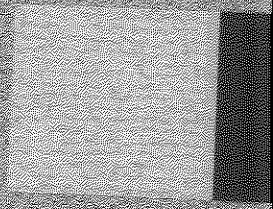
U.S. Department of Energy
Mound Plant
1 Mound Road
Miamisburg, Ohio 45343

Trial Burn Plan for a Glass Melt Furnace at the U.S. Department of Energy Mound Plant



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TRIAL BURN PLAN FOR A GLASS MELT FURNACE AT THE U.S. DEPARTMENT OF ENERGY MOUND PLANT

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EXECUTIVE SUMMARY

The Mound Facility is located in Miamisburg, Ohio, 12 miles south of Dayton, Ohio. The facility is operated by EG&G Mound Applied Technologies (MAT) for the U.S. Department of Energy (DOE). The U.S. DOE Mound Plant (Mound) is an integrated research, development, and production facility performing work in support of DOE weapons and energy programs, with emphasis on explosives and nuclear technology.

Manufacture, handling, and storage operations have resulted in the generation of wastes regulated by the Resource Conservation and Recovery Act (RCRA) and the Department of Energy. To address the resulting waste management issues, Mound constructed a glass melt furnace for thermal treatment of generated wastes.

Mound proposes to conduct a trial burn program to demonstrate the effectiveness of the thermal treatment unit in destroying organic hazardous constituents in waste feed. The waste feed will contain metals and waste constituents regulated by RCRA. No radioactive wastes will be evaluated during the trial burn program. Through testing, the fate of the metals and waste constituents will be determined.

The trial burn program will consist of two operating scenarios:

(1) Scenario 1 - Treatment of a liquid waste with a high heating value, and

(2) Scenario 2 - Treatment of an aqueous waste with a low heating value.

Each scenario will consist of three independent tests. Metals will be included in the feed during each test.

The purpose of this Trial Burn Plan is to provide a detailed description of the trial burn program. The objectives of the trial burn program, a description of the process, a summary of waste constituents, sampling and analytical protocol, and operating conditions are contained in this Trial Burn Plan.

SECTION 1

INTRODUCTION

The U.S. Department of Energy (DOE) Mound Plant (Mound) in Miamisburg, Ohio contains a glass melt furnace for thermal treatment of hazardous waste. Mound proposes to conduct a trial burn program to demonstrate the effectiveness of the thermal treatment unit for destruction of organic hazardous constituents in waste feed. The waste feed will contain metals and waste constituents regulated by the Resource Conservation and Recovery Act (RCRA). Through testing, the fate of the metals and waste constituents will be determined.

The trial burn program will consist of two operating scenarios: (1) Scenario 1 - treatment of a liquid waste with a high-heating value, and (2) Scenario 2 - treatment of an aqueous waste with a low-heating value. Each scenario will consist of three independent tests. Metals will be included in the feed during each test.

1.1 OBJECTIVES OF THE TRIAL BURN

The primary objective of the trial burn program is to demonstrate a contaminant destruction and removal efficiency (DRE) of at least 99.99 percent for the designated principal organic hazardous constituents (POHCs). For the testing program, the selected POHCs are tetrachloromethane (carbon tetrachloride) and tetrachloroethylene (PCE). The DRE will be demonstrated separately for each POHC. The secondary objective of the trial burn is to establish the fate of the metals (antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, silver, and thallium).

1.2 EXEMPTIONS

Mound is not requesting an exemption for the trial burn testing.

1.3 REGULATORY REQUIREMENTS

The glass melt furnace will be used for treatment of "mixed" waste (i.e., combination of hazardous and radioactive wastes). The regulations applicable for treatment of hazardous wastes are provided in Chapter 40 of the Code of Federal Regulations (CFR) Subpart 264 of 40. The glass melt furnace is designed to comply with the required performance standards. The trial burn program will demonstrate the capability of the furnace to meet performance standards, while processing a hazardous waste feed.

The U.S. Environmental Protection Agency (EPA) issued final rules for radionuclide emissions to air under 40 CFR Part 61 (National Emission Standards for Hazardous Air Pollutants (NESHAPS)) on 31 October 1989. The national emissions stan-

dards for emissions of radionuclides (other than radon) from DOE facilities are provided in Subpart H of 40 CFR Part 61.

Regulations indicate that emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of 10 mrem/year. In this application, facility means all buildings, structures, and operations on one contiguous site. To determine compliance with the standard, EG&G currently measures the amount of radionuclide emissions from point sources using in-line detectors. Previous annual reports submitted to the DOE indicate that the facility is in compliance with the EDE standard.

Operation of the glass melt furnace will be classified as new construction or a modification. As stated in the regulations, a change that results in any increase in the rate of emissions is a modification, no matter how small the increase. Regulations further stipulate that if the estimated maximum individual dose added by the new construction or modification is less than 1 percent of the standard (i.e., 1 percent of 10 mrem/-year, or 0.10 mrem/year), the modification or new construction does not need prior approval (notification and startup requirements). The EDE for the new construction or modification is calculated using computer models provided by the EPA. As outlined in 40 CFR 61.93 (a), emission monitoring and compliance procedures for DOE facilities require the use of the CAP-88 or AIRDOS-PC computer models, or other approved procedures, to calculate the EDE to members of the public. An evaluation of emissions of radionuclides from the glass melt furnace was conducted using EPA's AIRDOS-PC model.

The types and activity feed rates of radionuclides expected to be present in the furnace feed stream are shown on Table 1-1. The maximum distribution (i.e., millicurie percentage) of radionuclides is also shown. Actual activities expected to be present in the feed are substantially lower. As shown, during normal operations the major activity component of the mixed waste is expected to be tritium (Hydrogen-3). The mixed waste also is expected to contain Plutonium-238 and trace quantities of 12 other radioactive isotopes. The current data library for AIRDOS-PC, version 3.0, does not include Plutonium-238, therefore, for purposes of modeling, Plutonium-239 was substituted for Pu-238 (U.S. EPA, 1990). The 12 trace radionuclides listed in Table 1-1 are estimated based on the typical isotopic impurities of the weapons grade Pu-238 used at Mound. The trace radionuclides collectively constitute a very minor contribution to the total activity in the waste feed and projected emissions. The trace radionuclides were conservatively modeled as Th-232.

The waste feed to the glass melt furnace will be regulated so as to be in compliance with the exemption criteria of 0.10 mrem/year. As such, the modeling was conducted to back-calculate the quantity of radionuclides that could be treated and which would guarantee that the exemption criteria were not exceeded. Two scenarios were evaluated, as follows:

Table 1-1

Maximum Distribution of
Radionuclides in Waste Feed

Radionuclide	Activity Feed Rate (Millicuries/hr)	Percentage Activity In Feed (%)
Am-241	0.0089	0.0056
Co-60	0.0089	0.0056
Cs-137	0.0089	0.0056
H-3	159	99.7323
Pu-238	0.32	0.2007
Pu-239	0.0089	0.0056
Pu-240	0.0089	0.0056
Pu-241	0.0089	0.0056
Pu-242	0.0089	0.0056
Th-228	0.0089	0.0056
Th-230	0.0089	0.0056
Th-232	0.0089	0.0056
U-235	0.0089	0.0056
U-238	0.0089	0.0056

- Scenario 1 - Evaluation conducted based on the expected waste composition (shown on Table 1-1)

- Scenario 2 - Evaluation conducted for each individual radionuclide (as though fed separately)

Regulations indicate that adjustments can be made to account for radionuclide removal associated with effluent controls (Appendix D to 40 CFR Part 61). Adjustments are based on the physical state of the radionuclide and control devices installed between the place of use and the point of release. For the glass melt furnace, it was assumed that all radionuclides are in the gaseous state until cooled in the scrubber. Upon cooling (and prior to release) all isotopes but hydrogen-3 (tritium) are assumed to return to the particulate state. The following procedure was used to back calculate feed rates:

- Allowable emissions for each scenario were determined using the AIRDOS-PC model.

- Emissions for tritium were divided by an adjustment factor of 0.14 for capture in the scrubber liquid (Klingler and Armstrong, 1985; 1988).

- Emissions for all isotopes but tritium were divided by an adjustment factor of 10^{-3} for physical state (i.e., particulate) (40 CFR 61 Appendix D).

- Adjusted emissions for all isotopes but tritium were divided by an adjustment factor of 0.01 for particulates captured in HEPA filters (40 CFR 61 Appendix D).

Appendix D of 40 CFR Part 61 also allows for an additional adjustment factor of 0.05 for particulates captured in the venturi scrubber; however, as an additional conservatism, this emission reduction factor was not included in this analysis.

AIRDOS-PC was used to estimate radionuclide emission rates for each scenario. The effective dose equivalent to a hypothetical receptor located at the Mound Plant boundary in the predominant wind direction (470 meters north-northeast) was limited to 0.1 mrem/year.

The allowable emission rates associated with scenario 1 (expected waste composition) are provided on Table 1-2. Calculations determine that operation of the glass melt furnace at the maximum activity feed rates (shown on Table 1-1) for 2,000 hours per year results in emissions that are 60 percent lower than limits shown on Table 1-2. Allowable emission rates for scenario 2 (individual radionuclides) are presented in Table 1-3. Copies of the computer printout results from the AIRDOS-PC model runs are provided in Appendix A.

Table 1-2

Scenario 1 - Allowable Emissions and Feed Limitations Based on Expected Waste Composition[a]

Radionuclide	Allowable Emission Rate (Millicuries/yr)	Feed Rate (Curies/yr)
H-3	107,000	760
Pu-238[b]	0.015	1.5
Th-232[c]	0.005	0.5

[a]Effective Dose Equivalent of 0.1 mrem/yr.
[b]Plutonium-239 used as surrogate for Pu-238 in the model.
[c]Remaining radionuclides in source term (other than H-3 and Pu-238) conservatively modeled as Th-232 (i.e., Am-241, Co-60, Cs-137, Pu-239, Pu-240, Pu-241, Pu-242, Th-228, Th-230, U-235, and U-238).

Table 1-3

Scenario 2 - Maximum Allowable Emissions and Feed Limitations Based on Feed of Individual Radionuclides[a]

Radionuclide	Allowable Emission Rate[a] Millicuries/yr	Feed Rate[d] Curies/yr
H-3	115,000	820
Pu-238[b]	0.28	28
Th-232[c]	0.29	29

[a]Effective Dose Equivalent of 0.10 mrem/yr.
[b]Plutonium-239 used as surrogate for Pu-238 in the model.
[c]Remaining radionuclides in source term (other than H-3 and Pu-238) conservatively modeled as Th-232 (i.e., Am-241, Co-60, Cs-137, Pu-239, Pu-240, Pu-241, Pu-242, Th-228, Th-230, U-235 and U-238).
[d]Based on feed of individual radionuclide only. Combination of radionuclides will result in lower feed rates.

No radionuclides will be evaluated in the trial burn program since the waste feed will be controlled to ensure that the EDE does not exceed 0.10 mrem/year.

1.4 DOCUMENT ORGANIZATION

The information contained in this document has been organized into the following sections:

Section	Title
1	Introduction
2	Pre-Trial Burn Activities
3	Process Description
4	Waste Analysis
5	Detailed Engineering Description
6	Sampling and Analysis Procedures
7	Trial Burn Schedule
8	Trial Burn Protocol
9	Operating Conditions for Emissions Control Equipment
10	Shutdown Procedures
11	References

The following information is appended:

- Appendix A -- Determination of Radionuclide Emissions
- Appendix B -- Summary Reports for Trial Burn Test Programs Previously Conducted
- Appendix C -- Waste Types to be Treated at the U.S. Department of Energy (DOE) Mound Plant
- Appendix D -- Determination of Metals Regulations
- Appendix E -- Analytical Methods for Liquid, Sludge, and Solid Samples
- Appendix F -- Sampling and Analytical Methods for Stack Gases
- Appendix G -- Quality Assurance/Quality Control Plan

SECTION 2

PRE-TRIAL BURN ACTIVITIES

2.1 PREVIOUS OPERATIONS AND TESTS

Two test programs were previously conducted to determine the performance characteristics of the glass melt furnace when burning RCRA-regulated organic wastes.

In January 1985, while operating under interim status, nine trial burns were conducted. Simulated wastes containing RCRA Appendix VIII listed hazardous constituents were treated in the glass melter. During these experiments, full process and offgas monitoring was conducted following EPA protocols. It was found that the POHC destruction and removal efficiencies and hydrogen chloride and particulate removal efficiencies readily met regulatory requirements for incinerators.

In June 1987, other simulated wastes were burned. During these tests, the composition of the waste was based on a stream generated at the explosive production facility located at the U.S. DOE Mound Plant (Mound). The waste feed streams varied from extremely low heating value, highly aqueous mixtures to moderately high heating value mixtures. Methylene chloride was selected as the principal organic hazardous constituent for the tests. Known quantities of methylene chloride were added to the waste feed streams. Results again showed that the furnace provided the conditions necessary to destroy difficult-to-incinerate hazardous organics and thus met applicable regulatory standards.

Although the test results met the required criteria, both test programs were conducted independently, without EPA supervision. Therefore, the tests were not considered as successful demonstrations for regulatory purposes. Detailed information on these test programs is contained in Appendix B. The glass melt furnace has been idle since 25 September 1987.

2.2 INCINERATOR STARTUP/SHAKEDOWN OPERATIONS

Mound will perform startup and shakedown operations at the facility to recommission and to bring the glass melt furnace back to a point of operational readiness for the trial burn. Following the startup and shakedown operations, Mound will conduct the formal trial burn program.

Startup/Shakedown Period

The trial burn program will be performed after a maximum of 720 hours of startup and shakedown operations.

Startup/Shakedown Performance

The glass melt furnace is designed to comply with the following performance standards:

- Destruction and removal efficiency (DRE) of $\geq$ 99.99 percent for principal organic hazardous constituents.
- HCl emissions -- Controlled to $\leq$ 1 percent of the HCl in the exhaust prior to treatment by pollution abatement equipment.
- Particulate emissions -- Controlled to $\leq$ 0.08 grain/dry standard cubic foot (dscf), corrected to 7 percent oxygen.

Operating conditions during startup and shakedown are controlled to the extent necessary to ensure compliance with these requirements. During startup/shakedown, the operating conditions shown in Table 2-1 will be maintained or the unit will be shutdown and modified to meet the required conditions. During shakedown operations, non-waste surrogates will be introduced into the system.

Startup/Shakedown Conditions

Startup/shakedown activities will be conducted to bring the melter back to a point of operational readiness. Prior to testing the melter for compliance with DRE requirements and particulate and HCl emission rates, Mound will place restrictions on waste material fed to the melter. Startup of the system will commence when all systems have been tested and calibrated. The primary objective of system startup testing is to verify that all of the process monitoring and control devices are operational prior to introducing any waste to the melter. The parameters that will be monitored during the shakedown operations are presented in Table 2-1.

During startup/shakedown, a surrogate feed stream consisting of No. 2 fuel oil will be used to simulate the physical and thermal (heating value) characteristics of the waste feed. Calibration checks will be performed on all systems to verify performance and to make adjustments necessary to meet the design operating parameters.

Table 2-1

Shakedown/Startup System Operating Limits

Parameter	Maximum Limit	Minimum Limit
1. Waste feed rate (lb/hr)	70	NA
2. Molten glass temperature (°F)	2,500	1,600
3. Combustion gas temperature (°F)	2,500	1,500
4. Fan exhaust temperature (°F)	205	NA
5. Combustion gas flow rate (acfm)	600	0
6. Carbon monoxide concentration of exit gas (ppm)		
(a) Instantaneous	100	NA
(b) Average	100	NA
7. Recirculating water flow rate (gpm)	NA	15
8. Scrubber liquid pH	NA	7

NA = Not Applicable
lb/hr = pounds per hour
acfm = actual cubic feet per minute
ppm = parts per million
gpm = gallons per minute

SECTION 3

PROCESS DESCRIPTION

The thermal treatment system is located in an addition on the west side of the liquid waste disposal (WD) building. The addition consists of an 18-ft wide x 57-ft long x 24-ft high bay area. From the foundations to the ground level, the bay is constructed of poured-in-place reinforced concrete. Above ground level, the exterior walls are constructed of concrete blocks. Reinforced concrete beams are provided at the top of the masonry walls and at mid-height. The roof is built on a precast hollow concrete slab spanning across the exterior walls. Windows along the north, south, and west walls of the addition have been removed and the openings closed with concrete blocks.

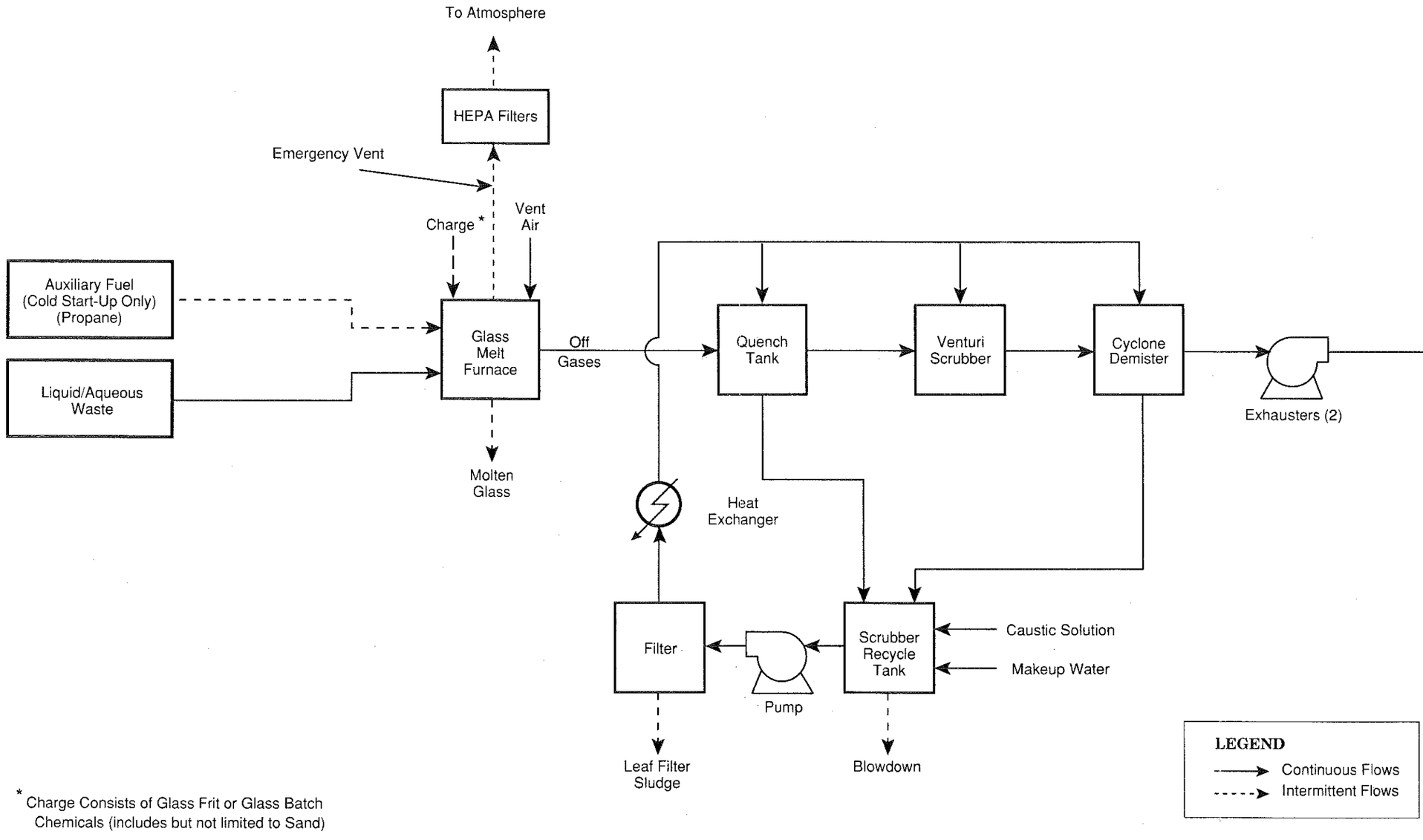
3.1 OVERALL SYSTEM DESCRIPTION

A schematic flow diagram of the thermal treatment system is shown in Figure 3-1. The thermal treatment system in use at the U.S. DOE Mound Plant (Mound) consists of an electrically heated glass melter, connected to a wet offgas scrubber system.

Prior to waste introduction, molten glass is formed in the furnace. Glass frit or glass batch chemicals (including but not limited to sand) are added to the furnace and heated to about 1400°F with a propane burner. Once glass reaches the molten state it will conduct electricity. The burner is then turned off and heat for maintaining or increasing the glass temperature is generated from the resistance of the glass to an electrical current passing through it.

Wastes are then added to the furnace through a port located in the furnace ceiling, as shown on Figure 3-2. Combustibles instantly ignite as they enter the chamber. Ash and incompletely burned solids and liquids fall directly onto the molten glass surface where combustion is completed. The ash is incorporated into the glass. Air for combustion is supplied through ports on both side walls. Air is induced by the offgas system exhaust fans.

Offgases exit the furnace through an exhaust port located in the ceiling at the end of the chamber opposite the feed port. The gases enter an offgas handling system. A quench tank and venturi scrubber combine to cool gases to less than 180°F, remove particulate matter, and neutralize acid gases generated in the combustion process. Sodium hydroxide (NaOH) is used for neutralization. The spent scrubber solution is filtered and recycled. Cooled gases are directed through a cyclone demister



* Charge Consists of Glass Frit or Glass Batch Chemicals (includes but not limited to Sand)

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FIGURE 3-1 BLOCK FLOW DIAGRAM OF GLASS MELT FURNACE

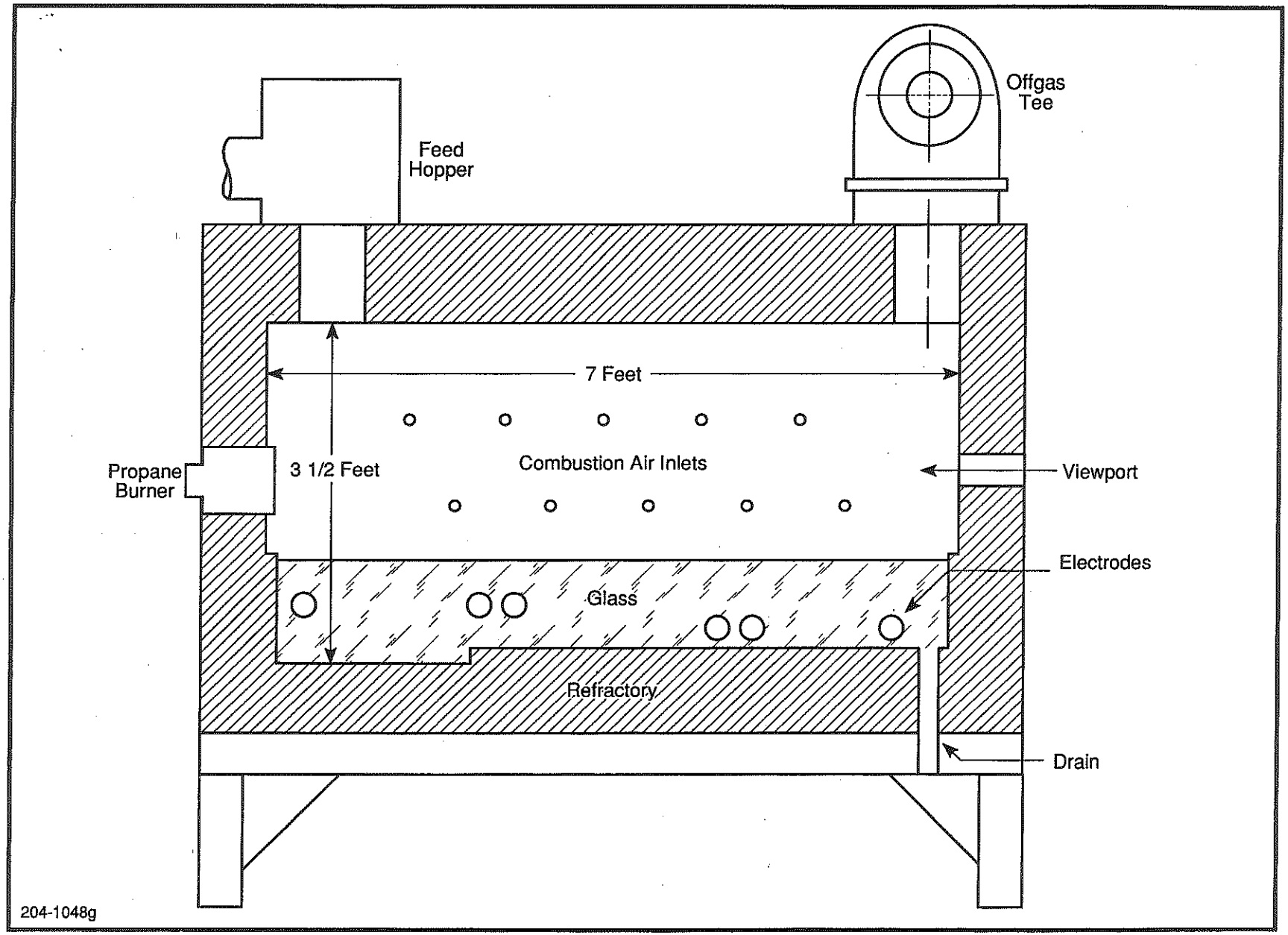


FIGURE 3-2 SCHEMATIC DIAGRAM OF GLASS MELT FURNACE

and discharged through exhausters and high efficiency particulate air (HEPA) filters to the atmosphere.

Scrubber solution is occasionally discharged during normal operations to avoid buildup of salts and tritium in the solution.

The furnace is also provided with an emergency pressure relief valve. The pressure relief valve is vented through HEPA filters and into the building exhaust duct.

The three major components of the system, the glass melt furnace, the offgas system, and the scrubber liquid system, are described in Subsections 3.2, 3.3, and 3.4, respectively.

3.2 GLASS MELT FURNACE

The glass melter (Pyro-Converter^{TR}), purchased from Penberthy Electromelt International, Inc., is of relatively standard manufacturer design. Modifications from the standard design requested by Mound were primarily related to furnace dimensions, waste feed techniques, and the location of feed and exhaust ports. These modifications were made to maximize gas residence time in the chamber. The manufacturer also was requested to provide a gas-tight outer covering for radioactivity control and extra external water cooling to minimize air cooling requirements.

The glass melter is an elongated chamber, designed to provide sufficient residence time to permit complete combustion of hazardous waste compounds. Figure 3-2 shows a schematic diagram of the glass melt furnace.

Two unique features make this joule-heated glass furnace attractive for waste treatment application: (1) waste is treated and toxic substances and radionuclides are immobilized by the molten glass bed; (2) the chamber is maintained at a uniformly high temperature without dependence on oxidative combustion.

Energy to maintain glass in the molten state and to heat the chamber walls and gases is supplied electrically. Electricity is supplied to the furnace via a 150 kilovolt-ampere (kVA), three-phase, 460-volt alternating current. Up to 150 kilowatts (kW) of power are available. The power supply is controlled by a three-phase, phase angle-firing silicone controlled rectifier (SCR) unit. Control is achieved by regulating the level of voltage to the furnace. The voltage determines the magnitude of the current supply (current = voltage/furnace resistance), which in turn controls the power (power = voltage x current). Each phase of the three-phase electrical system has an SCR control unit. The SCR units are manually regulated by an operator on the basis of voltage, current, and power meter

indicators, or automatically regulated by temperature controllers that activate the SCR units to maintain a set internal electrode temperature. In either case, current limiters built into the SCR units provide protection against over-current situations. Output of the SCR units is wired to electrode pairs in the furnace. Resistance to the current flow between electrodes generates the heat for the process.

3.3 OFFGAS SYSTEM

Initial gas treatment takes place in a vertical stainless steel quench tank. Hot gases exiting the glass furnace enter the quench tank through a side port near the base of the tank and exit at the top of the tank. Full-cone spray nozzles are spaced along the vertical center line and introduce recycled quench water counter-current to the ascending gases.

Two additional spray nozzles are located off-center to ensure the walls opposite the hot-gas inlet port are well wetted. The tank drains at its dish-shaped base directly into the scrubber recycle tank.

Wet scrubbing is completed in a high-energy venturi scrubber. A well-protected slide assembly adjusts the venturi throat slit to change the gas pressure differential across the throat. Manufacturer specifications call for a 104-centimeter (cm) water pressure differential to meet a particle removal efficiency of 99 percent (by weight) for an inlet gas particle loading of 1.15 grams (g)/cubic meter having a particle size distribution of:

- 100 percent below 7.0 micron
- 98 percent below 2.7 micron
- 92 percent below 1.6 micron
- 89 percent below 1.1 micron
- 74 percent below 0.56 micron
- 56 percent below 0.35 micron

Spray nozzles deliver caustic scrubber solution as fine droplets into the throat, wetting the metal surfaces and allowing the liquid to capture particles in the submicrometer size range.

The throat opens into a ribbed cylinder. High-velocity waste gases are directed tangentially into the cylinder. Additional scrubber liquid is pumped into the swirl causing an agglomeration of small droplets. Gases and entrained droplets exit the bottom of the cylinder and enter a cyclone demister. Droplets are forced into the demister wall by centrifugal force and are swept to the chamber's conical base by streams of water admitted to the cylinder upper wall. Solution from the venturi cylinder and demister drains to the scrubber recycle tank. Gases

leave the cyclone demister and flow through a heat-traced and insulated duct to the vent system fans (i.e., exhausters).

Two exhausters are installed in series and maintain the negative pressure necessary to induce proper air flow through the combustion chamber. A differential pressure of approximately 260 cm water gauge is supplied by the combined exhausters.

A butterfly valve following the exhausters is used in conjunction with the slide assembly to adjust the venturi scrubber throat to control gas flow through the system. Gases leaving the thermal treatment system flow through building exhaust ducts and through HEPA filters before being released to the atmosphere.

3.4 SCRUBBER LIQUID SYSTEM

A recycling, liquid system provides the quench water and caustic solution for offgas cleanup. Scrubber solution is stored in a stainless steel recycle tank. The quench tank, venturi scrubber, and cyclone demister drain by gravity into the scrubber recycle tank during offgas system operation. The tank is supplied with a volume measurement device and a pH probe. A pH controller constantly monitors scrubber liquid pH. Caustic is manually added through a metering pump to maintain the pH within the range of 7 to 10. The tank functions not only as a receptacle for recycled liquid, but also as a reservoir that moderates the rate of pH and temperature change in the scrubber system.

The scrubber recycle tank also supplies positive pressure on the suction side of the system's centrifugal pump. The pump withdraws liquid from the bottom drain of the recycling tank for discharge into the nozzles in the quench tank, venturi scrubber, and cyclone demister.

En route to the quench tank, scrubber and demister, the recycled solution passes through a solution filter, a heat exchanger, and a strainer. A ProGuard backwash filter system is used (Model number PG2103M-I). Filter cake is trapped on the outside of the filter elements. At a predetermined differential pressure, the unit automatically backwashes each of the filter elements. The backwash fluid and filter cake exit the filter for collection in a tank (or modified 55 gallon drum).

Filter effluent is directed to a liquid-to-liquid heat exchanger. The coolant liquid is a glycol/water solution. The glycol/water system is a closed loop system. Cooling of the gylcol/water solution is provided by an inline cooling tower.

The filtered and cooled scrubber liquid is recycled to the offgas treatment system.

3.5 WASTE FEED SYSTEM

During the trial burn program, two types of wastes will be treated: (1) high-heating value liquid waste, and (2) low-heating value aqueous waste.

The liquid feed system consists of a 55-gallon feed tank, a metering solvent pump, a 100-micron filter, a flow meter, a needle valve, a check valve, and a shut-off valve. Stainless steel tubing is used for liquid transport. The liquid nozzle allows full stream entry to the furnace. Waste feed atomization, a process which has traditionally caused problems in waste treatment operation, is not necessary since combustion is achieved by contact with the molten glass pool. The waste is fed in as a stream and drops primarily as a liquid onto the glass bed where it evaporates. The molten glass covering the chamber floor provides the energy for vaporization of the waste which "puddles" on the glass. The glass also protects the refractory from direct impingement by cool liquid. Since waste liquid evaporation takes place at the relatively nonturbulent feed end of the furnace chamber, the full volume of the chamber is available for combustion of organic vapors.

The waste atomization process, would not only sharply circumscribe feed characteristics, but because it inevitably projects droplets downstream and into the gas stream, might well result in inadequate waste destruction.

SECTION 4

WASTE ANALYSIS

4.1 ROUTINELY TREATED WASTE TYPES

The types of hazardous waste that the U.S. DOE Mound Plant (Mound) has been designed to store, handle, blend, and treat vary widely in chemical and physical characteristics. All wastes to be treated will be generated on-site; no off-site wastes will be accepted for treatment. The waste may be fed to the furnace in the form of liquid, heavy sludge, or a combination of both. Typical waste streams will consist of:

- Hazardous organic compounds
- Metals
- Radionuclides
- Inert materials
- Waste oils

The waste types that will be treated at Mound on a regular basis consist of EPA hazardous waste types D001, F001, F002, F003, and F005. A detailed description of the waste types to be treated is contained in Appendix C. The following information is provided:

- Table C-1
  - Waste name (Mound designation)
  - EPA identification number
  - Physical state
  - Heating value
  - Specific weight
  - Chemical components (range of percentages)
  - Analytical methods used to estimate concentration range of components
  - Heat of combustion
- Table C-2
  - RCRA Appendix VIII organic components that could be present in waste feed streams.

- Heat of combustion

- Table C-3

  - RCRA Appendix VIII metals that could be present in waste feed streams.

- Table C-4

  - Radionuclides that could be present in waste feed streams.

4.2 DESIGNED WASTE STREAMS FOR THE TRIAL BURN

During the trial burn, synthetic waste feeds will be utilized to simulate routinely treated waste. Proposed waste feed compositions have been formulated for the trial burn to challenge the permit limitations of the system for destruction and removal efficiency, combustion efficiency, chlorine, particulate, heating value, metals, and water content in the waste feeds.

The trial burn will consist of two different operating scenarios, each consisting of three independent tests. Two separate waste streams have been proposed for the two operating scenarios, and each waste stream has been designed to represent chemical characteristics and heating values of the routinely treated waste. The two scenarios are classified as follows:

Operating Scenario No. 1 - Liquid Waste with High-Heating Value

Operating Scenario No. 2 - Aqueous Waste with Low-Heating Value

Proposed synthetic waste compositions for the two operating scenarios are presented in Tables 4-1 and 4-2. A summary of waste feed parameters for the trial burn is presented in Table 4-3.

4.3 GLASS MELT FURNACE PERFORMANCE

4.3.1 Organic Wastes

The trial burn will be conducted in compliance with 40 CFR 264.343 performance standards, as follows:

- The process must achieve a minimum destruction and removal efficiency (DRE) of 99.99 percent for each designated principal organic hazardous constituent (POHC) in its permit for each waste feed (in this demonstration, carbon tetrachloride and tetrachloroethylene are the designated POHCs). DRE will be determined for each designated POHC from the following equation:

Table 4-1

Synthetic Waste Composition -- Operating Scenario No. 1
Liquid Waste with High Heating Value

Compound/Component	Feed Rate (lb/hr)	Metals Feed Rate (lb/hr)	Chlorine Content (% wt)	Cl Feed Rate (lb/hr)	Heat of Combustion (Btu/lb)	Heat Input Rate (Btu/hr)
Carbon tetrachloride	12.9	0	92.19	11.9	432	5,600
Tetrachloroethylene	13.9	0	85.6	11.9	2,142	29,800
No. 2 fuel oil	27.0	0	0	0	19,430	524,600
Methanol	15.2	0	0	0	10,259	155,900
Antimony trichloride ($SbCl_3$)	0.131	0.070	46.7	0.061	0	0
Arsenic trichloride ($AsCl_3$)	0.017	0.007	58.8	0.010	0	0
Barium chloride ($BaCl_2$)	0.106	0.070	34.1	0.036	0	0
Beryllium chloride ($BeCl_2$)	0.178	0.020	88.8	0.158	0	0
Cadmium chloride ($CdCl_2$)	0.033	0.020	38.8	0.013	0	0
Chromium (III) sulfate $Cr_2(SO_4)_3$	0.015	0.004	0	0	0	0
Lead oxide (PbO)	0.075	0.070	0	0	0	0
Mercury (II) oxide (HgO)	0.076	0.070	0	0	0	0
Selenium trioxide (SeO_3)	0.113	0.070	0	0	0	0
Silver oxide (Ag_2O)	0.075	0.070	0	0	0	0
Thallium chloride ($TlCl_3$)	0.106	0.070	34.2	0.036	0	0
Totals/Averages	70	0.541	34.4	24.1	~10,200	715,900

0170L

Table 4-2

Synthetic Waste Composition -- Operating Scenario No. 2
Aqueous Waste with Low Heating Value

Compound/Component	Feed Rate (lb/hr)	Metals Feed Rate (lb/hr)	Chlorine Content (% wt)	Cl Feed Rate (lb/hr)	Heat of Combustion (Btu/lb)	Heat Input Rate (Btu/hr)
Carbon tetrachloride	15.9	0	92.19	14.7	432	6,900
Tetrachloroethylene	17.2	0	85.6	14.7	2,142	36,800
Water	20.7	0	0	0	0	0
Methanol	15.2	0	0	0	10,259	155,900
Antimony trichloride ($SbCl_3$)	0.131	0.070	46.7	0.061	0	0
Arsenic trichloride ($AsCl_3$)	0.017	0.007	58.8	0.010	0	0
Barium chloride ($BaCl_2$)	0.106	0.070	34.1	0.036	0	0
Beryllium chloride ($BeCl_2$)	0.178	0.020	88.8	0.158	0	0
Cadmium chloride ($CdCl_2$)	0.033	0.020	38.8	0.013	0	0
Chromium (III) sulfate $Cr_2(SO_4)_3$	0.015	0.004	0	0	0	0
Lead oxide (PbO)	0.075	0.070	0	0	0	0
Mercury (II) oxide (HgO)	0.076	0.070	0	0	0	0
Selenium trioxide (SeO_3)	0.113	0.070	0	0	0	0
Silver oxide (Ag_2O)	0.075	0.070	0	0	0	0
Thallium chloride ($TlCl_3$)	0.106	0.070	34.2	0.036	0	0
Totals/Averages	70	0.541	42.4	29.7	~2,900	199,600

0170L

Table 4-3

Summary of Waste Feed Parameters for the Trial Burn

Parameter	Operating Scenario No. 1	Operating Scenario No. 2
Mass Flow Rate (lb/hr)	70	70
Chlorine Feed Rate (lb/hr)	24.1	29.7
Water Content (% by wt.)	0	30
Heat Input Rate (Btu/hr)	715,900	199,600
Heat Value (Btu/lb)	≈10,200	2,900

$$DRE = \frac{W_{in} - W_{out}}{W_{in}} \times 100\%$$

Where:

W_{in} = mass feed rate of one principal organic hazardous constituent (POHC) in the waste stream feeding the incinerator,

and

W_{out} = mass emission rate of the same POHC present in exhaust emissions prior to release to the atmosphere

- Stack emissions of more than 1.8 kilograms per hour (4 pounds per hour) of hydrogen chloride (HCl) must be controlled such that the rate of emission is no greater than the larger of either 1.8 kilograms per hour or 1% of the HCl in the stack gas prior to entering any pollution control equipment.

- Particulate matter to the atmosphere must be controlled such that the rate of emission is not in excess of 180 milligrams per dry standard cubic meter (0.08 grains per dry standard cubic foot) when corrected for the amount of oxygen in the stack gas according to the formula:

$$P_c = P_m \times \frac{14}{21-Y}$$

Where:

P_c = corrected concentration of particulate matter,

P_m = measured concentration of particulate matter,

and

Y = measured concentration of oxygen in the stack gas, using the Orsat method for oxygen analysis of dry flue gas.

Each performance standard will be discussed in the following subsections.

4.3.1.1 Destruction and Removal Efficiency (DRE)

For demonstrating compliance with the DRE standard requirements, tetrachloromethane (carbon tetrachloride) and tetrachloroethylene (PCE) have been selected as POHCs. The POHCs were selected based on two EPA recommended methods.

The first method for POHC selection was based on an EPA method based on heats of combustion as presented in the draft report entitled "Guidance Manual for Hazardous Waste Incinerator Permits," U.S. EPA Office of Solid Waste, July, 1983. This report suggests that the following formula be used to develop a POHC ranking value:

$$\text{POHC value} = (\%C) + 100/Hc$$

Where:

%C = Percent concentration of a hazardous constituent in a waste.

Hc = Heat of combustion, kilocalories per gram of that constituent.

The second method for selecting POHCs was based on more recent EPA guidance entitled "Guidance on Setting Permit Conditions and Reporting Trial Burn Results; Volume II of the Hazardous Waste Incineration Guidance Series," U.S. EPA Office of Solid Waste and Emergency Response, January, 1989. This document recommends selecting POHCs based on the thermal stability instead of heats of combustion. The guidance document provides a ranking of incinerabilities (ranked in decreasing degree of difficulty to incinerate) of RCRA Appendix VIII components. The compounds are divided into seven classes.

Using the heat of combustion method of selecting POHCs, carbon tetrachloride has the lowest heat of combustion value (0.24 kilocalories/gram or 432 Btu/lb) of any waste constituent to be treated by Mound, and thus shows the highest degree of difficulty of treatment. Tetrachloroethylene has a heat of combustion value of 1.19 kilocalories/gram (2,142 Btu/lb).

Carbon tetrachloride is ranked number 136-140 (out of 320) to incinerate based on thermal stability and is in Class 4. Tetrachloroethylene is ranked number 36 (out of 320) in difficulty to incinerate based on thermal stability and is in Class 2.

The choice of tetrachloromethane (carbon tetrachloride) and tetrachloroethylene as POHCs will satisfy both the heat of combustion and thermal stability methods for ranking the incinerability of POHCs. Carbon tetrachloride has the lowest heat

of combustion of any waste constituent to be treated, thus satisfying the heat of combustion ranking system. Tetrachloroethylene is a high ranking compound on the thermal stability list. In addition, both compounds have a high chlorine content and will provide a significant challenge to the scrubber system.

4.3.1.2 Emissions of HCl

The POHCs that have been selected for demonstration during the trial burn program were also selected for their chlorine contents. As shown on Table 4-1, carbon tetrachloride and tetrachloroethylene are composed of 92.2 percent chlorine and 85.6 percent chlorine, respectively. An average of 38 percent chlorine will be present in the feed streams. Emissions of HCl in the stack will be monitored to ensure compliance with regulatory criteria. HCl removal efficiency also will be determined (based on the mass of chlorine in the feed and the mass of HCl in stack gases).

4.3.1.3 Particulate Emissions

It is expected that the actual rate of particulate emissions will be extremely low during the trial burn program, based on the characteristics of the feed material. Process emissions will be monitored, however, to determine compliance with regulations.

4.3.2 Metal-Bearing Wastes

Metals emissions requirements were determined based on the report entitled "Guidance on Metals and Hydrogen Chloride Controls for Hazardous Waste Incinerators" (Draft Final Report dated September 1988).

Basically, permissible levels of metals can be set in one of the following ways:

- Limits set on feed rates (designated as Tier I limits)
- Limits set on emissions (designated as Tier II limits)

Tier I feed rates are back-calculated from Tier II emission limits assuming no credit for partitioning of metals into bottom ash or for removal of metals from stack gases by air pollution control devices (APCDs). Compliance with Tier I can be demonstrated simply by analysis of waste feeds. Compliance with Tier II must be demonstrated by stack emissions tests; partitioning and removal efficiencies associated with APCDs are considered.

Site information regarding the physical characteristics of the stack and the surrounding area that was used in tier classification calculations is provided on Table 4-4. Calculations for determination of metals limitations are contained in Appendix D.

