (② - SAME AS ①) (③ - SAME AS ①) (④ - CCl_4, TCE, Cl^-, pH)

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
*S.D.L.-Condition 1 Run 1	LANL-1-V-1-S.D.L.	9/4/86	dave kubak CAE
S.D.L.-Condition 1 Run 2	LANL-1-V-2-S.D.L.	9/4/86	d.k. CAE
S.D.L.-Condition 1 Run 3	LANL-1-V-3-S.D.L	9/4/86	d.k. CAE
S.D.L.-Condition 2 Run 1	LANL-2-V-1-S.D.L.	9/5/86	d.k.
S.D.L.-Condition 2 Run 2	LANL-2-V-2-S.D.L.	9/5/86	d.k.
S.D.L.-Condition 2 Run 3	LANL-2-V-3-S.D.L.	9/5/86	d.k.
S.D.L.-Condition 3 Run 1	LANL-3-V-1-S.D.L.	9/6/86	d.k.
S.D.L.-Condition 3 Run 2	LANL-3-V-2-S.D.L	9/6/86	d.k.
S.D.L.-Condition 3 Run 3	LANL-3-V-3-S.DL.	9/6/86	d.k.
S.D.L.-Condition 4 Run 1	LANL-4-V-1-S.D.L.	9/7/86	
S.D.L.-Condition 4 Run 2	LANL-4-V-2-S.D.L	9/7/86	
S.D.L.-Condition 4 Run 3	LANL-4-V-3-S.D.L.	9/7/86	

ANALYSIS REQUIRED: CCl_4, TCE, Cl^-, pH.

*S.D.L. = Scrubber Discharge Liquid

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
Caustic Sol'n - Condition 1	LANL-1-V-1-C.S.	9/4/86, 13:42	dave kubak CAE
Runs 1, 2, 3			
Caustic Sol'n - Condition 2	LANL-2-V-1-C.S.	9/5/86	dave kubak CAE
Runs 1, 2			
Caustic Sol'n - Condition 2	LANL-2-V-3-C.S.	9/5/86	d.k. CAE
Run 3			
Caustic Sol'n - Condition 3	LANL-3-V-1-C.S.	9/6/86	d.k. CAE
Run 1			
Caustic Sol'n - Condition 3	LANL-3-V-2-C.S.	9/6/86	d.k. CAE
Runs 2 + 3			
Caustic Sol'n - Condition 4	LANL-4-V-1,2,3-C.S.	9/7/86	d.k. CAE
Runs 1, 2 + 3			

ANALYSIS REQUIRED: Cl^-

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
Activated Charcoal (fresh)	LANL-1-V-1-A.C.(F.)	9/4/86	LANL-CAI personnel
- precondition 1+2 9/4/86			
Activated Charcoal (used)	LANL-1,2-V-1,2,3-A.C.(U)	9/6/86	LANL-CAI personnel
pre condition 3 - post condition 1+2			
Activated Charcoal (used) - pre-	LANL-3-V-3-A.C.(U.)	9/6/86	LANL-CAI personnel
Condition 4 — post Condition 3			
Activated Charcoal (used)	LANL-4-V-1,2,3-A.C.(U)	9/7/86	LANL-CAI personnel
- post Condition 4			

ANALYSIS REQUIRED: CCl_4, TCE, Cl^-, pH

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	# ml. sample	SAMPLE RECOVERY BY
~~Impinger Solution Blank~~				
~~- Conditions 1,2~~				
Impinger Solution Blank	LANL-1,2,3,4 M5-1,2,3-IMP. B.	9/6/85	543 ml	d.t CAE
- Conditions 3,4,1,2				
*Impinger Solution-Condition 1 Run 1	LANL-1-M5-1-IMP	9/4/86	542 ml.	d.t CAE
I.S. Condition 1 Run 2	LANL-1-M5-2-IMP.	9/4/86	684 ml.	
I.S. " 1 " 3	LANL-1-M5-3-IMP.	9/4/86	648 ml.	
I.S. " 2 " 1	LANL-2-M5-1-IMP.	9/5/86	557 ml	
I.S. " 2 " 2	LANL-2-M5-2-IMP.	9/5/86	540 ml.	
I.S. " 2 " 3	LANL-2-M5-3-IMP.	9/5/86	533 ml.	
I.S. " 3 " 1	LANL-3-M5-1-IMP.	9/6/86	640 ml	
I.S. " 3 " 2	LANL-3-M5-2-IMP.	9/6/86	680 ml	
I.S. " 3 " 3	LANL-3-M5-3-IMP.	9/6/86	533 ml.	
I.S. " 4 " 1	LANL-4-M5-1-IMP.	9/7/86	466 ml	
I.S. " 4 " 2	LANL-4-M5-2-IMP.	9/7/86	529 ml.	
I.S. " 4 " 3	LANL-4-M5-3-IMP.	9/7/86	505 ml	