Table 4-4

Metals Emissions Criteria Selection Parameters

1. Reference Information

A.	Facility Name:	U.S. DOE Mound Plant (Mound)
B.	Address:	1 Mound Road, Miamisburg, OH 45343
C.	Phone Number:	(513) 865-3078 (Larry Klingler)
D.	Date of Submission:	July 1990

2. Site Information

A. Stack Parameters

1.	Stack height	- 48 feet
2.	Exhaust temperature	- Ambient
3.	Inner stack diameter	- 4 feet
4.	Exit velocity	- 19 ft/sec
5.	Flow rate	- 14,000 acfm
6.	Latitude	- 39° 37' 42" N
	Longitude	- 84° 17' 15" W
	UTM (easting)	- 731250E 732.841 km
	UTM (northing)	- 4389900 N 4389.953 km

B. Terrain Parameters

1.	Maximum terrain rise	
	0 - 0.5 km radius	- 40.55 feet
	0.5 - 2.5 km radius	- 119.25 feet
	2.5 - 5.0 km radius	- 179.25 feet
2.	Shortest distance to fenceline	- 427 feet

C. Dimensions of Tallest Nearby Building Within 800 meters (approx. 0.5 miles)

1.	Distance from stack	- 1,063 feet
2.	Distance from nearest fenceline	- 119 feet
3.	Building height	- 74 feet
4.	Building length	- 183 feet
5.	Building width	- 133 feet

Limitations are set for noncarcinogenic metals and carcinogenic metals. A summary of the proposed feed rates for noncarcinogenic and carcinogenic metals is shown on Table 4-5. A discussion of the methodology used for determinization of feed rates for each category of metals is provided below.

4.3.2.1 Noncarcinogenic Metals

The noncarcinogenic metals expected to be present in the feed during routine operations are antimony, barium, lead, mercury, selenium, silver, and thallium. The Tier I levels for these noncarcinogenic metals (except selenium) are provided on Table 4-6. No emission levels have been set for selenium. However, since selenium is included in the determination for waste toxicity, waste feed will be spiked with 1,000 ppm. As shown, the Tier I feed limitations for barium, mercury, and silver are in excess of the maximum level expected to be present in the feed during routine operations (i.e., 1,000 ppm). For these metals, a feed rate of 1,000 ppm therefore, would be permissible. For the other three noncarcinogenic metals (lead, antimony, and thallium), the Tier II levels based on stack emissions would be applicable. Using the guidance document estimate of removal efficiencies (i.e., 97% removal by wet, high pressure (60 in wg) venturi scrubber), waste feed limitations were back calculated and are provided on Table 4-6. As shown, calculations indicate that it will be permissible to spike the waste feed streams with lead, antimony, and thallium at concentrations of 1,000 ppm.

4.3.2.2 Carcinogenic Metals

The carcinogenic metals expected to be present during routine operations are arsenic, cadmium, chromium, and beryllium. The Tier I emission levels for these carcinogenic metals are provided on Table 4-7. As shown, limits based on waste feed are very low. Tier II levels based on stack emissions also were calculated and are shown on Table 4-7. The collection efficiency for the high pressure venturi scrubber is 97 percent to 98 percent for the metals in question. Assuming the collection efficiency is accurate, the permissible concentration of each metal in the feed is shown in Table 4-7; the permissible carcinogenic metals concentrations are well below the maximum concentrations expected to be present.

The emission limitations for the four carcinogenic metals are cumulative. Using the assumed collection efficiencies, the mass feed of each of the four metals should be entered into equation (4-1) provided below. If the total exceeds 1.0, the mass feed of one or more of the metals should be reduced.

$$As/0.0067 + Cd/0.0187 + Cr/0.004 + Be/0.02 \leq = 1.0 \quad \text{Eqn (4-1)}$$

Where, As = mass feed rate of arsenic in lb/hr

Table 4-5

Parameters Used for Tier Selection

Site Information:

Exhaust Temperature	–	70 °F
Stack Gas Flow Rate	–	14,000 acfm
Effective Stack Height[a]	–	57 feet
Type of Terrain	–	Urban complex

Metals Feed Limitations: (Routine Operation.)

Metal	Feed Rate (lb/hr)	Concentration (ppm)
Antimony	0.070	1,000 ?
Arsenic	0.007	95 ?
Barium	0.070	1,000 ok
Beryllium	0.020	285 ok
Cadmium	0.020	266 ?
Chromium	0.004	57 ok
Lead	0.070	1,000 ?
Mercury	0.070	1,000 ?
Selenium	0.070	1,000 ?
Silver	0.070	1,000 ok
Thallium	0.070	1,000 ?

(a) See Appendix D – Effective stack height is greater than actual stack height due to buoyancy of exhaust gas plume.

Table 4-6

Permissible Emissions for Noncarcinogenic Metals

Tier I

Limitations Based on Waste Feed

	Feed Rate Limitation (lb/hr)	Feed Concentration[a] (ppm)
Antimony	0.03	429
Barium	5.0	71,429
Lead	0.009	129
Mercury	0.2	2,857
Selenium	N/A	1,000
Silver	0.3	4,286
Thallium	0.03	425

Tier II

Limitations Based on Stack Emissions

	Emission Limitation (lb/hr)	Assumed APCD Efficiency (%)	Estimated Feed Rate (lb/hr)	Estimated Feed Concentration[a] (ppm)
Antimony	0.03	97%	1.0	14,286
Lead	0.009	97%	0.29	2,857
Thallium	0.03	97%	1.0	14,286

[a]Concentration determined based on 70 lb/hr waste feed.

Table 4-7

Permissible Emissions for Carcinogenic Metals

Tier I

Limitations Based on Waste Feed

	Feed Rate Limitation (lb/hr)	Feed Concentration[a] (ppm)
Arsenic	0.0002	2.8
Cadmium	0.00056	8.0
Chromium	0.0008	11.4
Beryllium	0.0004	5.7

Tier II

Limitations Based on Stack Emissions

	Emission Limitation (lb/hr)	Assumed APCD Efficiency (%)	Estimated Feed Rate (lb/hr)	Estimated Feed Concentration[a] (ppm)
Arsenic	0.0002	97	0.0067	95
Cadmium	0.00056	97	0.0187	266
Chromium	0.0008	98	0.004	57
Beryllium	0.0004	98	0.02	285

[a]Concentration determined based on 70 lb/hr waste feed.

Cd = mass feed rate of cadmium in lb/hr
Cr = mass feed rate of chromium in lb/hr
Be = mass feed rate of beryllium in lb/hr

If the actual collection efficiency of the glass furnace and scrubber exceeds the 97 to 98 percent range, larger feed rates can be accepted. For purposes of the trial burn program, a spiked solution containing the maximum allowable quantity of each carcinogenic metal (based on Tier II emissions) will be utilized (i.e., 95 ppm As, 266 ppm Cd, 57 ppm Cr, and 285 ppm Be).

Following comparison of trial burn results, Equation 4-1 will be appropriately modified to limit the feed composition of the four carcinogenic metals.

SECTION 5

DETAILED ENGINEERING DESCRIPTION

The glass melt furnace at the U.S. DOE Mound Plant (Mound) is designed to treat liquid and sludge wastes. The system consists of the following components:

- Waste feed system
- Glass melt furnace
- Offgas system
- Scrubber liquid system
- Exhausters
- HEPA filters

5.1 MANUFACTURER'S NAME AND MODEL NUMBER OF THE GLASS MELTER

The glass melter was designed and constructed by Penberthy Electromelt International, Inc. It is custom made and has no model designation. The offgas scrubber unit was designed in-house and is constructed from a combination of Mound fabricated and purchased components.

5.2 TYPE OF UNIT

The glass melt furnace system consists of an electrically heated glass melter that is used as a combination of a combustion chamber and an ash/toxic immobilizer. The melter is followed by a wet offgas scrubber recycling system. The scrubber liquid drained from the offgas system is treated and fed back to the scrubber liquid recycling system. Offgases are discharged to the atmosphere after passing through two exhaust fans followed by HEPA filters. A schematic diagram of the system is shown in Figure 3-1, and a detailed description of the system is presented in Section 3.

5.3 DIMENSIONS OF THE UNIT

The internal dimensions of the glass melter plenum chamber are 84 in. long by 27.5 in. wide by 30.5 in. high. The cross sectional area of the combustion chamber is 5.8 sq ft. A molten glass bed occupies an additional 9 to 12 in. of height.

5.4 AUXILIARY FUEL SYSTEM

The glass melter is equipped with a 400,000 Btu/hr, propane fired burner. The burner is used only during cold startup of the unit to bring the glass to its molten state, at which time it becomes electrically conductive. Once the glass is capable of conducting current, the propane burner is turned off; it is not used during waste processing.

5.5 CAPACITY OF PRIME MOVER

Two centrifugal fans (exhausters) are installed in series and follow the wet scrubber system. The fans induce combustion air into the glass melter chamber and provide the differential pressure requirements of the offgas scrubbing unit. The first fan has a capacity to deliver 200 scfm of air flow at a static pressure of 42 in. water gauge; it is powered by a 7.5-hp motor. The second fan has a capacity to deliver 550 scfm of air flow at a static pressure of 61-in. water gauge; it is powered by a 15-hp motor.

5.6 AUTOMATIC WASTE FEED CUTOFF SYSTEM

All critical process data, including system pressures, temperatures, and emission analyzer information, are fed to a Kaye Instrument Digistrip III Recorder Data Logger for monitoring and recording. Alarm set points (high, low, and rate of change) are programmed independently for each input channel. Waste feed cutoff will be initiated automatically when selected measurements fall outside programmed ranges. For liquid feed operations, Digistrip relays will interact with the waste feed system, tripping the system shutoff valve when selected parameters are outside specified limits.

The parameters summarized in Table 10-1 will be used for automatic waste control. Thermocouples used for the aforementioned temperature measurements are B and J types; they will be calibrated by the Mound Standards Laboratory or by the manufacturer. Recalibration or replacement will be performed as specified by Department of Energy Quality Assurance Guidelines.

5.7 STACK GAS MONITORING AND POLLUTION CONTROL EQUIPMENT

Stack gas monitoring equipment is discussed in Section 6. Pollution control equipment consists of the glass melt furnace and the scrubber liquid system, which are described in detail in Section 3.

5.8 NOZZLE AND BURNER DESIGN

During startup, a propane burner is used to heat the glass bed to about 1,400°F. At this temperature, the glass is in a molten state and will conduct electricity. When this temperature is achieved, the burner is deactivated and electrical current is used to maintain and control the temperature of the bed. No waste atomization is utilized. Liquid and aqueous waste are free-fed directly to the furnace.

5.9 CONSTRUCTION MATERIALS

The glass melter consists of a rectangular box constructed of 310 stainless steel and lined on the floor and lower sides with Criteria I alumina, zirconia, and silicate fused-cast refractory to contain the glass pool. The upper chamber, where combustion takes place, consists of high-density firebrick. An outer layer of standard firebrick and an air space separate the interior refractory from the outer skin. Electrodes embedded in the glass pool are fabricated of high-purity iron.

The offgas duct between the furnace and the quench tank and the duct between the quench tank and the scrubber recycle tank are constructed of 316L stainless steel. Scrubber recycle tank nozzles are fabricated with Inconel 625 and 316 stainless steel. The venturi scrubber and the section of duct immediately preceding it are constructed of Hastelloy C-276. The remainder of the offgas ductwork is fabricated with 304L stainless steel. Exhaust fan impellers and casings are constructed of carbon steel.

The scrubber liquid system is composed of cast iron and stainless steel materials. The pump casing and filter housing are made of cast iron. The filter elements are constructed with 316 stainless steel. The heat exchanger and the recycling tank are fabricated with 316 stainless steel. Black iron pipe makes up most of the piping system. Pipe directly adjacent to the spray nozzles is 316 stainless steel. Stainless steel strainers separate the black iron and stainless steel pipe.

5.10 LOCATIONS AND DESCRIPTION OF TEMPERATURE, PRESSURE, AND FLOW-INDICATING AND CONTROL DEVICES

The control instruments used to monitor temperature, pressure, flow rates, stack emissions, and liquid pH are described in Table 5-1. The locations of these sensors are shown in Figure 5-1.

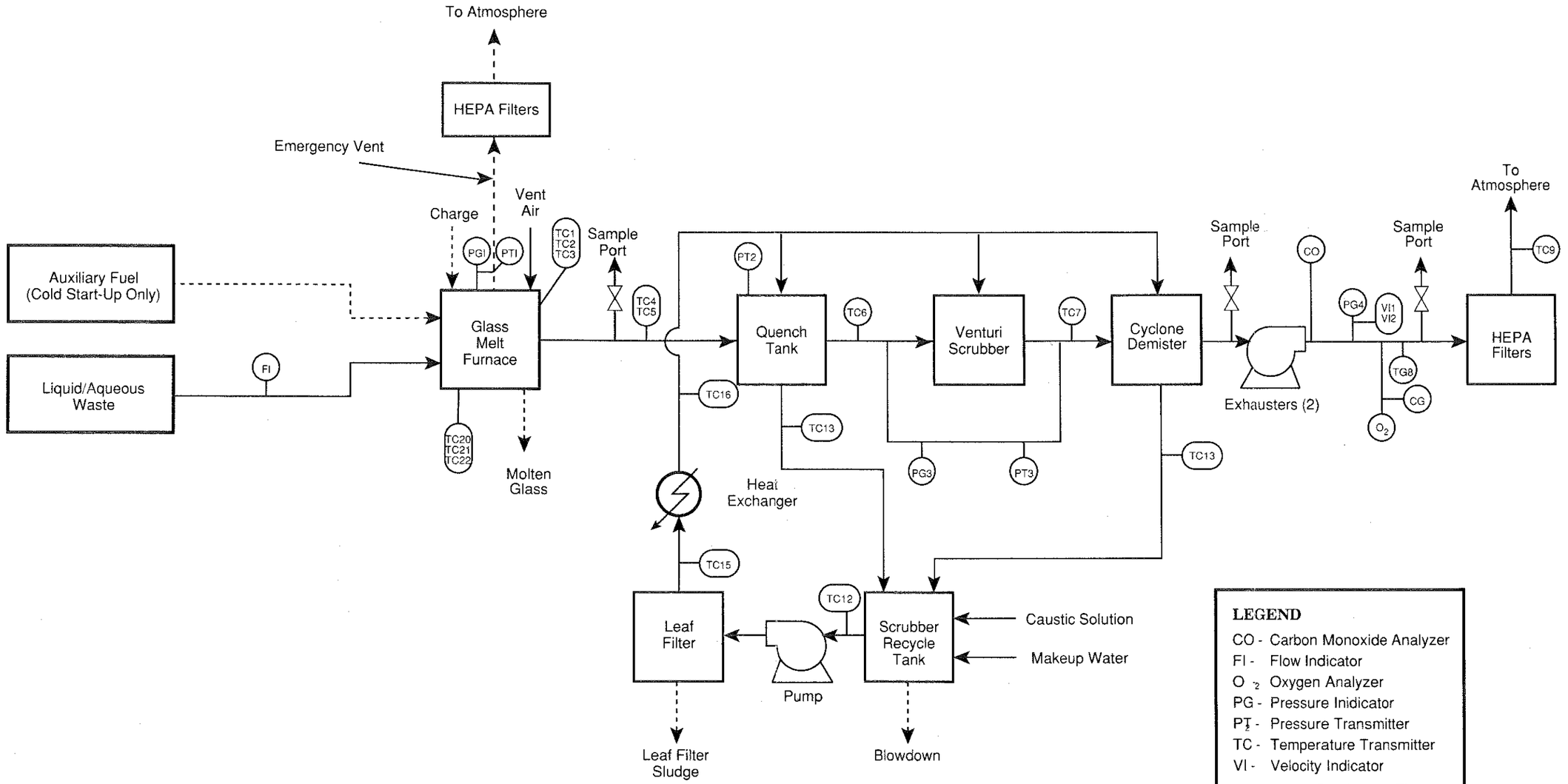
Table 5-1

Description of System Monitors

Measurement	ID	Instrument	Analysis Method	Range(s)	Recorded
Furnace Chamber Temperature - Zone 1	TC1	B Type Thermocouple	NA	32 to 3,092°F	X
Furnace Chamber Temperature - Zone 2	TC2	B Type Thermocouple	NA	32 to 3,092°F	X
Furnace Chamber Temperature - Zone 3	TC3	B Type Thermocouple	NA	32 to 3,092°F	X
Electrode A Temperature	TC20	K Type Thermocouple	NA	(-)330 to 2,300°F	
Electrode B Temperature	TC21	K Type Thermocouple	NA	(-)330 to 2,300°F	
Electrode C Temperature	TC22	K Type Thermocouple	NA	(-)330 to 2,300°F	
Furnace Cooling Water Temperature	TC19	J Type Thermocouple	NA	32 to 1,400°F	X
Furnace Chamber Pressure	PG1	Magnehelic Gauge	NA	0 to (-)15 Inches water	
	PT1	Pressure Transducer	NA	(-)10 to 10 Inches water	X
Offgas Temperature - Before Scrubber	TC4	B Type Thermocouple	NA	32 to 3,092°F	X
Offgas Temperature - Before Scrubber	TC5	B Type Thermocouple	NA	32 to 3,092°F	X
Offgas Temperature - After Spray Tank	TC6	J Type Thermocouple	NA	32 to 1,400°F	X
Offgas Temperature - After Venturi	TC7	J Type Thermocouple	NA	32 to 1,400°F	X
Offgas Temperature - After Fans	TC8	J Type Thermocouple	NA	32 to 1,400°F	X
Offgas Temperature - System Exit	TC9	J Type Thermocouple	NA	32 to 1,400°F	X
Offgas Velocity - System Exit	PG4	Magnehelic Gauge	NA	0 to 2 Inches water	
	VI1	Annubar - Pressure Transducer	NA	0 to 5 Inches water	X
Offgas Mass Flow Rate - System Exit	VI2	Kurz Mass Flow Meter	Thermal Sensor	0 to 2,500 feet/minute	X
Venturi Pressure Differential	PG3	Magnehelic Gauge	NA	0 to 80 inches water	X
	PT3	Pressure Transducer	NA	0 to 80 inches water	X
Spray Tank Pressure	PT2	Pressure Transducer	NA	0 to (-) 10 inches water	X
Flue Gas Oxygen	O_2	Teledyne 9700 Flue Gas Analyzer	Electrochemical Transducer	0 to 25%	X
Flue Gas Carbon Monoxide	CO	Beckman 865 Analyzer	Nondispersive Infrared	0 to 1,000 ppm	X
Flue Gas Combustibles	CG	Teledyne 9700 Flue Gas Analyzer	Catalytic Sensor	0 to 5%	X

Table 5-1
(continued)

Measurement	ID	Instrument	Analysis Method	Range(s)	Recorded
Scrubber Liquor Temperature - Supply	TC12	J Type Thermocouple	NA	32 to 1,400°F	X
Spray Tank Drain	TC13	J Type Thermocouple	NA	32 to 1,400°F	X
Demister Drain	TC14	J Type Thermocouple	NA	32 to 1,400°F	X
Heat Exchanger Inlet	TC15	J Type Thermocouple	NA	32 to 1,400°F	X
Heat Exchanger Outlet	TC16	J Type Thermocouple	NA	32 to 1,400°F	X
Furnace Coolant Temperature -					
Radiator Inlet	TC17	J Type Thermocouple	NA	32 to 1,400°F	X
Radiator Outlet	TC18	J Type Thermocouple	NA	32 to 1,400°F	X
Scrubber Liquor pH	pH	Leeds & Northrup	NA	0-14	X



204-1048m

FIGURE 5-1 LOCATIONS OF FLOW-INDICATOR AND CONTROL DEVICES

SECTION 6

SAMPLING AND ANALYSIS PROCEDURES

Sampling and analysis procedures to be implemented during the trial burn are specified in this section. The associated Quality Assurance/Quality Control (QA/QC) mechanisms to be employed are also presented.

6.1 SAMPLING LOCATIONS

During the trial burn, waste feed and system discharge (exhaust gases, scrubber blowdown, and solids) will be sampled for analysis. The locations of the sampling points and a summary of parameters to be sampled and analyzed for each test are shown in Figure 6-1.

6.2 SUMMARY OF SAMPLING AND ANALYSIS PROCEDURES

During the trial burn program, samples will be collected and analyzed from the following sample locations:

Sample Location	Type of Sample
1	Liquid/aqueous waste
2	Molten glass
3	Filter sludge
4	Scrubber blowdown
5	Stack gases

A summary of the sampling and analysis plan for each of the sampling locations is presented in Tables 6-1 through 6-5.

6.3 SAMPLING EQUIPMENT

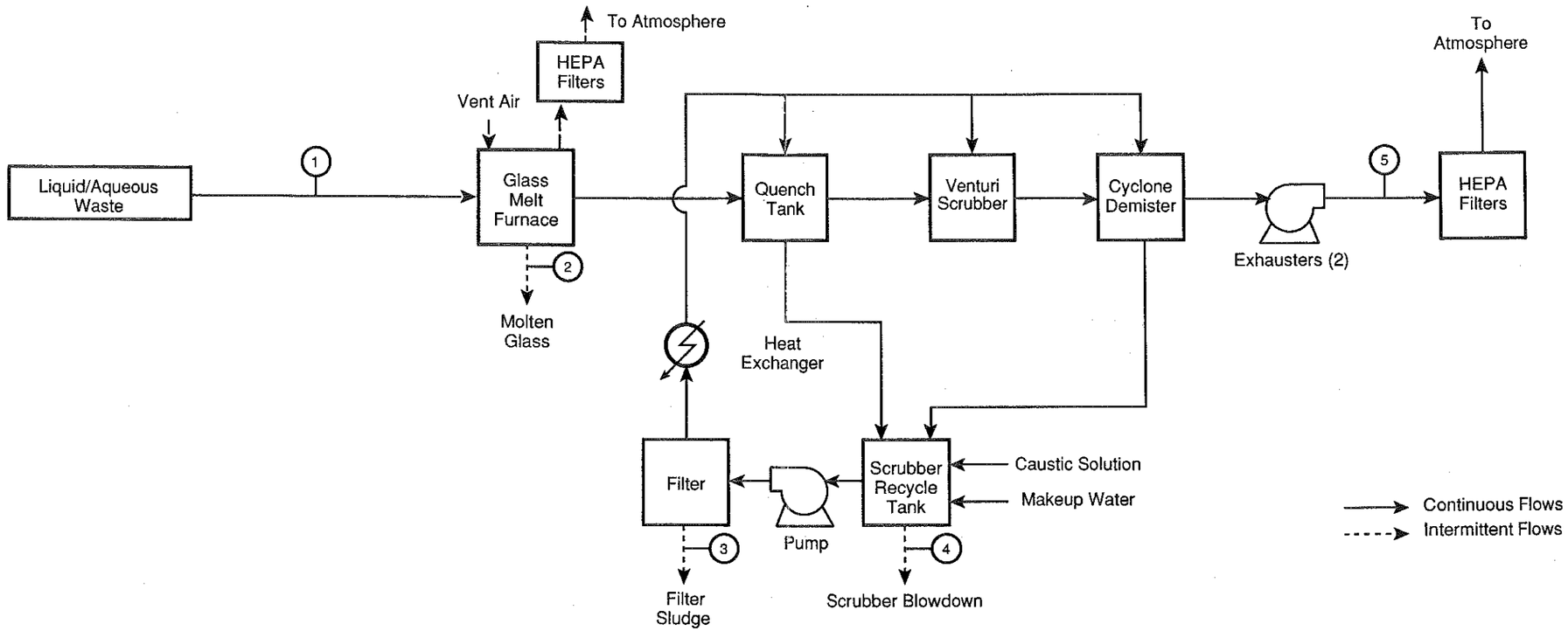
A summary of the sampling equipment that will be utilized during the trial burn program is summarized in Table 6-6.

6.4 SAMPLING TECHNIQUES

Sampling techniques for solids, sludges, liquids, and gases are described in the following subsections.

6.4.1 Solids

The only solid sample that will be collected during the trial burn is from the molten glass bed. Due to the extreme difficulty in collecting this sample, only a single grab sample will be collected after each test run.



Parameters Sampled/Analyzed	1 Liquid/Aqueous Waste	2 Molten Glass	3 Filter Sludge	4 Scrubber Blowdown	5 Stack Gases
Volatile Organics	X		X	X	X
Particulates					X
HCl					X
Carbon Dioxide					X
Carbon Monoxide					X
Oxygen					X
Suspended Solids				X	
pH				X	
Volumetric Flow Rate (Liquids)	X				
Volumetric Flow Rate (Gases)					X
Water Content	X		X		X
Heating Value	X				
Total Chlorine	X			X	
Sulfer Content	X				
% Ash	X				
Metals		X	X	X	X

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FIGURE 6-1 SAMPLING POINT LOCATIONS

Sampling Point Number:	1							
Description:	Organic Liquid/Aqueous Waste							
Test Objective:	Determine the DRE of the Glass Melt Furnace							
Sampling Objective:	Collect a Representative Sample							
Parameters to be Tested:	Volatile Organics	Sulfur Content	Total Chlorine	Heating Value	Water Content	% Ash	Metals [a]	Volumetric Flow Rate (Liquid)
Sampling or Monitoring Method: [b]	Grab sample (100-200 milliliters) collected using composite liquid waste sampler (coliwasa) from each drum prior to each test run. Samples are composited into appropriate bottles for analysis.							Not Applicable
Sample Extraction/Analysis Method(s): [c]	Method 5030/ Method 8240	ASTM D129	Parr Bomb EPA 325.2	ASTM D240	ASTM 2216-80	EPA Method 209	EPA Methods 3010, 3020, 3050, 6010, 7000 Series	Pump Calibration Test
Sampling or Monitoring Design: (Number of Samples Per Condition)								
- Total Number of Samples Collected	3	3	3	3	3	3	3	3
- Site Blanks [d]	1	1	0	0	0	0	1	0
- Trip Blanks [e]	1 Per Shipment	0	0	0	0	0	0	0
- Lab Blanks [f]	1	1	1	1	1	0	1	0
- Blank Spikes [f]	1	1	1	1	0	0	1	0
- Number of Sample Replicates [f]	1	1	1	1	1	1	1	0
- Number of Matrix Spikes [f]	1	1	1	1	0	0	1	0
- Total Number of Samples Analyzed [d]	8	8	7	7	5	4	8	3

NOTES:
[a] Metals include antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, silver and thallium.
[b] Sampling methods are described in Section 6.
[c] Sample extraction/analysis methods are described in Appendix E.
[d] Trip blanks not added to total - run only if contamination problems found.
[e] One per condition of sampling.
[f] One per analytical batch for liquid matrix. (A batch consists of a maximum of 20 samples).

204-1048a

TABLE 6-1 SAMPLING AND ANALYSIS PLAN FOR THE ORGANIC LIQUID/AQUEOUS WASTE

Sampling Point Number:	2	
Description:	Molten Glass	
Test Objective:	Determine the DRE of the Glass Melt Furnace	
Sampling Objective:	Collect a Representative Sample	
Parameters to be Tested:		Metals[e]
Sampling or Monitoring Method: [a]	Due to extreme difficulty of sampling, a single grab sample (500 grams) will be collected after each test run.	
Sample Extraction/Analysis Method(s): [b]	Method 1310 3010/3020 6010/7000	
Sampling or Monitoring Design:		
- Total Number of Samples Collected	6	
- Site Blanks	1	
- Trip Blanks [c]	0	
- Lab Blanks	1 Per Batch [d]	
- Blank Spikes	1	
- Number of Sample Replicates	1	
- Number of Matrix Spikes	1	
- Total Number of Samples Analyzed [c]	11	

NOTES:
[a] Sampling methods are described in Section 6.
[b] Sample extraction/analysis methods are described in Appendix E.
[c] Trip blanks not added to total - run only if contamination problems found.
[d] A batch consists of a maximum of 20 Samples.
[e] Metals include antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, silver, and thallium.

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TABLE 6-2 SAMPLING AND ANALYSIS PLAN FOR THE MOLTEN GLASS

Sample Point Number:	3		
Description:	Filter Sludge		
Test Objective:	Determine the DRE of the Glass Melt Furnace		
Sampling Objective:	Collect a Representative Sample		
Parameters to be Tested:	Volatile Organics	Water Content	Metals [e]
Sampling or Monitoring Method: [a]	A grab sample (200-300 grams) of leaf filter sludge will be collected after each test run.		
Sample Extraction/Analysis Method(s): [b]	Method 5030/ Method 8240	ASTM 2216-80	Method 1310 3010/3020 6010/7000
Sampling or Monitoring Design:			
- Total Number of Samples Collected	6	6	6
- Site Blanks	1	0	1
- Trip Blanks [c]	1 Per Shipment	0	0
- Lab Blanks	1 Per Batch [d]	1	1 Per Batch [d]
- Blank Spikes	1 Per Batch [d]	0	1
- Number of Sample Replicates	1 Per Batch [d]	1	1
- Number of Matrix Spikes	1 Per Batch [d]	0	1
- Total Number of Samples Analyzed [c]	11	8	11

NOTES:
[a] Sampling methods are described in Section 6.
[b] Sample extraction/analysis methods are described in Appendix E.
[c] Trip blanks not added to total - run only if contamination problems found.
[d] A batch consists of a maximum of 20 Samples.
[e] Metals include antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, silver, and thallium

204-1048e

TABLE 6-3 SAMPLING AND ANALYSIS PLAN FOR THE FILTER SLUDGE

Sampling Point Number:	4				
Description:	Scrubber Blowdown				
Test Objective:	Determine the DRE of the Glass Melt Furnace				
Sampling Objective:	Collect a Representative Sample				
Parameters to be Tested:	Volatile Organics	Suspended Solids	pH	Total Chloride	Metals[e]
Sampling or Monitoring Method: [a]	Frequency of blowdown dependent on process operation. One grab sample collected at the end of each test run.				
Sample Extraction/Analysis Method(s): [b]	Method 5030/ Method 8240	Method 209C	Method 423	EPA Method 300.0	EPA Methods 3010, 3020, 3050, 6010, 7000 Series
Sampling or Monitoring Design:					
- Total Number of Samples Collected	6	6	6	6	6
- Site Blanks	1	1	0	1	0
- Trip Blanks [c]	1 Per Shipment	0	0	0	0
- Lab Blanks	1 Per Batch [d]	1	0	1 Per Batch [d]	1 Per Batch [d]
- Blank Spikes	1 Per Batch [d]	0	0	1 Per Batch [d]	1 Per Batch [d]
- Number of Sample Replicates	1 Per Batch [d]	1	1	1 Per Batch [d]	1 Per Batch [d]
- Number of Matrix Spikes	1 Per Batch [d]	0	0	1 Per Batch [d]	1 Per Batch [d]
- Total Number of Samples Analyzed [c]	11	9	7	11	10

NOTES:
[a] Sampling methods are described in Section 6.
[b] Sample extraction/analysis methods are described in Appendix E.
[c] Trip blanks not added to total - run only if contamination problems found.
[d] A batch consists of a maximum of 20 samples.
[e] Metals include antimony, arsenic, barium, beryllium, cadium, chromium, lead, mercury, selenium, silver, and thallium.

204-1048d

TABLE 6-4 SAMPLING AND ANALYSIS PLAN FOR THE SCUBBER BLOWDOWN

Sampling Point Number:	1							
Description:	Organic Liquid/Aqueous Waste							
Test Objective:	Determine the DRE of the Glass Melt Furnace							
Sampling Objective:	Collect a Representative Sample							
Parameters to be Tested:	Volatile Organics	Sulfur Content	Total Chlorine	Heating Value	Water Content	% Ash	Metals [a]	Volumetric Flow Rate (Liquid)
Sampling or Monitoring Method: [b]	Grab sample (100-200 milliliters) collected using composite liquid waste sampler (coliwasa) from each drum prior to each test run. Samples are composited into appropriate bottles for analysis.							Not Applicable
Sample Extraction/Analysis Method(s): [c]	Method 5030/ Method 8240	ASTM D129	Parr Bomb EPA 325.2	ASTM D240	ASTM 2216-80	EPA Method 209	EPA Methods 3010, 3020, 3050, 6010, 7000 Series	Pump Calibration Test
Sampling or Monitoring Design: (Number of Samples Per Condition)								
- Total Number of Samples Collected	3	3	3	3	3	3	3	3
- Site Blanks [d]	1	1	0	0	0	0	1	0
- Trip Blanks [e]	1 Per Shipment	0	0	0	0	0	0	0
- Lab Blanks [f]	1	1	1	1	1	0	1	0
- Blank Spikes [f]	1	1	1	1	0	0	1	0
- Number of Sample Replicates [f]	1	1	1	1	1	1	1	0
- Number of Matrix Spikes [f]	1	1	1	1	0	0	1	0
- Total Number of Samples Analyzed [d]	8	8	7	7	5	4	8	3

NOTES:
[a] Metals include antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, silver and thallium.
[b] Sampling methods are described in Section 6.
[c] Sample extraction/analysis methods are described in Appendix E.
[d] Trip blanks not added to total - run only if contamination problems found.
[e] One per condition of sampling.
[f] One per analytical batch for liquid matrix. (A batch consists of a maximum of 20 samples).

204-1048a

TABLE 6-1 SAMPLING AND ANALYSIS PLAN FOR THE ORGANIC LIQUID/AQUEOUS WASTE

Sampling Point Number:	2	
Description:	Molten Glass	
Test Objective:	Determine the DRE of the Glass Melt Furnace	
Sampling Objective:	Collect a Representative Sample	
Parameters to be Tested:		Metals[e]
Sampling or Monitoring Method: [a]	Due to extreme difficulty of sampling, a single grab sample (500 grams) will be collected after each test run.	
Sample Extraction/Analysis Method(s): [b]	Method 1310 3010/3020 6010/7000	
Sampling or Monitoring Design:		
- Total Number of Samples Collected	6	
- Site Blanks	1	
- Trip Blanks [c]	0	
- Lab Blanks	1 Per Batch [d]	
- Blank Spikes	1	
- Number of Sample Replicates	1	
- Number of Matrix Spikes	1	
- Total Number of Samples Analyzed [c]	11	

NOTES:
[a] Sampling methods are described in Section 6.
[b] Sample extraction/analysis methods are described in Appendix E.
[c] Trip blanks not added to total - run only if contamination problems found.
[d] A batch consists of a maximum of 20 Samples.
[e] Metals include antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, silver, and thallium.

204-1048c

TABLE 6-2 SAMPLING AND ANALYSIS PLAN FOR THE MOLTEN GLASS

Sample Point Number:	3		
Description:	Filter Sludge		
Test Objective:	Determine the DRE of the Glass Melt Furnace		
Sampling Objective:	Collect a Representative Sample		
Parameters to be Tested:	Volatile Organics	Water Content	Metals [e]
Sampling or Monitoring Method: [a]	A grab sample (200-300 grams) of leaf filter sludge will be collected after each test run.		
Sample Extraction/Analysis Method(s): [b]	Method 5030/ Method 8240	ASTM 2216-80	Method 1310 3010/3020 6010/7000
Sampling or Monitoring Design:			
- Total Number of Samples Collected	6	6	6
- Site Blanks	1	0	1
- Trip Blanks [c]	1 Per Shipment	0	0
- Lab Blanks	1 Per Batch [d]	1	1 Per Batch [d]
- Blank Spikes	1 Per Batch [d]	0	1
- Number of Sample Replicates	1 Per Batch [d]	1	1
- Number of Matrix Spikes	1 Per Batch [d]	0	1
- Total Number of Samples Analyzed [c]	11	8	11

NOTES:
[a] Sampling methods are described in Section 6.
[b] Sample extraction/analysis methods are described in Appendix E.
[c] Trip blanks not added to total - run only if contamination problems found.
[d] A batch consists of a maximum of 20 Samples.
[e] Metals include antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, silver, and thallium

204-1048e

TABLE 6-3 SAMPLING AND ANALYSIS PLAN FOR THE FILTER SLUDGE

Sampling Point Number:	4				
Description:	Scrubber Blowdown				
Test Objective:	Determine the DRE of the Glass Melt Furnace				
Sampling Objective:	Collect a Representative Sample				
Parameters to be Tested:	Volatile Organics	Suspended Solids	pH	Total Chloride	Metals[e]
Sampling or Monitoring Method: [a]	Frequency of blowdown dependent on process operation. One grab sample collected at the end of each test run.				
Sample Extraction/Analysis Method(s): [b]	Method 5030/ Method 8240	Method 209C	Method 423	EPA Method 300.0	EPA Methods 3010, 3020, 3050, 6010, 7000 Series
Sampling or Monitoring Design:					
- Total Number of Samples Collected	6	6	6	6	6
- Site Blanks	1	1	0	1	0
- Trip Blanks [c]	1 Per Shipment	0	0	0	0
- Lab Blanks	1 Per Batch [d]	1	0	1 Per Batch [d]	1 Per Batch [d]
- Blank Spikes	1 Per Batch [d]	0	0	1 Per Batch [d]	1 Per Batch [d]
- Number of Sample Replicates	1 Per Batch [d]	1	1	1 Per Batch [d]	1 Per Batch [d]
- Number of Matrix Spikes	1 Per Batch [d]	0	0	1 Per Batch [d]	1 Per Batch [d]
- Total Number of Samples Analyzed [c]	11	9	7	11	10

NOTES:
[a] Sampling methods are described in Section 6.
[b] Sample extraction/analysis methods are described in Appendix E.
[c] Trip blanks not added to total - run only if contamination problems found.
[d] A batch consists of a maximum of 20 samples.
[e] Metals include antimony, arsenic, barium, beryllium, cadium, chromium, lead, mercury, selenium, silver, and thallium.

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TABLE 6-4 SAMPLING AND ANALYSIS PLAN FOR THE SCUBBER BLOWDOWN

Sampling Point Number:	5								
Description:	Stack Gases								
Test Objective:	Determine the DRE of the Glass Melt Furnace								
Sampling Objective:	Collect a Representative Sample								
Parameters to be Tested: [i]	Volatile Organics	Metals [i]	Carbon Monoxide	Oxygen	Carbon Dioxide	Particulates	HCl [b]	Water Content	Volumetric Flow Rate (Gas)
Sampling or Monitoring Method: [a]	Volatile Organic Sampling Train (VOST)	Draft EMSL Metals	EPA Method 10 [g]	EPA Method 3A [g]	EPA Method 3	EPA Method 5			
Sample Extraction/Analysis Method(s): [a]	EPA Method 5040	Total Metals	EPA Method 10	EPA Method 3A	EPA Method 3	EPA Method 5	EPA Method 300.0	EPA Method 5	
Sampling or Monitoring Design: [f]	~20 Liters/Pair Tubes	≥60 dscf	Single Point Monitoring Continuous Emission Monitoring		Single Point Integrated [h]		≥60 dscf		
- Total Number of Samples Collected	4 Tube Pairs Collected/ 3 Analyzed Per Test; 6 Tests	6	6	6	6	6	6	6	6
- Site Blanks	1 Set [d]	1	0	0	0	1	1	0	0
- Trip Blanks [c]	1	0	0	0	0	0	0	0	0
- Lab Blanks	1	1	0	0	0	0	1	0	0
- Blank Spikes	1	1	0	0	0	0	1	0	0
- Number of Sample Replicates	0	0	0	0	0	0	3	0	0
- Number of Matrix Spikes	All Samples [e]	0	0	0	0	0	1	0	0
- Total Number of Samples Analyzed	21	9	6	6	6	7	13	6	6

NOTES:
[a] Detailed description of sampling and analysis procedures are presented in Section 6 and Appendix F.
[b] An aliquot of the combined impingers one and two will be removed for HCl determination by mercuric nitrate titration (EPA 300.0).
[c] Trip blanks run only if contamination problems found.
[d] Set includes Tenax/Tenax-charcoal tube pair and HPLC water.
[e] All samples spiked with Contractor Laboratory Program (CLP) Volatile Organic Analysis (VOA) surrogates.
[f] Triplicate tests will be performed for each of two process operating conditions.
[g] Process CEM system to be utilized.
[h] Each integrated bag sample will be analyzed in triplicate.
[i] Metals include antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, silver, and thallium.

204-1048f

TABLE 6-5 SAMPLING AND ANALYSIS PLAN FOR STACK GASES

Table 6-6

Sampling Equipment

Stream	Sampling Equipment
Organic liquid/aqueous waste	Composite liquid waste sampler (Coliwasa) and glass volatile organic analysis (VOA) bottle with Teflon-lined lid.
Molten glass	Glass rod and wide-mouth borosilicate bottle with Teflon-lined lid.
Filter sludge	Teflon scoop and wide-mouth glass bottle with Teflon-lined lid.
Scrubber blowdown	Wide-mouth glass bottle with Teflon-lined lid.
Scrubber discharge	EPA Method 5 sampling train; volatile organic sampling train (VOST); multi-metals sampling train; EPA Methods 3, 3A, and 10 sampling trains.

A glass rod will be used to collect the sample from the molten glass. The rod will be inserted into the highly viscous molten glass pool through one of the side ports. The rod will be rotated a few times so that a glass glob is formed around the sampler. The sample will be taken out and quenched immediately in deionized water. The sample will be secured in a wide-mouth Teflon bottle.

6.4.2 Sludge

A grab sample will be collected from the filter sludge after each test. Samples will be collected using a Teflon spoon and secured in a wide-mouth glass bottle with Teflon-lined lid.

6.4.3 Liquids

The following liquid samples will be collected during the trial burn.

- Liquid/aqueous waste
- Scrubber blowdown liquid

Liquid/Aqueous Waste

Using the composite liquid waste sampler (Coliwasa) technique, a grab sample will be collected from each drum of waste introduced into the feed system.

The Coliwasa is a device employed to sample free-flowing liquids and slurries contained in drums, shallow open-top tanks, pits, and similar containers. It consists of a glass, plastic, or metal tube equipped with an end closure that can be opened and closed while the tube is submerged in the material to be sampled (see Figure 6-2). Due to the characteristics of the expected waste, Coliwasa construction will be restricted to glass or Teflon.

Coliwasas will be obtained commercially (NASCO) or will be fabricated to conform to the specifications detailed in Figure 6-2.

The sequence of steps for collecting a sample using a Coliwasa are as follows:

1. Clean Coliwasa.

2. Adjust sampler's locking mechanism to ensure that the stopper provides a tight closure. Open sampler by placing stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

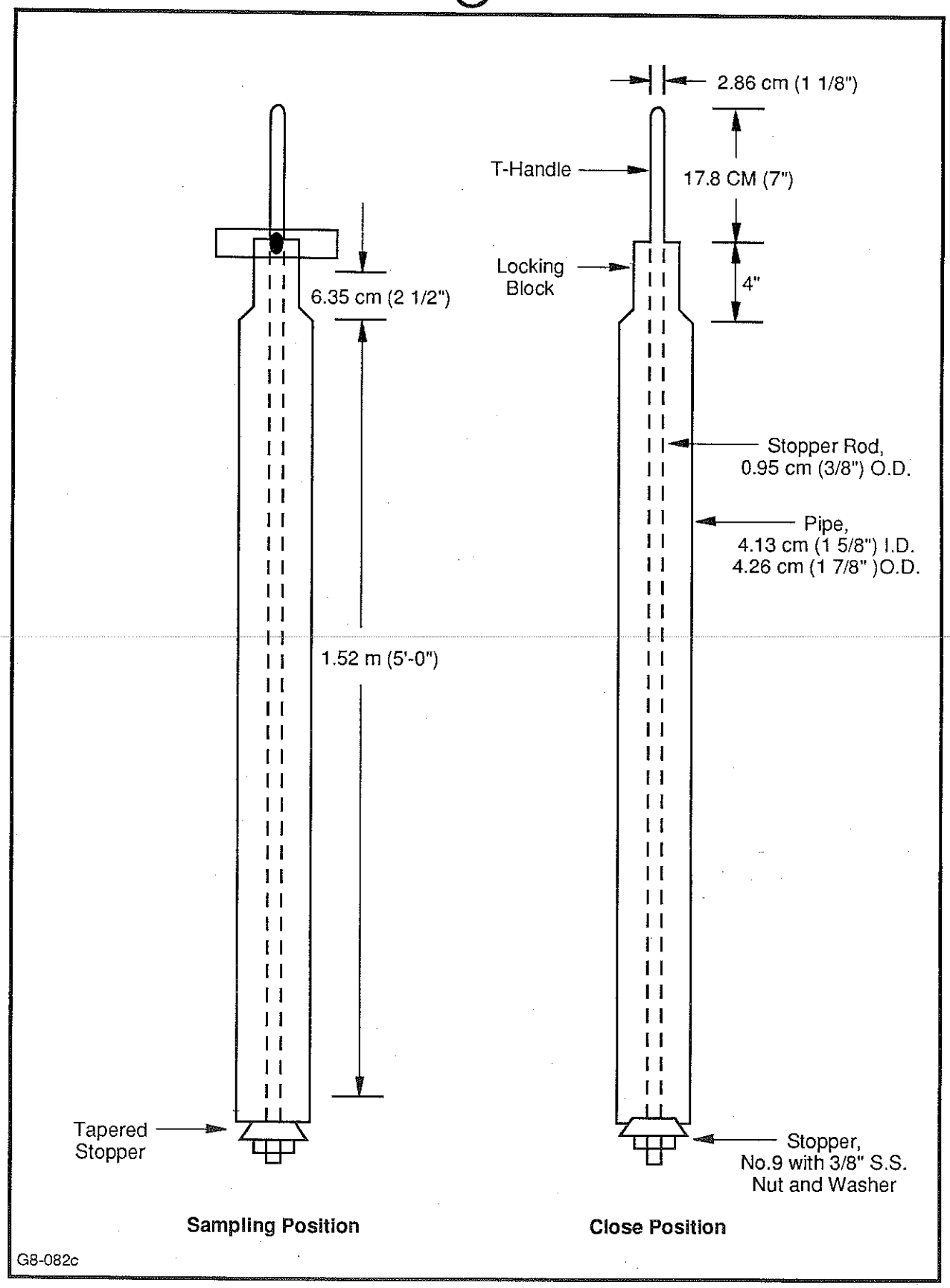


FIGURE 6-2 COMPOSITE LIQUID WASTE SAMPLER (COLIWASA)

3. Slowly lower the sampler into the waste at a rate that permits the level of liquid inside and outside the sampler to remain the same. If the level of waste in the sampler tube is lower inside than outside, the sampling rate is too fast and will produce a nonrepresentative sample.

4. When the sampler hits the bottom of the waste container, push sampler tube down to close and lock the stopper by turning the T-handle until it is upright and one end rests on the locking block.

5. Withdraw Coliwasa from waste and wipe the outside with a disposable cloth or rag.

Collected sample will then be poured into appropriate sample bottles.

Scrubber Blowdown Liquid

One grab sample of scrubber blowdown liquid will be collected after each test run. The scrubber liquid will be replaced with fresh solution following each test run.

6.4.4 Gases

The following sampling methods will be employed to monitor stack exhaust gas conditions.

Parameter	Sampling Method
Particulates, HCl, volumetric flow rate, moisture content	EPA Method 5 sampling train
Volatile organic compounds	Volatile organic sampling train (VOST) (Per SW 846 Method 0030)
Metals	Multi-metals sampling train per Draft EMSL Method
Gaseous constituents (O_2, CO, and CO_2)	Continuous emissions monitoring (CEM) system for O_2 and CO employing EPA Methods 3A and 10, respectively; integrated bag sampling train for CO_2 employing EPA Method 3

A description of each of these methods is described in the following subsections.

6.4.4.1 Method 5 Sampling Train

One Method 5 sampling train will be used to collect stack samples for analysis of the following parameters:

- Particulates
- HCl
- Volumetric flow rate
- Moisture content

The standard Method 5 test train will consist of the following components:

- A 316 stainless steel nozzle with an inside diameter sized to sample isokinetically.
- A heated, borosilicate-lined probe, 2 to 3 feet long, equipped with a thermocouple to measure flue gas temperature, and an S-type pitot tube to measure flue gas velocity pressure.
- A heated oven containing a borosilicate filter holder with a 90-mm quartz fiber filter.
- An impinger train comprised of four impingers containing: (1) 100 ml HPLC water; (2) 100 ml HPLC water; (3) dry; (4) 300-gm silica gel.
- A vacuum hose to connect the outlet of the impinger train to the control module.
- A control module containing a 3 cfm carbon vane vacuum pump (sample gas mover); a calibrated dry gas meter (sample gas volume measurement device); a calibrated orifice (sample gas flow rate monitor); and inclined manometers (orifice and gas stream pressure indicators).
- A switchable calibrated digital pyrometer to monitor flue and sample gas temperatures.

6.4.4.2 Volatile Organic Sampling Train (VOST)

The volatile POHCs and products of incomplete combustion (PICs) in the stack gas emission stream will be determined using the VOST methodology. The sampling train will consist of the following components connected in series:

- A heated Teflon or glass probe containing a glass wool (plug) particulate filter.

- The probe is connected to an ice-water-cooled condenser followed by a temperature sensor, an adsorption cartridge containing 1.6 grams of Tenax-GC, and a condensate trap.

- A section of Teflon tubing to connect the outlet of the condensate trap to a second condenser, which is followed by a backup sorbent trap containing 1 gram of Tenax-GC and 1 gram of activated charcoal, a second condensate collector, and a tube containing silica gel.

- The tube of silica gel is connected via an umbilical cord to a control console containing flow controllers, a calibrated 1 liter per revolution dry gas meter, a sample pump, temperature indicators, and other components.

6.4.4.3 Multi-Metals Sampling Train

The multi-metals sampling train used to measure the target metals and to determine the volumetric flow rate and moisture content of the scrubber emission stream will consist of the following components:

- A borosilicate nozzle with an inside diameter sized to sample isokinetically.

- A heated borosilicate-lined probe, 2 to 3 feet long, equipped with a thermocouple to measure the gas temperature, and an s-type pitot tube to measure the gas velocity pressure.

- A heated oven containing a borosilicate filter holder with a 90-mm quartz fiber filter set on a Teflon support pad.

- An impinger train containing six impingers: (1) dry; (2) 100 ml 5 percent HNO_3/10 percent H_2O_2; (3) 100 ml 5 percent HNO_3/10 percent H_2O_2; (4) 100 ml 4 percent $KMnO_4$/10 percent H_2SO_4; (5) 100 ml 4 percent $KMnO_4$/10 percent H_2SO_4; (6) 300-grams silica gel plus a thermocouple to measure sample gas exit temperature.

- A vacuum hose to connect the outlet of the impinger train to a control module.

- A control module containing a 3 cfm carbon vane vacuum pump (sample gas mover); a calibrated dry gas meter

(sample gas volume measurement device); a calibrated orifice (sample gas flow rate monitor); and inclined manometers (orifice and gas stream pressure indicators).

- A switchable calibrated digital pyrometer to monitor flue and sample gas temperatures.

6.4.4.4 Continuous Emissions Monitoring (CEM) System

The process CEM system will be used to monitor carbon monoxide and oxygen constituents employing EPA Methods 10 and 3A, respectively.

Carbon monoxide is monitored continuously using a sample gas extraction system coupled to a Beckman Model 865 non-dispersive infrared (NDIR) analyzer as specified in EPA Method 10 (CFR 40, Chapter I, App. A). The Beckman instrument has range options of 0 to 100 parts per million (ppm) and 0 to 1,000 ppm. The analyzer's 0 to 1,000 ppm range is equipped with a linearizer circuit board to provide linear concentration readouts to the meter and to a Digistrip III data logger. A gas conditioning assembly is used to prepare the flue gas sample for the NDIR cell. A gas sample is drawn from the flue duct by way of a Lear Siegler probe assembly. This probe features an electrically heated filter chamber that is located adjacent to, but outside the mounting flange so that the filter can be easily maintained. Separate gas connections at the filter permit sample extraction, backflush, and calibration gas injection. The sample is next drawn through two heat exchanger coils in series that are immersed in solution maintained at just above freezing temperature. Moisture that condenses from the sample is caught in traps. Two additional filters remove remaining particle matter from the sample, and then a pump sends it through a rotameter and to the analyzer. Span gases of zero air, 400 ppm CO, and 1,000 ppm CO are routinely used to calibrate the analyzer. However, for the trial burn, zero air or nitrogen and, three upscale protocol/gas standards will be utilized to calibrate the CO analyzer in conformance with EPA method 10 requirements. For EPA Method 10, the minimum detectable concentration of CO has been determined to be 20 ppm in a range of 1 to 1,000 ppm. Collaborative tests have shown that this method can be executed with accuracies within ±10.1 mg CO/m^3.

A Teledyne Model 9700 oxygen analyzer will be used to continuously monitor O_2 in the exit gas stream. The analyzer employs a microfuel cell (electro-chemical transducer) to provide an electrical signal that is directly proportional to, and specific to, oxygen concentration in the gas adjacent to its sensing surface. The instrument is rated to have an accuracy of -1 percent to +1 percent of scale, over a range selection of 0 to

5 and 0 to 25 percent O_2. A sample conditioning system cleans and cools the gas sample for the analyzer. Sample gas is drawn into the system through a two-way selector valve. Cooling water is introduced through a spray nozzle. The sample gas and cooling water mixture then enters the pump. The discharge of the pump goes through a mixer tube where the sample gas is thoroughly scrubbed. The mixer tube empties into a separator, with the water going to a drain and the sample gas (via a filter condensate trap) to the oxygen analyzer. During the trial burn, zero air or nitrogen and two or three upscale protocol/gas standards will be utilized to calibrate the oxygen analyzer in conformance with EPA Method 3A requirements.

6.4.4.5 Gas Stream Composition Sampling Train

Carbon dioxide will be sampled in accordance with EPA Method 3. One train will be used to measure the concentration of fixed gases during each sampling period (i.e., 2 hours). The unheated stainless steel or Teflon gas sampling probe will be strapped alongside the multi-metals probe. The Method 3 sampling train will consist of the following components:

- A stainless steel or Teflon probe.
- An air- or water-cooled condenser to remove moisture from the sampled gases.
- A Teflon-coated diaphragm pump to draw a sample of the gases.
- A Tedlar bag to contain the sample of flue gases.

Carbon dioxide will be analyzed using Orsat techniques.

6.4.4.6 Volumetric Flow Rate Determination

The volumetric flow rate measurements will be obtained utilizing the procedures outlined in EPA Method 1A and EPA Method 5. The velocity measurements will be conducted at a single point in the duct.

6.4.4.7 Test Point Locations and Sample Train Positions

A schematic showing the positions of sampling trains is shown in Figure 6-3.

The distances between test trains and flow disturbances are provided in length (number of feet) and in duct diameters (corresponding to 6-inch inside diameter (ID) duct).

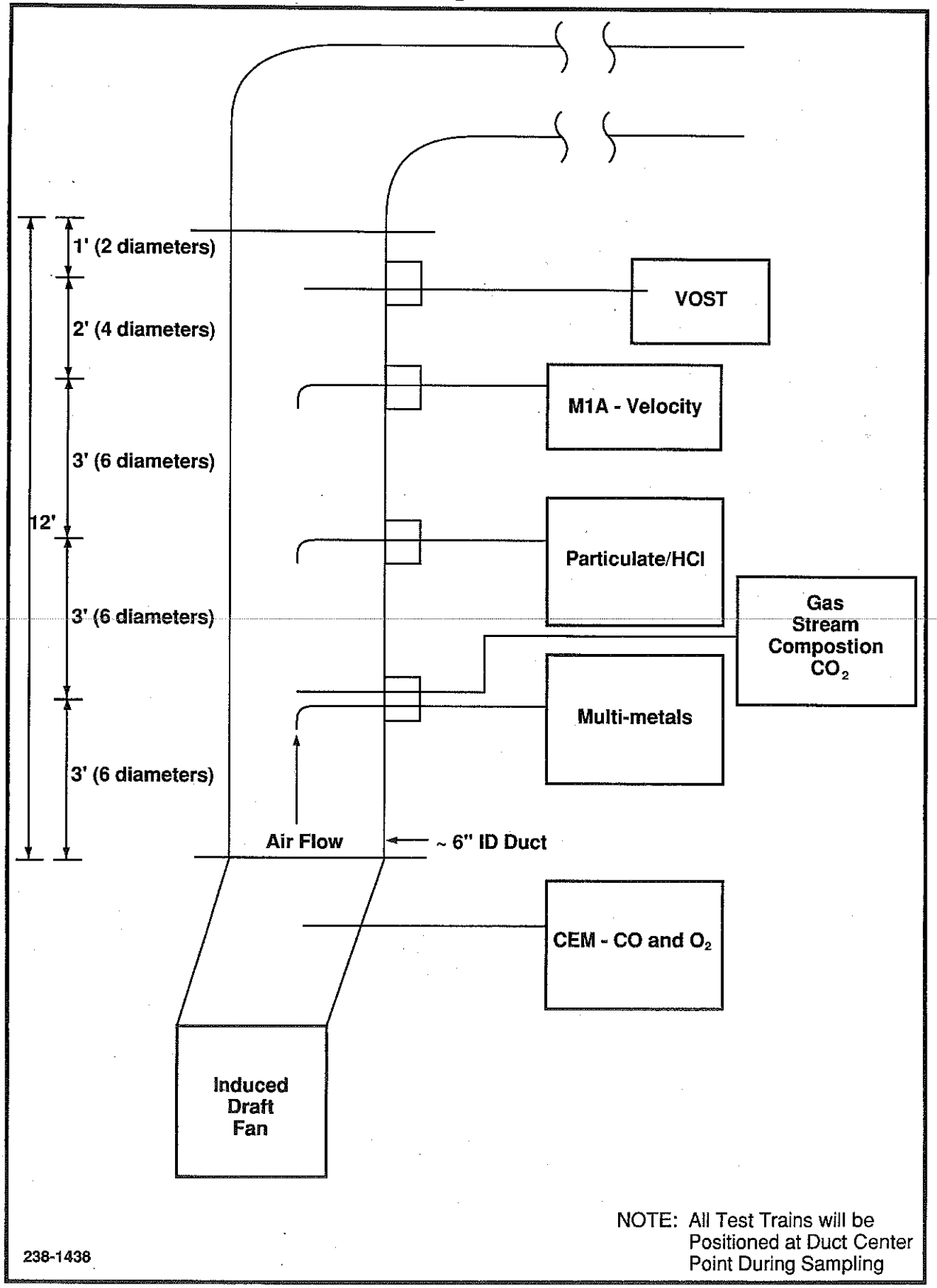


FIGURE 6-3 TEST POINT LOCATIONS AND SAMPLE TRAIN POSITIONS FOR STACK GASES

6.5 SAMPLING EQUIPMENT CALIBRATION

The following sampling equipment will be calibrated before and after field usage:

- Velocity measurement devices
- Gas volume metering equipment
- Gas flow rate metering systems
- Gas composition measuring apparatus (Orsat)

Acceptance limits for calibration for each equipment item are shown in Table 6-7. The calibration records will include device numbers, calibration dates, methods, data, and results, and will be maintained on file in workbooks at the WESTON offices. Copies of applicable calibration records will also be available at the job site.

Detailed sampling procedures for the different parameters are shown in Figures 6-4 through 6-6, as follows:

- EPA Method 5 - Particulates and HCl (Figure 6-4)
- VOST - Volatile organics (Figure 6-5)
- Multi-metals (Figure 6-6)

6.6 SAMPLE RECOVERY, STORAGE, AND PRESERVATION

All samples will be recovered at a field laboratory, located indoors next to the site, according to the EPA Reference Method procedures. Summaries of the recovery, storage, and preservation procedures are shown in Figures 6-7 through 6-9. Procedures are included for the following parameters:

- EPA Method 5 - Particulate and HCl (see Figure 6-7)
- VOST - Volatile organics (see Figure 6-8)
- Multi-metals (see Figure 6-9)

Note that no special recovery, storage, or preservation preparations are required for the Method 3 (CO_2) procedure other than ensuring that the gas sampling bag, train, and Orsat are leak-free; the Orsat contains fresh reagents; and the Orsat passes the performance check on an ambient air sample. A schematic diagram of sample recovery procedure for Method 3 is presented in Figure 6-10.

6.7 SAMPLE TRANSPORT AND CUSTODY

Chain-of-custody procedures document the history of samples and constitute a crucial part of sampling and analysis programs.

Table 6-7

Activity Matrix for Calibration of Equipment

Apparatus	Acceptance Limits	Frequency and Method of Measurement	Action If Requirements Are Not Met
Wet test meter	Capacity 3.4 cu m/hr (120 cu ft/hr); accuracy within ±1.0 percent.	Calibrate initially, and then yearly by liquid displacement.	Adjust until specifications are met, or return to manufacturer.
Dry gas meter	$Y_1 = \pm 0.02\ Y$	Calibrate versus wet test meter initially, and when post-test check exceeds $Y \pm 0.05\ Y$.	Repair or replace 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 percent of absolute temperature.	Calibrate each initially as a separate component against a mercury-in-glass thermometer; then before each field trip compare 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°C ±14°C (248°F ± 25°F) at a flow rate of 20 l/min (0.71 cu ft/min).	Calibrate component initially by APTD-0576 if constructed by APTD-0581, or use published calibration curves.	Repair or replace and then reverify the calibration.

* EPA 600/9-76-005, Quality Assurance Handbook for Air Pollution Measurement Systems - Volume III, U.S. EPA, Office of Research and Development, Environmental Monitoring and Support Laboratory, Research Triangle Park, North Carolina, January 1976, as revised.

Table 6-7
(continued)

Apparatus	Acceptance Limits	Frequency and Method of Measurement	Action if Requirements are not Met
Barometer	±2.5 mm (0.1 in.) Hg of mercury-in-glass barometer	Calibrate initially versus mercury-in-glass barometer; check before and after each field test.	Adjust to agree with a certified barometer.
Probe nozzle	Average of three I.D. 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.
S-type pitot tube and/or probe assembly	All dimension specifications met, or calibrate according to Subsection 3.1.2, and mount in an interference-free manner.	When purchased, use method in Subsections 3.1.1 and 3.1.2; visually inspect after each field test.	Do not use pitot tubes that do not meet face opening specifications; repair or replace as required.
Stack gas temperature measurement system	Capable of measuring within 1.5 percent of minimum absolute stack temperature.	When purchased and after each field test, calibrate against ASTM 63C or 63F thermometer.	Adjust to agree with Hg bulb thermometer, or construct a calibration curve to correct the readings.
Analytical balance	±1 mg of Class S weights.	Check with Class S weights upon receipt.	Adjust or repair.

Table 6-7
(continued)

Apparatus	Acceptance Limits	Frequency and Method of Measurement	Action if Requirements are not Met
Differential pressure gauge (does not include manometers)	Agree within ±5 percent of inclined manometers	Initially and after each field use.	Reject test results, or consult administrator if post-test calibration is out of specification.
Orsat analyzer	Average of three replicates should be 20.9 ±0.5 percent (absolute)or known concentration ±0.5 (absolute).	Upon receipt and before any test in which the analyzer has not been checked during the previous 3 months; determine percent O_2 in ambient air, or use a calibration gas with known CO, CO_2, and O_2 concentrations.	Check Orsat analyzer for leaking valves, for spent absorbing reagent, and/or operator techniques; take corrective action.
Rotameter or rate meter	Smooth curve of rotameter actual flow rates with no evidence of error.	Check with wet test meter or volume meter at 6-month intervals or at indication of erratic behavior.	Repeat calibration steps until limits are attained.

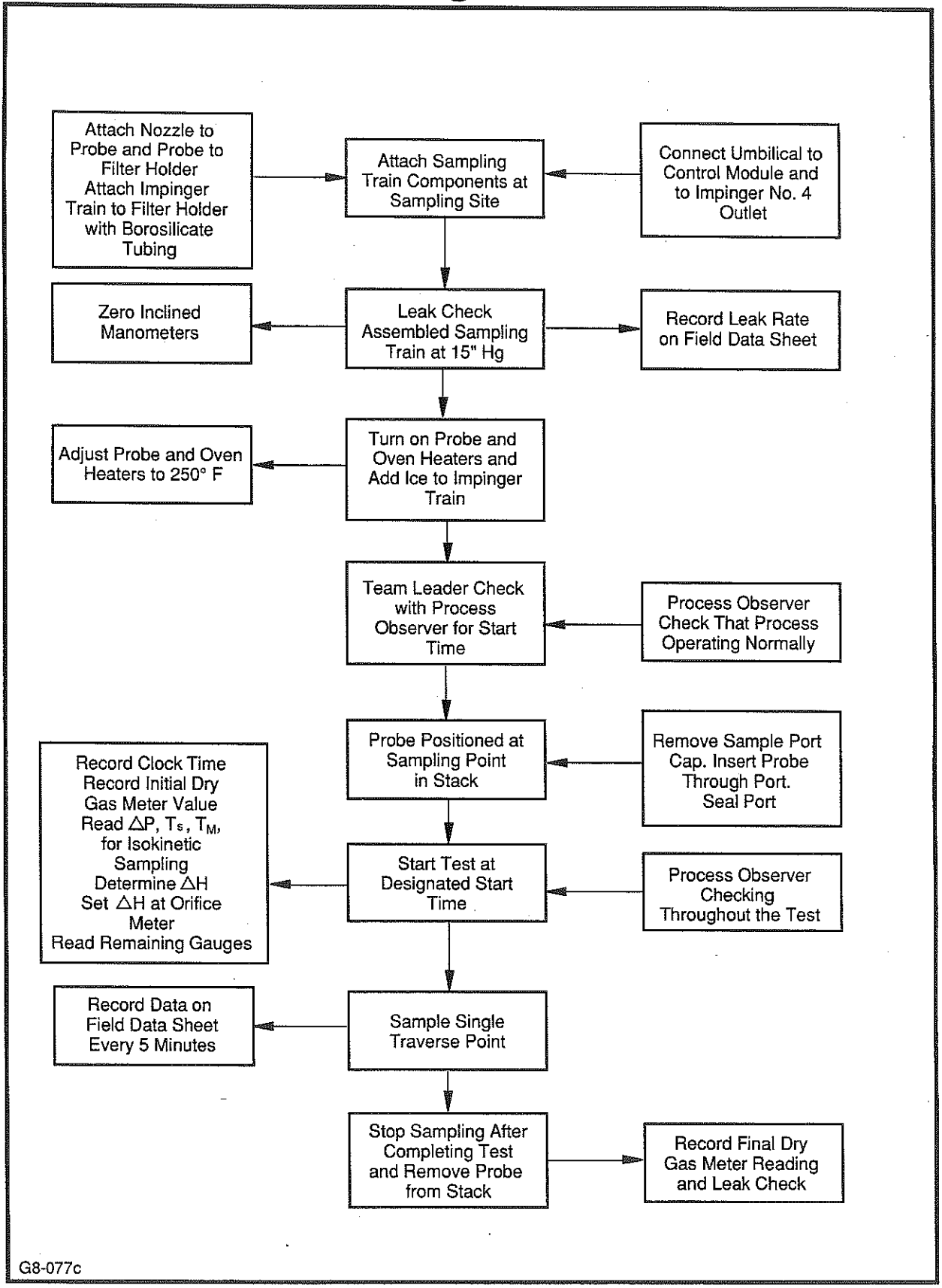


FIGURE 6-4 METHOD 5 SAMPLING PROCEDURES FOR PARTICULATE AND HCl

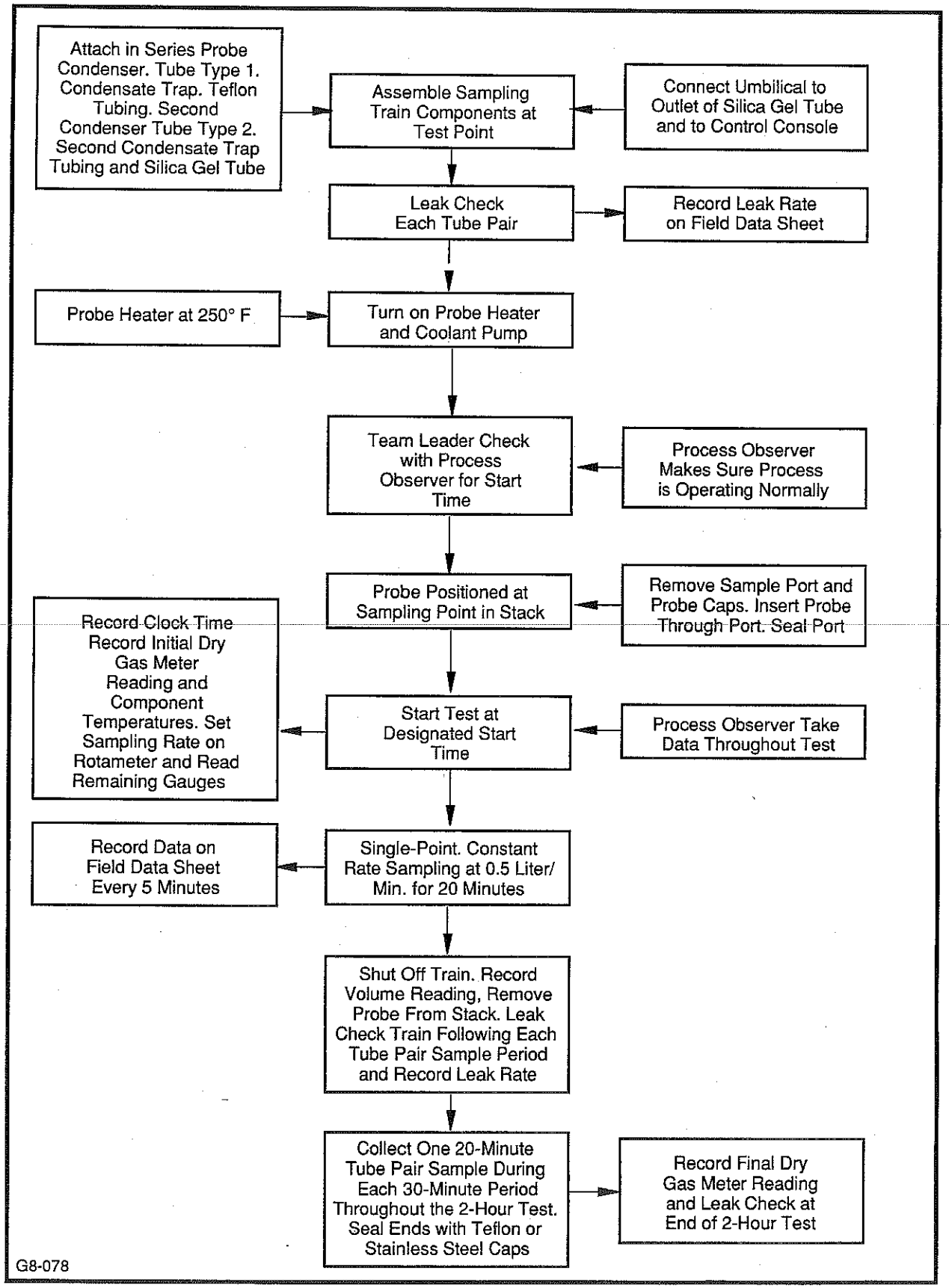


FIGURE 6-5 SAMPLING PROCEDURES FOR VOST

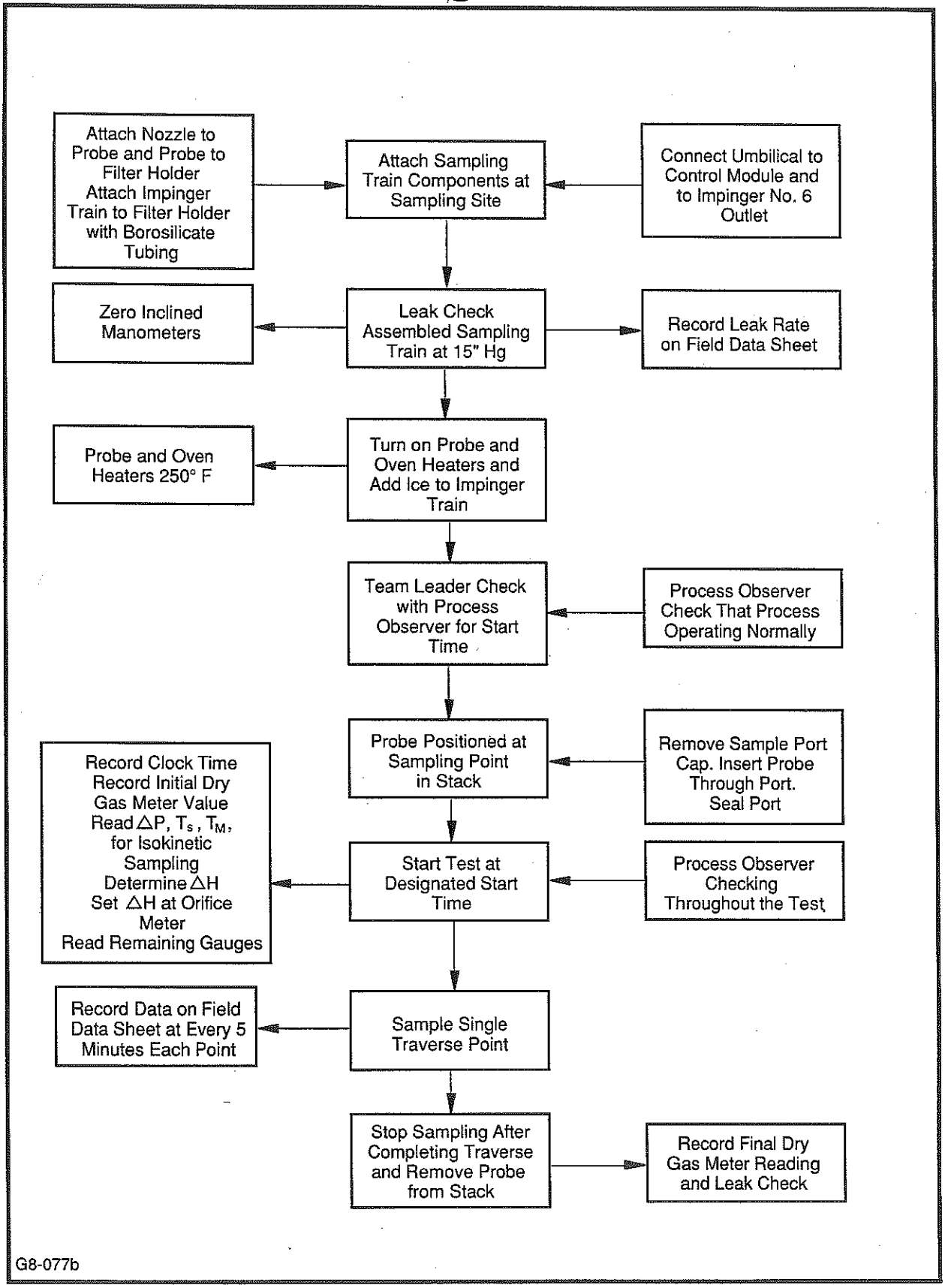


FIGURE 6-6 SAMPLING PROCEDURES FOR MULTI-METALS

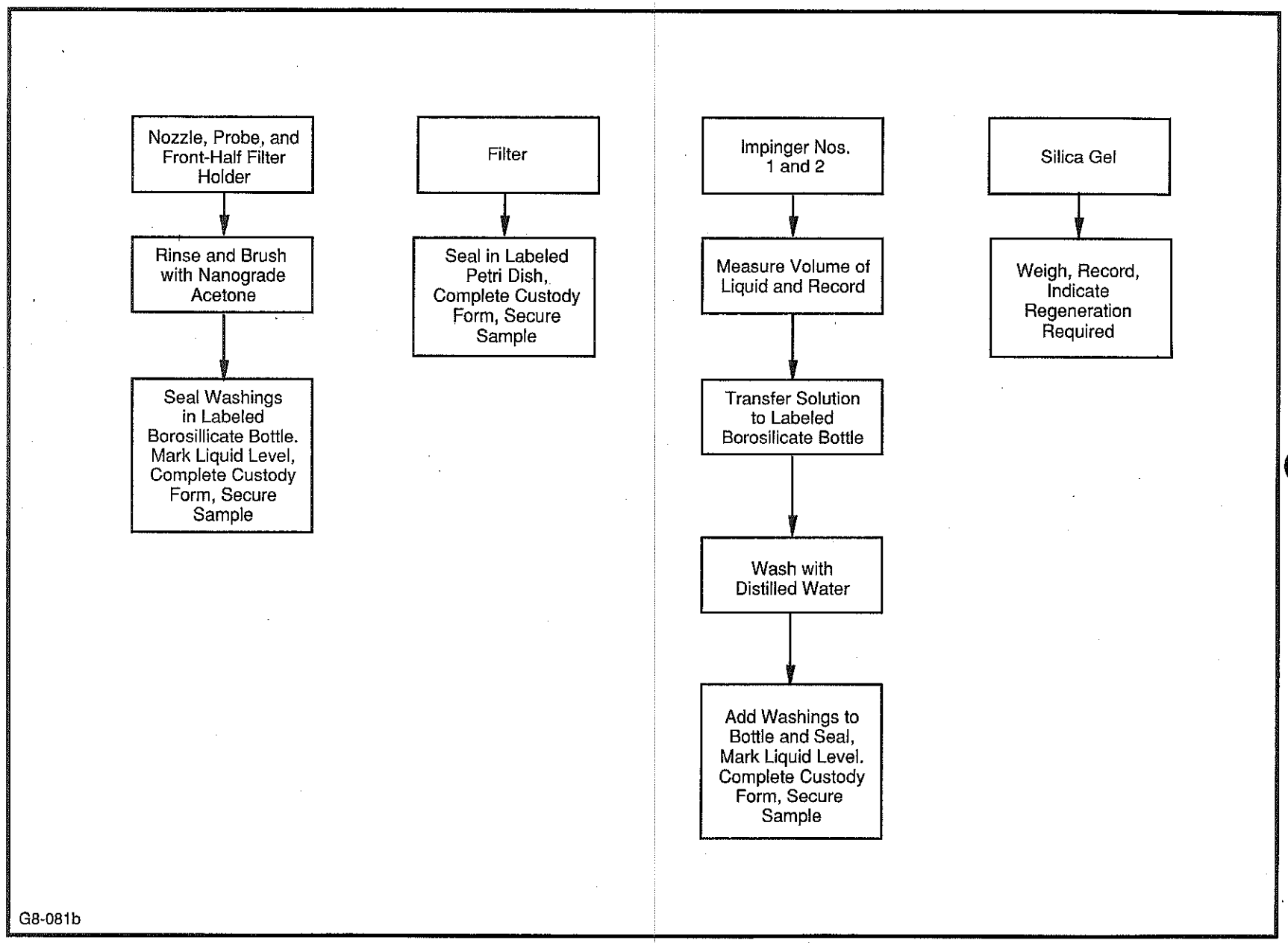
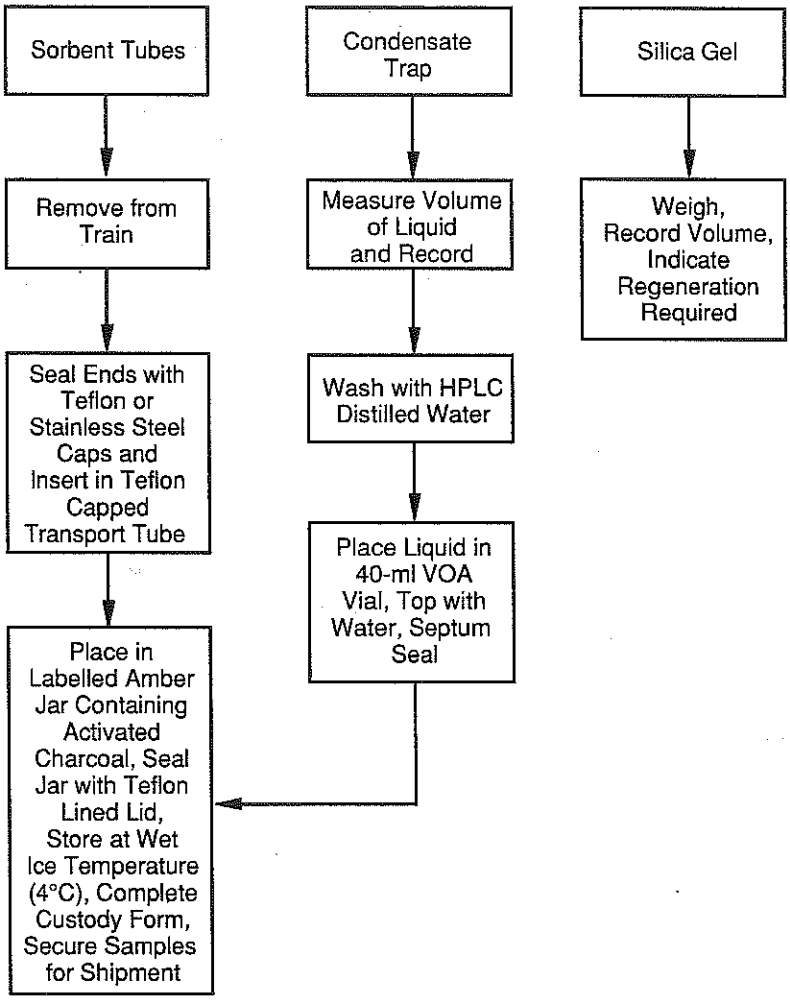


FIGURE 6-7 SAMPLE RECOVERY PROCEDURES FOR METHOD 5 - PARTICULATE AND HCL



G8-082b Key: HPLC- High Performance Liquid Chromatography

FIGURE 6-8 SAMPLE RECOVERY PROCEDURES FOR VOST

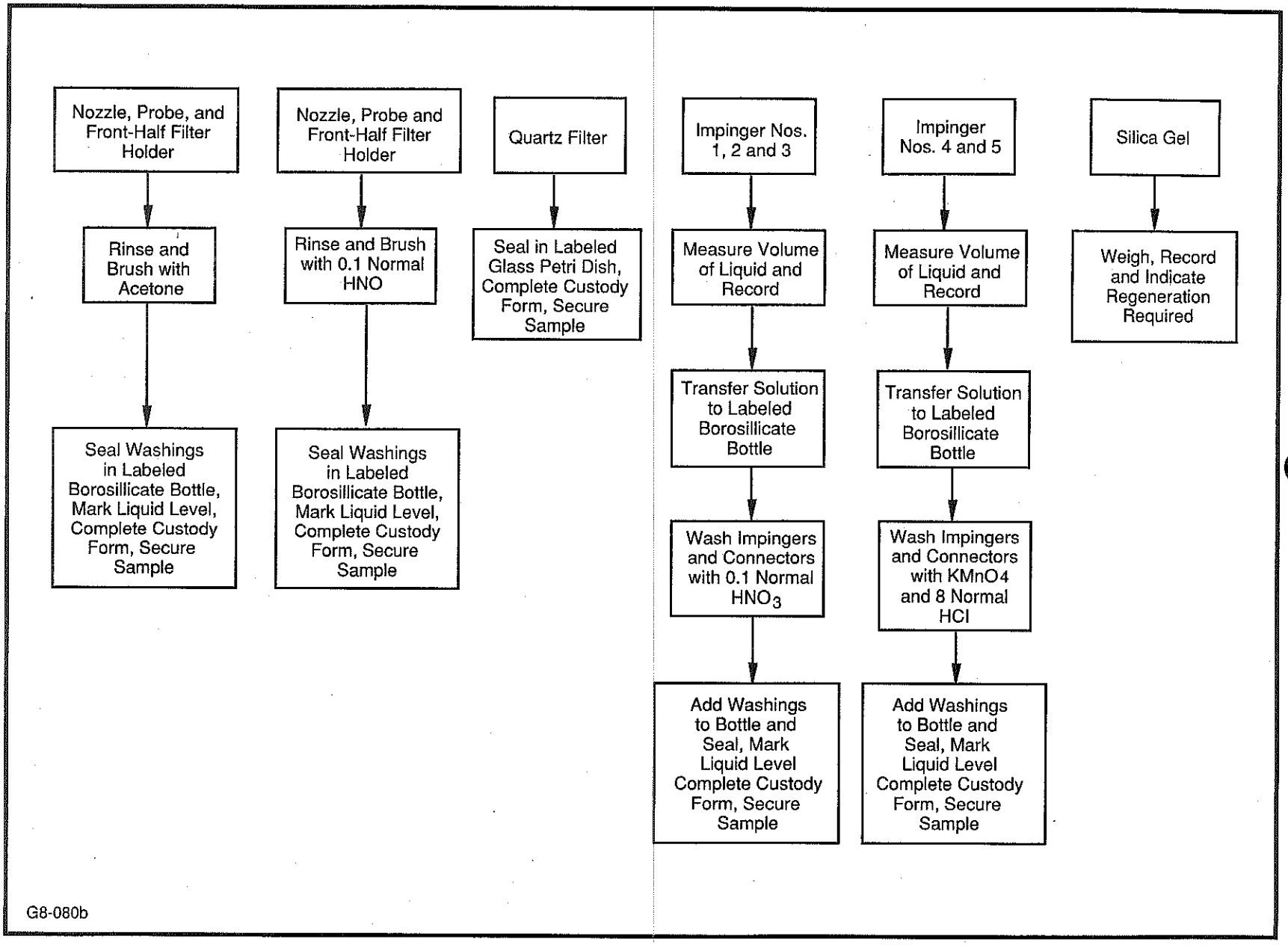


FIGURE 6-9 SAMPLE RECOVERY PROCEDURES FOR MULTI-METALS

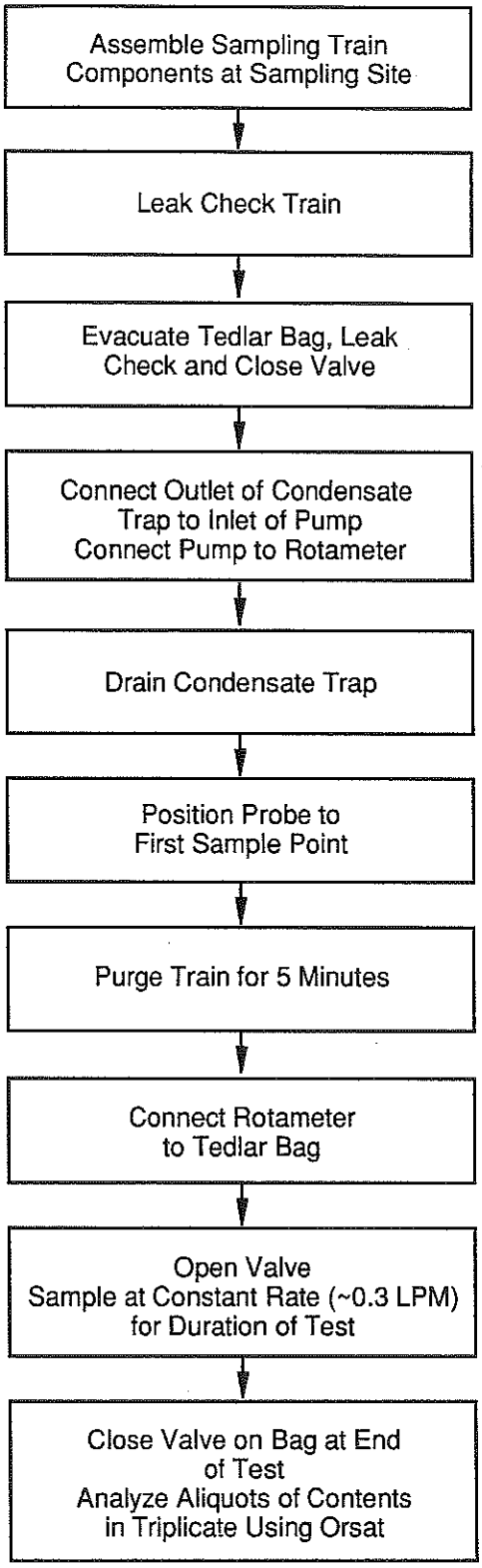


FIGURE 6-10 SAMPLE RECOVERY PROCEDURES FOR METHOD 3-CO_2

Chain-of-custody documentation assists and enables the identification and tracing of a sample from the time of collection through the time of analysis.