ANALYSIS REQUIRED: Cl^- NOTE: SAMPLES WERE COLLECTED IN 0.1N NaOH

*I.S. ≡ Impinger Solution CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
* Makeup Water - Condition 1 Run 1	LANL-1-V-1-M.W.	9/4/86	dave kubek CAE
MW - Condition 1 Run 2	LANL-1-V-2-M.W.	9/4/86	d.k.
MW - Condition 1 Run 3	LANL-1-V-3-M.W.	9/4/86	d.k
MW - Condition 2 Run 1	LANL-2-V-1-M.W.	9/5/86	d.k
MW - Condition 2 Run 2	LANL-2-V-2-M.W.	9/5/86	d.k
MW - Condition 2 Run 3	LANL-2-V-3-M.W.	9/5/86	d.k
MW - Condition 3 Run 1	LANL-3-V-1-M.W.	9/6/86	dk
MW - Condition 3 Run 2	LANL-3-V-2-M.W.	9/6/86	dk
MW - Condition 3 Run 3	LANL-3-V-3-M.W.	9/6/86	dk
MW - Condition 4 Run 1	LANL-4-V-1-M.W.	9/7/86	dk
MW - Condition 4 Run 2	LANL-4-V-2-M.W.	9/7/86	dk
MW - Condition 4 Run 3	LANL-4-V-3-M.W	9/7/86	dk

ANALYSIS REQUIRED: CCl_4, TCE, Cl^-

* Makeup Water ≡ MW

CARRIER: Rt Kaf

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos National Laboratories LOCATION: Controlled Air Incinerator

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
① CCl_4 feed stock	LANL-1-V-1-CCl_4	9/4/86	LANL-CAI personel
- Conditions 1,2,3,+4			
② TCE feed stock	LANL-1-V-1-TCE	9/4/86	"
- Conditions 1,2,3,+4			
* ③ Liquid Mixture Feed	LANL-1-V-1-L.M.F.	9/4/86	"
Condition 1 Run 1			
L.M.F. - Condition 1 Run 2	LANL-1-V-2-L.M.F.	9/4/86	"
L.M.F - Condition 1 Run 3	LANL-1-V-3-L.M.F.	9/4/86	"
L.M.F. - Condition 2 Run 1	LANL-2-V-1-L.M.F.	9/5/86	"
L.M.F - Condition 2 Run 2	LANL-2-V-2-L.M.F.	9/5/86	"
L.M.F. - Condition 2 Run 3	LANL-2-V-3-L.M.F.	9/5/86	"

ANALYSIS REQUIRED: ① % CCl_4 ② - % TCE ③ % CCl_4, % TCE, Cl^-, FILTERABLE PARTICULATE.

* L.M.F.

CARRIER: Ruth Kral

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Lab LOCATION: CAI outlet

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
VOST Trap	1-V-1-T	9/4/86	P. Kaufmann
Box #1	1-V-1-TC		
	1-V-2-T		
	1-V-2-TC		
	1-V-3-T		
	1-V-3-TC		
	1-V-4-T		
Box #2	1-V-4-TC		
	1-V-5-T		
	1-V-5-TC		
	1-V-6-T		
	1-V-6-TC		
Field Blank	1-V-(1-6)-T		
Field Blank	1-V-(1-6)-TC		
VOST Condinsate Bottle	1-V-(1-6)-Con		

CARRIER: Pete Kaufmann

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Labs LOCATION: CAI outlet

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
VOST Trap Box #3	2-V-1-T	9/5/86	P. Kaufmann
	2-V-1-TC		
	2-V-2-T		
	2-V-2-TC		
	2-V-3-T		
	2-V-3-TC		
Box #4	2-V-4-T		
	2-V-4-TC		
	2-V-5-T		
	2-V-5-TC		
	2-V-6-T		
	2-V-6-TC		
Field Blank Box #4	2-V-(1-6)-T		
Field Blank Box #4	2-V-(1-6)-TC		
VOST condensate Box #3	2-V-(1-6)-Con		