As samples are collected, entries will be made on the chain-of-custody forms. Data to be noted include:

- Date
- Samples
- Sample description
- Client/program
- Container and preservative
- Analyses required
- Special instructions/notes

Sample containers are also labelled with:

- Date
- Sample description
- Preservatives
- Analyses required
- Client/program

All volatile organics samples will be stored on ice at approximately 4°C. Process samples (sludge, molten glass, and liquids) will be stored separately from the stack samples to avoid cross contamination. When samples are received at the laboratory, the sample custodian will verify each and every sample against the chain-of-custody forms, note any discrepancies or losses of samples, and then sign for receipt of the samples. Samples will remain under the control of the sample custodian until samples are transferred to the analysts for processing. Analysts will acknowledge receipt of samples by signing the chain-of-custody forms.

6.8 SAMPLE COLLECTION AND ANALYSIS TURNAROUND TIME

A summary of sample holding times is provided in Table 6-8. The following information is also provided:

- Matrix (e.g., scrubber blowdown)
- Parameter (e.g., particulates)
- Maximum holding time between collection and analysis or extraction, as appropriate

6.9 ANALYTICAL PROCEDURES

Sample analyses for all parameters will be conducted at the WESTON laboratory located in Lionville, Pennsylvania. The WESTON laboratory is certified by several state agencies to

Table 6-8

Summary of Sample Holding Times

Matrix	Parameter											
	Volatile Organics	Metals (Except H_g)[a]	Particulates	HCl	Carbon Dioxide	Suspended Solids	pH	Total Chlorine	Sulfur Content	Percent Ash	Heating Value	Water Content
Organic Liquid/ Aqueous Waste	14 days	6 months	N.A.	N.A.	N.A.	N.A.	N.A.	28 days	N.A.[b]	7 days	N.A.	N.A.
Molten Glass	N.A.	6 months	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Filter Sludge	14 days	6 months	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Scrubber Blowdown	14 days	6 months	N.A.	N.A.	N.A.	7 days	Immedi- ately	28 days	N.A.	N.A.	N.A.	N.A.
Stack Gases	14 days	6 months	28 days	28 days	24 hours	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. - Not applicable
[a]Holding time for mercury is 28 days
[b]None published

perform a variety of analyses of air, water, wastewater, and soil samples.

6.9.1 Analytical Methods

A summary of the extraction and analytical methods is presented in Tables 6-1 through 6-5. Analytical methods for liquids and solids are presented in Appendix E, while the analytical methods for stack gases are presented in Appendix F.

6.9.2 Analytical Equipment

WESTON's analytical laboratory is equipped to perform environmental analyses. The three main instrumentation laboratories are:

- Organic Laboratory
- Inorganic Laboratory
- Gas chromatography/mass spectrometry (GC/MS) Laboratory

An inventory of analytical equipment available at the Lionville laboratory is shown in Table 6-9.

6.10 REAGENTS

Only those reagents that are specified in the preparation, sampling, recovery, or analytical methods will be used during the trial burn.

6.11 REAGENTS PREPARATION

All reagents used in the preparation, sampling, recovery, extraction, or analytical methods will be of nanograde quality (i.e., distilled in glass). The VOST sorbents will be prepared according to Method 0030 requirements.

6.12 CALIBRATION STANDARDS

The calibration standards will be those that are specified in the appropriate methods.

6.13 CALIBRATION PROCEDURES

The calibration procedures will be those that are specified in the appropriate methods.

6.14 SAMPLE METHOD BLANKS

The sample method blanks (i.e., laboratory blank, blank spikes, blank spike duplicates) that will be analyzed during the demonstration test program are those that are specified in Tables 6-1 through 6-5.

Table 6-9

WESTON Analytics
Inventory of Analytical Equipment
At Lionville Laboratory

Type	Quantity
High Pressure Liquid Chromatograph	2
Ion Chromatograph	1
Atomic Absorption Apparatus	3
Technicon Automatic Analyzer	1
Gas Chromatograph/Mass Spectrometer	11
Total Organic-Halide Analyzer	3
Inductively Coupled Plasma Apparatus	3
Chromatograph Integrators	2
Organic and Total Carbon Analyzers	2
Gas Chromatograph Detectors	25
Flame Ionization Detectors (5)	
Electron Capture Detectors (12)	
Hall Electrolytic Conductivity Detectors (2)	
Photoionization Detector (4)	
Flame Photometric Detector (1)	
Nitrogen Phosphorus Detector (1)	
Gas Chromatographs	25
Purge and Traps	5
Spectrophotometers	4
pH Instruments	4
Specific Ion Analyzer	1
Liquid Scintillation Counter	1

6.15 LABORATORY QUALITY CONTROL ACCEPTANCE CRITERIA

Summaries of the laboratory quality control acceptance criteria to be adhered to during the trial burn program are provided in Tables 6-10 through 6-12. A copy of the QA/QC plan is contained in Appendix G.

6.16 DATA REPORTING

A summary of the data to be obtained during the trial burn and to be presented in the final test report is included in Table 6-13.

6.17 AUDIT ANALYSIS

WESTON will analyze audit samples (i.e., VOST) provided by the State of Ohio EPA or the U.S. EPA during the trial burn program.

Table 6-10

Quality Assurance/Quality Control Requirements for Trial Burn

Analysis	Volatile Organics: VOST (Total ng)	Volatile Organics: 8240 (ug/L or ug/kg)	Metals (ug/L)	Chloride (mg/L)
Detection Limits[a]	25-50	5-10	0.2-50	0.5
Initial Cal. (% RSD)	≤30%	≤30%	≤30%	≤30%
Continuing Cal. (% RPD)	≤25%	≤25%	≤10%	≤10%
Precision (% RPD)	N/A	≤40%	≤20%	≤20%
Surrogate Recovery	50-150%	Table 6-11	N/A	N/A
Spike Recovery	N/A	Table 6-12	75-125%	75-125%
Completeness	90%	90%	90%	90%

[a]Refer to individual methods for analyte specific detection limits.

Cal. - Calibration
N/A - Not Applicable

RPD = Relative Percent Difference
RSD = Relative Standard Deviation

Table 6-11

Matrix Spike Recovery Limits - VOA

Fraction	Matrix Spike Compound	Water	Soil/Sediment
VOA	1,1-Dichloroethene	61-145%	59-172%
VOA	Trichlorethene	71-120%	62-137%
VOA	Chlorobenzene	75-130%	60-133%
VOA	Toluene	76-125%	59-139%
VOA	Benzene	76-127%	66-142%

Table 6-12

Contract Required Surrogate Spike Recovery Limits - VOA

Fraction	Surrogate Compound	Water	Low/Medium Soil
VOA	Toluene-d_8	88-110%	81-117%
VOA	4-Bromofluorobenzene	86-115%	74-121%
VOA	1,2-Dichloroethane-d_4	76-114%	70-121%

Table 6-13

Summary of Data to be Obtained During the Trial Burn and to be Presented in the Final Test Report

Item	Data Reported for Each Test Run	Reporting Units
Organic liquid/ aqueous waste	Volatile organics concentration and mass flow rate	ug/g;lb/hr
	Total chlorine concentration and mass flow rate	ug/g; lb/hr
	Heating value	Btu/lb
	Water content	percent by weight
	Ash	percent by weight
	Metals concentration and mass flow rate	ug/g; lb/hr
	Volumetric flow rate (liquid)	gpm
	Total sulfur concentration and mass flow rate	ug/g; lb/hr
Molten glass	Metals concentration	ug/L
Filter sludge	Volatile organics concentration	ug/g
	Metals concentration	ug/L
Scrubber blowdown	Volatile organics concentration	ug/L
	Suspended solids	percent by weight
	pH	
	Total chlorine concentration	ug/g
	Metals concentration	ug/L
Stack gas	Average particulate concentration	grains (gr)/wscf; gr/dscf @ 7% O_2
	Particulate mass emission rate	lb/hr

Table 6-13
(continued)

Item	Data Reported for Each Test Run	Reporting Units
	HCl concentration	ppm by volume
	HCl mass emission rate	lb/hr
	Volatile organics concentration	lb/dscf; ppb/volume
	Volatile organics mass flow rate	lb/hr
	Carbon dioxide concentration (dry basis)	percent by volume
	Oxygen concentration (dry basis)	percent by volume
	Carbon monoxide concentration (dry basis)	ppm by volume
	Metals concentrations	g/dscf; lb/dscf
	Metals mass emission rate	lb/hr
	Moisture content	percent by volume
	Molecular weight of dry gas	lb/lb-mol
	Molecular weight of wet gas	lb/lb-mol
	Static pressure	in. H_2O; in. Hg
	Absolute pressure	in. Hg
	Average temperature	°F; °R
	Average gas stream velocity	ft/sec
	Sectional area	sq ft
	Average gas stream volumetric flow rate	wscf/min;dscf/min
Stack sampling data	Sampling duration	minutes
	Nozzle diameter	inches
	Cross-sectional area of nozzle	sq ft
	Barometric pressure	in. Hg
	Average orifice pressure differential	in. H_2O
	Average dry gas meter temperature	°F

Table 6-13
(continued)

Item	Data Reported for Each Test Run	Reporting Units
	Average absolute dry gas meter temperature	°R
	Total liquid collected by train	ml
	Standard volume of water vapor collected	cu ft
	Sample volume at meter conditions	cu ft
	Sample volume at standard conditions	dscf
	Particulate front-half wash residue catch fraction	grams
	Particulate filter catch fraction	grams
	Total particulate catch weight	grams
System Performance Characteristics	Total mass of POHCs in the feed	lb/hr
	Total mass of POHCs in exhaust emissions	lb/hr
	DRE	percent
	HCl removal efficiency	percent

SECTION 7

TRIAL BURN SCHEDULE

The trial burn program will be conducted in two scenarios, each consisting of three tests. A summary of each scenario is presented in Subsection 4.2.

7.1 OVERALL SCHEDULE

The tentative overall schedule of the trial burn program is presented in Figure 7-1. The schedule shows the number of days instead of the dates, since the actual operating schedule is not known at this time. It is anticipated that one test per day will be conducted. Up to two (2) tests per day will be conducted, however, time permitting.

7.2 TYPICAL DAILY SCHEDULE

A breakdown of the schedule for typical activities on the days when trial burn tests are conducted is shown in Figure 7-2. A typical test will consist of a minimum of 4 hours of steady-state operation.

7.3 QUANTITY OF WASTE

Based on a 4-hour test duration, the quantity of waste required for each test will be 280 pounds, as follows.

$$\text{Waste required per test} = 70 \frac{\text{lb}}{\text{hr}} \times 4 \frac{\text{hr}}{\text{test}} = 280 \text{ lb}$$

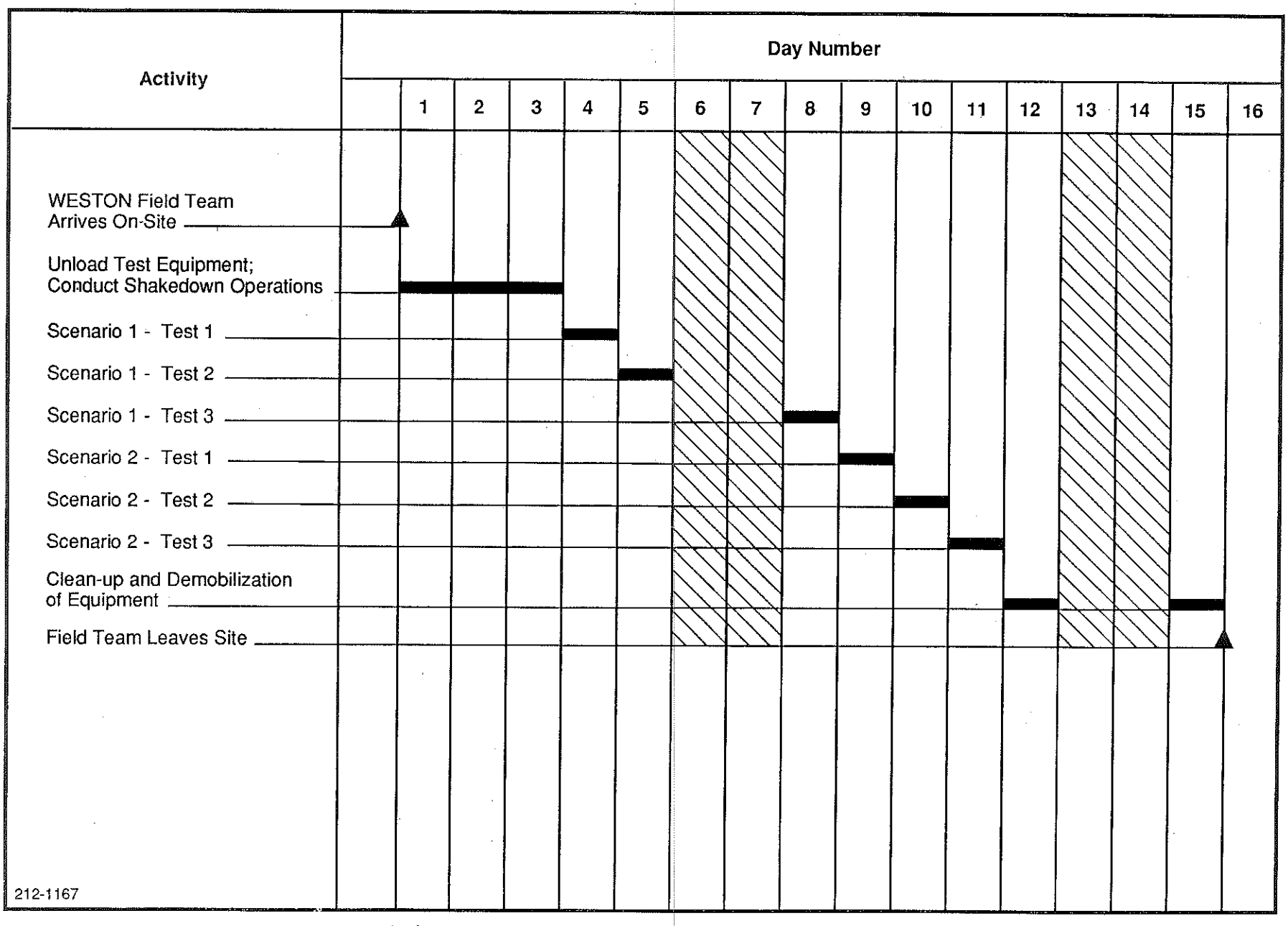


FIGURE 7-1 TENTATIVE OVERALL TRIAL BURN SCHEDULE

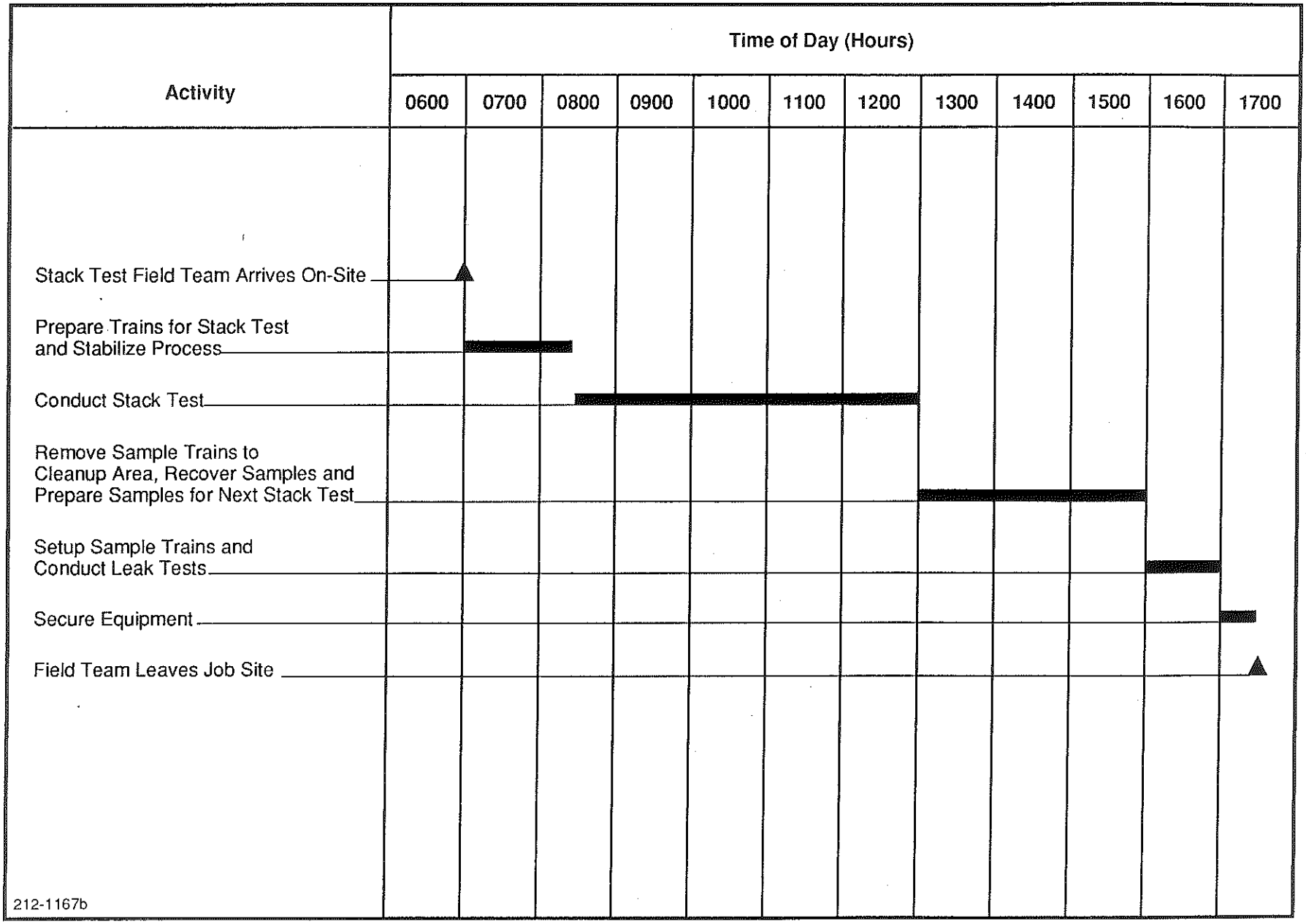


FIGURE 7-2 TYPICAL SCHEDULE OF DAILY ON-SITE ACTIVITIES DURING TRIAL BURN PROGRAM

SECTION 8

TRIAL BURN PROTOCOL

8.1 WASTE TYPES

The typical waste types that the facility is expected to treat on a regular basis are summarized in Appendix C. However, during the trial burn, synthetic waste streams will be designed to simulate typical waste characteristics and their heating values.

Two scenarios will be evaluated: 1) liquid waste with a high-heating value; and 2) aqueous waste with a low-heating value. The synthetic waste compositions for each scenario are presented in Tables 4-1 and 4-2.

8.2 TEMPERATURE RANGES

After the steady-state conditions have been reached, the molten glass furnace temperature will be maintained between 1700°F and 2450°F.

8.3 WASTE FEED RATES

Waste feed rate was designed to simulate maximum heat input conditions during full-scale operation. Based on the designed synthetic waste feeds, a waste feed rate of 70 lb/hr will be employed during the trial burn.

8.4 COMBUSTION GAS VELOCITY

Combustion gas velocity will be a function of the thermal content of the waste being processed. Sufficient air will be admitted to the furnace to ensure that chamber oxygen content is not less than 7 percent as measured by the process oxygen monitor at the stack. The maximum velocity will be 50 feet/second (fps) as measured by flow meters in the stack. Since no dilution air is being admitted downstream of the furnace, this will be an indicator of combustion gas velocity when adjusted for furnace conditions.

8.5 STACK FLOW PARAMETERS

The maximum stack flow parameters are as follows:

Maximum Stack Temperature	205°F
Maximum Stack Gas Velocity	50 fps
Maximum Flow Rate	600 acfm

8.6 USE OF AUXILIARY FUEL

Auxiliary fuel will be used during start up of the system. During cold startup, glass melting is initiated by means of a 400,000 Btu/hr, propane fired burner. As glass melts, it becomes conductive. The energy requirements for continuing the state change, raising, and then maintaining the bed temperature can gradually be assumed by electric current. The auxiliary fuel system will not be used once the glass is in a molten state.

SECTION 9

OPERATING CONDITIONS FOR EMISSION CONTROL EQUIPMENT

Process operating emission parameters that will be maintained during the trial burn program are presented in Table 9-1.

Table 9-1

Operating Conditions for Emission Control Equipment

Parameter	Anticipated Value	Control Limits	Required Value
Combustion air flow rate (scfm)	175	NA	NA
Residence time (sec)	1.6	1.0-2.0	NA
Stack gas oxygen (percentage dry volume)	7.0	12.0	NA
Stack gas carbon monoxide (ppm)	0	100	100
Combustion efficiency (percentage)	99.95	99.90	99.9

NA = Not applicable

SECTION 10

SHUTDOWN PROCEDURES

10.1 THE AUTOMATIC WASTE FEED CUTOFF SYSTEM

All critical process data, including system pressures, temperatures, and analyzer information, are fed to a Kaye Instrument Digistrip III Recorder Data Logger for monitoring and recording. Alarm set points (high, low, and rate of change) can be programmed independently for each input channel. Waste feed cutoff will be initiated automatically when selected measurements fall outside prescribed ranges. For liquid feed operations, Digistrip relays will interact with the waste feed system, tripping the system shutoff valve when selected results are outside specified limits.

The warning and shutdown parameters of the automatic waste feed cutoff system are presented in Table 10-1.

Table 10-1

Limits of Automatic Waste Feed System Parameters

Parameter	Warning	Warning and Feed Shutdown
High CO	50 ppm peak	100 ppm peak 100 ppm 1-hour rolling average (or equivalent)
Low furnace chamber: draft		0.25 in. water column
High furnace chamber: draft		6.00 in. water column
High furnace chamber temperature (Feed end thermocouple)	2,400°F	2,500°F
Low furnace chamber temperature (Off-gas end thermocouple)		1,500°F
High furnace chamber temperature (Off-gas end thermocouple)		2,500°F
Low scrubber pH	7.5	7.0
Low venturi differential pressure		25 in. water column
High venturi differential pressure		55 in. water column
High offgas temperature (After spray tank)	200°F	205°F
High offgas temperature (After venturi)	190°F	205°F
High scrubber liquid feed flow		0.4 gal/minute
Low scrubber liquid feed flow		0.03 gal/minute
Low flue gas velocity		100 feet/minute (1.7 feet/second)
High flue gas velocity		50 feet/second

0172L

SECTION 11

REFERENCES

1. "Guidance Manual for Hazardous Waste Incinerator Permits", U.S. EPA Office of Solid Waste, July 1983.

2. "Guidance on Setting Permit Conditions and Reporting Trial Burn Results; Volume II of the Hazardous Waste Incineration Guidance Series", U.S. EPA Office of Solid Waste and Emergency Response, January 1989.

3. "Guidance on Metals and Hydrogen Chloride Controls for Hazardous Waste Incinerators", Draft Final Report, U.S. EPA Office of Solid Waste, Waste Treatment Branch, September 1988

4. "Glass Furnace Project Final Report," L.M. Klingler and K.M. Armstrong, MLM-3229, February 1985.

5. "A Study of Tritium Waste Processing by Means of the Cyclone Incinerator," Draft Report, L.M. Klingler and K.M. Armstrong, 1988.

6. "Users Guide for AIRDOS-PC, Version 3.0," U.S. Environmental Protection Agency, EPA/520/6-89-035, December 1989.

7. Personal Communication with Barry Parks and Bill Phillips, U.S. EPA, confirming use of Pu-239 as surrogate for Pu-238 in AIRDOS-PC assessment, August 1990.

U.S. Department of Energy
Mound Plant
1 Mound Road
Miamisburg, Ohio 45343

Trial Burn Plan for a Glass Melt Furnace at the U.S. Department of Energy Mound Plant

Appendices

July 1990

Prepared By:
Roy F. Weston, Inc.
Weston Way
West Chester, Pennsylvania

Appendix A

Determination of Radionuclide Emissions

COMPUTER RUN FOR
SCENARIO 1 -
EXPECTED WASTE COMPOSITION

METEOROLOGICAL AND PLANT INFORMATION SUPPLIED TO PROGRAM----

AVERAGE VERTICAL TEMPERATURE GRADIENT OF THE AIR (DEG K/METER)

IN STABILITY CLASS E	0.0728
IN STABILITY CLASS F	0.1090
IN STABILITY CLASS G	0.1455

PLUME DEPLETION AND DEPOSITION PARAMETERS

NUCLIDE	GRAVITATIONAL FALL VELOCITY (METERS/SEC)	DEPOSITION VELOCITY (METERS/SEC)	SCAVENGING COEFFICIENT (1/SEC)	EFFECTIVE DECAY CONSTANT IN PLUME (PER DAY)
H-3	0.000	0.00000	0.000E+00	0.000E+00
PU-239	0.000	0.00180	0.100E-04	0.000E+00
TH-232	0.000	0.00180	0.100E-04	0.000E+00

FREQUENCY OF ATMOSPHERIC STABILITY CLASSES FOR EACH DIRECTION

SECTOR	FRACTION OF TIME IN EACH STABILITY CLASS						
	A	B	C	D	E	F	G
N	0.0000	0.0365	0.0807	0.6076	0.1295	0.1239	0.0218
NNW	0.0000	0.0566	0.0860	0.4061	0.2436	0.1671	0.0405
NW	0.0000	0.0963	0.1089	0.5333	0.1320	0.1295	0.0000
WNW	0.0000	0.1446	0.0889	0.4547	0.1893	0.1225	0.0000
W	0.0254	0.0848	0.1624	0.2610	0.1382	0.2905	0.0378
WSW	0.0550	0.1068	0.1334	0.2456	0.0855	0.2098	0.1639
SW	0.0168	0.0439	0.2591	0.4356	0.0524	0.1922	0.0000
SSW	0.0181	0.0746	0.1303	0.4613	0.1270	0.1484	0.0404
S	0.0000	0.0802	0.1312	0.4922	0.0874	0.1070	0.1020
SSE	0.0101	0.0771	0.0881	0.5936	0.1021	0.0991	0.0300
SE	0.0076	0.0455	0.0854	0.5754	0.1004	0.1178	0.0678
ESE	0.0000	0.0190	0.0731	0.6497	0.1066	0.0971	0.0544
E	0.0083	0.0489	0.0863	0.5765	0.0844	0.1398	0.0558
ENE	0.0068	0.0222	0.1511	0.5200	0.1428	0.1167	0.0404
NE	0.0044	0.0299	0.1068	0.5621	0.1731	0.0784	0.0454
NNE	0.0000	0.0207	0.0776	0.6752	0.1277	0.0759	0.0230

FREQUENCIES OF WIND DIRECTIONS AND RECIPROCAL-AVERAGED WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.090	0.00	2.12	3.98	4.69	3.34	1.94	0.77
NNW	0.032	0.00	1.37	3.79	3.65	3.13	2.31	0.77
NW	0.039	0.00	1.65	3.52	3.15	3.08	2.32	0.00
WNW	0.023	0.00	1.36	3.83	3.44	3.17	1.85	0.00
W	0.035	1.68	2.00	2.49	3.02	3.12	1.91	0.77
WSW	0.024	1.70	2.62	3.12	2.20	2.76	2.32	0.77
SW	0.026	1.68	0.97	2.17	3.44	2.87	2.32	0.00
SSW	0.049	1.68	2.23	2.95	4.47	2.98	2.10	0.77
S	0.071	0.00	1.77	2.85	4.27	3.44	2.32	0.77
SSE	0.044	1.68	1.62	2.31	3.72	3.60	2.31	0.77
SE	0.058	1.68	1.45	2.41	4.82	3.89	2.09	0.77
ESE	0.096	0.00	2.57	3.11	4.81	3.84	2.15	0.77
E	0.105	1.06	1.92	3.62	4.32	3.85	2.02	0.77
ENE	0.065	1.68	2.75	3.05	4.77	3.96	2.11	0.77
NE	0.101	1.68	1.31	3.98	4.71	3.39	2.31	0.77
NNE	0.142	0.00	2.54	4.35	5.71	3.61	2.31	0.77

FREQUENCIES OF WIND DIRECTIONS AND TRUE-AVERAGE WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.090	0.00	3.03	4.28	5.44	3.58	2.32	0.77
NNW	0.032	0.00	2.44	4.10	4.70	3.36	2.49	0.77
NW	0.039	0.00	2.41	4.25	4.43	3.29	2.49	0.00
WNW	0.023	0.00	2.04	4.43	4.22	3.40	2.27	0.00
W	0.035	2.16	2.87	3.77	3.36	3.34	2.30	0.77
WSW	0.024	2.18	3.18	3.66	3.58	2.87	2.49	0.77
SW	0.026	2.16	1.30	3.45	4.34	3.02	2.49	0.00
SSW	0.049	2.16	3.15	3.79	5.33	3.17	2.40	0.77
S	0.071	0.00	2.40	3.76	5.00	3.67	2.49	0.77
SSE	0.044	2.16	2.42	3.89	4.87	3.82	2.48	0.77
SE	0.058	2.16	2.17	4.05	5.57	4.05	2.40	0.77
ESE	0.096	0.00	3.12	4.37	5.92	4.01	2.42	0.77
E	0.105	1.47	2.80	4.15	5.68	4.03	2.36	0.77
ENE	0.065	2.16	3.32	4.32	5.84	4.11	2.40	0.77
NE	0.101	2.16	1.99	4.50	5.73	3.63	2.49	0.77
NNE	0.142	0.00	3.08	4.87	6.34	3.83	2.48	0.77

CLEAN AIR ACT COMPLIANCE REPORT
(Version 3.0 November 1989)

Facility: MOUND PLANT

Address: P, O. BOX 3000
MIAMISBURG , OH. 45343
Annual Assessment for Year: 1990
Date Submitted: 7/18/90

Comments: GLASS MELTER TRIAL BURN PLAN ANALYSIS

Prepared By:

Name:
Title:
Phone #: ( ) -

Prepared for:
U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

CLEAN AIR ACT COMPLIANCE REPORT 7/18/90 9:53 AM

Facility: MOUND PLANT
Address: P, O. BOX 3000 City: MIAMISBURG State: OH
Comments: GLASS MELTER TRIAL BURN PLAN ANALYSIS
Year: 1990

	Dose Equivalent Rates to Nearby Individuals (mrem/year)
Effective Dose Equivalent	0.1000
Highest Organ Dose is to ENDOSTEUM	0.1400

----------EMISSION INFORMATION----------

Radio-nuclide	Class	Amad	Stack #1 (Ci/y)
H-3	*	0.0	1.1E+02
PU-239	Y	1.0	1.5E-05
TH-232	Y	1.0	5.0E-06
Stack Height (m)			14.63
Stack Diameter (m)			1.22
Momentum (m/s)			5.7

----------SITE INFORMATION----------

Wind Data	DAY1502.WND	Temperature (C)	20
Food Source	LOCAL	Rainfall (cm/y)	100
Distance to Individuals (m)	470	Lid Height (m)	1000

*NOTE: The results of this computer model are dose estimates. They are only to be used for the purpose of determining compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.

ORGAN DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL

ORGAN	DOSE EQUIVALENT RATE TO THE ORGAN (mrem/y)
GONADS	9.0E-02
BREAST	8.9E-02
RED MARROW	9.4E-02
LUNGS	1.2E-01
THYROID	8.9E-02
ENDOSTEUM	1.4E-01
REMAINDER	1.2E-01
EFFECTIVE	1.0E-01

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY PATHWAY FOR ALL RADIONUCLIDES

	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE ENDOSTEUM (mrem/y)
INGESTION	8.3E-02	7.1E-02
INHALATION	1.9E-02	7.4E-02
AIR IMMERSION	1.2E-12	1.3E-12
GROUND SURFACE	1.6E-07	7.2E-08
TOTAL:	1.0E-01	1.4E-01

MOUND PLANT

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY RADIONUCLIDE FOR ALL PATHWAYS

RADIONUCLIDE	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE ENDOSTEUM (mrem/y)
H-3	9.5E-02	7.0E-02
PU-239	5.4E-03	5.9E-02
TH-232	1.7E-03	1.5E-02
TOTAL :	1.0E-01	1.4E-01

MOUND PLANT

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION
OF DISTANCE IN THE DIRECTIONS OF THE
MAXIMALLY EXPOSED INDIVIDUAL FOR
ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTION : NORTH-NORTHEAST

DISTANCE (meters)	EFFECTIVE DOSE EQUIVALENT (mrem/y)
470	1.0E-01
1000	4.2E-02
3000	9.0E-03
10000	1.9E-03
80000	1.7E-04

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS:	N	NNE	NE	ENE	E	ESE	SE	SSE
DISTANCE (METERS):								
470	7.2E-02	1.0E-01	8.4E-02	5.1E-02	8.5E-02	7.5E-02	4.6E-02	4.4E-02
1000	3.3E-02	4.2E-02	3.4E-02	2.2E-02	3.8E-02	3.2E-02	2.0E-02	1.7E-02
3000	7.6E-03	9.0E-03	7.3E-03	5.0E-03	9.0E-03	7.1E-03	4.5E-03	3.5E-03
10000	1.6E-03	1.9E-03	1.7E-03	1.2E-03	2.2E-03	1.8E-03	1.2E-03	7.6E-04
80000	1.5E-04	1.7E-04	1.7E-04	1.2E-04	2.3E-04	1.8E-04	1.3E-04	6.7E-05

	S	SSW	SW	WSW	W	WNW	NW	NNW
DISTANCE (METERS):								
470	5.8E-02	4.0E-02	2.8E-02	2.0E-02	2.9E-02	2.5E-02	4.2E-02	3.0E-02
1000	2.3E-02	1.8E-02	1.2E-02	9.7E-03	1.7E-02	1.1E-02	1.7E-02	1.4E-02
3000	5.3E-03	4.3E-03	2.6E-03	2.5E-03	4.6E-03	2.3E-03	3.7E-03	3.3E-03
10000	1.6E-03	9.9E-04	4.8E-04	8.2E-04	1.0E-03	4.4E-04	6.8E-04	7.5E-04
80000	1.8E-04	9.9E-05	3.9E-05	1.0E-04	1.0E-04	3.6E-05	5.2E-05	7.4E-05

MOUND PLANT

COMPUTER RUNS FOR SCENARIO 2 - INDIVIDUAL RADIONUCLIDES

0173L

40 CFR Part 61
National Emission Standards
for Hazardous Air Pollutants

CLEAN AIR ACT COMPLIANCE REPORT
(Version 3.0 November 1989)

Facility: MOUND PLANT

Address: P, O. BOX 3000
MIAMISBURG , OH. 45343
Annual Assessment for Year: 1990
Date Submitted: 7/18/90

Comments: GLASS MELTER TRIAL BURN PLAN ANALYSIS

Prepared By:

Name:
Title:
Phone #: ( ) -

Prepared for:
U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

Facility: MOUND PLANT
Address: P, O. BOX 3000 City: MIAMISBURG State: OH
Comments: GLASS MELTER TRIAL BURN PLAN ANALYSIS
Year: 1990

	Dose Equivalent Rates to Nearby Individuals (mrem/year)
Effective Dose Equivalent	0.1000
Highest Organ Dose is to REMAINDER	0.1200

----------EMISSION INFORMATION----------

Radio-nuclide	Class	Amad	Stack #1 (Ci/y)
H-3	*	0.0	1.1E+02
Stack Height (m)			14.63
Stack Diameter (m)			1.22
Momentum (m/s)			5.7

----------SITE INFORMATION----------

Wind Data	DAY1502.WND	Temperature (C)	20
Food Source	LOCAL	Rainfall (cm/y)	100
Distance to Individuals (m)	470	Lid Height (m)	1000

*NOTE: The results of this computer model are dose estimates. They are only to be used for the purpose of determining compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.

ORGAN DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL

ORGAN	DOSE EQUIVALENT RATE TO THE ORGAN (mrem/y)
GONADS	9.3E-02
BREAST	9.3E-02
RED MARROW	9.3E-02
LUNGS	9.4E-02
THYROID	9.3E-02
ENDOSTEUM	7.3E-02
REMAINDER	1.2E-01
EFFECTIVE	1.0E-01

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY PATHWAY FOR ALL RADIONUCLIDES

	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE REMAINDER (mrem/y)
INGESTION	8.6E-02	1.0E-01
INHALATION	1.4E-02	1.4E-02
AIR IMMERSION	0.0E-01	0.0E-01
GROUND SURFACE	0.0E-01	0.0E-01
TOTAL:	1.0E-01	1.2E-01

MOUND PLANT

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY RADIONUCLIDE FOR ALL PATHWAYS

RADIONUCLIDE	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE REMAINDER (mrem/y)
H-3	1.0E-01	1.2E-01
TOTAL :	1.0E-01	1.2E-01

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION
OF DISTANCE IN THE DIRECTIONS OF THE
MAXIMALLY EXPOSED INDIVIDUAL FOR
ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTION : NORTH-NORTHEAST

DISTANCE (meters)	EFFECTIVE DOSE EQUIVALENT (mrem/y)
470	1.0E-01
1000	4.1E-02
3000	8.8E-03
10000	1.9E-03
80000	1.8E-04

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION
OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL
RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS:	N	NNE	NE	ENE	E	ESE	SE	SSE
DISTANCE (METERS):								
470	7.0E-02	1.0E-01	8.2E-02	5.0E-02	8.3E-02	7.3E-02	4.5E-02	4.3E-02
1000	3.2E-02	4.1E-02	3.4E-02	2.2E-02	3.7E-02	3.1E-02	1.9E-02	1.7E-02
3000	7.4E-03	8.8E-03	7.1E-03	4.9E-03	8.8E-03	6.9E-03	4.4E-03	3.4E-03
10000	1.6E-03	1.9E-03	1.7E-03	1.2E-03	2.2E-03	1.7E-03	1.2E-03	7.4E-04
80000	1.5E-04	1.8E-04	1.8E-04	1.2E-04	2.3E-04	1.8E-04	1.3E-04	6.8E-05

	S	SSW	SW	WSW	W	WNW	NW	NNW
DISTANCE (METERS):								
470	5.6E-02	3.9E-02	2.7E-02	1.9E-02	2.8E-02	2.4E-02	4.1E-02	2.9E-02
1000	2.3E-02	1.8E-02	1.1E-02	9.4E-03	1.6E-02	1.0E-02	1.7E-02	1.4E-02
3000	5.2E-03	4.2E-03	2.5E-03	2.4E-03	4.4E-03	2.2E-03	3.6E-03	3.2E-03
10000	1.6E-03	9.7E-04	4.7E-04	8.1E-04	1.0E-03	4.3E-04	6.7E-04	7.3E-04
80000	1.9E-04	1.0E-04	4.0E-05	1.0E-04	1.1E-04	3.7E-05	5.3E-05	7.5E-05

MOUND PLANT

CLEAN AIR ACT COMPLIANCE REPORT
(Version 3.0 November 1989)

Facility: MOUND PLANT

Address: P, O. BOX 3000
MIAMISBURG , OH. 45343
Annual Assessment for Year: 1990
Date Submitted: 7/18/90

Comments: GLASS MELTER TRIAL BURN PLAN ANALYSIS

Prepared By:

Name:
Title:
Phone #: ( ) -

Prepared for:
U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

CLEAN AIR ACT COMPLIANCE REPORT 7/18/90 10:00 AM

cility: MOUND PLANT
ddress: P, O. BOX 3000 City: MIAMISBURG State: OH
Comments: GLASS MELTER TRIAL BURN PLAN ANALYSIS
Year: 1990

	Dose Equivalent Rates to Nearby Individuals (mrem/year)
Effective Dose Equivalent	0.1000
Highest Organ Dose is to ENDOSTEUM	1.1

----------EMISSION INFORMATION----------

Radio-nuclide	Class	Amad	Stack #1 (Ci/y)
PU-239	Y	1.0	2.8E-04

Stack Height (m)	14.63
Stack Diameter (m)	1.22
Momentum (m/s)	5.7

----------SITE INFORMATION----------

Wind Data	DAY1502.WND	Temperature (C)	20
Food Source	LOCAL	Rainfall (cm/y)	100
Distance to Individuals (m)	470	Lid Height (m)	1000

*NOTE: The results of this computer model are dose estimates. They are only to be used for the purpose of determining compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.

ORGAN DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL

ORGAN	DOSE EQUIVALENT RATE TO THE ORGAN (mrem/y)
GONADS	1.4E-02
BREAST	1.4E-03
RED MARROW	9.0E-02
LUNGS	3.1E-01
THYROID	1.4E-03
ENDOSTEUM	1.1E+00
REMAINDER	5.0E-02
EFFECTIVE	1.0E-01

MOUND PLANT

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY PATHWAY FOR ALL RADIONUCLIDES

	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE ENDOSTEUM (mrem/y)
INGESTION	1.1E-02	1.9E-01
INHALATION	9.0E-02	9.2E-01
AIR IMMERSION	1.3E-11	1.3E-11
GROUND SURFACE	1.9E-06	7.5E-07
TOTAL:	1.0E-01	1.1E+00

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY RADIONUCLIDE FOR ALL PATHWAYS

RADIONUCLIDE	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE ENDOSTEUM (mrem/y)
PU-239	1.0E-01	1.1E+00
TOTAL :	1.0E-01	1.1E+00

MOUND PLANT

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION
OF DISTANCE IN THE DIRECTIONS OF THE
MAXIMALLY EXPOSED INDIVIDUAL FOR
ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTION : NORTH-NORTHEAST

DISTANCE (meters)	EFFECTIVE DOSE EQUIVALENT (mrem/y)
470	1.0E-01
1000	4.1E-02
3000	8.7E-03
10000	1.8E-03
80000	7.3E-05

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION
OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL
RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS:	N	NNE	NE	ENE	E	ESE	SE	SSE
DISTANCE (METERS):								
470	7.1E-02	1.0E-01	8.3E-02	5.0E-02	8.4E-02	7.4E-02	4.5E-02	4.3E-02
1000	3.2E-02	4.1E-02	3.4E-02	2.2E-02	3.7E-02	3.1E-02	1.9E-02	1.7E-02
3000	7.3E-03	8.7E-03	7.1E-03	4.8E-03	8.7E-03	6.8E-03	4.4E-03	3.4E-03
10000	1.4E-03	1.8E-03	1.5E-03	1.0E-03	1.9E-03	1.5E-03	1.0E-03	6.8E-04
80000	5.4E-05	7.3E-05	6.1E-05	3.9E-05	6.6E-05	5.5E-05	3.5E-05	2.7E-05

	S	SSW	SW	WSW	W	WNW	NW	NNW
DISTANCE (METERS):								
470	5.7E-02	3.9E-02	2.7E-02	2.0E-02	2.9E-02	2.4E-02	4.1E-02	2.9E-02
1000	2.3E-02	1.8E-02	1.1E-02	9.6E-03	1.6E-02	1.0E-02	1.7E-02	1.4E-02
3000	5.2E-03	4.1E-03	2.5E-03	2.4E-03	4.3E-03	2.2E-03	3.5E-03	3.1E-03
10000	1.4E-03	8.6E-04	4.3E-04	6.9E-04	8.7E-04	3.9E-04	6.1E-04	6.5E-04
80000	4.5E-05	3.2E-05	1.8E-05	2.0E-05	3.0E-05	1.6E-05	2.6E-05	2.6E-05

40 CFR Part 61
National Emission Standards
for Hazardous Air Pollutants

CLEAN AIR ACT COMPLIANCE REPORT
(Version 3.0 November 1989)

Facility: MOUND PLANT

Address: P, O. BOX 3000
MIAMISBURG , OH. 45343
Annual Assessment for Year: 1990
Date Submitted: 7/18/90

Comments: GLASS MELTER TRIAL BURN PLAN ANALYSIS

Prepared By:

Name:
Title:
Phone #: ( ) -

Prepared for:
U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

CLEAN AIR ACT COMPLIANCE REPORT 7/18/90 10:03 AM

Facility: MOUND PLANT
Address: P, O. BOX 3000 City: MIAMISBURG State: OH
Comments: GLASS MELTER TRIAL BURN PLAN ANALYSIS
Year: 1990

	Dose Equivalent Rates to Nearby Individuals (mrem/year)
Effective Dose Equivalent	0.1000
Highest Organ Dose is to ENDOSTEUM	0.8800

EMISSION INFORMATION

Radionuclide	Class	Amad	Stack #1 (Ci/y)
TH-232	Y	1.0	2.9E-04

Stack Height (m)	14.63
Stack Diameter (m)	1.22
Momentum (m/s)	5.7

SITE INFORMATION

Wind Data	DAY1502.WND	Temperature (C)	20
Food Source	LOCAL	Rainfall (cm/y)	100
Distance to Individuals (m)	470	Lid Height (m)	1000

*NOTE: The results of this computer model are dose estimates. They are only to be used for the purpose of determining compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.

ORGAN DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL

ORGAN	DOSE EQUIVALENT RATE TO THE ORGAN (mrem/y)
GONADS	3.2E-04
BREAST	3.4E-04
RED MARROW	7.0E-02
LUNGS	5.4E-01
THYROID	3.3E-04
ENDOSTEUM	8.8E-01
REMAINDER	8.1E-04
EFFECTIVE	1.0E-01

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY PATHWAY FOR ALL RADIONUCLIDES

	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE ENDOSTEUM (mrem/y)
INGESTION	1.2E-03	3.0E-02
INHALATION	9.9E-02	8.5E-01
AIR IMMERSION	3.1E-11	3.6E-11
GROUND SURFACE	3.5E-06	1.8E-06
TOTAL:	1.0E-01	8.8E-01

MOUND PLANT

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY RADIONUCLIDE FOR ALL PATHWAYS

RADIONUCLIDE	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE ENDOSTEUM (mrem/y)
TH-232	1.0E-01	8.8E-01
TOTAL :	1.0E-01	8.8E-01

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION
OF DISTANCE IN THE DIRECTIONS OF THE
MAXIMALLY EXPOSED INDIVIDUAL FOR
ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTION : NORTH-NORTHEAST

DISTANCE (meters)	EFFECTIVE DOSE EQUIVALENT (mrem/y)
470	1.0E-01
1000	4.1E-02
3000	8.6E-03
10000	1.7E-03
80000	6.7E-05

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION
OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL
RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS:	N	NNE	NE	ENE	E	ESE	SE	SSE
DISTANCE (METERS):								
470	7.1E-02	1.0E-01	8.3E-02	5.0E-02	8.3E-02	7.4E-02	4.5E-02	4.3E-02
1000	3.2E-02	4.1E-02	3.3E-02	2.2E-02	3.7E-02	3.1E-02	1.9E-02	1.7E-02
3000	7.2E-03	8.6E-03	7.0E-03	4.8E-03	8.5E-03	6.7E-03	4.3E-03	3.4E-03
10000	1.4E-03	1.7E-03	1.5E-03	1.0E-03	1.9E-03	1.5E-03	1.0E-03	6.5E-04
80000	5.0E-05	6.7E-05	5.6E-05	3.6E-05	6.1E-05	5.1E-05	3.3E-05	2.4E-05

	S	SSW	SW	WSW	W	WNW	NW	NNW
DISTANCE (METERS):								
470	5.7E-02	3.9E-02	2.7E-02	2.0E-02	2.9E-02	2.4E-02	4.1E-02	2.9E-02
1000	2.3E-02	1.8E-02	1.1E-02	9.4E-03	1.6E-02	1.0E-02	1.7E-02	1.4E-02
3000	5.0E-03	4.0E-03	2.4E-03	2.3E-03	4.3E-03	2.2E-03	3.5E-03	3.1E-03
10000	1.3E-03	8.3E-04	4.1E-04	6.7E-04	8.5E-04	3.7E-04	5.9E-04	6.3E-04
80000	4.1E-05	3.0E-05	1.6E-05	1.9E-05	2.8E-05	1.5E-05	2.4E-05	2.5E-05

Development Of Input For AIRDOS-PC Model

A. Determine Percentage of Activity Contributed by Each Radionuclide

Radionuclide	Activity in Feed (mCi/hr)	Percentage Activity[a] (%)
Am-241	0.0089	0.0056
Co-60	0.0089	0.0056
Cs-137	0.0089	0.0056
H-3	159	99.7323
Pu-238	0.32	0.2007
Pu-239	0.0089	0.0056
Pu-240	0.0089	0.0056
Pu-241	0.0089	0.0056
Pu-242	0.0089	0.0056
Th-228	0.0089	0.0056
Th-230	0.0089	0.0056
Th-232	0.0089	0.0056
U-235	0.0089	0.0056
U-238	0.0089	0.0056
Total	159.4268	

a) Percentage Activity = $\frac{\text{Radionuclide Activity}}{\text{Total Activity (159.4268)}} \times 100\%$

B. Determine Percentage Total Activity at Emission Point

Assume 100 millicuries feed

1. Determine Activity for each radionuclide
   (i.e., Percentage Activity in Feed x 100 mCi)

Radionuclide	Activity in 100 mCi Feed (mCi)	Activity at Emission Pt (mCi)(a)(b)	Percentage Activity At Emission Pt (%)(c)
Am-241	0.0056	0.000000056	0.0000004
Co-60	0.0056	0.000000056	0.0000004
Cs-137	0.0056	0.000000056	0.0000004
H-3	99.7323	13.962522	99.9999808
Pu-238	0.2007	0.000002007	0.0000143
Pu-239	0.0056	0.000000056	0.0000004
Pu-240	0.0056	0.000000056	0.0000004
Pu-241	0.0056	0.000000056	0.0000004
Pu-242	0.0056	0.000000056	0.0000004
Th-228	0.0056	0.000000056	0.0000004
Th-230	0.0056	0.000000056	0.0000004
Th-232	0.0056	0.000000056	0.0000004
U-235	0.0056	0.000000056	0.0000004
U-238	0.0056	0.000000056	0.0000004
Total	100.0000	13.96252468	100.0000000

(a) Activity at Emission Pt For non-tritium isotopes (mCi) = Activity in 100 mCi x 10^{-3} (Adjustment for physical state) x 0.01 (adjustment for HEPA filters)

(b) Activity at Emission Pt For tritium (mCi) = Activity in 100 mCi x (1 - 0.86 (efficiency for capture in scrubber))

(c) Percentage Activity at Emission Pt (%) = Activity at emission for each radionuclide/ Total Activity (13.96252468 mCi) x 100%

Appendix B

Summary Reports for Trial Burn Test Programs Previously Conducted

Testing Conducted in
January 1985

Monsanto

CR/DS
(Co./Div./Dept./Location)

Sampling/Analysis
(Type of Report)

REPORT NO.: MSL-5265
ESC-EAG-85-70

JOB/PROJECT NO.: 760

DATE: December 17, 1985

PERIOD COVERED: January 14-31, 1985

TITLE: RCRA DEMONSTRATION TEST RESULTS OF A PILOT-SCALE GLASS MELT FURNACE INCINERATION SYSTEM AT MONSANTO RESEARCH CORPORATION - MOUND LABORATORY

AUTHORS: James A. Peters

SAMPLING TEAM: C.F. Duncan, J.A. Peters, J.S. Malone.
Environmental Sciences Center, CR&D, St. Louis
K.M. Armstrong, Mound Laboratory, Miamisburg

ABSTRACT: A research test program was conducted to demonstrate that Mound Laboratory's low-level radioactive waste incineration technology is applicable to hazardous waste disposal including wastes currently generated at Monsanto plants. The particular attribute of the glass furnace which enables it to successfully treat radioactive wastes--the encapsulation and immobilization in glass of radioactive ash--make it an attractive technology for hazardous waste streams, especially problem sludges and solids with high concentrations of heavy metals which concentrate in bottom ash.

The test program was designed to simulate a RCRA incinerator trial burn. Organic compounds such as acrylonitrile, acetonitrile, carbon tetrachloride, chlorobenzene, phenol, and xylene were destroyed to 99.999 to 99.99999%. Sludge with cadmium added was burned, and 40-60% of the cadmium was retained in the glass melt. Results indicate that this innovative technology can have numerous practical applications within the corporation.

TECHNICAL APPROVAL: Richard Kimerle
Richard A. Kimerle
Environmental Sciences Center
Senior Fellow

APPROVED BY: William M Mees
W.M. Mees
Environmental Sciences Center
Quality Assurance Specialist

APPROVAL DATE: 12-18-85

C O M P A N Y C O N F I D E N T I A L

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REPT. NO.: MSL-5265
ESC-EAG-85-70 AUTHORS: James A. Peters
TITLE: RCRA DEMONSTRATION TEST RESULTS OF A PILOT-SCALE GLASS MELT FURNACE INCINERATION SYSTEM AT MONSANTO RESEARCH CORPORATION - MOUND LABORATORY

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R-1088(C) (REV. 1/80)

I. INTRODUCTION

Emission testing was conducted at Monsanto Research Corporation-Mound Laboratory's pilot-scale glass melt furnace/incineration system from January 14-31, 1985. Sampling was conducted by personnel from the Environmental Sciences Center of Monsanto CR&D, St. Louis under the direction of Jay Doty of Mound Laboratory. The incineration system was operated by Larry Klingler and Kay Armstrong of the Waste Technology Group of Mound Laboratory. Sample analyses were performed by Pollution Control Science, Inc of Miamisburg, Ohio, Industrial Testing Laboratories Inc. of St. Louis, the Environmental Sciences Center Ultratrace Group, and the Physical Sciences Center under the direction of James Peters. During one test day, invited visitors from the Regional Air Pollution Control Agency (RAPCA) of Dayton, the Ohio EPA of Columbus, and EPA's Hazardous Waste Engineering Research Laboratory (HWERL) Thermal Destruction Branch in Cincinnati observed the operation and testing.

The purpose of this test program was to demonstrate that this low-level radioactive waste incineration technology is applicable to hazardous waste disposal, including wastes currently being generated at one or more Monsanto locations. The demonstration test program was designed to simulate a RCRA incinerator trial burn; the RCRA incineration performance standards were monitored (DRE of POHCs, particulate and HCl emissions, and CO concentration in exhaust gas). The particular attribute of the glass furnace which enables it to successfully treat low-level radioactive wastes--the encapsulation and immobilization in glass of radioactive ash--make it an attractive technology for hazardous waste streams, especially problem solids and sludges, with high levels of heavy metals which concentrate in the ash (1).

Such a development project falls within the Environmental Sciences Center's charter as a supplier of innovative technology to Monsanto, and introduces formal technology exchange between government-sponsored Mound Laboratory research programs and Monsanto operating companies.

II. SUMMARY OF EMISSION TESTING RESULTS

A. Waste Compositions

The program purpose was challenged by burning different types of organic waste streams: a chlorinated liquid "cocktail" waste, a mock corporate waste, and a hazardous sludge with metals.

Table 1 describes the generalized waste types and descriptions which were incinerated in the glass furnace test program, as taken from the program sampling plan (2). Waste B, consisting of Waste C blended with the Mound WWTP sludge, was planned for the program but eliminated due to time and cost constraints.

TABLE 1. DESCRIPTION OF WASTE TYPES TESTED IN MOUND LAB GLASS MELT FURNACE INCINERATION DEMONSTRATION PROGRAM

Waste Designation	Description
Waste A	Mound Lab wastewater treatment plant sludge spiked with cadmium, acrylonitrile (AN), carbon tetrachloride (CCl4), chlorobenzene (ClBz), and phenol
Waste B	NOT TESTED
Waste C	Synthetic Texas City AN-5 acetonitrile (ACN) waste containing AN
Waste D	"Cocktail" waste consisting of kerosene spiked with CCl4, ClBz, phenol, and scintillation fluid (11.1% xylene)

Table 2 lists the particulate test runs with the corresponding waste types and VOST test runs for DRE determinations. Each waste type was "blended" with known amounts of constituents and chosen POHCs. Grab samples of Mound Lab WWTP sludge were analyzed and compared to previous analyses of the sludge, as shown in Table 3. The poor recoveries of CCl4 are attributed to the unrepresentative sampling of the sludge, possible uneven mixing of spiked compounds, and analysis matrix interferences effects. The analyses for phenol and ClBz, however, did compare well to spiked concentrations in the sludge.

TABLE 2. SUMMARY OF WASTE FEED COMPOSITIONS, FEED RATES, AND TEST RUN SCHEDULE FOR THE MOUND LAB GLASS MELT FURNACE INCINERATION DEMONSTRATION TEST

Parameter	EPA Method 5 Test Run Number								
	1	2	3	4	5	6	7	8	9
Waste Type:	C	C	C	D	D	D	A	A	A
Date:	1/22	1/23	1/23	1/24	1/29	1/29	1/30	1/31	1/31
Feed Rate, lb/hr:	43.2	51.4	26.8	31.9	30.5	47.3	134	89	56
Composition:									
AN	3%	5%	5%	--	--	--	1.4%	2.8%	2.8%
ACN	77%	75%	75%	--	--	--	--	--	--
H2O(a)	21%	20%	20%	--	--	--	10%	1.0%	1.0%
CCl4	--	--	--	2.0%	2.9%	2.9%	1.5%	3.0%	3.0%
ClBz	--	--	--	2.2%	3.6%	3.6%	1.0%	2.1%	2.1%
Phenol	--	--	--	2.3%	2.7%	2.7%	1.2%	2.4%	2.4%
ppm Xylene	--	--	--	2664	3885	3885	--	--	--
Sludge	--	--	--	--	--	--	85%	89%	89%
Kerosene	--	--	--	91%	88%	88%	--	--	--
VOST Run #'s:	2-3	4-5	6	7-10	12	13-14	15-17	18-19	20

(a) Does not include H2O content of sludge.

TABLE 3. SUMMARY OF MOUND WWTP SLUDGE COMPOSITION, MEASURED AND HISTORICAL, FOR MOUND LAB GLASS MELT FURNACE INCINERATION PROGRAM

Parameter	Sludge Run #7	Sludge Run #8	Historical Range
Total Solids	--	--	12.6-27.6%
Total Volatile Solids	--	--	31.1-56.9 of TS
H2O Content	50.43%	46.0%	--
BTU Content	1217 Btu/lb	1111 Btu/lb	--
Total Chlorine	0.57%	0.63%	--
Total Bromine	120 ppm	122 ppm	--
Total Fluoride	<30 ppm	<30 ppm	--
Total Iodide	< 5 ppm	< 5 ppm	--
CCl4	<10 ppm	<10 ppm	--
ClBz	0.73%	0.48%	--
Phenol	0.73%	2.42%	--
Aluminum	0.3%	0.3%	--
Antimony	--	--	<31 ppm
Arsenic	--	--	0.8-2.6 ppm
Barium	1.8 ppm	3.4 ppm	--
Beryllium	0.2 ppm	0.2 ppm	<3.0 ppm
Cadmium (a)	328 ppm	631 ppm	13-18 ppm
Calcium	0.7%	0.5%	--
Chromium	50 ppm	32 ppm	116-162 ppm
Copper	492 ppm	387 ppm	1618-3438 ppm
Iron	0.5%	0.4%	--
Lead	--	--	15-394 ppm
Magnesium	1.4%	1.2%	--
Manganese	<126 ppm	<94 ppm	--
Mercury	--	--	5.1-22.2 ppm
Nickel	<104 ppm	64 ppm	146-309 ppm
Phosphorus	<0.3%	<0.2%	--
Potassium	751 ppm	713 ppm	--
Selenium	--	--	<0.6 ppm
Silicon	23 ppm	19 ppm	--
Silver	49 ppm	18 ppm	12.5-349 ppm
Sodium	<206 ppm	138 ppm	--
Tin	30 ppm	30 ppm	--
Titanium	363 ppm	219 ppm	--
Zinc	432 ppm	217 ppm	1298-3204 ppm

(a) Cadmium oxide was spiked into sludge test run samples #7 and #8.

B. Destruction and Removal Efficiency (DRE) of Principal Organic Hazardous Constituents (POHCs)

Federal regulations (40CFR264.343) under the Resource Conservation and Recovery Act (RCRA) state that an incinerator burning hazardous waste must be designed, constructed, and maintained so that it will meet several performance standards. The most important of these is that the incinerator achieve a DRE of 99.99% for each POHC, where the DRE is determined from the following equation:

$$DRE = \frac{(Win - Wout)}{Win} \times 100\%$$

where Win = Mass feed rate of one POHC in the waste stream feeding the incinerator, and
Wout = Mass emission rate of the same POHC present in exhaust emissions prior to release to the atmosphere.

A complete summary of the DRE results for the entire testing program is presented in Table 4. The DRE results shown with a ">" sign indicate that the POHC concentration was below detection (<10 ng in a 10-30 L gas sample) in the scrubber outlet stack gas. Where results are presented without a ">" sign, some trace concentration of the POHC was measured in the stack gas, typically 0.4-30 ug/m3. Most measurable stack gas POHC emission rates were less than one-millionth of the POHC feed rate to the glass melt incinerator, well below the RCRA performance standard of 99.99% DRE or one-ten-thousandth of the POHC feed rate. Most (93%) of the DREs were five "nines" (99.999) or greater; a graphical display of the distribution of DREs is given in Figure 1. Only one DRE of fifty-four was less than 99.99%, and that instance was attributable to formation of Products of Incomplete Combustion (PICs) from burning kerosene. Another test run under identical feed conditions showed >99.999% DRE for that POHC (xylene).

The total uncertainty or error in the DRE values is somewhat difficult to calculate. In practice, the W-values (Win and Wout) are determined based on:

$$W = (\text{flow rate})(\text{sampling time})(\text{POHC concentration})$$

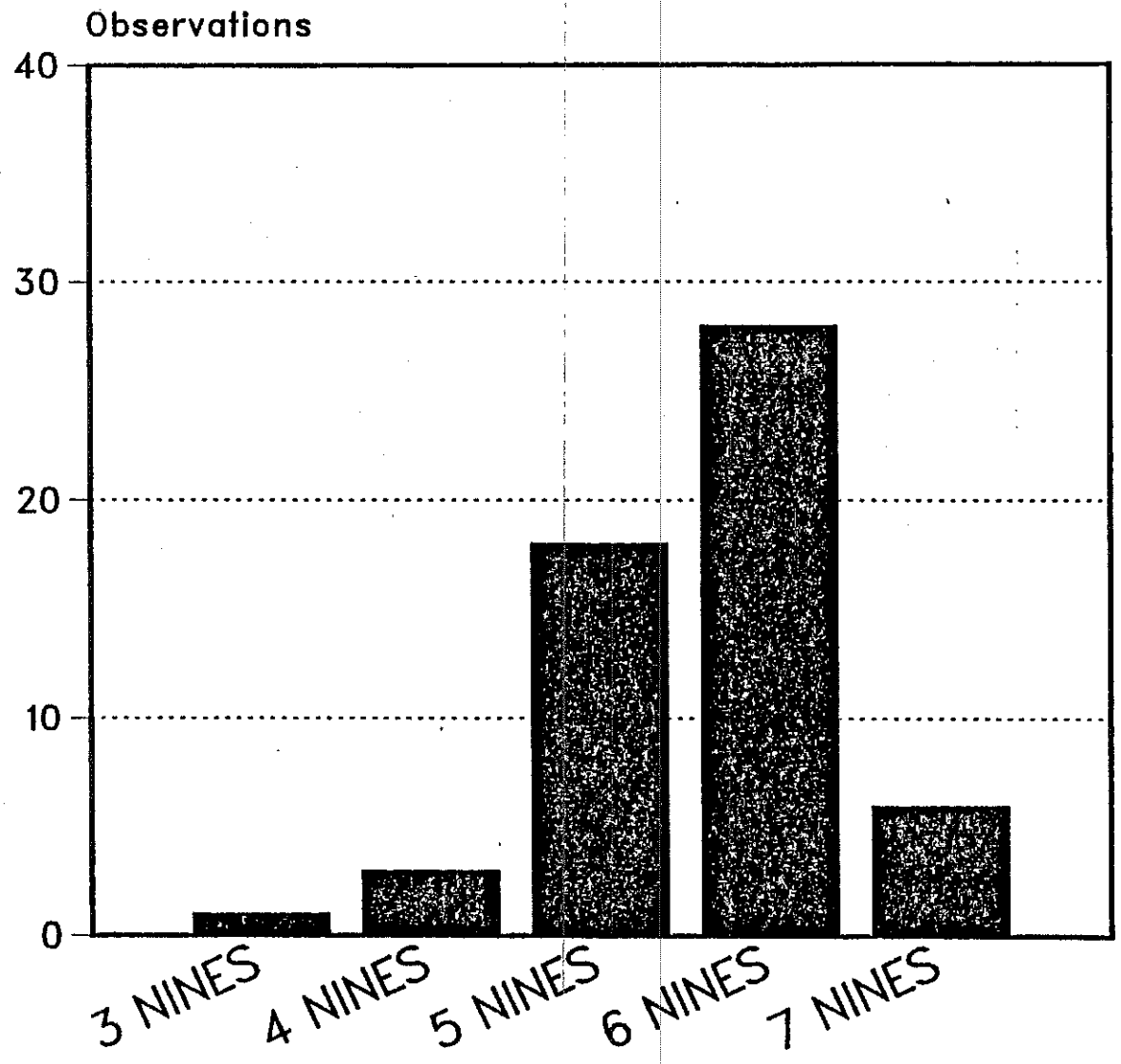
The DRE equation can be rearranged as follows:

$$DRE = 1 - \frac{Wout}{Win}$$

and, if sampling times are equal, as follows:

$$DRE = 1 - \frac{(\text{Stack flow})(\text{stack concentration})}{(\text{feed flow})(\text{feed concentration})}$$

FIGURE 1. DISTRIBUTION OF DREs FOR ALL POHCs, MOUND LAB GLASS MELT FURNACE INCINERATOR PROGRAM



Stack flow has a total error (bias and precision) of about ±6% of the mean, stack concentration has an error of about ±45%, feed flow is estimated to have an error of ±10%, and feed concentration is also estimated to have an error of ±10% due to POHC stratification. The total error of the whole Wout/Win quotient of the DRE equation would then be about ±48%. Only when a calculated DRE result is very close to another order-of-magnitude in number of nines would this total error have much effect in results interpretation.

TABLE 4. SUMMARY OF DRE RESULTS FOR ALL WASTE TYPES BURNED IN THE MOUND LAB GLASS MELT FURNACE INCINERATION DEMONSTRATION PROGRAM

VOST Run No.	Waste Type	Destruction and Removal Efficiency, %					
		ACN	AN	CCl4	ClBz	Phenol	Xylenes
2	C	99.99995	99.99988	--	--	--	--
3	C	99.99999	>99.99994	--	--	--	--
4	C	99.99999	>99.99997	--	--	--	--
5	C	99.99999	>99.99998	--	--	--	--
6	C	99.99998	>99.99995	--	--	--	--
7	D	--	--	>99.99986	>99.99987	99.99987	99.99841
8	D	--	--	>99.99988	>99.99989	>99.99989	99.99843
9	D	--	--	>99.99992	>99.99993	>99.99993	99.99906
10	D	--	--	>99.99983	>99.99984	>99.99985	99.99764
12	D	--	--	>99.99990	>99.99992	>99.99990	99.99929
13	D	--	--	>99.99992	99.99989	>99.99992	99.97484
14	D	--	--	>99.99993	>99.99994	>99.99992	>99.99954
15	A	--	>99.99998	>99.99998	99.99972	99.99978	--(a)
16	A	--	>99.99999	>99.99999	99.99990	99.99998	--(a)
17	A	--	>99.99998	99.99998	99.99993	>99.99998	--(a)
18	A	--	>99.99998	>99.99998	99.99993	>99.99998	--(a)
19	A	--	>99.99999	>99.99999	99.99976	>99.99999	--(a)
20	A	--	99.99994	>99.99998	99.99966	>99.99997	--(a)

(a) No xylenes fed to the incinerator, but xylenes were detected in the stack gas as Products of Incomplete Combustion (PICs) from burning sludge in Waste Type A.

A summary of all individual POHC feed rates (Win) and emission rates (Wout) are presented in Tables 5 and 6, respectively. Most POHCs were generally below the sampling and analytical detection limit in the stack gas. Acrylonitrile was detected in the stack gas in only two of eleven test runs; carbon tetrachloride in only one of thirteen; chlorobenzene in seven of thirteen; and phenol in three of thirteen. Acetonitrile was measured in the stack gas in all five of its test runs, but comprised 75% of the feed. Xylenes, which comprised 11.1% of the scintillation fluid spiked in the waste, were detected in all five possible test runs. Xylene, however, is a probable PIC from burning kerosene, into which the scintillation fluid was spiked.

Xylene also appeared as a PIC during the sludge tests (Waste A), with emission rates higher than the sum of all four other POHCs, as highlighted in Table 6. Xylene concentrations in the incinerator stack gas were in the same order of magnitude as that found in an industrial coal-fired boiler (3).

TABLE 5. SUMMARY OF INDIVIDUAL POHC FEED RATES (Win) TO THE GLASS MELT FURNACE

VOST Run Nos.	Waste Type	POHC Feed Rate, g/hr					
		ACN	AN	CCl4	ClBz	Phenol	Xylenes
2-3	C	251.46	9.80	--	--	--	--
4-5	C	291.42	19.43	--	--	--	--
6	C	151.95	10.13	--	--	--	--
7-10	D	--	--	289.4	318.3	332.8	38.5
12	D	--	--	401.2	498.0	373.5	53.7
13-14	D	--	--	622.2	772.3	579.3	83.3
15-17	A	--	850.9	911.7	607.8	729.3	--
18-19	A	--	1130.3	1211.0	847.7	968.8	--
20	A	--	711.2	762.0	533.4	609.6	--

Note: Blanks indicate no POHC in the waste feed.

TABLE 6. SUMMARY OF INDIVIDUAL POHC EMISSION RATES (Wout) FROM THE GLASS MELT FURNACE-SCRUBBER CONTROL SYSTEM

VOST Run Nos.	Waste Type	POHC Emission Rate, ug/hr(g X E-6)					
		ACN	AN	CCl4	ClBz	Phenol	Xylenes
2	C	6450	667.2	--	--	--	--
3	C	1065	<304.2	--	--	--	--
4	C	1219	243.6	--	--	--	--
5	C	1505	<223.8	--	--	--	--
6	C	1328	<295.2	--	--	--	--
7	D	--	--	<409.5	<409.5	449.9	613.2
8	D	--	--	<356.3	<356.3	<356.3	605.2
9	D	--	--	<239.3	<239.3	<239.3	360.0
10	D	--	--	<505.2	<505.2	<505.2	908.8
12	D	--	--	<383.9	<383.9	<383.9	<383.9
13	D	--	--	<494.7	<840.6	< 494.7	20,957.7
14	D	--	--	<449.1	<449.1	<449.1	<449.1
15	A	--	<196.1	<196.1	1679	1620	800.3*
16	A	--	<84.8	<84.8	603.1	100.7	167.5*
17	A	--	<152.4	198.2	442.0	<152.4	5014*
18	A	--	<182.9	<182.9	565.2	<182.9	5233*
19	A	--	<127.2	<127.2	2056	<127.2	5550*
20	A	--	426.4	<164.0	1787	<164.0	3640*

* POHC was not fed to incinerator; emission rate shown is for PICs.

C. Particulate Emissions and Scrubber Control Efficiency

The RCRA performance standard for particulate emissions from incinerators is 180 mg/m3 (0.08 gr/dscf) when corrected for the amount of oxygen in the stack gas according to the formula:

$$P(corr) = P(meas) \times 14/(21-Y)$$

where P is the particulate concentration and Y is the measured concentration of oxygen in the stack gas using EPA Method 3. This correction procedure is to be used on all hazardous waste incinerators except those operating under conditions of oxygen enrichment. The introduction of bleed air to the exhaust blower creates a condition of oxygen enrichment, and some other appropriate correction formula must be used to compare particulate concentration against the RCRA standard. The only problem area for the glass melt furnace particulate emissions occurs during the burning of sludge. The particulate concentrations at the scrubber inlet are all close to the RCRA standard when burning liquid wastes tested in the program.

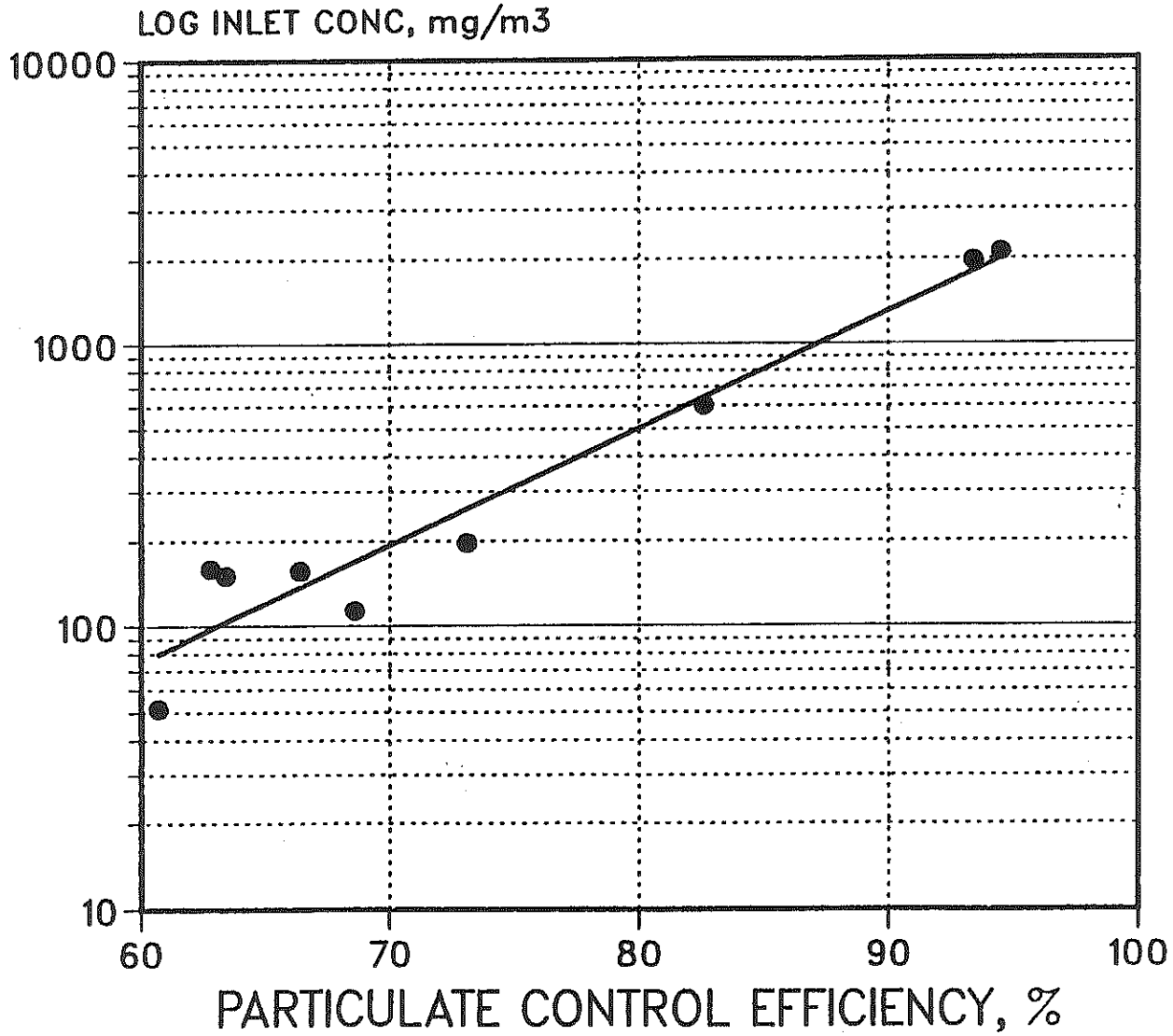
The scrubber's ability of control particulate emissions improved as the inlet particulate concentration increased, as shown in Figure 2. The first two waste types were relatively "clean" wastes compared to burning solids in production of particulate emissions, and the scrubber was nor designed to operate on the fine particulate in that concentration range.

TABLE 7. SUMMARY OF PARTICULATE CONTROL EFFICIENCIES AS DETERMINED USING EPA METHOD 5, MOUND LAB WET SCRUBBER SYSTEM

Run No.	Date	Waste Type	Mass Basis, lb/hr			Concentration Basis, mg/m3		
			Inlet	Outlet	Eff,%	Inlet	Outlet*	Eff,%
1	1/22	Synth.AN-5	0.0524	0.0280	46.6	51.6	20.3	60.7
2	1/23	Synth.AN-5	0.0931	0.0416	55.3	113.4	35.6	68.6
3	1/24	Kero-cocktl	0.154	0.0676	56.1	151.4	54.9	63.4
4	1/24	Kero-cocktl	0.166	0.0698	58.0	159.7	59.4	62.8
5	1/29	Kero-cocktl	0.193	0.0756	60.8	156.8	52.7	66.4
6	1/29	Kero-cocktl	0.2475	0.0820	66.9	197.0	52.9	73.1
7	1/30	Sludge spkd	0.358	0.0766	78.6	1970.2	130.9	93.4
8	1/30	Sludge spkd	0.1295	0.0612	52.7	602.3	104.6	82.6
9	1/31	Sludge spkd	0.552	0.0844	84.7	2115.9	115.5	94.5

* Particulate concentrations are uncorrected for O2 in stack gas; see 40CFR264.343(c) for correction. RCRA performance standard is 180 mg/m3 when corrected.

FIGURE 2. SCRUBBER CONTROL EFFICIENCY VS. INLET CONCENTRATION OF PARTICULATE



D. HCl Emissions and Scrubber Control Efficiency

A summary of the scrubber inlet and outlet gas stream testing for HCl emissions and control efficiency is presented in Table 8. At least 99.5% HCl control efficiency was achieved in all cases where organic chlorine compounds were present in the waste feed.

TABLE 8. SUMMARY OF HCl CONTROL EFFICIENCIES, MOUND LAB WET SCRUBBER SYSTEM

Run No.	Date	Waste Type	HCl Emissions, lb/hr Inlet	HCl Emissions, lb/hr Outlet*	Efficiency,%*
1	1/22	Synthetic AN-5	<0.0006	0.0045	**
2	1/23	Synthetic AN-5	0.0015	<0.0014	**
3	1/24	Kerosene Cocktail	0.737	<0.0013	>99.8
4	1/24	Kerosene Cocktail	2.101	0.0014	99.9
5	1/29	Kerosene Cocktail	1.000	<0.00084	>99.9
6	1/29	Kerosene Cocktail	1.289	<0.0018	>99.9
7	1/30	Sludge Spiked	0.892	0.0022	99.8
8	1/30	Sludge Spiked	0.394	0.0018	99.5
9	1/31	Sludge Spiked	1.938	0.0095	99.5

* RCRA performance standard for hazardous waste incinerators is less than 4 lb/hr or 99% control.
** Virtually no chlorine in waste feed, so HCl removal efficiency results were meaningless.

E. Fate of Metals in the Glass Melt Furnace Incineration/Off-Gas System

Cadmium oxide (CdO) was spiked into the Waste A sludge feed at a concentration of 0.2%, or 2000 ppm, so that the fate of heavy metals in the incineration system could be studied. These test runs include particulate test runs 7 through 9. Cadmium in the sludge was analyzed and found to be 328 ppm in sludge from test run 7 and 631 ppm in sludge from test runs 8 and 9.

In theory, the inorganic constituents which do not vaporize in the combustion zone of the furnace should convectively sink in the glass pool and react with a relatively small amount of glass formers to create a glass matrix. Molten glass from the furnace melter can be batch or continuously drained into a receiving canister, cooled to ambient, and disposed in a landfill. Presumably the glass matrix would be resistent

to leaching, could pass the proposed EPA Toxicity Characteristic Leaching Procedure (TCLP), and could be disposed safely in a sanitary rather than hazardous waste landfill. Moreover, entrained particulates and more volatile inorganic constituents removed by the offgas system (as a scrubber sludge or ESP/baghouse ash) could be recycled to the glass melter at a lowered operating temperature to eliminate/encapsulate secondary waste streams (4). Prior testing at the Mound Laboratory on low-level radioactive waste streams had demonstrated excellent retention of nonvolatile and semivolatile radioactive metallic elements (5). Mass balance experiments had shown furnace ash retentions of 75% for plutonium-238, 40-80% for cesium-137, and 70-88% for cobalt-60.

The addition of CdO to the spiked sludge (Waste A) and subsequent analyses of the movement of cadmium did not fare as well. Table 9 presents the results of cadmium fate in the incinerator-disposal system. Based on the difference between the feed rate and scrubber inlet emission rate (furnace outlet rate), the Cd retention for runs 7, 8, and 9 were 62%, 39%, and 42% respectively; these retentions are slightly lower than those observed with radioactive elements, but similar enough. The total amount of Cd which should have remained in the glass melt was:

$$380 \text{ g CdO} \times \frac{0.875 \text{ g Cd}}{\text{g CdO}} = \frac{332 \text{ g Cd}}{2000 \text{ lb glass}} \times \frac{1 \text{ lb}}{454 \text{ g}} = 366 \text{ ppm Cd in glass}$$

Analysis of the glass after completion of run 9 showed no detectable Cd at a detection limit of 0.01% or 100 ppm. It is possible that the Cd was unevenly distributed in the glass because of very slow convective mixing, and that the analysis missed the Cd in the glass due to nonrepresentative sampling. Also, the extraction/digestion procedure may have insufficiently extracted the Cd from the glass matrix.

Cadmium analysis of the scrubber water proved fruitless in defining the Cd material balance. The scrubber water contained only 0.28-0.36 ppm Cd, or about 50 mg/hr increase, far short of the 20-30 g/hr shown to be removed based on the inlet/outlet stack gas sampling. Under alkaline conditions, however, the CdO removed by the scrubber should precipitate from the scrubber water and be continuously removed by the scrubber liquid filter. The scrubber filter sludge was unfortunately not analyzed for Cd content, and would be expected to contain the 20-30 g Cd/hr.

Cadmium emission control efficiencies were 98%, 68%, and 72% for test runs 7, 8, and 9, respectively. These control efficiencies are slightly less than the 83-95% particulate control efficiencies, as anticipated, due to CdO formation in the furnace offgas as a fine particulate which would be harder to scrub at high efficiency.

TABLE 9. SUMMARY OF CADMIUM FATE IN THE MOUND LAB GLASS MELT FURNACE INCINERATION SYSTEM

Run No.	Cd Feed Rate, g/hr	Exit Furnace Rate, g/hr	Scrubber Outlet Rate, g/hr	Scrubber Liq Conc, mg/L	Glass Conc, ppm
7	83.3	31.3	0.655	0.360	--
8	47.3	28.8	9.18	--	
9	47.3	27.2	7.76	0.279	<100

F. Carbon Monoxide (CO) Emissions

CO concentration of the glass melt furnace offgas was measured in the scrubber inlet duct, just downstream of the inlet particulate sampling port. In general, CO concentrations remained very low and steady, indicative of stable furnace operation. The highest CO concentrations of the program were during the sludge burning, when a four-minute CO spike of about 260 ppm occurred. The entire compilation of two-minute readings is given in Appendix C - Operating Data Printouts.

TABLE 10. SUMMARY OF CARBON MONOXIDE EMISSIONS DURING WASTE BURNS

Day	EPA 5 Runs	VOST Runs	CO Concentration in Offgas, ppm		
			Average	Std Deviation	Range
1	1	2-3	1.4	8.7	0 - 89.5
2	2-3	4-6	3.7*	9.6	0 - 99.1
3	4	7-10	3.9*	3.0	0 - 14.2
4	5-6	12-14	13.7*	23.7	0 - 94.0
5	7	15-17	16.8	8.6	2.9 - 24.4
6	8-9	18-20	10.2	26.1	0 - 259.7

* Zero baseline drift noted for CO analyzer.

G. PAH Emissions from Sludge Burning

During the program design phase, concern was voiced by CED that the sludge burns may produce high concentrations of polynuclear aromatic hydrocarbons (PAH) in the offgas. It was believed that wet sludge introduction to the furnace may significantly lower that combustion efficiency and form PAH in elevated quantities as PICs. To answer this concern, sampling for PAH was conducted at the scrubber inlet location during particulate test run 8.

(DATA TO SUPPLIED WHEN ANALYSIS IS COMPLETED)

H. Nitrogen Oxide Emissions

Nitrogen oxide (NOx) emissions were measured during burning of Waste D (kerosene cocktail) and Waste A (spiked sludge) at the scrubber outlet location. Table 11 presents the emission results. Dilution air was added to the scrubber outlet gas stream to allow the exhaust blower blower to operate in an efficient regime. Based on the difference between inlet and outlet gas flows, it is estimated that the concentration results for NOx runs 1A-1D would be 1.24 times higher without dilution air, and that NOx runs 2 and 3 would be 2.76 times higher; no change would result for NOx lb/hr emission rate.

TABLE 11. SUMMARY OF NOx EMISSION TEST RESULTS

Date	Run No.	Waste Feed	NOx Emissions ppm	NOx Emissions lb/hr
1/29	1A	Kerosene Cocktail	38	0.108
	1B		6.5	0.018
	1C		9	0.026
	1D		12	0.034
	AVG		16.4	0.047
	CV		±89%	±89%
1/30	2A	Sludge	69	0.077
	2B		51	0.057
	2C		61	0.068
	2D		64	0.072
	AVG		61.3	0.069
	CV		±12%	±12%
1/31	3A	Sludge	35	0.049
	3B		32	0.045
	3C		37	0.052
	3D		17	0.024
	AVG		30.3	0.043
	CV		±30%	±30%

III. FACILITY DESCRIPTION AND OPERATION

The commercially available (through Pernberthy Electromelt International, Inc. as the PYRO-CONVERTER™) joule-heated glass furnace, shown in Figure 3, has successfully incinerated and treated low-level radioactive wastes in DOE-sponsored research programs. Although the manufacturer claims that the furnace can treat hazardous wastes, no actual testing of the unit has ever been reported.