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Lab LOCATION: CAI Outlet

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
VOST Trap	3-V-1-T	9/6/86	P. Kaufmann
	3-V-1-TC		
Box #5	3-V-2-T		
	3-V-2-TC		
	3-V-3-T		
	3-V-3-TC		
	3-V-4-T		
Box #6	3-V-4-TC		
	3-V-5-T		
	3-V-5-TC		
	3-V-6-T		
	3-V-6-TC		
Field Blank Box #7	3-V-(1-6)-T		
Field Blank	3-V-(1-6)-TC		
VOST condensate	3-V-(1-6)-TCN		

CARRIER: Butt Kaufmann

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Lab LOCATION: CAI Outlet

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
VOST Traps	4-V-1-T	9/7/86	D. Kaufmann
	4-V-1-TC		
	4-V-2-T		
	4-V-2-TC		
	4-V-3-T		
	4-V-3-TC		
	4-V-4-T		
	4-V-4-TC		
	4-V-5-T		
	4-V-5-TC		
	4-V-6-T		
	4-V-6-TC		
Field Blank	4-V-(1-6)-T		
Field Blank	4-V-(1-6)-TC		
VOST condensate	4-V-(1-6)-CON		

CARRIER: [illegible]

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos Natl. Lab LOCATION: CAI Outlet

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
VOST Traps	(1-4) -V-1-T -A	9/7/86	P. Kaufmann
Audit Tanks	(1-4) -V-1-TC-A		
	(1-4) -V-2-T -A		
	(1-4) -V-2-TC-A		
	(1-4) -V-3-T -A		
	(1-4) -V-3-TC-A		
	(1-4) -V-4-T -A	9/8/86	
	(1-4) -V-4-TC-A		
	(1-4) -V-5-T -A		
	(1-4) -V-5-TC-A		
	(1-4) -V-6-T -A		
	(1-4) -V-6-TC-A		
Trip Blank	(1-4) -V-All-T		
Trip Blank	(1-4) -V-All-TC		

CARRIER: Pilot Kaufman

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos LOCATION: Los Alamos N.M

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
11Cm GFT	21507		
	21508		
	21509		
	21510		
	21511		
	21512		
	21513		
	21514		
	21515		
	21516		
	21517		
	21518		
	21519		
	21520		

CARRIER: _____

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY
[illegible]	J Chapman	4:00P	8/28/86	To Field

LABORATORY ANALYSIS BY: _____ DATE: _____

Clean Air Engineering, Inc.

CHAIN-OF-CUSTODY

CLIENT: Los Alamos LOCATION: Los Alamos N. M.

DESCRIPTION OF SAMPLE	SAMPLE NUMBER	RECOVERY DATE	SAMPLE RECOVERY BY
11cm GFF	21548		
	21549		
	21550		
	21551		
	21552		
	21553		
	21554		
	21555		
	21556		
	21557		

CARRIER:

RELINQUISHED BY	RECEIVED BY	TIME	DATE	REASON FOR CHANGE OF CUSTODY
[illegible]	J Chapman	4:00 P	8/28/86	to Field

LABORATORY ANALYSIS BY: DATE:

Clean Air Engineering, Inc.

CYLINDER GAS AUDIT SAMPLES

Parameter Sheet
VOST

Audit Samples

Run	1	2	3	4	5	6
Field Measurements						
Pb	23.05	23.05	23.05	23.05	23.05	23.05
Theta	20	20	20	20	20	20
Tm	27	29	31	22	25	27
Vm	9.93	11.39	10.91	10.12	10.28	10.6
Vmstd	7.50	8.55	8.13	7.77	7.82	8.01
Yd	1.0032	1.0032	1.0032	1.0032	1.0032	1.0032
Cylinder #	AAL12421	AAL12421	AAL12421	AAL11924	AAL11924	AAL11924
Laboratory Data						
CCl4, (ng)	<10	<10	<10	615	***	730
Uncertnty	1	1	1	62	***	73
TCE, (ng)	502	605	614	<10	***	<10
Uncertnty	50	61	61	1	***	1
Results CCl4						
ug/m3	<1.333	<1.170	<1.230	79.110	***	91.170
ppbv, dry	<0.21	<0.18	<0.19	12.36	***	14.25
lbE-10/dscf	<0.832	<0.730	<0.767	49.359	***	56.884
Results TCE						
ug/m3	66.933	70.793	75.504	<1.286	***	<1.249
ppbv, dry	12.25	12.95	13.82	<0.24	***	<0.23
lbE-10/dscf	41.762	44.170	47.109	<0.803	***	<0.779