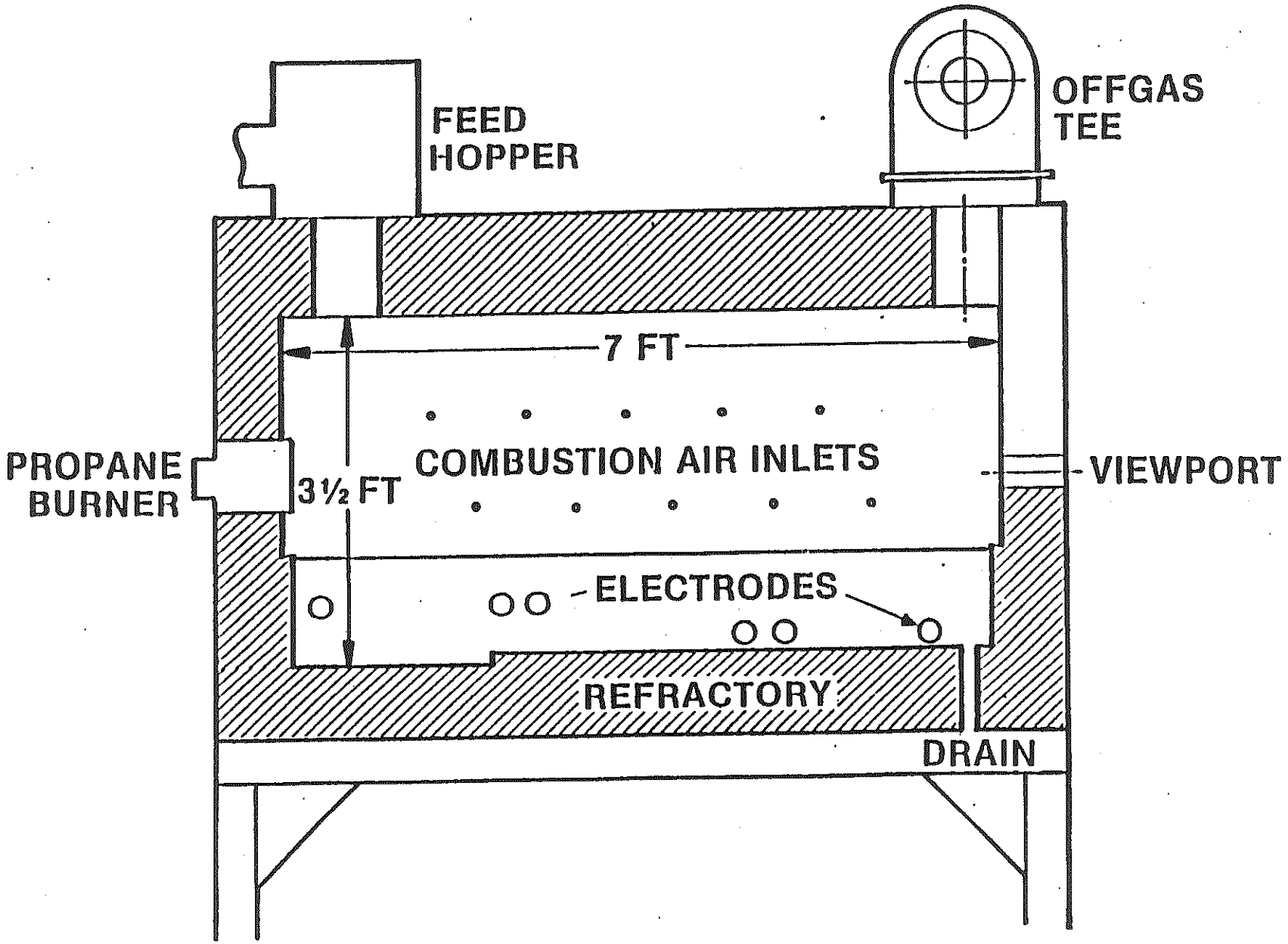
Heat for the combustion process is provided by a pool of molten soda-lime glass. The fact that the temperature of the glass is controlled electrically accounts for some important processing advantages. First, the temperature of the glass can be easily and precisely controlled at a remote location, ensuring a comfortable and physiologically safe working environment for operating personnel. Second, the glass acts as a heat sink, creating an incineration chamber of uniform temperature throughout. This guarantees that the waste stream is exposed to optimum or desired combustion temperature constantly during its residence in the furnace. As a result, even organics of high persistence or difficult "incinerability" are likely to be destroyed.

An additional advantage of this system over conventional incinerators is that the molten glass pool provides enough heat to sustain the high temperature of the chamber without any reliance on the Btu content of waste streams. Consequently, wastes high in water content can be processed without predrying or blending steps. Any water entering the system is readily evaporated while any contained organic waste compounds are thermally destroyed.

A major concern of all radioactive waste disposal systems is to provide packaging for the final waste form in such a way that no contamination will occur to the environment. For ash from incineration processes, this usually means solidification prior to final packaging to prevent dispersion or leaching. Most often, incinerator bottom ash is a volume-reduced hazardous waste which is disposed in a secure hazardous waste landfill. With the glass furnace treatment of hazardous wastes, solidification of the resulting combustion ash occurs in the same chamber as incineration. This is accomplished by allowing the ash to fall into the pool of molten glass, convectively sink, and subsequently encapsulate any associated radioactive species or inorganic toxic substances in what has been shown to be an essentially inert and leach resistant final waste form. This capability eliminates ash handling steps normally identified with conventional incineration processes, thereby reducing the chances of personnel exposure to harmful substances.

The furnace offgases are directed to a wet scrubber system shown in Figure 4. The hot offgas is cooled to 130°F in a spray chamber with a dilute alkaline solution (1% NaOH, KOH, or Na2CO3) that neutralizes most of the acid gases and removes about half of the particulate matter. The cooled offgas is further scrubbed in a high energy venturi scrubber followed by a cyclone separator and mist eliminator that remove the acid gases to greater than 99% and the particulate matter to up to 96%. The alkaline scrub liquor from the spray tank and venturi flows to a recycle tank and is pumped through a filter and heat exchanger back to the spray

SCHEMATIC OF JOULE-HEATED GLASS FURNACE *



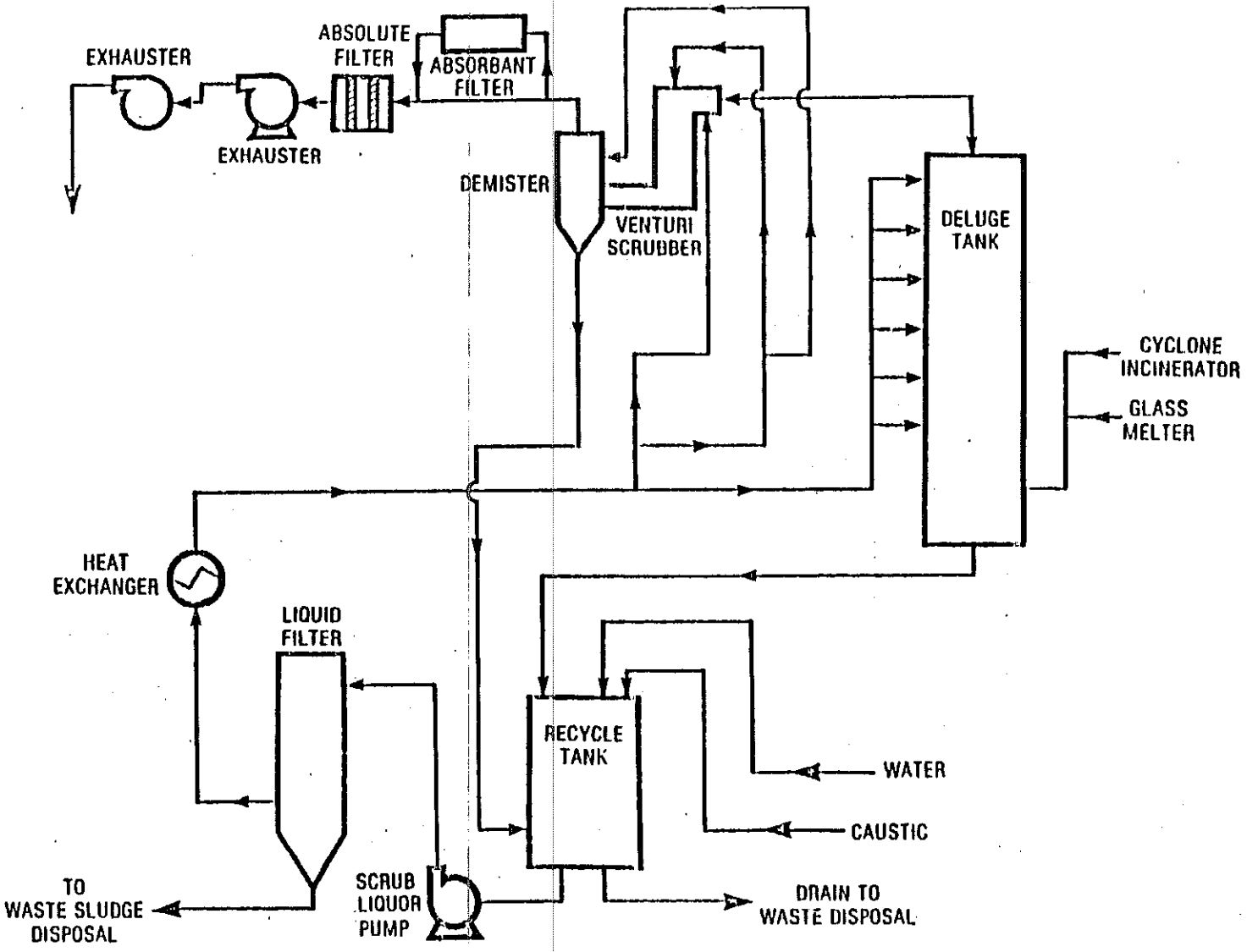


FIGURE 4. WET OFFGAS SYSTEM

tank and venturi. The pH is maintained above 8.3 to prevent corrosion in the scrubbing system. Typical operating scrubber flow is about 25-30 gpm to the venturi and spray chamber nozzles, and the scrubber system holds about 285 gallons. Design delta P is 43 in. H2O.

After the wet scrubbing system, the offgas passes through a primary HEPA filter before it is pulled through the blowers and exhausted through the building HEPA filtering system. These HEPA filters were removed and/or bypassed for the hazardous waste burn project.

Furnace and offgas operating parameters were monitored continuously and reported every two minutes by the instrumentation system. These operating parameters included electrical power to each electrode (kW); furnace chamber or combustion zone temperatures (inlet and outlet); offgas temperatures; scrubber deluge, mist eliminator and exhaust temperatures and pressure; scrubber pH; various gas flow delta P's; and scrubber inlet concentrations of CO2 and CO. Table 12 summarizes the ranges of each operating parameters during each test day and the corresponding organic and particulate sampling test run numbers.

Combustion zone temperature was monitored at two locations--chamber temperature 1 was under the solids feeder at the front of the furnace and chamber temperature 2 was at the offgas end of the furnace near the furnace wall. During the sludge burns it can be seen that T1 < T2 because of evaporative cooling (H2O driven off) at that end of the furnace. For the other two liquid wastes, which had high Btu content, T1 > T2 because of the rapid combustion upon feeding.

TABLE 12. SUMMARY OF GLASS MELT FURNACE AND OFFGAS SYSTEM OPERATING PARAMETERS DURING EMISSION TESTING

Parameter	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Date (1985)	1/22	1/23	1/24	1/29	1/30	1/31
Partic & HCl Runs	1	2-3	4	5-6	7-8	9
VOST Runs	2-3	4-6	7-10	12-14	15-17	18-20
GMF Chmbr T1, °F	2313-2547	1742-2771	1698-2686	1686-2768	1677-2107	1651-2098
GMF Chmbr T2, °F	1759-1921	1877-2306	1772-2054	1714-1942	1930-2341	1844-2357
Offgas Temp, °F	1304-1470	1330-1574	1277-1517	1228-1507	1212-1331	1004-1255
Exh Gas Temp, °F	120-190	143-189	137-194	142-193	86-110	92-110
Electrode AB, kW	25.2-26.2	22.5-25.2	23.0-24.7	24.8-26.7	25.8-28.1	25.0-27.8
Electrode BC, kW	26.4-27.2	23.8-27.0	25.5-26.4	25.9-27.9	25.1-28.0	24.9-28.0
Electrode CD, kW	26.4-27.2	23.3-26.0	24.2-25.7	24.5-28.1	22.8-25.0	22.8-24.9

IV. SAMPLING AND ANALYTICAL PROCEDURES

The sampling and analytical program was designed to determine the DRE of the POHCs in the wastes, quantify the major pollutants from burning wastes in the glass melt furnace, and provide mass balance information on the fate of metals in the wastes. A sampling and analytical plan for the program (ESC Report No. ESC-EAG-P-84-21, October 1984) was prepared and distributed before testing began.

The scrubber inlet sampling location, shown in Figure 5, had a single 3-inch port with packing gland installed in a 5.75-inch I.D. duct. The sample port was 17.7 diameters from the nearest upstream disturbance (incinerator connection) and 6.6 diameters from the nearest downstream disturbance (expansion joint), well within the criteria of EPA Method 1 for suitable sampling location. Gas velocity was monitored single point at a location 18.1 diameters downstream of the expansion joint and 7.3 diameters downstream of a thermocouple port for gas temperature.

The scrubber outlet sampling locations, shown in Figures 6 and 7, were numerous. Gas temperature was monitored at the horizontal duct location off the mist eliminator after the duct insulation terminated. A permanent "annubar" flow sensor with water manometer was installed downstream of the sampling ports. The annubar is a piccolo-type tube which is a velocity averaging device. Upstream from the annubar two ports 90° apart were used to conduct p-type pitot tube traverses in accordance with the procedures outlined in EPA Method 2C--Determination of Stack Gas Velocity and Volumetric Flow Rate from Small Stacks or Ducts (Standard Pitot Tube). Further upstream, in the vertical part of the duct at the blower outlet, velocity was also monitored single point near the particulate sampling location for isokinetic purposes, as shown in Figure 7. Duct static pressure was monitored 6.2 diameters beyond that. The annubar flow monitor was calibrated against a p-type pitot tube (coefficient 0.99) and velocity traverse for dry standard cubic feet per minute (dscfm) flow rate for future Mound Lab projects, and these calibration curves are presented in Figures 8 and 9.

Stack gas dry molecular weight was determined during each test run using the Fyrite option of EPA Method 3 to measure percentages of O2 and CO2. Stack gas moisture was determined either gravimetrically using the condensation procedure or calculated using saturation vapor pressure tables according to EPA Method 4.

The POHCs in the scrubber outlet gas were sampled using a Volatile Organic Sampling Train (VOST), shown in Figure 10, and modifications to the VOST protocol outlined in Section 1.2.1.13 of EPA-SW-846 for determination of emissions of volatile organic compounds from hazardous waste incinerators. The modifications include replacing the charcoal portion of the backup sorbent trap with a trap containing only Tenax as in the front trap, and using the sorbent cleanup procedure shown in Figure 11. Rather than check the "cleanliness" of each newly-prepared trap with an FID (which has insufficient sensitivity to detect blank contamination), selected traps are analyzed immediately after preparation using the analytical protocol for the POHCs of interest to determine "fresh" lab blank contamination.

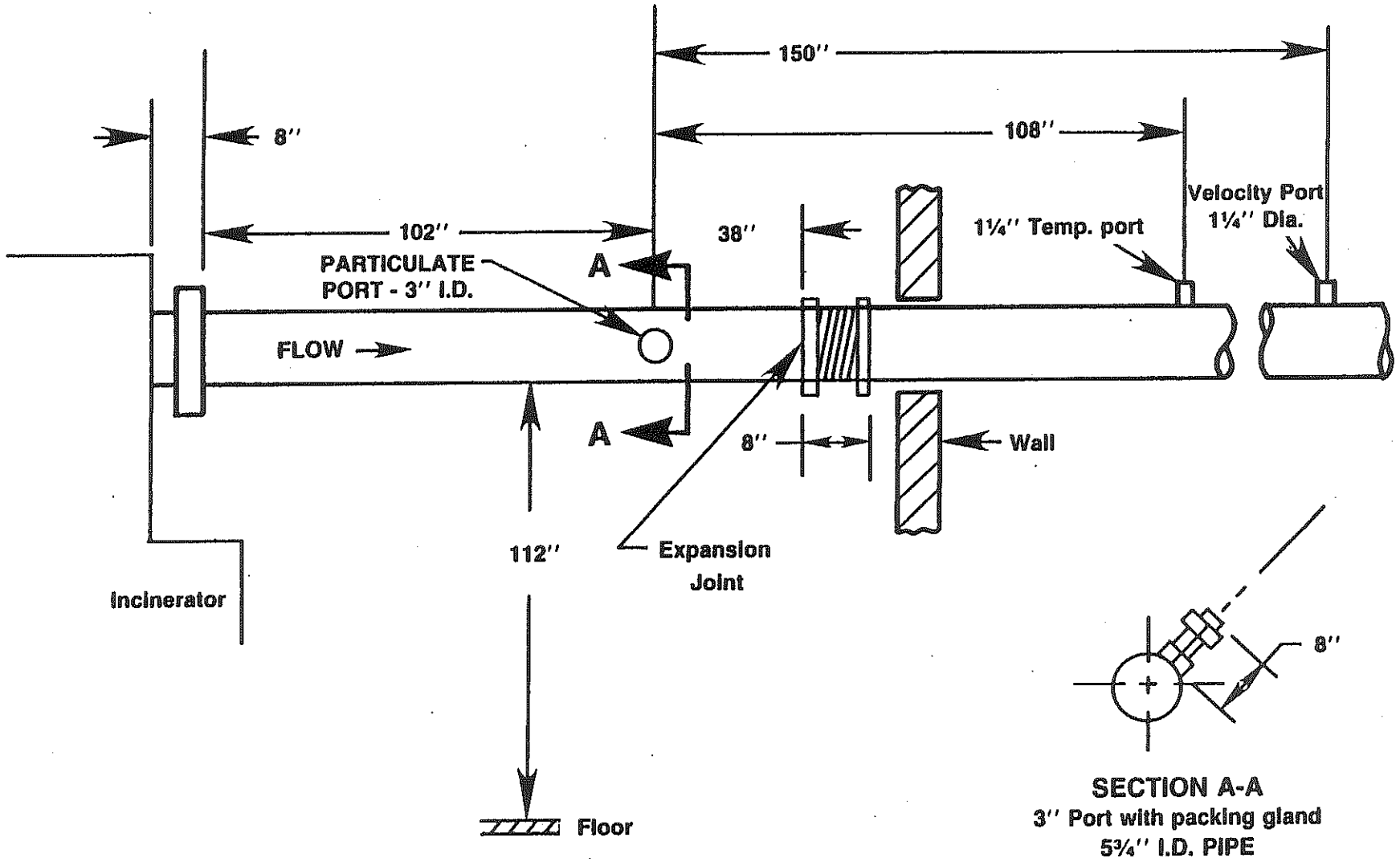


FIGURE 5. SCRUBBER INLET - INCINERATOR

NOTE:

1) Saturation Temp. Taken Exit Mist. Elim.
2) Velocity Taken At Annubar Downstream Of EPA-5 Port.

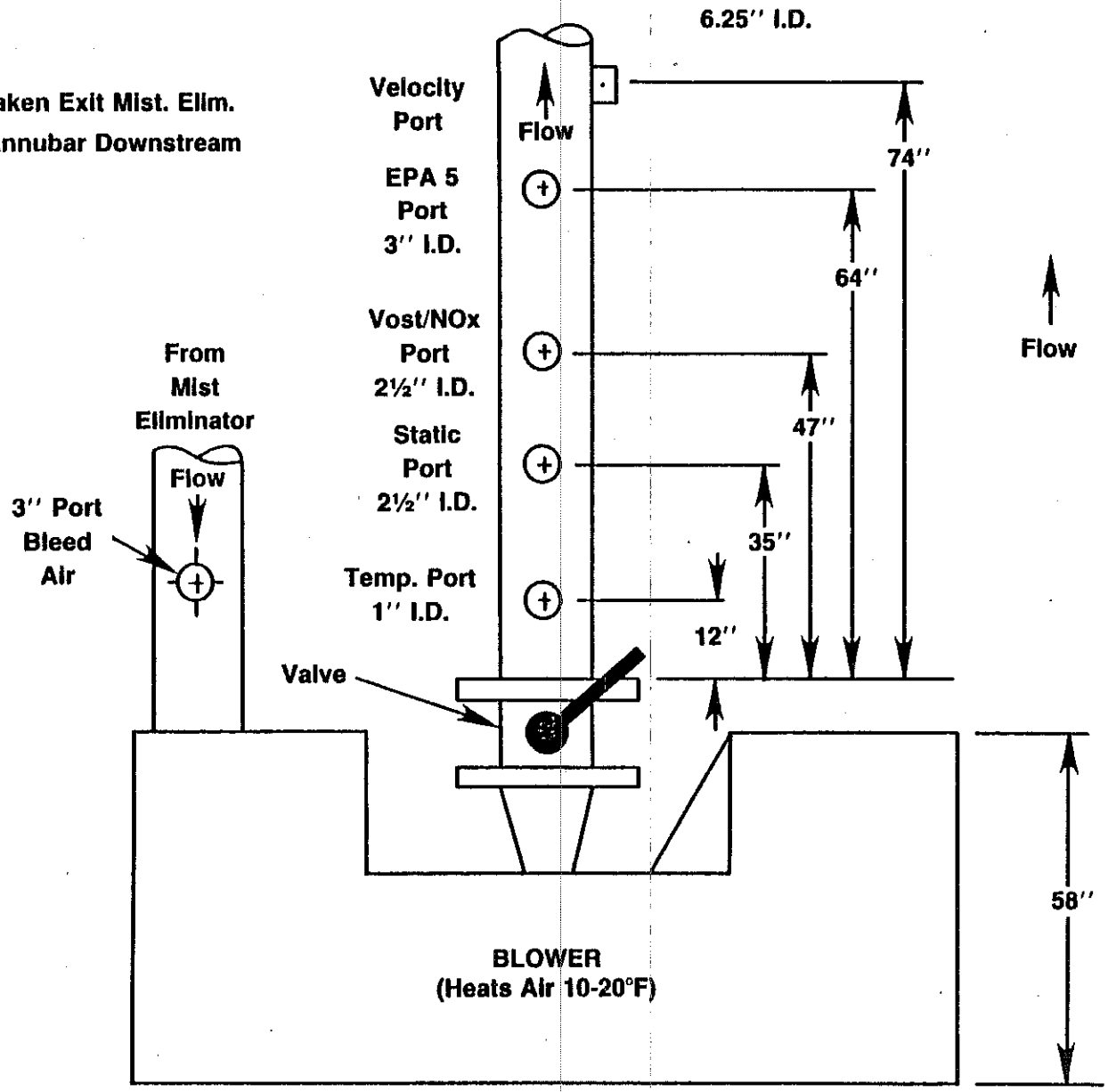


FIGURE 6. EXIT SCRUBBER AND MIST ELIMINATER SAMPLING LOCATIONS

FIGURE 7. ALTERNATE VIEW OF SCRUBBER OUTLET SAMPLING LOCATIONS.

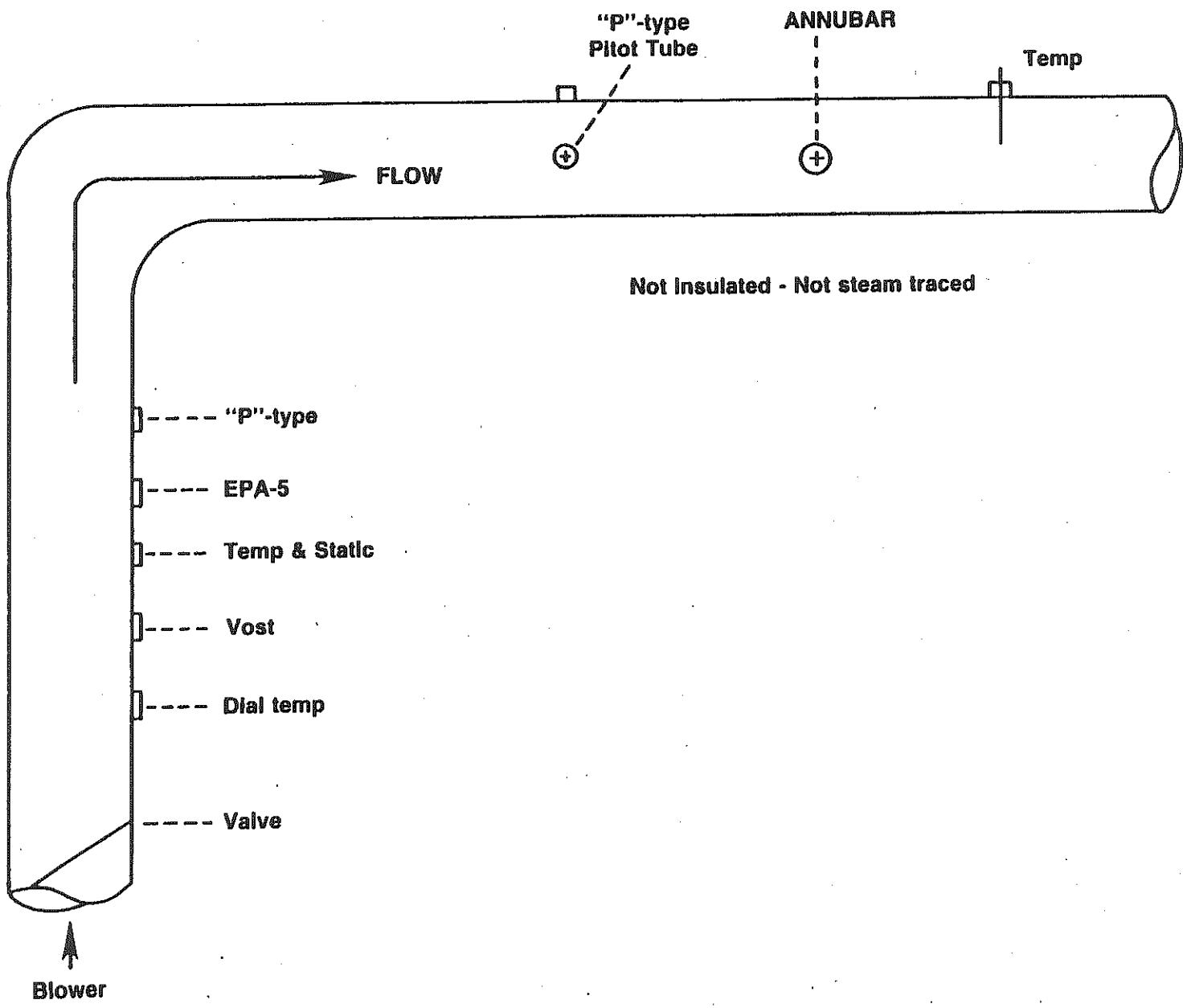


FIGURE 8. CALIBRATION OF MOUND GLASS MELT FURNACE SCRUBBER OUTLET FLOW ANNUBAR AGAINST P-TYPE PITOT TUBE

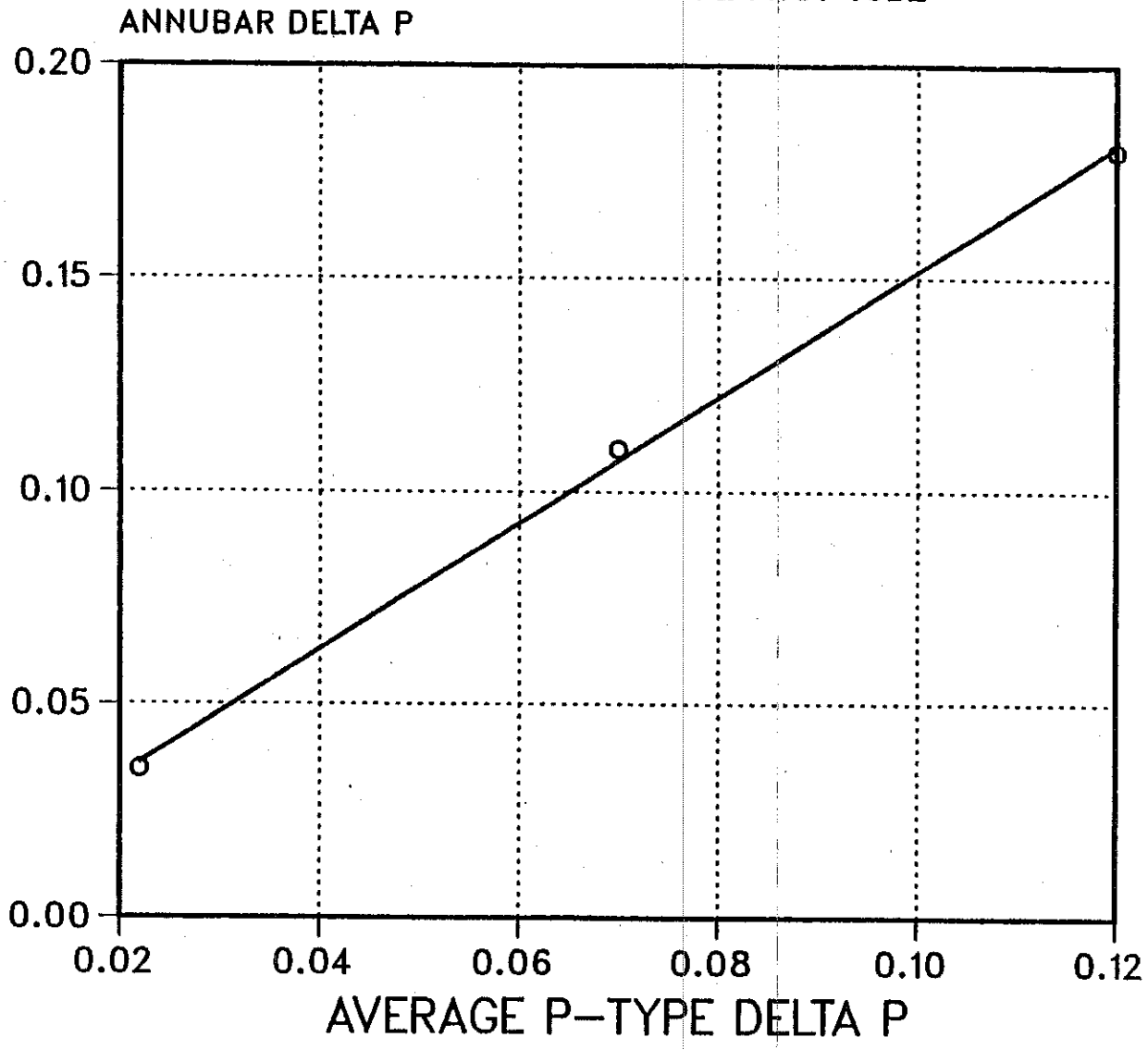
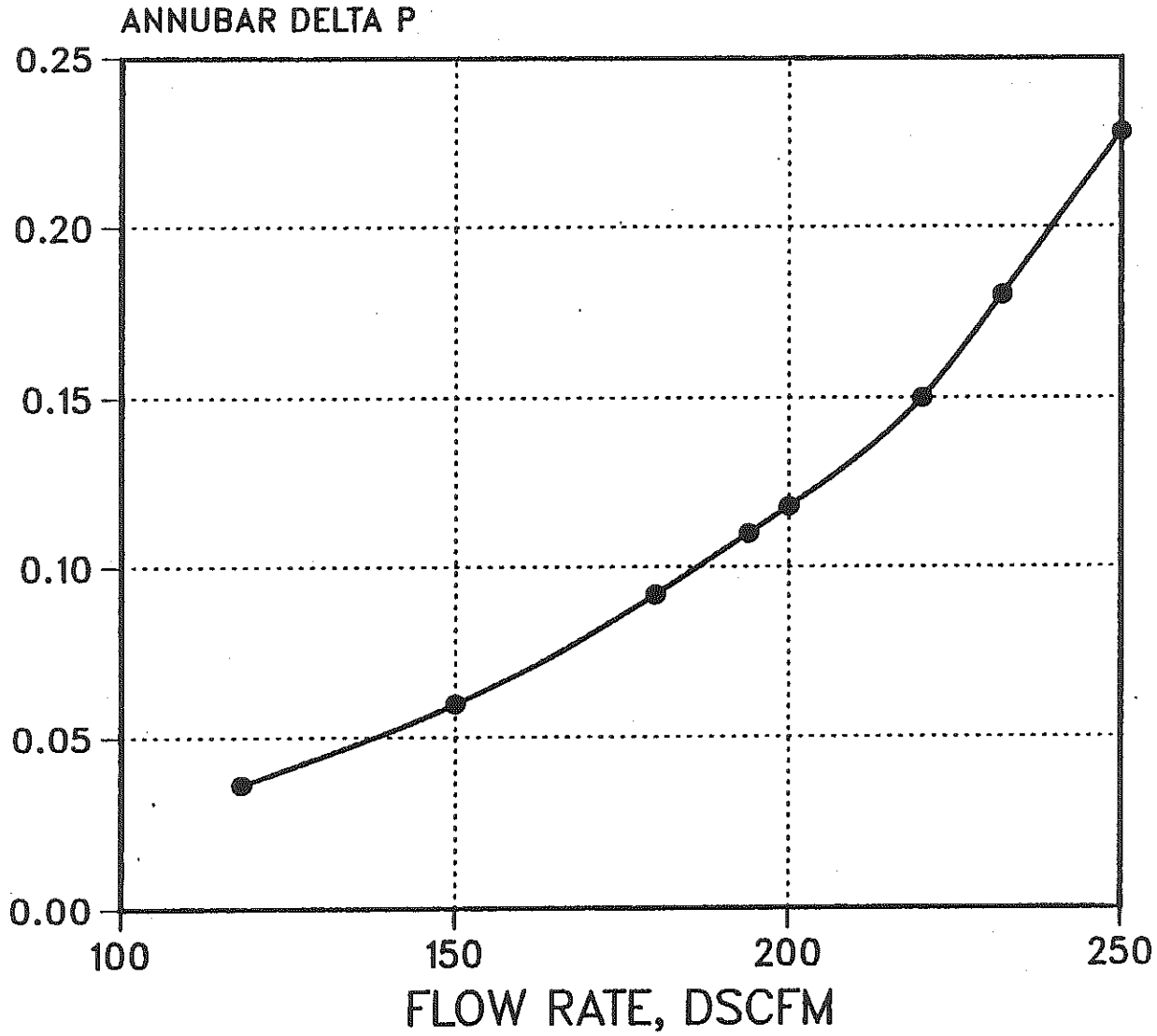
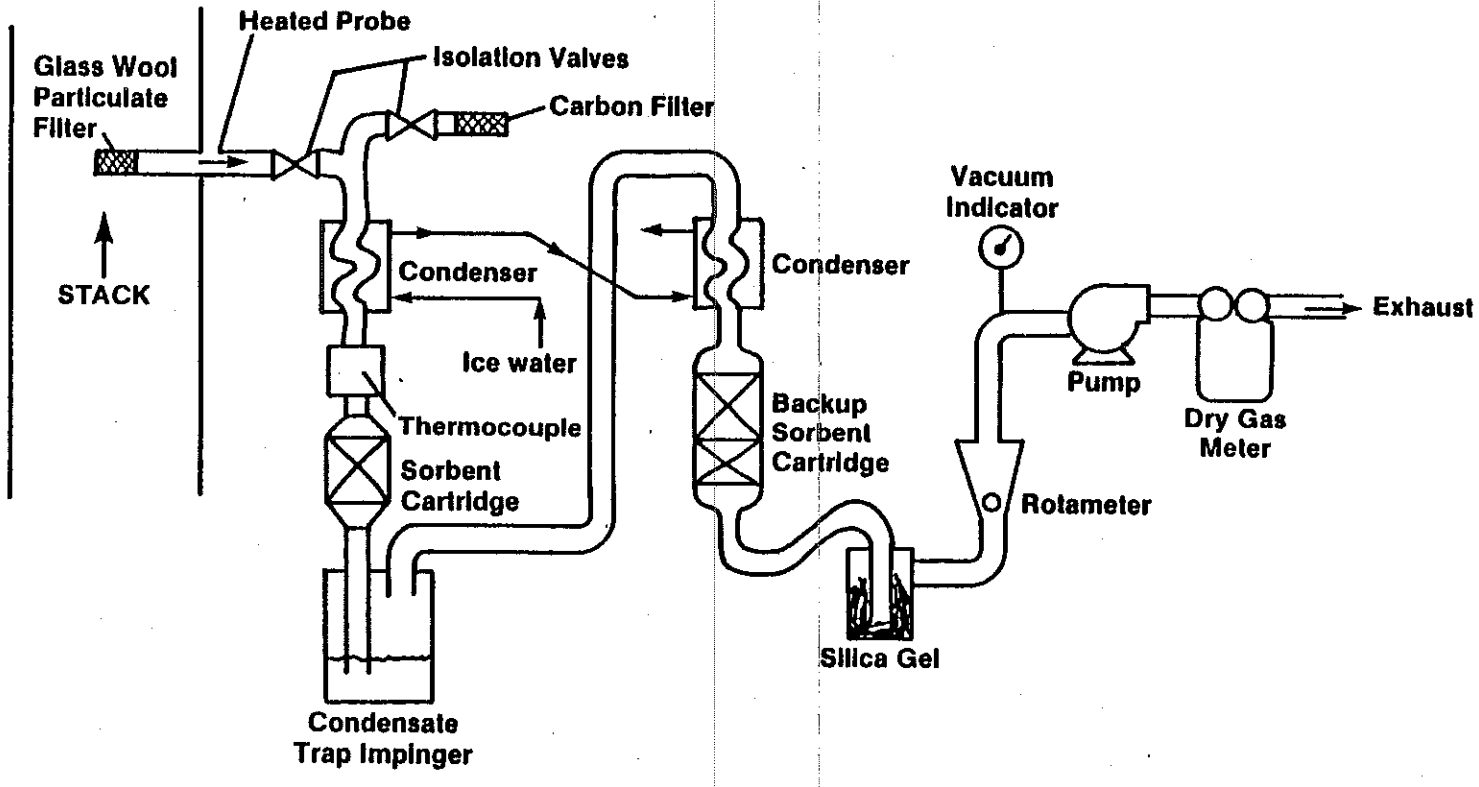


FIGURE 9. CALIBRATION OF MOUND GLASS MELT FURNACE OUTLET ANNUBAR FOR VOLUMETRIC FLOW RATE





SCHEMATIC OF
VOLATILE ORGANIC SAMPLING TRAIN (VOST)

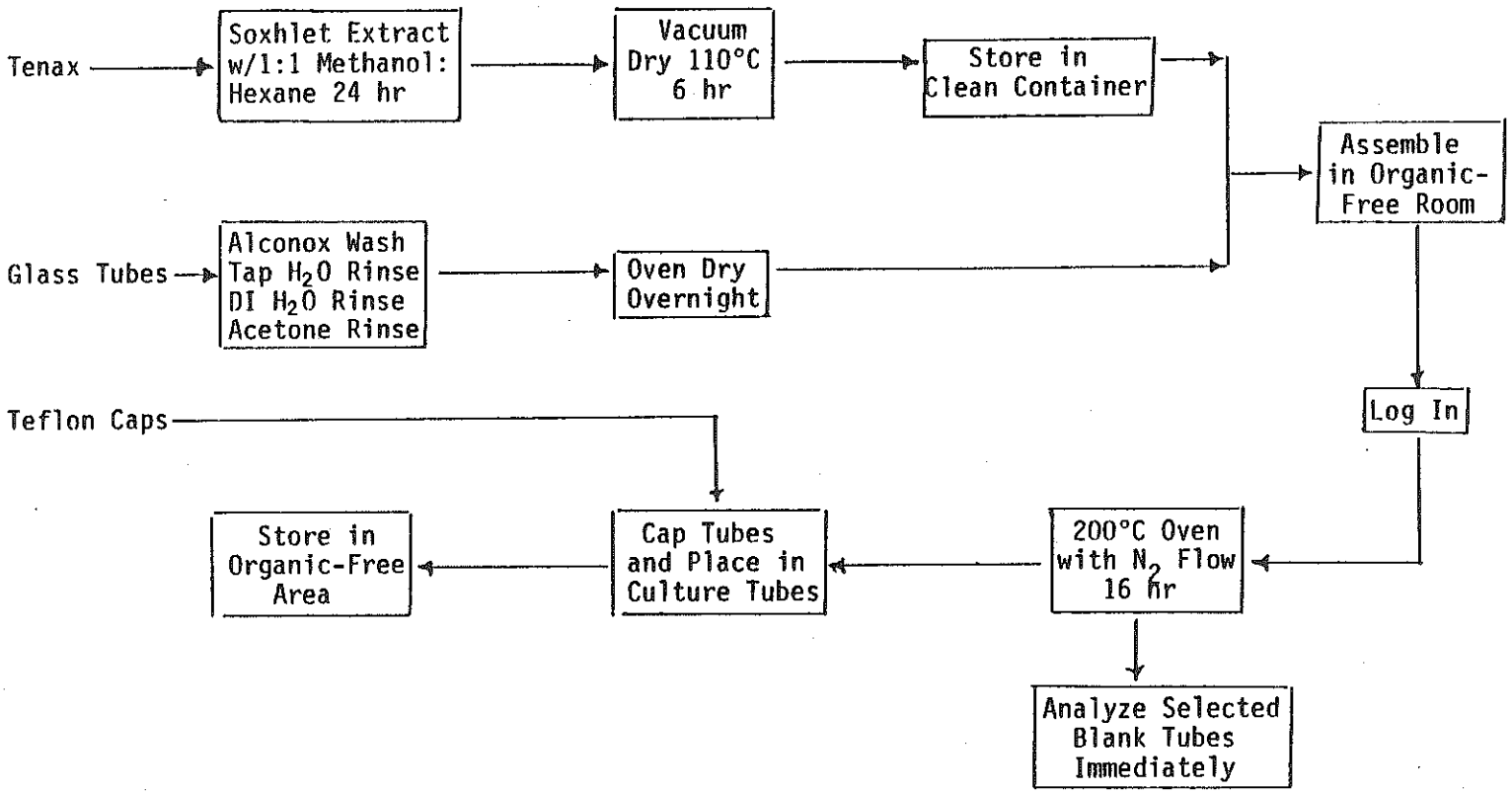


Figure 11. VOST trap cleanup and preparation procedure of Monsanto ESC.

VOST trap analysis followed the protocol outlined in EPA Method 3720 of EPA-SW-846 with one exception: the thermal desorption of the sample into a purge-and-trap apparatus was relaced by thermal desorption directly to a cryogenically-cooled GC column. The volatile POHCs are separated by temperature-programmed gas chromatography and detected by low resolution mass spectrometry. The concentrations of POHCs are calculated using the response factor internal standard technique. The ESC analysis procedure is Method MSAN09, descibed more fully in Appendix B.

Particulate emissions at the scrubber inlet and outlet locations were determined using a modification of EPA Method 5C--Determination of Particulate Emissions From Stationary Sources with Small Stacks or Ducts. Rather than traversing the duct during sample collection, single point sampling in the center of the duct was done; because of the packing gland at the scrubber inlet, traversing was virtually impossible. A water-cooled probe was used at the scrubber inlet location (1130-1470°F). Stainless-steel probe rinsing for the inlet and outlet particulate recovery was accomplished using an innovative Duncan drill brush procedure. The particulate filters and front-half rinse residues were saved for later metals analysis.

The filter and rinse residue samples underwent sample workup according to the procedure outlined in EPA Method 3020 of EPA-SW-846, which is a nitric acid digestion and dilution. Analysis for Arsenic followed the procedures outlined in EPA Method 7060 (atomic absorption, furnace technique), and analysis for Mercury followed the procedures outlined in EPA Method 7470 (atomic absorption, cold-vapor technique). All other metals were analyzed using EPA Method 6010 (inductively coupled plasma method).

Hydrogen chloride was collected in the back half of the EPA Method 5 sampling train in an absorbing solution of 0.1 N NaOH. The HCl is trapped in the dilute solution, forming ionic sodium chloride. Analysis for chlorides was done using a chloride ion specific electrode (ISE) and expanded scale millivolt/pH meter. The analysis procedure is basically a modification of the NIOSH S246 procedure for HCl in air. The collected sample is adjusted to pH 5 with acetic acid, and the chloride ISE reading is taken and compared to an external standards curve prepared from a series of five chloride standard solutions.

One particulate test run at the scrubber inlet location used a Modified Method 5 sampling train and procedures, shown in Figure 12 and outlined in Section 1.2.1.8 of EPA-SW-846 for the determination of polynuclear aromatic hydrocarbon (PAH) emissions. This may be a concern from the burning of waste sludge. The analysis scheme for quantifying the collected PAH is shown in Figure 13.

NOx emissions were determined using the procedures outlined in EPA Method 7, where a grab sample is collected in an evacuated flask containing a dilute sulfuric acid-hydrogen peroxide absorbing solution, and the nitrogen oxides, except nitrous oxide, are measured colorimetrically using the phenoldisulfonic acid (PDS) procedure.

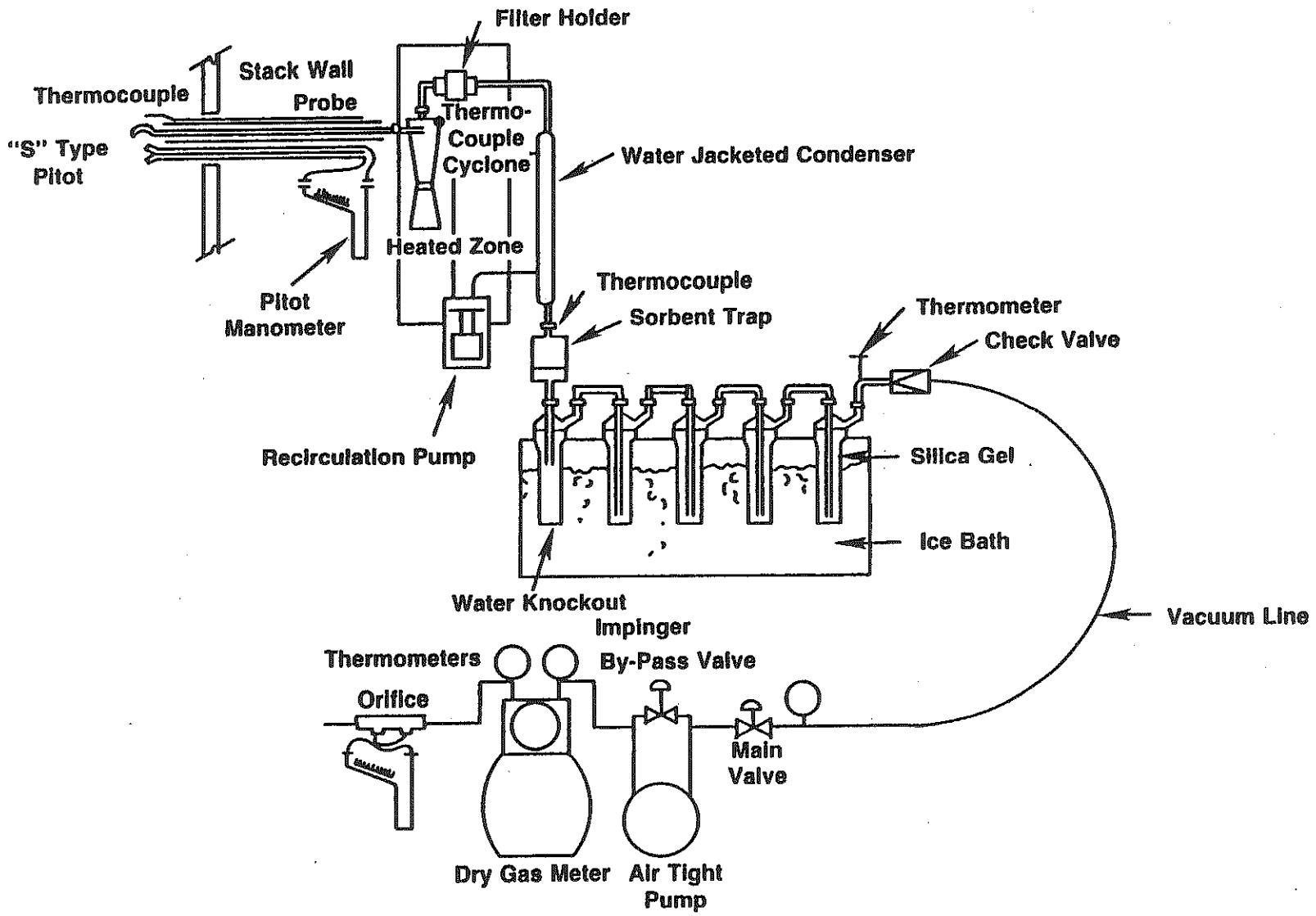


FIGURE 12. MM5 TRAIN SCHEMATIC DIAGRAM.

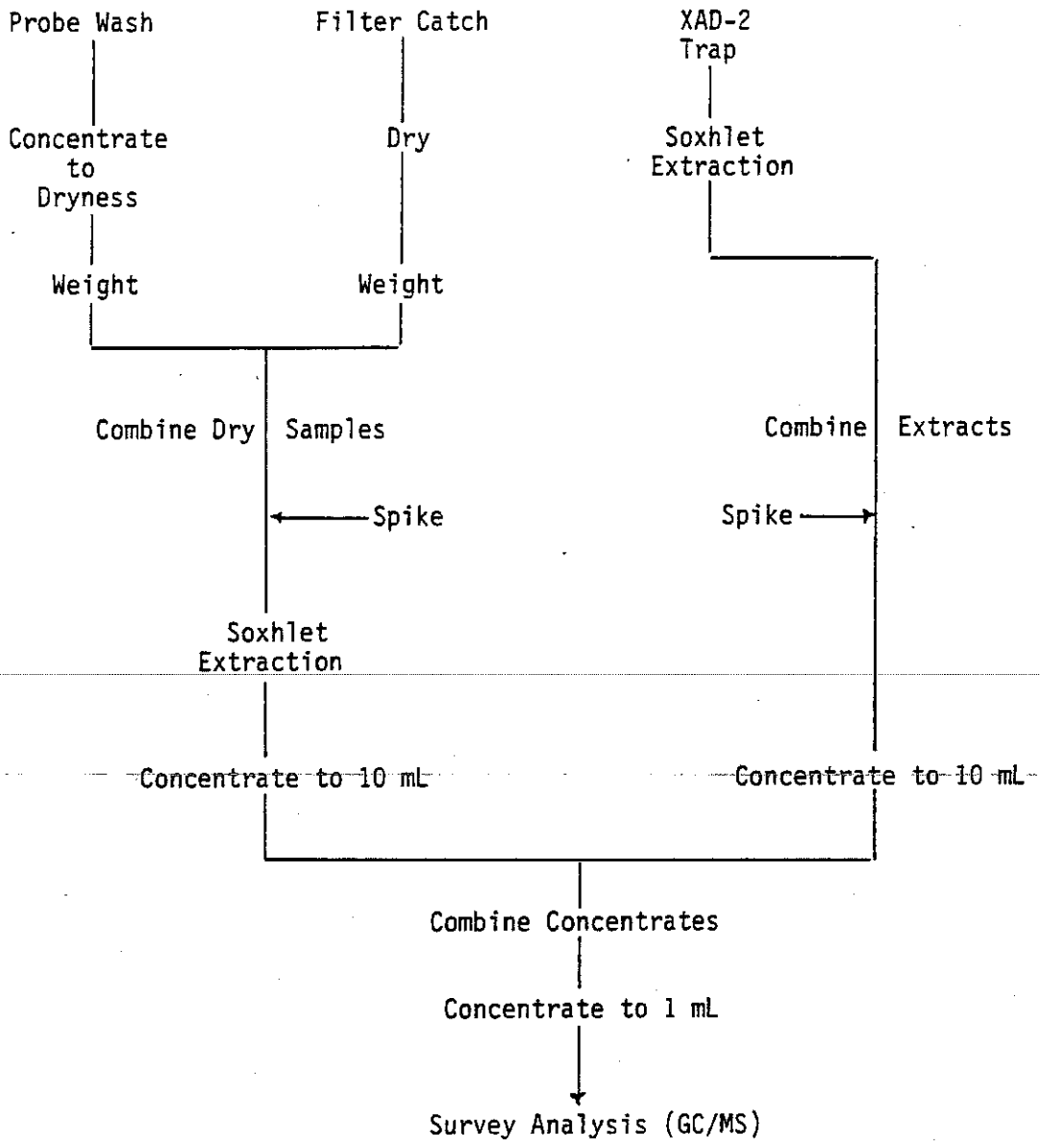


Figure 13. Analysis scheme for modified Method 5 samples.

CO emissions were monitored continuously at the scrubber inlet using EPA Method 10. A sample gas extraction and conditioning system removed particulate matter and moisture before introduction to a Beckman 864 NDIR analyzer. Span gases of zero air (nitrogen), 105 ppm CO, and 1000 ppm CO were used to calibrate the analyzer.

Scrubber water samples were grabbed from a tap which was flushed with several volumes before sample collection. Samples were collected before the first test run and at the conclusion of each test day; no scrubber blowdown occurred during the program duration. Analysis of the scrubber water for metals followed EPA Methods 6010, 7060, and 7470.

At the beginning and end of the glass melt furnace incineration program, a sample of the glass melt was tapped from the furnace for extraction and metals analysis. Because of slight residual radioactive contamination, the glass samples were analyzed at the Mound Laboratory for inorganic constituents with emphasis on cadmium content.

V. QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

The objective of a QA/QC program is to assure that the precision and accuracy of all environmental data generated by or for Monsanto are commensurate with data quality objectives. Data quality objectives for precision and accuracy are established based on the measurement system(s) chosen and on prior knowledge of the data usage. The measurement methods in this program have been validated through studies which used replicates, spikes, collaborative tests, calibrations, and recovery studies.

Data quality objectives in this program were to generate data which would be used strictly for internal corporate purposes and for the performance evaluation of the pilot-scale control units. QA/QC in this program included the use of EPA reference methods for sampling and analysis, adherence to established procedures, method blanks, quantification against prepared standards, redundant data calculation, and chain-of-custody documentation. Most of this information is included in Apendices A and B, which contain the field data sheets, example calculations, analysis request forms, chain-of-custody forms, and analytical reports.

Table 13 presents the VOST Tenax tube field and lab blank analysis results, an important parameter for determining the "cleanliness" of tubes used for trace organic analysis. Because the Tenax tubes are thermally desorbed for GC/MS analysis, no QC data on precision via splits is possible. Previous lab studies on VOST precision have shown about ±15% difference for paired analyses, and field splits (collocated runs) have indicated intralaboratory precisions of about ±15% and interlaboratory precisions of about ±40%, depending on the compound. VOST accuracy is considered acceptable when audit gas analysis is within ±50% of the true value.

TABLE 13. VOST BLANK TUBE QC SUMMARY

VOST Run No.	Tube No.	Compound					
		ACN	AN	CCl4	ClBz	Phenol	Xylene
1	F 1-16	ND	ND	--	--	--	--
1	B 51	ND	ND	--	--	--	--
Lab	2104	ND	ND	--	--	--	--
Lab	2014	ND	ND	--	--	--	--
Lab	17	ND	ND	--	--	--	--
11	F 2081	--	ND	<10	<10	<10	<10
11	B 56	--	ND	<10	ND	<10	<10
Lab	17	--	ND	<10	ND	<10	<10
Lab	17	--	ND	<10	ND	ND	<10
Lab	17	--	ND	ND	ND	ND	ND

Note: Blanks (--) indicate that compound was not analyzed for, and <10 means that the compound had an MS response but was below detection
ND = none detected with a limit of detection of 10 ng
F = front tube in VOST
B = back tube in VOST

All other method blank information is shown on the analysis reports which are compiled in Appendix B - Analysis Reports. No blank contamination problems were experienced in the program.

VI. REFERENCES

1. Dial, C. J. "Hazardous Waste Treatment Research--U.S. ENvironmental Protection Agency." U.S. Environmental Protection Agency, HWERL, EPA/600/M-85/013 (NTIS PB85-176667). March 1985.

2. Peters, J. A. "Sampling Plan for Pilot-Scale Incinerator RCRA Demon-Demonstration at Mound Laboratory." Monsanto Report No. ESC-EAG-P-84-21. October 1984. 50 p.

3. Peters, J. A. "Miniburn Test Results of Residue Combustion at Nitro Plant No. 8 Boiler." Monsanto Report No. MSL-4831 (ESC-EAG-85-20). June 1985.

4. Freeman, H. M. "Innovative Thermal Hazardous Waste Treatment Processes." U.S. Environmental Protection Agency, HWERL, EPA/600/2-85/049 (NTIS PB85-192847). April 1985.

5. Klingler, L. M. and K. M. Armstrong. "Wet Offgas Scrubbing for Radwaste Thermal Processing." U.S. Department of Energy, MLM-3191(OP) (NTIS DE85-002120). March 1985.

APPENDIX A

EXAMPLE CALCULATIONS
FIELD DATA SHEETS
QA/QC DOCUMENTATION

CHAIN OF CUSTODY CHRONICLE PCS # _____

Company: Monsanto Attn: _____

Facility/Site: Monsanto Mound Phone: _____

Address: _____

CONTAINER CONTENTS

BOTTLE				ANALYSIS	SAMPLER		LAB
No	Type	Size	Preserv.		Filt(Y/N)	Observations	Observations
48	?			method 5 Inlet & outlet			
12				" NOx			
18				filters			
				Blanks			
				methylene chloride front PAH			
				HCl			
				receive 6 bag Three			
				going to MRC			

CHAIN OF CUSTODY CHRONICLE

I have received these materials in good condition from the above person.

Name: C D Quinn Signature: Coral Lee Moody

Date: 2/1/85 Time: 1219 Remarks: _____

I have received these materials in good condition from the above person.

Name: _____ Signature: _____

Date: _____ Time: _____ Remarks: _____

I have received these materials in good condition from the above person.

Name: _____ Signature: _____

Date: _____ Time: _____ Remarks: _____

I have received these materials in good condition from the above person.

Name: _____ Signature: _____

Date: _____ Time: _____ Remarks: _____

Particulate

Process _ Samples – Inlet

SAMPLE IDENTIFICATION LOG

MRC Job No. C7-000-760.16-900 Customer Representative LARRY KLINGLER

Contract No. _____ MRC Contract Manager JIM PETERS

Plant Name or Code MOUND Team Leader C DUNCAN

Sampling Location	Run Number	Date Sampled	Type of Sample & No. of Containers	Analysis Required	Sample recovered By (Initials) and Comments.
Inlet	1	1-22-	EPA 5 ; 2	Total Part.	CD. 1 Front & Wash 1 Filter
Inlet	2	1-23	EPA 5 ; 2	Total Part.	CD.
"	3	1/24	"	"	CD
"	4	1/24	"	"	CD
"	5	1/29	"	"	CD
"	6	1/29	"	"	CD
"	7	1/30	"	"	CD
"	8	1/31	"	Total Part. & PAH	CD ↓
"	9				
Blank	1/31	EPA 5 ; 1		PAH	CD

HCl

Process Samples Inlet

SAMPLE IDENTIFICATION LOG

MRC Job No. 07-000-760.16-900 Customer Representative LARRY KLINGLER

Contract No. _____ MRC Contract Manager JIM PETERS

Plant Name or Code MOUND Team Leader C DUNCAN

Sampling Location	Run Number	Date Sampled	Type of Sample & No. of Containers	Analysis Required	Sample recovered By (Initials) and Comments.
Inlet	1	1-22	HCl ; 1	Total HCL	CFD
Inlet	2	1/23	HCL ; 1	Total. HCL	CD
"	3	1/24	"	"	CFD
"	4	1/24	"	"	CFD
"	5	1/24	"	"	CFD
"	6	1/29	"	"	CFD
"	7	1/30	"	"	CFD
"	8	1/31	"	"	CFD

Particulate

Process Samples ~ Outlet

SAMPLE IDENTIFICATION LOG

MRC Job No. 07-000-760.16-900 Customer Representative LARRY KLINGLER

Contract No. _____ MRC Contract Manager JIM PETERS

Plant Name or Code MOUND Team Leader C DUNCAN

Sampling Location	Run Number	Date Sampled	Type of Sample & No. of Containers	Analysis Required	Sample recovered By (Initials) and Comments.
Scrubber Outlet	1	1-22-85	(2) containers 1- Particulate - EPA 5	Part.	QSM 1-filter in petri dish 1-wheaton bottle
" "	2	1-23-85	(2) " "	↑	QSM
" "	3	1-24-85	(2) " "		QSM
" "	4	1-24-85	(2) " "		QSM
" "	5	1-29-85	(2) " "		QSM
" "	6	1-29-85	(2) " "	↓	QSM
" "	7	1-30-85	(2) " "	Part.	QSM
" "	8	1/31/85	(2) " "	Part ~~Blank~~	KJD
" "	9	1/31/85		Part.	↓
			Blanks		
Scrubber Inlet & Outlet		1-31-85	H_2O (1)	HCl	QSM
" " "		1-31-85	0.1 N (NaOH)	HCl	QSM
" " "		1-31-85	Acetone (1)	total part.	QSM
" " "		1-31-85	NO_x (1)	NOx	JAP
" " "		1-31-85	Filter (1)	Hg + As	JAP
" " "		1-31-85	Filter (1)	ICP metals	JAP
" " "		1/31/85	$MeCl_2$	Part. & PAH	CJD JM

HCl

Process Samples – Outlet
SAMPLE IDENTIFICATION LOG

MRC Job No. 07-000-760.16-900 Customer Representative LARRY KLINGLER

Contract No. _____ MRC Contract Manager JIM PETERS

Plant Name or Code MOUND Team Leader C DUNCAN

Sampling Location	Run Number	Date Sampled	Type of Sample & No. of Containers	Analysis Required	Sample recovered By (Initials) and Comments.
Scrubber Outlet	1	1-22-85	1 (1) ~~HCL~~ BACK-HALF -EPA-5	HCL	KJM (1) Wheaton bottle
" "	2	1-23-85	2 (1) HCL- BACK-HALF EPA-5	↓	QSM
" "	3	1-24-85	~~1~~ 2 (1) " "		QSM
" "	4	1-24-85	~~1~~ 2 (1) " "		QSM
" "	5	1-29-85	~~1~~ 2 (1) " "		QSM
" "	6	1-29-85	~~1~~ 2 (1) " "		QSM
" "	7	1-30-85	~~1~~ 2 (1) " "		QSM
" "	8	1/31/85	" "		CFD
" "	9	1/31/85	" "	↓	CFD

NOx
Process Samples - Outlet
SAMPLE IDENTIFICATION LOG

MRC Job No. 07-000-760.16-900 Customer Representative LARRY KLINGLER

Contract No. _____ MRC Contract Manager JIM PETERS

Plant Name or Code MOUND Team Leader C DUNCAN

Sampling Location	Run Number	Date Sampled	Type of Sample & No. of Containers	Analysis Required	Sample recovered By (Initials) and Comments.
SCRUBBER OUTLET	1-A	1-29	NOx abs. soln in plastic bottle (1)	NOx	JSM, CFD
"	1-B	1-29	"	"	JSM, CFD
"	1-C	1-29	"	"	JSM, CFD
"	1-D	1-29	"	"	JSM, CFD
"	2-A	1-30	"	"	CFD, JSM
"	2-B	1-30	"	"	CFD, JSM
"	2-C	1-30	"	"	CFD, JSM
"	2-D	1-30	"	"	CFD, JSM
"	3-A	1/31	"	"	JAP
"	3-B	1/31	"	"	JAP
"	3-C	1/31	"	"	JAP
"	3-D	1/31	"	"	JAP

Process Scrubber Water & Waste Feed-Grab Samples

SAMPLE IDENTIFICATION LOG

MRC Job No. 07-000-760.16-900 Customer Representative LARRY KLINGLER

Contract No. _____ MRC Contract Manager JIM PETERS

Plant Name or Code MOUND Team Leader C DUNCAN

Sampling Location	Run Number	Date Sampled	Type of Sample & No. of Containers	Analysis Required	Sample recovered By (Initials) and Comments.
SCRUBBER TAP	1-SS	1-22	Wheaton Bottle w/liq. (1)	Metals	JAP
"	1-SF	1-22	"	"	JAP
"	2-SF	1-23	"	"	JAP
"	3-SF	1-24	"	"	JAP for Runs 3&4
"	6-SF	1-29	"	"	JAP for Runs 5&6
"	7-SF	1-30	"	"	JAP
SLUDGE FEED	7	1-30	small wide mouth (1)	organics, metals etc.	JAP
SCINTILLATION FLUID	6	1-30	" " (1)	organics	JAP
SLUDGE FEED	9	1-31	" " (1)	organics, metals Btm, H_2O	JAP for runs 8&9
SCRUBBER TAP	9-SF	1-31	Wheaton (1)	Metals	JAP
PCS:	Run	1-SS,	1-SF thru 9-SF for Hg, As		by AAS (total Hg, As)
	then	send	samples to Ind. Testing Labs, St. Louis, MO		

VOST
Process Samples - Outlet
SAMPLE IDENTIFICATION LOG

MRC Job No. 07-000-760.16-900 Customer Representative LARRY KLINGLER

Contract No. _____ MRC Contract Manager VAN PETERS

Plant Name or Code MOAB Team Leader C DUNCAN

Sampling Location	Run Number	Date Sampled	Type of Sample & No. of Containers	Analysis Required	Sample recovered By (Initials) and Comments.
Scrubber Outlet	1-VOST	1-16	Tenax tube in culture tube (1)	GC/MS for AN, ACN	JAP field blank #1-16
"	1-VOST	1-16	"	"	JAP field blank #51
"	2-VOST	1-22	"	"	JAP #10
"	2-VOST	1-22	"	"	JAP #2107
"	3-VOST	1-22	"	"	JAP #2121
"	3-VOST	1-22	"	"	JAP #55
"	4-VOST	1-23	"	"	JAP #1801
"	4-VOST	1-23	"	"	JAP #1785
"	5-VOST	1-23	"	"	JAP #2123
"	5-VOST	1-23	"	"	JAP #2072
"	6-VOST	1-23	"	"	JAP #36
"	6-VOST	1-23	"	"	JAP #2026
"	7-VOST	1-24	"	GC/MS for CCl_4, Cl_2, phenol, etc	JAP #2018
"	7-VOST	1-24	"	"	JAP #2143
"	8-VOST	1-24	"	"	JAP #5
"	8-VOST	1-24	"	"	JAP #2097
"	9-VOST	1-24	"	"	JAP #29
"	9-VOST	1-24	"	"	JAP #79
"	10-VOST	1-24	"	"	JAP #72
"	10-VOST	1-24	"	"	JAP #1-24
"	11-VOST	1-29	"	"	JAP #56 Field Blank
"	11-VOST	1-29	"	"	JAP #2041 Field Blank
"	12-VOST	1-29	"	"	JAP #1783
"	12-VOST	1-29	"	"	JAP #1778

VOST
Process Samples - Outlet
SAMPLE IDENTIFICATION LOG

IRC Job No. 07-000-760.16-900 Customer Representative LARRY KLINGLER

Contract No. _____ MRC Contract Manager VIM PETERS

Plant Name or Code Mocad Team Leader C DUNCAN

Sampling Location	Run Number	Date Sampled	Type of Sample & No. of Containers	Analysis Required	Sample recovered By (Initials) and Comments.
SCRUBBER OUTLET	13-VOST	1-29	Tenax tube in culture tube (1)	GC/MS for CCl_4, @ Cl, phenol, etc.	JAP # 44
"	13-VOST	1-29	"	"	JAP # 1757
"	14-VOST	1-29	"	"	JAP # 1777
"	14-VOST	1-29	"	"	JAP # 2144
"	15-VOST	1-30	"	CCl_4, PN, chlorobenz, phenol	JAP # 39
"	15-VOST	1-30	"	"	JAP # 1-30
"	16-VOST	1-30	"	"	JAP # 2062
"	16-VOST	1-30	"	"	JAP # 2-30
"	17-VOST	1-30	"	"	JAP # 2099
"	17-VOST	1-30	"	"	JAP # 2163
"	18-VOST	1-31	"	"	JAP # 1789
"	18-VOST	1-31	"	"	JAP # 2135
"	19-VOST	1-31	"	"	JAP # 1753
"	19-VOST	1-31	"	"	JAP # 1791
"	20-VOST	1-31	"	"	JAP # 1502
"	20-VOST	1-31	"	"	JAP # 2100

W_{IN}

Run #	AN, g/min	ACN, g/min
2	9.80	251.46
3	9.80	251.46
4	19.43	291.42
5	19.43	291.42
6	10.13	151.95

$\frac{lb}{hr} \times \frac{hr}{60\,min} \times \frac{453.57\,g}{lb} = g/min$

W_{OUT} $\quad ng/L = \mu g/m^3$

Run #	AN, ng	ACN, ng	V_{mstd} L	C_{AN} ng/L	C_{ACN} ng/L	Q m^3/hr	AN $\mu g/min$	ACN $\mu g/min$
2	27	261	23.096	1.169	11.301	570.86	11.12	107.5
3	< 10	35	18.755	0.533	1.866	570.86	< 5.07	17.75
4	~ 10	~ 50	18.302	0.546	2.732	446.16	~ 4.06	~ 20.3
5	< 10	64	18.977	0.501	3.373	446.16	< 3.73	25.08
6	< 10	45	15.115	0.662	2.977	446.16	< 4.92	22.14

40% breakage

$\frac{m^3}{hr} \times \frac{hr}{60\,min} = \frac{m^3}{min}$

$\frac{\mu g}{min} \times \frac{1000\,ng}{\mu g} \times \frac{60\,min}{hr} =$

W_OUT — ng/L = µg/m³

EPA 5 Run	Outlet Flow dscfm	dscm/hr	Sample Vol. dsm³		ng AN	CCl4	ClBz	Ph	Xyl	AN	CCl4	ClBz	Ph	Xyl
				V7	13.005L	~~X~~	<10	<10	11	15	X	<0.77	<0.77	0.846	1.153
4 (7-10)	313	531.8		V8	14.943	~~X~~	<10	<10	<10	17	X	<0.67	<0.67	<0.67	1.138
				V9	22.166	~~X~~	<10	<10	<10	15	X	<0.45	<0.45	<0.45	0.677
				V10	10.534	~~X~~	<10	<10	<10	18	X	<0.95	<0.95	<0.95	1.709
5 (12)	383	650.7		V12	17.019	~~X~~	<10	<10	<10	<10	X	<0.59	<0.59	<0.59	<0.59
6 (13-14)	413	701.7		V13	14.192	~~X~~	<10	17	<10	424	X	<0.705	1.198	<0.705	29.876
				V14	15.550	~~X~~	<10	<10	<10	<10	X	<0.64	<0.64	<0.64	<0.64
7 (15-17)	156	265.0		V15	13.574	<10	<10	86	83	41	<0.74	<0.74	6.336	6.115	3.02
				V16	31.628	<10	<10	72	12	20	<0.32	<0.32	2.276	0.38	0.632
				V17	17.390	<10	13	29	<10	329	<0.575	0.748	1.668	<0.575	18.919
8 (18-19)	156	265.0		V18	14.533	<10	<10	31	<10	287	<0.69	<0.69	2.133	<0.69	19.748
				V19	20.625	<10	<10	160	<10	432	<0.48	<0.48	7.758	<0.48	20.945
9 (20)	195	331.3		V20	20.203	~~28~~	<10	109	<10	222	1.287 ~~<0.495~~	<0.495	5.395	<0.495	10.988

no W_{IN} all PICs from sludge combustion

µg/hr

AN	CCl4	ClBz	Ph	Xyl
X	~~<1.005E-3~~ 409.5	~~<1.446E-3~~ 356.3	~~<1.446E-3~~ 409.5	~~<1.446E-3~~ 449.9	613.2
X	~~<1.446E-3~~ 356.3	~~<1.446E-3~~ 356.3	~~<1.446E-3~~ 356.3	~~<1.446E-3~~ 356.3	605.2
X	~~<1.446E-3~~ 356.3	~~<1.206E-3~~ 297.3	~~<1.206E-3~~ 297.3	~~<1.206E-3~~ 297.3	360.6
X	~~<1.446E-4~~ 505.2	~~<1.446E-4~~ 505.2	~~<1.446E-4~~ 505.2	~~<1.446E-4~~ 505.2	906.8
X	~~<1.786E-3~~	~~<1.786E-3~~	~~<1.786E-3~~	~~3.214E-3~~
X	~~<9.[illegible]~~ 383.9			

AN	CCl4	ClBz	Ph	Xyl
X	~~<1.005E-3~~ 494.7	~~1.446E-3~~ 840.6	~~<1.005E-3~~ 494.7	~~4.815E-3~~ 20,957.7
X	~~<9.[illegible]~~ 449.1			

AN	CCl4	ClBz	Ph	Xyl
~~<2.[illegible]E-3~~ 196.1	~~<2.[illegible]E-3~~ 196.1	~~2.[illegible]E-2~~ 1679	~~8.[illegible]E-2~~ 1620	~~1.[illegible]E-2~~ 800.3
~~<1.[illegible]E-3~~ N.D.	~~<1.[illegible]E-3~~ 84.5	~~8.[illegible]E-3~~ 603.1	~~1.[illegible]E-3~~ 100.7	~~2.[illegible]E-3~~ 167.5
~~<1.[illegible]E-3~~ 153.4	~~<1.[illegible]E-3~~ 191.2	~~6.[illegible]E-3~~ 442.0	~~2.[illegible]E-3~~ 152.4	~~7.[illegible]E-3~~ 521.1
~~<2.[illegible]E-3~~ 182.9	~~2.[illegible]E-3~~ 182.9	~~6.[illegible]E-3~~ 566.2	~~<2.[illegible]E-3~~ 182.9	~~7.[illegible]E-3~~ 521.5
~~<2.[illegible]E-3~~ 137.2	~~<2.[illegible]E-3~~ 137.2	~~8.[illegible]E-3~~ 205.6	~~<2.[illegible]E-3~~ 137.2	~~7.[illegible]E-3~~ 5550
<1.611E-3	<1.811E-3	~~8.[illegible]E-3~~	~~<1.[illegible]E-3~~	~~7.[illegible]E-3~~ 5550

~~3.[illegible]E-3~~ 426.4	~~<1.484E-3~~ <1640	~~1.284E-3~~ 1787	~~<1.484E-3~~ <1664.0	~~23.[illegible]E-3~~ 3640

W_{IN} g/hr

VOST #	AN	CCl4	ClBz	Ph	Xyl
7-10	X	289.4	318.3	332.8	38.5
12	X	401.2	498.0	373.5	53.7
13-14	X	622.2	772.3	579.3	83.3
15-17	850.9	911.7	607.8	729.3	X
18-19	1130.3	1211.0	847.7	968.8	X
20	711.2	762.0	533.4	609.6	X

Outlet Stack Gas Parameters

Run#	Gas Temp, °F	% H_2O	Gas Velocity, ft/s	Volumetric Flow acfm	dscfm
1	200.8	20	46.34	584	366
2	194.2	14	36.50	460	313
3	187	16	39.34	496	329
4	208	22	41.66	525 ~~[illegible]~~	313
5	180	13	43.04	542	383
6	203	23	54.37	685	413
7	114	1.0	13.87	175	156
8	110	1.7	13.94	176	156
9	113	1.5	17.46	220	195

~~[illegible]~~

$$V_{m_{std}} = (17.64)(Y)\frac{V_m P_{bar}}{(T_m + 460)}$$

17.64 × 1.019 × 28.316 = 508.985

ng/L = µg/m³

DRE's

Compound

one-millionth to one-ten-millionth

VOST Run #	AN	CCl_4	$ClBz$	Phenol	Xylenes
7	X	> 99.99986 ✓	> 99.99987 ✓	99.99987 ✓	99.9984 ✓
8	X	> 99.99988 ✓	> 99.99989 ✓	> 99.99989 ✓	99.99843 ✓
9	X	> 99.99992 ✓	> 99.99993 ✓	> 99.99993 ✓	99.99906 ✓
10	X	> 99.99983 ✓	> 99.99984 ✓	> 99.99985 ✓	99.99764 ✓
12	X	> 99.99990 ✓	> 99.99992 ✓	> 99.99990 ✓	> 99.99929 ✓
13	X	> 99.99992 ✓	99.99989 ✓	> 99.99992 ✓	99.97484 ✓ ←
14	X	> 99.99993 ✓	> 99.99994 ✓	> 99.99992 ✓	> 99.99954 ✓
15	> 99.99998	> 99.99998 ✓	99.99972 ✓	99.99978 ✓	X
16	> 99.99999	> 99.99999 ·	99.99990 ✓	99.99998 ✓	X
17	> 99.99998	99.99998 ✓	99.99993 ✓	> 99.99998 ✓	X
18	> 99.99998	> 99.99998 ✓	99.99993 ✓	> 99.99998 ✓	X
19	> 99.99999	> 99.99999 ·	99.99976 ✓	> 99.99999 ·	X
20	99.99994	> 99.99998 ✓	99.99966 ✓	> 99.99997 ✓	X

Nines

3	4	5	6	7
1	3	18	28	6

99.99537 (16)

S = 0.009037

CV =

		PM			HCl		
Waste	Run#	IN	%Eff	OUT	IN	OUT	%Eff
ACN	1	0.0524	46.6	0.0280	<0.0006	0.0045	Neg
ACN	2	0.0931	55.3	0.0416	0.0015	<0.0014	—
Ker	3	0.154	56.1	0.0676	0.737	<0.0013	>99.8
Ker	4	0.166	58.0	0.0698	2.101	0.0014	99.9
Ker	5	0.193	60.8	0.0756	1.000	<0.00084	>99.9
Ker	6	0.2475	66.9	0.0820	1.289	<0.0018	>99.8
Sludge	7	0.358	78.6	0.0766	0.892	0.0022	99.8
Sludge	8	0.1295	52.7	0.0612	0.394	0.0018	99.5
Sludge	9	0.552	84.7	0.0844	1.938	0.0095	99.5

Cadmium

Scrubber

6-SF end of non CdO scrubbing, conc = $< 0.05\ mg / 0.855\ L = < 0.058\ mg/L$

7-SF conc = $0.21\ mg / 583\ mL = 0.360\ mg/L \Rightarrow 391\ mg$ total

9-SF conc = $0.16\ mg / 573\ mL = 0.279\ mg/L \Rightarrow 303\ mg$ total / 6 hr

1,086 L H_2O in total scrubber system $= 50.5\ mg/hr$

7 IN		8 IN		9 IN	
Filter	Beaker	F	B	F	B
200,000 µg	59,000	89,000 µg	50,000	81,000	52,000
259 mg		139 mg		133 mg	

7 OUT		8 OUT		9 OUT	
F	B	F	B	F	B
4,100		35,000 µg	1,200	27,000	1,000
	5.1	36.2 mg		28. mg	

Nickel + chromium show up in inlet samples
degraded product of SS

500 g IN TO FURNACE TOTAL

7 IN ⇒ 0.06895 lb/hr = 31.3 g/hr
7 out ⇒ 0.001444 = 0.655 g/hr } 98% control

8 IN ⇒ 0.0636 = 28.84
8 out ⇒ 0.02025 = 9.18 } 68% control

9 IN ⇒ 0.0601 = 27.24
9 out ⇒ 0.01712 = 7.76 } 71.5%

~~859~~ 324 g CdO (Cd/CdO = 112.4/128.4 = 0.875) ⇒ $\frac{284\ g\ Cd}{6\ hr} = 47.3\ g/$

380 g CdO = $\frac{332\ g\ Cd}{2000\ lb\ \frac{454\ g}{lb}} = 36\ ppm$ (7) 500 g × 0.875 / 6 hr = 120 g/hr

62%
39%
42%

2 - 2083
3 - 2118
4 - 2031
27 - 2054

NC$_x$

$$V_{sc} = 17.64\,(V_f - 25)\left[\frac{P_f}{T_f} - \frac{P_i}{T_i}\right]$$

T in °R, P in bar-vac (abs)

	Run		P_i	P_f	T_i	T_f	V_f	V_{sc}	m	C	lb/hr
	1A	2/2	1.85	30.87	526	525	2083	2006.7	144.85	4.51E-6 (37.8)	0.1077
	1B	3/3	2.11	29.87	526	525	2118	1952.2	24.11	7.71E-7 (6.5ppm)	0.0184
1/29	1C	4/4	2.11	29.77	526	525	2031	1864.3	32.18	1.08E-6 (9.0)	0.0257
23,890 dscfh	1D	27/27	2.11	28.57	526	525	2054	1803.9	40.96 cv=89	1.42E-6 (11.9)	0.0339
	2A	2/2	2.02	28.97	524	524	2083	1867.1	245.25	8.22E-6 (69)	0.0770
1/30	2B	3/3	2.07	28.77	524	524	2118	1874.2	181.35	6.04E-6 (51)	0.0566
	2C	4/4	2.02	29.17	524	524	2031	1833.4	213.55	7.27E-6 (61)	0.0682
9,372	2D	27/27	2.07	29.07	524	524	2054	1844.2	225.25	7.63E-6 (64)	0.0715
	3A	2/2	1.91	28.82	524	525	2083	1864.3	124.35	4.16E-6 (35)	0.0488
1/31	3B	3/3	3.21	28.52	524	525	2118	1783.3	109.75	3.84E-6 (32)	0.0450
11,714	3C	4/4	2.11	28.82	524	525	2031	1803.7	128.75	4.46E-6 (37)	0.0522
	3D	27/27	2.41	28.92	524	525	2054	1810.8	59.98	2.07E-6 (17)	0.0242

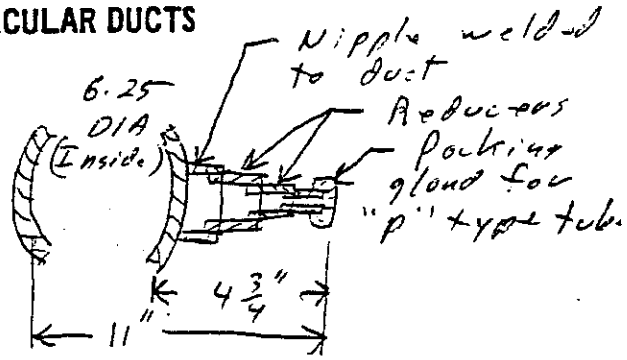
$$C = 6.243E\text{-}5\ \frac{m}{V_{sc}}$$

C = lb/dscf

$$\frac{lb}{dscf} \times 1.6018E7 = \frac{mg}{m^3} \times \frac{24.04}{46} = ppm$$

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT Monsanto Mound
DATE Jan 14, 1983
SAMPLING LOCATION Scrubber Outlet
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) ~~11.75~~ 11.00
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 4.75
STACK I.D., (DISTANCE A - DISTANCE B) 6.25
NEAREST UPSTREAM DISTURBANCE
NEAREST DOWNSTREAM DISTURBANCE
CALCULATOR CD



SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	4.4	6.25	0.28	4.75	5.03 Too Close
2	14.6		0.91		5.66 5-5/8
3	29.6		1.85		6.60 6-5/8
4	70.4		4.40		9.15 9-1/8
5	85.4		5.34		10.09 10-1/8
6	95.6		5.98		10.73 Too Close

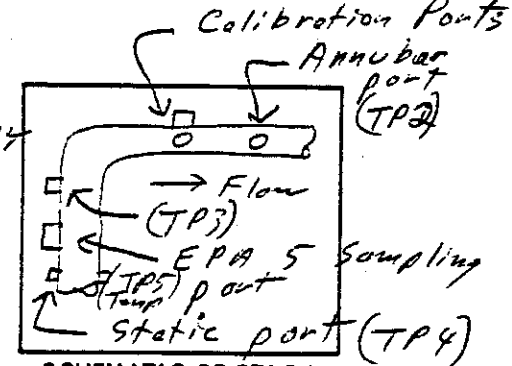
PLANT: [illegible] LOCATION: [illegible] I.D. #

INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY)	1	2	3	4
				RUN #:	TP1	TP1	TP1	TP1
Load EPA-5 (revised) Side 1				DATE:	1-15-85	1-15-85	1-15-85	1-15-85
Store variables				TIME:	1030 HRS	1045	1100	1115
Meter volume	V_m	ft^3	ENTER					
Barometric pressure	P_{bar}	In. Hg	ENTER					
Pressure diff. on orifice	ΔH	In. H_2O	ENTER					
Meter temperature	T_m	Deg F	A	V_m				
Meter calibration factor	Y		ENTER					
Volume water in imp.	V_{wc}	ml	ENTER					
Volume water in sil gel	V_{wsg}	gm	ENTER					
Particulate collected	M_n	mg	R/S	Y				
Compute volume meter standard			B	$V_m(std)$				
Compute volume water standard			R/S	$V_{wc}(std)$				
Compute percent moisture			R/S	B_{ws}				
Compute mass loading	concentration	grn/DSCF	R/S	C's'				
	concentration	lb./DSCF	R/S	C_s				
Load EPA-2								
Stack temperature	Ts AVG	Deg F	STO 2		78.8	89	104	150
Average velocity head	$\sqrt{\Delta P}$		STO 3		0.27	0.15	0.25	0.32
Pitot tube calibration	C_p		STO 4		0.99	0.99	0.99	0.99
Absolute stack pressure	P_s	In. Hg	STO 5		29.38	29.38	29.38	29.39
Dry molecular weight	M_d	AIR	STO 6		29.0	29.0	29.0	29.0
Mole fraction H_2O	B_{wo}		STO 7		0.018	0.015	0.026	0.030
Compute velocity	V_s	FPS	B	V_s AVG	18.23	10.22	17.30	23.82
Stack area	A	ft^2	STO 9		0.21	0.21	0.21	0.21
Compute stack flow rate	Q_s	DSCFM	C	Q_s	13028	7159	11713	13886
Dry Standard		DSCFM	Q ÷ 60		217	120	195	231
Actual Vs x A x 60		ACFM			230	129	218	293

					TP3	TP3	TP3	TP3
	T_s Avg		Sto. 2		89	99	164	169
	$\sqrt{\Delta P}$		Sto 3		0.26	0.15	0.26	0.35
	C_p		Sto. 4		0.99	0.99	0.99	0.99
	P_s		Sto 5		29.38	29.38	29.38	29.39
	M_d		Sto. 6		29.0	29.0	29.0	29.0
	B_{wo}		Sto 7		0.018	0.015	0.026	0.030
	V_s		B	V_s Avg	17.72	10.31	18.15	25.69
	A		Sto 9		0.21	0.21	0.21	0.21
	Q_s	DSCFM	C	Q_s	12429	7124	12075	15015
Compute mass loading		DSCFM	A÷60		207	119	201	250
Emission Rate lbs/hr	Q_s (DSCFM) × C (lbs/DSCF) ACFM				223	130	229	324
	Isokinetic				3%	1%	5%	10%
Data Reduction By: (Initials)								

EPA METHOD 2
VELOCITY TRAVERSE DATA AND CALIBRATION OF ANNUBAR (TP1)

PLANT MONSANTO MOUND
LOCATION SCRUBBER OUTLET
DATE JAN 15, 1985 RUN NO. PRELIMINARY
STACK INNER DIAMETER, (in.) 6.25
BAROMETRIC PRESSURE, (in. Hg) 29.38
CROSS SECTIONAL AREA, (ft²) 0.21
OPERATORS CD, JP, JM
PITOT TUBE I.D. NO. 2 FT
AVG. COEFFICIENT, Cp = 0.99
LAST DATE CALIBRATED NEW FROM FACTORY JAN, 1985



SCHEMATIC OF STACK CROSS SECTION

Note: ~ 10° F ΔT Between TP5 & TP2

TRAVERSE PT. No.	Traverse TP1 VEL. Hd. Δp (in.) H_2O	STACK TEMPERATURE t_s (°F) TP5	Annubar $\sqrt{\Delta p}$ TP2	Positive P_g (in. Hg) TP4	EPA 5 ΔP TP3	
A1	0.07	88	0.11	+0.05	0.07	
2	.06	88	0.11	+0.05	0.07	Sat. Exit mist
3	.08	88	0.11	+0.05	0.07	
4	.09	88	0.11	+0.05	0.07	60°F
B1	.06	90	0.11	+0.05	0.07	
2	.05	90	0.11	+0.05	0.07	$\frac{.5218}{29.38}$ = 1.8
3	.08	90	0.11	+0.05	0.07	
4	.08 Avg √.27	90 Avg (88.8)	0.11 Avg √.33	+0.05	0.07	(√.26 avg)
B1	.02	94	0.04	-0.03	0.02	
2	.02	98	0.04	-0.03	0.02	Sat.
3	.025	98	0.04	-0.03	0.025	
4	.020	98	0.04	-0.03	0.025	64°F
A1	.020	100	0.04	-0.03	0.025	
2	.020	100	0.035	-0.03	0.020	$\frac{.6009}{29.38}$ = 2.1
3	.025 Avg √.15	102	0.030	-0.03	0.020	
4	.030	104 Avg (99)	0.030	-0.03	0.020	(√.15 avg)
A1	.060	112	0.11	+0.05	0.070	Sat.
2	.06	114	0.11	+0.05	0.07	
3	.06	114	0.11	+0.05	0.07	71°F
4	.08	114	0.11	+0.05	0.07	
B1	.06	114	0.11	+0.05	0.07	$\frac{.7648}{29.38}$ = 2.6
2	.05	114	0.11	+0.05	0.07	
3	.08	115	0.11	+0.05	0.07	
4	.07	115	0.11	+0.05	0.07	(√.26 avg)
	√.25	(Avg 114)	Avg √.33			
		AVERAGE				