*** Detector Quenched or Sample Broken

86.12462	2-V-(1-6)-T,TC	56235	CCl4		8	NG	1
		79016	TCE	<	10	NG	1
86.12463	3-V-1-T,TC	56235	CCl4		2170	NG	217
		79016	TCE		231	NG	23
86.12464	3-V-2-T,TC	56235	CCl4		2230	NG	223
		79016	TCE		235	NG	23
86.12465	3-V-3-T,TC	56235	CCl4		5660	NG	566
		79016	TCE		1240	NG	124
86.12466	3-V-4-T,TC	56235	CCl4		4440	NG	444
		79016	TCE		543	NG	54
86.12467	3-V-5-T,TC	56235	CCl4		258	NG	26
		79016	TCE		6	NG	1
86.12468	3-V-6-T,TC	56235	CCl4		2993	NG	300
		79016	TCE		8	NG	1
86.12469	3-V-(1-6)-T,TC	56235	CCl4	<	10	NG	1
		79016	TCE	<	10	NG	1
86.12470	4-V-1-T,TC	56235	CCl4		5600	NG	560
		79016	TCE		52	NG	5
86.12471	4-V-2-T,TC	56235	CCl4		590	NG	59
		79016	TCE	<	10	NG	1
86.12472	4-V-3-T,TC	56235	CCl4		2600	NG	260
		79016	TCE		36	NG	4
86.12473	4-V-4-T,TC	56235	CCl4		5200	NG	520
		79016	TCE		210	NG	21
86.12474	4-V-5-T,TC	56235	CCl4		6200	NG	620
		79016	TCE		162	NG	16
86.12475	4-V-6-T,TC	56235	CCl4		4900	NG	490
		79016	TCE		116	NG	12
86.12476	4-V-(1-6)-T,TC	56235	CCl4	<	10	NG	1
		79016	TCE	<	10	NG	1
86.12477	(1-4)-V-1-T,TCA	56235	CCl4	<	10	NG	1
		79016	TCE		502	NG	50
86.12478	(1-4)-V-2-T,TCA	56235	CCl4	<	10	NG	1
		79016	TCE		605	NG	61
86.12479	(1-4)-V-3-T,TCA	56235	CCl4	<	10	NG	1
		79016	TCE		614	NG	61
86.12480	(1-4)-V-4-T,TCA	56235	CCl4		615	NG	62
		79016	TCE	<	10	NG	1
86.12481	(1-4)-V-5-T,TCA	56235	CCl4			NG	
		79016	TCE		Broken	NG	
86.12482	(1-4)-V-6-T,TCA	56235	CCl4		730	NG	73
		79016	TCE	<	10	NG	1
86.12483	(1-4)V-ALL-T,TC	56235	CCl4	<	10	NG	1
		79016	TCE	<	10	NG	1

Date: 12/1/86

Approved, Contracting

Date: 12/1/86

Approved, Quality Control

VOST FIELD DATA SHEET
DATA SET # 85

PLANT LANL
LOCATION CAT
OPERATOR Kaufmann
DATE 9/7/86
RUN # Audit 1
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 21.5"
LEAK CHECK AFTER <0.1" Hg/Min @ 15"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. 11
Yd 1.0032
Bp 23.05

Tank # AAL 12421
start time 2025

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE NA	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 61.85	ΔH	Vac.	COMMENTS:
5	~.5	35		12	13	18	26	26	64.38	1.0	2	
10	~.5	35		12	12	19	27	26	66.82	1.0	2	
15	~.5	35		11	10	19	27	27	69.28	1.0	2	
20	~.5	35		11	11	18	28	27	71.78	1.0	2	
								27	9.93	1.0		

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-(1-4)-V-1 - Audit

VOST FIELD DATA SHEET
DATA SET # 26

PLANT LANL
LOCATION CAT
OPERATOR Rauhmann
DATE 9/7/86
RUN # Audit 2
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/Min @ 15"
LEAK CHECK AFTER <0.1" Hg/Min @ 15"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VI
Yd 1.0032
Bp 23.05

Tank # AAL 12421
start time 2100

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE NA	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 72.35	ΔH	COMMENTS: Vac.
5	~.5	37		12	12	18	29	29	75.24	1.0	2
10	~.5	37		10	12	18	29	28	78.00	1.0	2
15	~.5	37		10	11	18	30	29	~~80.79~~ *	1.0	2
20	~.5	37		10	11	18	30	29	~~83.74~~	1.0	2
									83.74		
								29	11.39	1.0	

CONDENSATE SAMPLES:

* 80.96

SAMPLE I.D.: COMMENTS:

LANL-(1-4)-V-2-Audit

VOST FIELD DATA SHEET
DATA SET # 27

PLANT LANL
LOCATION CAI
OPERATOR Kaufmann
DATE 9/7/86
RUN # Audit 3
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE 20.1" Hg/min 6.15"
LEAK CHECK AFTER 20.1" Hg/min 6.15"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VI
Yd 1.0032
Bp 23.09

Tank # AAL 12421
Start Time 2132

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 85.10	ΔH	COMMENTS: Vac.
			NA								
5	~.5	36		12	10	19	31	30	87.90	1.0	2
10	~.5	36		10	10	18	31	30	90.57	1.0	2
15	~.5	36		11	11	18	32	30	93.35	1.0	2
20	~.5	36		10	10	19	32	30	96.01	1.0	2
								31	10.91	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-(1-4)-V-3-Audit

VOST FIELD DATA SHEET
DATA SET # 28

PLANT LANL
LOCATION CAI
OPERATOR KOHLMANN
DATE 9/3/86
RUN # Audit 4
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 17"
LEAK CHECK AFTER <0.1" Hg/min @ 15"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VT
Yd 1.0032
Bp 23.13

Tank # AAL 11924
start time 0842

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE NA	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 96.66	ΔH	COMMENTS: Vac.
5	~.5	35		14	15	18	21	22	99.25	1.0	2
10	~.5	35		13	13	17	21	22	102.82	1.0	2
15	~.5	35		13	14	17	22	22	104.37	1.0	2
20	~.5	35		14	14	18	22	23	106.78	1.0	2
								22	10.12	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: COMMENTS:

LANL-(1-4)-V-4 - Audit

VOST FIELD DATA SHEET
DATA SET # 29

PLANT LANL
LOCATION CAT
OPERATOR Kaufmann
DATE 9/8/86
RUN # Audit 5
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 17"
LEAK CHECK AFTER <0.1" Hg/min @ 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit Tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. 11
Yd 1.0032
Bp 23.13

Tank # AAL 11924
start time 0920

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE NA	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 7.48	ΔH	COMMENTS: Vac.
5	~.5	35		13	13	17	25	24	—	1.0	2
10	~.5	35		11	11	17	25	25	12.51	1.0	2
15	~.5	35		~~16~~ 12	~~15~~ 12	18	27	26	15.12	1.0	2
20	~.5	35		13	13	17	25	26	17.76	1.0	2
								25	10.28	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-(1-4)-V-5-Audit

VOST FIELD DATA SHEET
DATA SET # 30

PLANT LANL
LOCATION CAT
OPERATOR Kaufmann
DATE 9/8/86
RUN # Audit 6
FIELD BLANK I.D.: TENAX
TENAX/CHARCOAL
LEAK CHECK BEFORE <0.1" Hg/min @ 17"
LEAK CHECK AFTER <0.1" Hg/min @ 17"
CARTRIDGE I.D.:
TENAX
TENAX/CHAR

STACK I.D. Audit tank
PROBE NO. NA
VOST NO.
FILTER I.D. NA
PROBE HEATER SET NA
METER BOX NO. VI
Yd 1.0032
Bp 28.13

Tank # AAL 11924
start time 0950

Diagram of sample location

TIME minutes	SAMPLING RATE l/min	ss ball	GAS TEMPERATURES, DEG C 1 PROBE	2 TENAX 1	3 TENAX 2	4 GAS OUT	5 METER IN	6 METER OUT	VOLUME GAS METERED liters INITIAL: 18.59	ΔH	COMMENTS: Vac.
			NA								
5	~.5	35		10	11	17	27	27	21.20	1.0	2
10	~.5	35		11	10	17	28	27	24.88	1.0	2
15	~.5	35		11	9	17	28	27	26.48	1.0	2
20	~.5	35		11	11	17	28	27	29.19	1.0	2
								27	10.60	1.0	

CONDENSATE SAMPLES:

SAMPLE I.D.: _____ COMMENTS: _____

LANL-(1-4)-V-6-Audit