1030 HRS

Low Flow thru furnace Bypass Air at Blower

Mid flow thru furnace

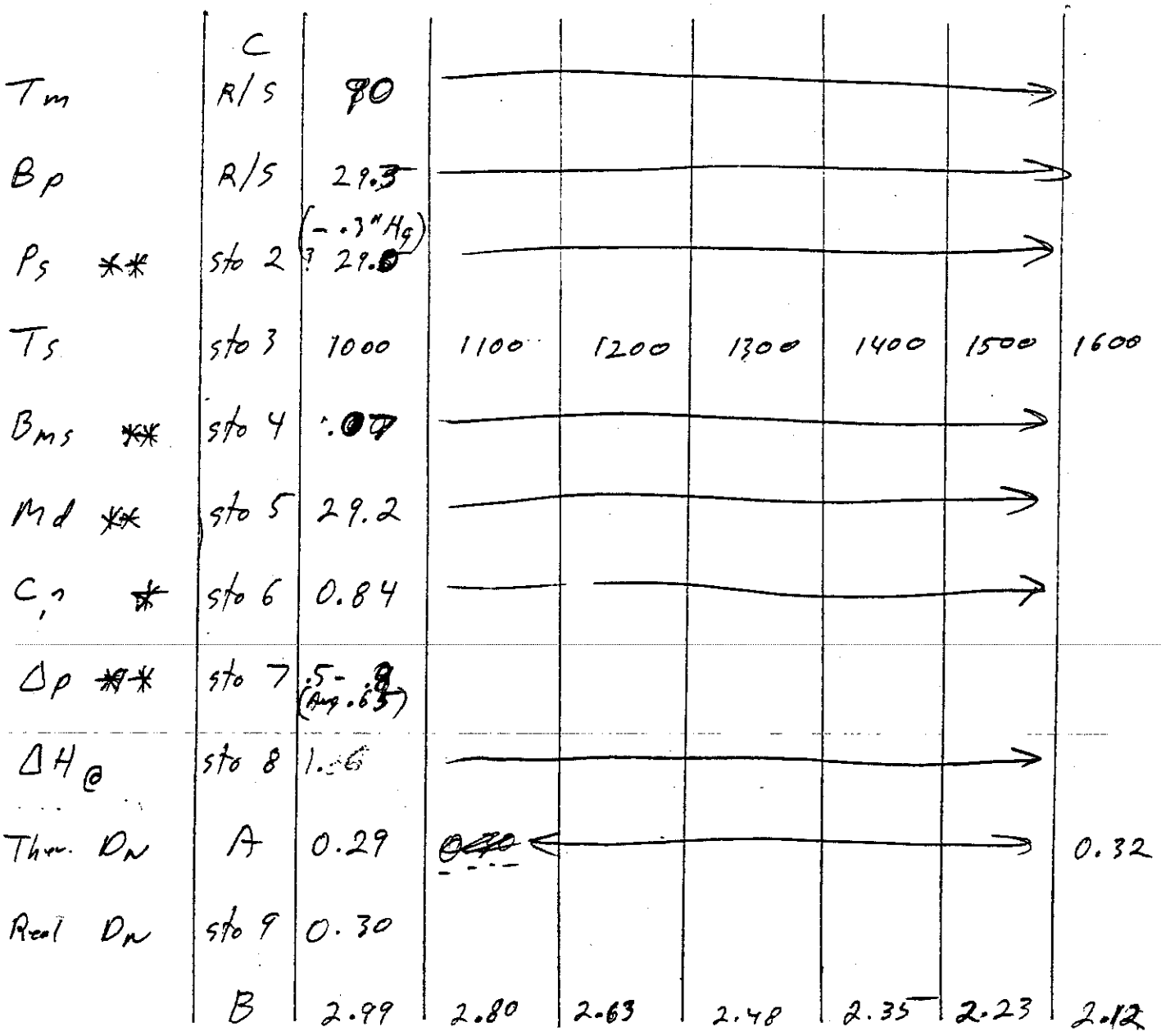
Mid flow thru furnace (Same as low flow)

Inlet & Outlet

PLANT: Monaco LOCATION: Scrubber I.D. #

	INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY) RUN #:	traverse	single point	1.9" Type	Traverse
Line	Load EPA-5 (revised) Side 1				DATE:	1-22	1-22	1-22	1-23
4	Store variables				TIME:	Inc.	Start	- Up	
	Meter volume	V_m	ft^3	ENTER					
6	Barometric pressure	P_{bar}	In. Hg	ENTER					
	Pressure diff. on orifice	ΔH	In. H_2O	ENTER					
	Meter temperature	T_m	Deg F	A	V_m				
	Meter calibration factor	Y		ENTER					
	Volume water in imp.	V_{wc}	ml	ENTER					
	Volume water in sil gel	V_{wsg}	gm	ENTER					
	Particulate collected	M_n	mg	R/S	Y				
2	Compute volume meter standard			B	$V_{m(std)}$				
	Compute volume water standard			R/S	$V_{wc(std)}$				
	Compute percent moisture			R/S	B_{ws}				
	Compute mass loading	concentration	grn/DSCF	R/S	C'_s				
3		concentration	lb./DSCF	R/S	C_s				
	Load EPA-2								
7	Stack temperature	Ts AVG	Deg F	STO 2		193	193	1369	196
	Average velocity head	$\sqrt{\Delta P}$		STO 3		.53	.55	1.0	.42
	Pilot tube calibration	C_p		STO 4		.99		.84	.99
	Absolute stack pressure	P_s	In. Hg	STO 5		29.33		29.30	29.28
	Dry molecular weight	M_d		STO 6		29.2		29.2	29.23
1	Mole fraction H_2O	B_{wo}		STO 7		.17		.07	.18
5	Compute velocity	V_s	FPS	B	V_s AVG	60.5		106.4	32.3
	Stack area	A	ft^2	STO 9		0.21	0.21	0.88	0.21
	Compute stack flow rate	Q_s	DSCFM	C	Q_s	20152		18136	15753
	Dry Standard		DSCFM	Q ÷ 60		336		302.3	262.6
	Actual Vs x A x 60		ACFM			510		1150	406
	Load EPA-5 (revised) side 2								
	Store variables	B_{ws}		STO 5					
		$V_{m(std)}$		STO 7					
		lb./DSCF		STO 8					
	Stack temperature	T_s	Deg F	ENTER					
	Sampling time	θ	min	ENTER					
	Stack gas velocity	V_s	ft/sec	A					
	Abs. stack gas pressure	P_s	In. Hg	ENTER					
	Nozzle area	A_n	ft^2						
	Percent Isokinetic			R/S	%I				
	Compute mass loading	concentration	gm./DSCM	B	C "S"				
	Emission Rate (lbs/hr)	Q_s (DSCFM)	X	C_s (lbs/DSCF)					
		Pollutant:							
	Data Reduction By: (Initials)								

NOMOGRAPH HP-65
INLET SCRUBBER
EPA 5



* Assumed - based on design
** Based on previous runs

EPA METHOD 5 NOMOGRAPH (HP-65)

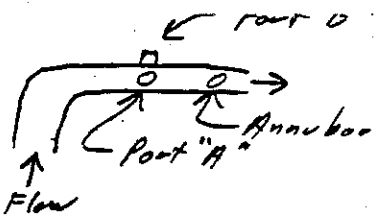
PLANT Mound USED ON RUN NO.:

DATE CALCULATOR:

SAMPLING LOCATION Scrubber Outlet

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Run card			-
2	Initialize program		C	0.00
3	Enter average T_m (meter temp.) °f If meter temp. unknown, use ambient + 20°F	80° °f 80°	R/S	T_m
4	Enter P_{bar} (Barometric pressure at meter)	29.30 29.46 In Hg	R/S	T_m/P_m
5	Enter P_s (static pressure in stack) [$P_{bar} \pm$ .073x stack gauge pressure in In. H_2O]	29.46 In Hg	STO 2	
6	Enter average T_s (stack temperature) °f	100 110 193 °f 120 130 140 150	STO 3	
7	Enter B_{ms} (mole fraction of (H_2O) vapor in gas stream)	Fraction of H_2O 0.018 .17	STO 4	
8	Enter M_d (molecular weight of dry gas)	lbs/lb mole 30.0	STO 5	
9	Enter C_p (type "S" pitot tube coefficient)	0.99	STO 6	
10	Enter average Δ_p (.025) (.07)	In. H_2O	STO 7	
11	Enter $\Delta H_@$ (Calibrated pressure differential across orifice)	In. H_2O 1.90	STO 8	
12	"A"	.29	A	D_n theo. .29 (nozzle dia. in inches)
13	Enter actual D_n	.314 ~~.782~~ In.	STO 9	
14	"B"	20.56	B	K factor
	"D" - Molecular Weight of stack gas (M_s)		D	lbs/lb moles

PRELIMINARY VELOCITY TRAVERSE



PLANT Mound
DATE See Below
LOCATION Scrubber Outlet, traverse, 2 ports, "P" type, near annub.
STACK I.D. 6.25"
BAROMETRIC PRESSURE, in. Hg See Below
STACK GAUGE PRESSURE, in. H_2O See Below
OPERATORS CD, JM

SCHEMATIC OF TRAVERSE POINT LAYOUT

	TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
	A 1		193
	2		
Jan 22	3		
Latitt .4" H_2O	4		
Avg $\sqrt{0.53}$	B 1		
300 Hrs.	2		
CM @ 17.0	3		
	4		
Jan 23,85	B 1	0.18	196
Latitt .25" H_2O	2	0.17	
503 Hrs	3	0.20	
	4	0.19	
Avg $\sqrt{0.42}$	A 1	0.14	
CM	2	0.15	
	3	0.20	
	4	0.22	
	A 1	0.31	188
Jan 24,85	2	0.29	
Latitt 0.42" H_2O	3	0.38	
242 Hrs.	4	0.44	
Avg $\sqrt{0.59}$	B 1	0.31	
CM	2	0.31	
	3	0.36	
	4	0.35	
	AVERAGE	Avg $\sqrt{0.59}$	

Saturation Temp. at Denister exit

Saturation Temp. at F

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

EPA (Dur) 233
4/72

Note: ~ 10° F Temp diff. from EPA 5 port to traverse port.

INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY)	PART.	HCL	Part.	HCL
				RUN #:	1-OUT	1-OUT	2-OUT	2-OUT
Load EPA-5 (revised) Side 1				DATE:	1-22-85	1-22	1/23	1/23
Store variables				TIME:	1645 →	1745	1355	1455
Meter volume	V_m	ft^3	ENTER		55.722	—	46.216	—
Barometric pressure	P_{bar}	In. Hg	ENTER		29.30	—	29.28	—
Pressure diff. on orifice	ΔH	In. H_2O	ENTER		2.98	—	2.1	—
Meter temperature	T_m	Deg F	A	V_m	90.6	—	83.5	—
Meter calibration factor	Y		ENTER		.998	—	.998	—
Volume water in imp.	V_{wc}	ml	ENTER		264.7		151.7	
Volume water in sil gel	V_{wsg}	gm	ENTER		10.9		2.8	
Particulate collected factor	M_n	mg	R/S	Y	1		1	
Compute volume meter standard			B	$V_{m(std)}$	52.622	—	44.09	
Compute volume water standard			R/S	$V_{wc(std)}$	12.97	—	7.27	
Compute percent moisture			R/S	B_{ws}	0.20	—	0.14	
Compute mass loading factor	concentration	grn/DSCF/mg	R/S	C's'	2.93E-4		3.49E-4	
factor	concentration	lb./DSCF/mg	R/S	C_s	4.19E-8		5.00E-8	
Load EPA-2								
Stack temperature	Ts AVG	Deg F	STO 2		200.8	—	194.2	
Average velocity head	$\sqrt{\Delta P}$		STO 3		.599	—	.48	
Pilot tube calibration	C_p		STO 4		0.99	—	0.99	
Absolute stack pressure	P_s	In. Hg	STO 5		29.33	—	29.30	
Dry molecular weight	M_d		STO 6		29.2	-	29.23	
Mole fraction H_2O	B_{wo}		STO 7		0.20	—	0.14	
Compute velocity	V_s	FPS	B	V_s AVG	46.34	-	36.5	
Stack area	A	ft^2	STO 9		0.21	—	0.21	
Compute stack flow rate	Q_s	DSCFH	C	Q_s	21958		18760	
Dry Standard		DSCFM	Q ÷ 60		365.9		312.7	
Actual Vs x A x 60		ACFM			583.9		459.9	
Load EPA-5 (revised) side 2								
Store variables	B_{ws}		STO 5		0.20		0.14	
	$V_{m(std)}$		STO 7		52.62		44.09	
	lb./DSCF		STO 8					
Stack temperature	T_s	Deg F	ENTER		200.8		194.2	
Sampling time	θ	min	ENTER		60		60	
Stack gas velocity	V_s	ft/sec	A		46.34		36.5	
Abs. stack gas pressure	P_s	In. Hg	ENTER		29.33		29.30	
Nozzle area	A_n	ft^2	.314 dia.		~~7.96E-4~~	5.38E-4	5.38E-4	
Percent Isokinetic			R/S	%I	~~[illegible]~~	93.6	91.8	
Compute mass loading	concentration	~~gm/DSCM~~ lb/dscf	B	"C's"	1.27E-6		2.22E-6	
Emission Rate (lbs/hr)	20152 from traverse Q_s (DSCFH) X C_s (lbs/DSCF)				0.0280		0.0416	
	Pollutant:		HCl			0.0045		<0.0014
Data Reduction By: (Initials)								

INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY) RUN #:	3-PART	3-HCl	4-PART	4-HCl
Load EPA-5 (revised) Side 1				DATE:	9/24/85†	→		→
Store variables				TIME:	1132	to 1132	1403	to 1503
Meter volume	V_m	ft^3	ENTER		52.668	→	51.707	
Barometric pressure	P_{bar}	In. Hg	ENTER		28.93	→	→	→
Pressure diff. on orifice	ΔH	In. H_2O	ENTER		2.6	—	2.5	—
Meter temperature	T_m	Deg F	A	V_m	81.0	—	96.2	—
Meter calibration factor	Y		ENTER		0.99	→	→	→
Volume water in imp.	V_{wc}	ml	ENTER		183.6		270	
Volume water in sil gel	V_{wsg}	gm	ENTER		13.0		17.9	
Particulate collected	M_n	mg	R/S	Y	1	→	→	→
Compute volume meter standard			B	$V_{m(std)}$	48.54		47.29	
Compute volume water standard			R/S	$V_{wc(std)}$	9.26		13.55	
Compute percent moisture			R/S	B_{ws}	0.16		0.22	
Compute mass loading factor	concentration	grn/DSCF	R/S	C's'	3.11E-4		3.36E-4	
factor	concentration	lb./DSCF/mg	R/S	C_s	4.45-8		4.66E-8	
Load EPA-2								
Stack temperature	Ts AVG	Deg F	STO 2		187.3		208.3	
Average velocity head	$\sqrt{\Delta P}$		STO 3		.516		.531	
Pilot tube calibration	C_p		STO 4		0.99	→	→	→
Absolute stack pressure	P_s	In. Hg	STO 5		28.95†	—	28.95	
Dry molecular weight	M_d		STO 6		29.37	→	→	→
Mole fraction H_2O	B_{wo}		STO 7		0.16		0.22	
Compute velocity	V_s	FPS	B	V_s AVG	39.34		41.66	
Stack area	A	ft^2	STO 9		0.21	→	→	→
Compute stack flow rate	Q_s	DSCFH	C	Q_s	19722		18781	
Dry Standard		DSCFM	Q ÷ 60		329		313	
Actual Vs x A x 60		ACFM			496		525	
Load EPA-5 (revised) side 2								
Store variables	B_{ws}		STO 5		0.16		0.22	
	$V_{m(std)}$		STO 7		49.54		47.29	
	lb./DSCF		STO 8		—		—	
Stack temperature	T_s	Deg F	ENTER		187		208.3	
Sampling time	θ	min	ENTER		60	→	→	→
Stack gas velocity	V_s	ft/sec	A		39.34		41.66	
Abs. stack gas pressure	P_s	In. Hg	ENTER		28.95†		28.95†	
Nozzle area	A_n	ft^2			5.38E-4	→	→	→
Percent Isokinetic		~~lb/dscf~~	R/S	%I	98.4		98.4	
Compute mass loading	concentration	~~grn/DSCF~~	B	C"s"	3.43E-6		3.71E-6	
Emission Rate (lbs/hr)	Q_s (DSCFH)	X C_s (lbs/DSCF) TSP			0.0676		0.0698	
	Pollutant:	HCl			<0.0013		0.0014	
Data Reduction By: (Initials)								

PLANT: Mound - WD LOCATION: [illegible] I.D.:

INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY)	Part.	HCL	Part	HCL
				RUN #:	5-Out	5-Out	6-Out	6-Out
Load EPA-5 (revised) Side 1				DATE:	1/29-85	→		→
Store variables				TIME:	1046 to	1146	1424 to	1559
Meter volume	V_m	ft^3	ENTER		57.942	—	39.308	
Barometric pressure	P_{bar}	In. Hg	ENTER		29.41	→		→
Pressure diff. on orifice	ΔH	In. H_2O	ENTER		3.4		4.5	
Meter temperature	T_m	Deg F	A	V_m	79.3		98.5	
Meter calibration factor	Y		ENTER		0.998	→		→
Volume water in imp.	V_{wc}	ml	ENTER		158.6		212.6	
Volume water in sil gel	V_{wsg}	gm	ENTER		16.6		15.9	
Particulate collected factor	M_n	mg	R/S	Y	1		1	
Compute volume meter standard			B	$V_{m(std)}$	56.13		36.87	
Compute volume water standard			R/S	$V_{wc(std)}$	8.25		10.76	
Compute percent moisture			R/S	B_{ws}	0.13		0.23	
Compute mass loading factor	concentration	grn/DSCF/mg	R/S	C'_s	2.74E-4		4.16E-4	
factor	concentration	lb./DSCF/mg	R/S	C_s	3.93E-8		5.48E-8	
Load EPA-2								
Stack temperature	Ts AVG	Deg F	STO 2		180		203	
Average velocity head	$\sqrt{\Delta P}$		STO 3		.576		0.70	
Pilot tube calibration	C_p		STO 4		0.99	→		→
Absolute stack pressure	P_s	In. Hg	STO 5		29.43		29.44	
Dry molecular weight	M_d		STO 6		29.38		29.35	
Mole fraction H_2O	B_{wo}		STO 7		0.13		0.23	
Compute velocity	V_s	FPS	B	V_s AVG	43.04		54.37	
Stack area	A	ft^2	STO 9		0.21	→		→
Compute stack flow rate	Q_s	DSCFH	C	Q_s	22975		24805	
Dry Standard		DSCFM	Q ÷ 60		383		413	
Actual Vs x A x 60		ACFM			542		685	

Load EPA-5 (revised) side 2

Store variables	B_{ws}		STO 5		0.13		0.23	
	$V_{m(std)}$		STO 7		56.13		36.87	
	lb./DSCF		STO 8		—		—	
Stack temperature	T_s	Deg F	ENTER		180		203	
Sampling time	θ	min	ENTER		60	—	35	
Stack gas velocity	V_s	ft/sec	A		43.04		54.37	
Abs. stack gas pressure	P_s	In. Hg	ENTER		29.43		29.44	
Nozzle area	A_n	ft^2			5.38E-4	→		→
Percent Isokinetic			R/S	%I	95.4		99.5	
Compute mass loading	concentration	~~gm/DSCF~~ lb/dscf	B	"C"S"	3.29E-6		3.30E-6	
Emission Rate (lbs/hr)	Q_s (DSCFH) X C_s (lbs/DSCF)				0.0756		0.0820	
	Pollutant:	HCl			<0.00084		<0.0018	
Data Reduction By: (Initials)								

INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY)	Part.	HCL	Part.	HCL
By Pass Air Inlet Blower.				RUN #:	7-Outlet →		8-Outlet →	
Load EPA-5 (revised) Side 1				DATE:	1/30/85 →		1/30/85 →	
Store variables				TIME:	1353 To	1600	1313 To	1418
Meter volume	V_m	ft^3	ENTER		75.428		38.704	
Barometric pressure	P_{bar}	In. Hg	ENTER		29.37		29.21	
Pressure diff. on orifice	ΔH	In. H_2O	ENTER		1.2		1.2	
Meter temperature	T_m	Deg F	A	V_m	79.6		80.8	
Meter calibration factor	Y		ENTER		0.998		0.998	
Volume water in imp. +	V_{wc}	ml	ENTER		8.1		6.1	
Volume water in sil gel	V_{wsg}	gm	ENTER		14.9		7.3	
Particulate collected factor	M_n	mg	R/S	Y	1		1	
Compute volume meter standard			B	$V_{m(std)}$	73.01		36.94	
Compute volume water standard			R/S	$V_{wc(std)}$	1.08		0.63	
Compute percent moisture			R/S	B_{ws}	0.01		0.017	
Compute mass loading factor	concentration	grn/DSCF/mg	R/S	C's	2.11E-4		4.17E-4	
factor	concentration	lb./DSCF/mg	R/S	C_s	3.02E-8		5.97E-8	

Load EPA-2

Stack temperature	Ts AVG	Deg F	STO 2		114.2		110.1
Average velocity head	$\sqrt{\Delta P}$		STO 3		0.20		0.20
Pilot tube calibration	C_p		STO 4		0.99		0.99
Absolute stack pressure	P_s	In. Hg	STO 5		29.37		29.21
Dry molecular weight	M_d		STO 6		29.21		28.95
Mole fraction H_2O	B_{wo}		STO 7		0.01		0.017
Compute velocity	V_s	FPS	B	V_s AVG	13.87		13.94
Stack area	A	ft^2	STO 9		0.21		0.21
Compute stack flow rate	Q_s	DSCFH	C	Q_s	9375		9370
Dry Standard		DSCFM	Q ÷ 60		156		156
Actual Vs x A x 60		ACFM			175		176

Load EPA-5 (revised) side 2

Store variables	B_{ws}		STO 5		0.01		0.017
	$V_{m(std)}$		STO 7		73.01		36.94
	lb./DSCF		STO 8		—		—
Stack temperature	T_s	Deg F	ENTER		114.2		110.1
Sampling time	θ	min	ENTER		125		60
Stack gas velocity	V_s	ft/sec	A		13.87		13.94
Abs. stack gas pressure	P_s	In. Hg	ENTER		29.37		29.21
Nozzle area	A_n	ft^2			7.96E-4		7.96E-4
Percent Isokinetic			R/S	%I	98.7		104.1
Compute mass loading	concentration	~~lb/dscf~~ ~~gm./DSCF~~	B	C's	8.17E-6		6.53E-6
Emission Rate (lbs/hr)	Q_s (DSCFH) X	C_s (lbs/DSCF)			0.0766		0.0612
	Pollutant:	HCl			0.0022		0.0018
Data Reduction By: (Initials)							

PLANT: Mount - WV LOCATION: Scrubber Outlet I.D. #

INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY)	Part.	HCL
				RUN #:	9-Outlet →	
Load EPA-5 (revised) Side 1				DATE:	1/31/95 →	
Store variables				TIME:	1718 to 1918	
Meter volume	V_m	ft^3	ENTER		43.978	
Barometric pressure	P_{bar}	In. Hg	ENTER		29.21	
Pressure diff. on orifice	ΔH	In. H_2O	ENTER		2.0	
Meter temperature	T_m	Deg F	A	V_m	78.0	
Meter calibration factor	Y		ENTER		0.998	
Volume water in imp.	V_{wc}	ml	ENTER		4.5	
Volume water in sil-gel	V_{wsg}	gm	ENTER		8.8	
Particulate collected factor	M_n	mg	R/S	Y	1	
Compute volume meter standard			B	$V_m(std)$	42.27	
Compute volume water standard			R/S	$V_{wc}(std)$	0.627	
Compute percent moisture			R/S	B_{ws}	0.015	
Compute mass loading factor	concentration	gm/DSCF/mg	R/S	C's	3.64 E-4	
factor	concentration	lb./DSCF/mg	R/S	C_s	5.22E-9	
Load EPA-2						
Stack temperature	Ts AVG	Deg F	STD 2		112.6	
Average velocity head	$\sqrt{\Delta P}$		STD 3		0.25	
Pilot tube calibration	C_p		STD 4		0.99	
Absolute stack pressure	P_s	In. Hg	STD 5		29.22	
Dry molecular weight	M_d		STD 6		28.92	
Mole fraction H_2O	B_{wo}		STD 7		0.015	
Compute velocity	V_s	FPS	B	V_s AVG	17.46	
Stack area	A	ft^2	STD 9		0.21	
Compute stack flow rate	Q_s	DSCFH	C	Q_s	11714	
Dry Standard		DSCFM	Q ÷ 60		195	
Actual Vs x A x 60		ACFM			220	

Load EPA-5 (revised) side 2

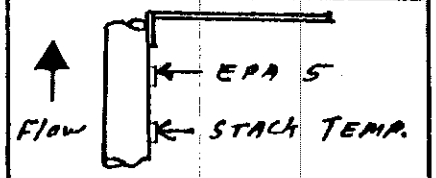
Store variables,	B_{ws}		STD 5		0.015	
	$V_m(std)$		STD 7		42.27	
	lb./DSCF		STD 8			
Stack temperature	T_s	Deg F	ENTER		112.6	
Sampling time	θ	min	ENTER		60	
Stack gas velocity	V_s	ft/sec	A		17.46	
Abs. stack gas pressure	P_s	In. Hg	ENTER		29.22	
Nozzle area	A_n	ft^2			9.96E-4	
Percent Isokinetic		lb./lb. ft	R/S	%I	95.3	
Compute mass loading	concentration	~~gm/DSCM~~	B	C"S	9.21E-6	
Emission Rate (lbs/hr)	Q_s (DSCFM)	X C_s (lbs/DSCF)			0.0844	
	Pollutant:		N/C			0.0095
Data Reduction By: (Initials)						

EPA ME
FIELD DATA

SCRUBBER OUTLET

PLANT MOUND
DATE JAN 22, 1985
SAMPLING LOCATION WD - SCRUB. OUT
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 1 - PART. - OUT
OPERATOR Malone
AMBIENT TEMPERATURE 60 °F
BAROMETRIC PRESSURE 29.30 "Hg
STATIC PRESSURE, (P_s) +.42 ins "H_2O
FILTER NUMBER (s) 47361
PITOT TUBE No. & Cp. ANNUBAR & Gamma 0.998 "P" TYPE

WASTE - C
TEMP. - 2390
FEED RATE -



PROBE LENGTH AND TYPE 2 FT. S.S.
NOZZLE I.D. ~~.352~~ .314
ASSUMED MOISTURE, % SATURATED EXIT MIST. EL.
SAMPLE BOX NUMBER 3
METER BOX NUMBER ESC 2
METER ΔH@ 1.90
K FACTOR HP85 - SEE BELOW
PRE-TEST LEAK CHECK RATE .001 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE .001 CFM @ 6 "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY (Δp_s), in. H_2O	EPA 5 VELOCITY (HEAD) in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F		DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	248± SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F		248± PROBE TEMPERATURE, °F	"P"
						DESIRED	ACTUAL			INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F				Stdic		
			575.202	~~Δp~~ Δp	"P"			Point	Avg.								
Single	00	16:45	575.202	.46	.32	2.8	2.8	202	144	93	78	3.7	263	73	1.37	242	.26
point	05		580.300	.52	.37	3.0	3.0	200	145	99	79	3.9	267	69	.43	240	.30
sampling	10		584.802	.52	.37	3.0	3.0	200	145	100	80	4.0	267	72	.44	239	.31
@ center	15		589.435	.53	.38	3.1	3.1	200	145	100	81	4.2	265	75	.45	238	.32
of duct	20		594.010	.58	.42	3.4	3.4	199	144	100	82	4.3	264	77	.48	237	.34
	25		598.885	.47	.35	2.9	2.9	200	144	99	83	4.5	262	77	.40	240	.28
	30		603.515	.47	.35	2.9	2.9	200	144	99	83	4.6	259	78	.40	244	.29
	35		607.975	.47	.35	2.9	2.9	201	144	99	84	4.8	256	77	.40	247	.29
	40		612.500	.47	.35	2.9	2.9	201	143	99	84	5.0	252	76	.40	248	.28
	45		617.715	.48	.35	2.9	2.9	202	144	99	85	5.2	250	76	.40	250	.28
	50		621.525	.48	.35	2.9	2.9	202	143	99	85	5.5	248	77	.40	252	.28
	55		626.195	.48	.35	3.1	3.1	202	141	99	85	6.1	246	77	.40	251	.29
	60	17:45	630.924		AVG		END of Test										
					$\sqrt{\Delta p}$												
			55.722		0.599		2.98	200.8	143.8	99.6							

SCRUBBER OUTLET

CLEAN-UP DATA

Plant MOUND Comments: TRAIN COLLECTS HCl AND H_2O

Date JAN 22, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIFIED

Run Number 1 - PART - OUT

Sample Box Number ESC 3

Clean-up Man Malone

IMPINGERS

100 ml 0.1 N NaOH; empty

	#1	#2	#3	##	##
Final Vol.	806.2 gm	642.0 gm	508.9 gm	ml	ml
Initial Vol.	603.4 gm	589.5 gm	499.5 gm	ml	ml
Net Vol.	202.8 gm	52.5 gm	9.4 gm	ml	ml

Total Net Volume in Impingers 264.7 gm

SILICA GEL

Final Weight	718.6 gm	g	g
Initial Weight	707.7 gm	g	g
Net Weight	10.9 gm	g	g

Total Net Weight in Silica Gel 10.9 gm

Total Moisture 275.6 gm

Filter Number(s) 47361 (1922062-21)

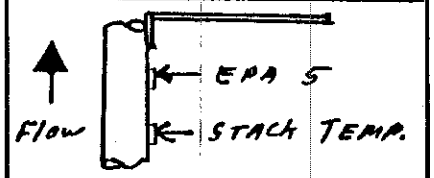
MRC 7/73

EPA ME. 5
FIELD DATA

SCRUBBER OUTLET

PLANT MOUND
DATE JAN 23, 1985
SAMPLING LOCATION WD - SCRUB. OUT
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 2 - PART. - OUT
OPERATOR Malone
AMBIENT TEMPERATURE 85° [redacted] °F
BAROMETRIC PRESSURE 29.28 "Hg
STATIC PRESSURE, (P_s) +.24 "H_2O
FILTER NUMBER (s) 47364
PITOT TUBE No. & Cp. ANNUBAR & "P" TYPE

WASTE - "C"
TEMP. - 2400
FEED RATE - ____



PROBE LENGTH AND TYPE 2 FT. S.S.
NOZZLE I.D. .314
ASSUMED MOISTURE, % SATURATED EXIT MIST. EL.
SAMPLE BOX NUMBER 3
METER BOX NUMBER ESC 2
METER ΔH@ 1.90
K FACTOR HP85 - SEE BELOW
PRE-TEST LEAK CHECK RATE .001 CFM @ 13 "Hg
POST TEST LEAK CHECK RATE .001 CFM @ 6 "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

ANNUBAR Temp = 180° F

READ AND RECORD ALL DATA EVERY 5 MINUTES

CO_2=4.2 | O_2=15.2 | Time = 14:30
CO_2=3.5 | O_2=15.5 | Time = 14:35

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY (Δp_s), in. H_2O Annubar	EPA P_s HEAD "p"	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F Probe	STACK TEMPERATURE (T_s), °F Mist.	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F 248 ± 25	IMPINGER TEMPERATURE, °F	IMPINGER Static	PROBE TEMPERATURE, °F 248 ± 25	"p"
Single	0	1355	631.041	.34	.24	2.2	2.2	191	133	71	69	3.4	290	69	+2.4	291	.20
Point	5		634.890	.33	.24	2.2	2.2	192	134	76	69	3.4	283	65	.24	265	.20
	10		638.805	.33	.24	2.2	2.2	192	136	83	70	3.6	274	66	.24	250	.19
center	15		642.690	.33	.23	2.1	2.1	193	136	89	71	3.8	267	68	.23	250	.19
of Stack	20		646.540	.33	.23	2.1	2.1	194	136	92	73	4.0	261	70	.23	248	.19
	25		650.375	.33	.23	2.1	2.1	194	136	95	74	4.0	255	70	.24	248	.19
	30		654.120	.33	.23	2.1	2.1	195	136	96	76	4.2	251	71	.24	250	.19
	35		657.995	.32	.23	2.1	2.1	195	135	98	78	4.5	247	71	.24	249	.18
	40		661.850	.32	.23	2.1	2.1	196	135	99	79	4.8	245	71	.24	249	.18
	45		665.745	.32	.23	2.1	2.1	196	134	100	80	4.8	242	70	.24	249	.19
	50		669.670	.32	.23	2.1	2.1	196	133	101	81	5.0	242	70	.24	250	.19
	55		673.435	.32	.23	2.0	2.0	196	132	101	82	5.2	241	69	.24	250	.19
	60	14:55	677.257		End of Test												
							AVG √DP ΔH 1.45			89.5							
			46.216	#01 √0.48					134.7								

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SCRUBBER OUTLET

CLEAN-UP DATA

Plant MOUND

Date JAN 22, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIFIED

Run Number 2 - PART - OUT

Sample Box Number ESC

Clean-up Man Malone

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ml 0.1 N NaOH; empty

	#1	#2	#3	#4	#5
Final Vol.	736.1 gm‡	628.5 gm‡	504.4 gm‡	ml	ml
Initial Vol.	614.6 gm‡	601.8 gm‡	500.9 gm‡	ml	ml
Net Vol.	121.5 gm‡	26.7 gm‡	3.5 gm‡	ml	ml

Total Net Volume in Impingers 151.7 gm‡

SILICA GEL

Final Weight	776.0 gm	g	g
Initial Weight	773.2 gm	g	g
Net Weight	2.8 gm	g	g

Total Net Weight in Silica Gel 2.8 gm

Total Moisture 154.5 gm

Filter Number(s)	#7364	MRC 1922062-24

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Mound
DATE Jan 23, 1985
SAMPLING TIME (24-hr CLOCK) 1300 HRS
SAMPLING LOCATION Static pressure line exit scrubber
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) 1
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE ~60 °F
OPERATOR CD

COMMENTS: $.44(\%\ CO_2) + .32(\%\ O_2) + .28(\%\ N_2 + CO)$

$$\%\ EA = \frac{\%\ O_2 - 0.5\%\ CO}{.264 \times \%\ N_2 - (\%\ O_2 - 0.5\%\ CO)} \times 100$$

$$\frac{15.35}{(.264 \times 80.80) - 15.35} \times 100 = 25\%$$

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	4.2	4.2	3.5	3.5	—	—	3.85	44/100	1.69
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	15.2	15.2	15.5	15.5	—	—	15.35	32/100	4.91
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	—	—	—	—	—	—		28/100	—
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.80	28/100	22.62
								TOTAL	29.23

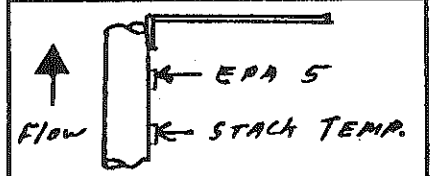
EPA (Dur) 230
4/72

EPA ME. 5
FIELD DATA

SCRUBBER OUTLET

PLANT MOUND
DATE JAN 24, 1985
SAMPLING LOCATION WD - SCRUB. OUT
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 3 - PART. - OUT
OPERATOR Malone
AMBIENT TEMPERATURE 75 °F
BAROMETRIC PRESSURE 28.93 "Hg
STATIC PRESSURE, (P_s) "H_2O
FILTER NUMBER (s) 47350
PITOT TUBE No. & Cp. ANNUBAR & "P" TYPE

WASTE - "D"
TEMP. -
FEED RATE -



PROBE LENGTH AND TYPE 2 FT. S.S.
NOZZLE I.D. .314
ASSUMED MOISTURE, % SATURATED EXIT MIST. EL.
SAMPLE BOX NUMBER 3
METER BOX NUMBER ESC - 2
METER ΔH@ 1.90
K FACTOR HP85 - SEE BELOW
PRE-TEST LEAK CHECK RATE .001 CFM @ 13 "Hg
POST TEST LEAK CHECK RATE .000 CFM @ 15 "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

CLOCK Time →	11:00	11:10
CO_2 →	4.5%	4.5%
O_2 →	16.5%	16.0%

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O Annubar	VELOCITY HEAD (Δp_s), in. H_2O "P"	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F PORT	STACK TEMPERATURE (T_s), °F Mist.	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	IMPINGER TEMPERATURE, °F STATIC	PROBE TEMPERATURE, °F	+ "P"
single	0	1032	677.355	.40	.24	2.8	2.8	177	110	67	66	6.0	258	65	+.73	267	+.22
point	5		681.780	.39	.26	2.8	2.8	180	114	73	66	6.2	268	59	.71	255	.23
	10		686.241	.38	.26	2.7	2.7	181	118	81	67	6.4	274	61	.69	247	.24
Center	15		690.460	.38	.26	2.6	2.6	184	123	87	69	6.9	273	63	.70	243	.24
of Stack	20		694.715	.38	.26	2.6	2.6	185	126	90	70	7.1	270	64	.70	242	.24
	25		699.095	.38	.26	2.5	2.5	187	128	92	72	7.2	265	66	.70	244	.24
	30		703.500	.37	.26	2.5	2.5	188	130	94	73	7.6	261	67	—	244	.24
	35		707.765	.38	.28	2.7	2.7	190	132	96	75	8.5	257	67	—	246	.25
	40		712.280	.39	.28	2.6	2.6	192	134	97	77	9.0	253	69	.30	247	.25
	45		716.660	.39	.28	2.6	2.6	193	135	97	78	9.2	251	69	.29	248	.25
	50		721.120	.39	.28	2.6	2.6	195	136	99	79	9.7	250	71	.30	248	.25
	55		725.570	.39	.28	2.6	2.6	196	137	99	81	10.0	248	71		248	.25
	60		730.023		AVG	END	OF Test										
					$\sqrt{\Delta P}$												
			52.668		.516		2.63	187.3	126.9	~~98.4~~ 91.0							

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SCRUBBER OUTLET

CLEAN-UP DATA

Plant MOUND
Date JAN 23, 1985
Sampling Location INCINERATOR
Sample Type EPA 5 - MODIFIED
Run Number 3 - PART - OUT
Sample Box Number ESC-3
Clean-up Man Malone

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ml 0.1 N NaOH; empty

	#1	#2	#3	#4	#5
Final Vol.	747.8 gm	625.5 gm	504.4 gm	ml	ml
Initial Vol.	603.8 gm	590.7 gm	499.6 gm	ml	ml
Net Vol.	144.0 gm	34.8 gm	4.8 gm	ml	ml

Total Net Volume in Impingers 183.6 gm

SILICA GEL

Final Weight	789.0 gm	g	g
Initial Weight	776.0 gm	g	g
Net Weight	13.0 gm	g	g

Total Net Weight in Silica Gel 13.0 gm

Total Moisture 196.6 gm

Filter Number(s)		MRC #
	47350	1922062-2

DRY MOLECULAR WEIGHT DETERMINATION

PLANT 1/24/1985 - Mound
DATE 1/24/1985
SAMPLING TIME (24-hr CLOCK) 1110 - 1125
SAMPLING LOCATION Scrubber Outlet
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS)
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE ~ 60°F
OPERATOR JM, CD

COMMENTS:

Sample taken from str. line

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2		4.5		4.5		—	4.5	44/100	1.98
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)		16.5		16.0			16.25	32/100	5.20
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)		—		—				28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							79.25	28/100	22.19
								TOTAL	29.37

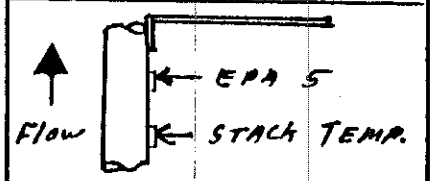
EPA (Dur) 230
4/72

EPA ME.)5
FIELD DATA

PLANT MOUND
DATE JAN 24, 1985
SAMPLING LOCATION WD - SCRUB. OUT
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 4 - PART. - OUT
OPERATOR Malone
AMBIENT TEMPERATURE 92 °F
BAROMETRIC PRESSURE 28.93" Hg
STATIC PRESSURE, (P_s) +.32 "H_2O
FILTER NUMBER (s) 47348
PITOT TUBE No. & Cp. ANNUBAR & "P" TYPE

SCRUBBER OUTLET

WASTE - "D"
TEMP. -
FEED RATE -



PROBE LENGTH AND TYPE 2 FT. S.S.
NOZZLE I.D. .314
ASSUMED MOISTURE, % SATURATED EXIT MIST. EL.
SAMPLE BOX NUMBER 3
METER BOX NUMBER ESC-2
METER ΔH@ 1.90
K FACTOR HP85 - SEE BELOW
PRE-TEST LEAK CHECK RATE .001 CFM @ 12 "Hg
POST TEST LEAK CHECK RATE ____ CFM @ ____ "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

clock time →	14:35	14:38
CO_2 →	6.0%	5.5%
O_2 →	16.5%	16.8%

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O Annubar	VELOCITY HEAD (Δp_s), in. H_2O "P"	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F Probe	STACK TEMPERATURE (T_s), °F Mist.	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	IMPINGER Static	PROBE TEMPERATURE, °F	"P"
Single	0	14:03	730.155	.40	.29	2.6	2.6	208	141	91	93	3.8	279	77	+.33	281	.27
point.	5		734.520	.40	.29	2.6	2.6	208	141	97	93	4.0	280	73	.32	270	.26
	10		738.845	.40	.29	2.6	2.6	208	141	103	93	4.0	278	76	.32	261	.26
center	15		743.105	.41	.29	2.6	2.6	208	142	103	93	4.2	272	80	.32	255	.27
of stack.	20		747.620	.40	.28	2.5	2.5	208	142	103	93	4.6	264	81	.32	252	.27
	25		752.055	.40	.28	2.5	2.5	208	142	104	93	4.9	258	81	.32	250	.26
	30		756.640	.40	.28	2.3	2.3	208	143	102	93	5.0	253	80	.32	248	.26
	35		760.855	.40	.28	2.3	2.3	209	143	100	93	5.1	248	81	.32	248	.26
	40		764.820	.40	.28	2.3	2.3	209	143	99	93	5.2	244	81	.32	249	.26
	45		768.910	.40	.28	2.5	2.5	209	142	99	92	6.0	245	80	.32	248	.26
	50		773.225	.39	.28	2.5	2.5	209	141	98	92	6.2	244	80	.32	248	.26
	55		777.585	.39	.27	2.4	2.4	208	140	97	91	6.2	244	81	.32	248	.26
	60		781.862			END	OF TEST		~~139~~								
			51.707		√.531		2.5	208.3	141.8		46.2						

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Mound
DATE JAN 24, 1995
SAMPLING TIME (24-hr CLOCK) 1435 - 1438
SAMPLING LOCATION Scrubber Outlet
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) _____
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE ~ 90°F
OPERATOR CD

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2		6.0		5.5			5.75	44/100	2.53
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)		16.5		16.8			16.65	32/100	5.33
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)							-	28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							77.60	28/100	
								TOTAL	29.59

EPA (Dur) 230
4/72

SCRUBBER OUTLET

CLEAN-UP DATA

Plant MOUND
Date JAN 24, 1985
Sampling Location INCINERATOR
Sample Type EPA 5 - MODIFIED
Run Number 4 - PART - OUT
Sample Box Number ESC
Clean-up Man Malone

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ml 0.1 N NaOH; empty

	#1	#2	#3	#4	#5
Final Vol.	814.3 gm	642.5 gm	507.2 gm	ml	ml
Initial Vol.	604.7 gm	589.7 gm	499.6 gm	ml	ml
Net Vol.	209.6 gm	52.8 gm	7.6 gm	ml	ml

Total Net Volume in Impingers 270.0 gm

SILICA GEL

Final Weight	759.0 gm	g	g
Initial Weight	741.1 gm	g	g
Net Weight	17.9 gm	g	g

Total Net Weight in Silica Gel 17.9 ~~287.9~~ gm

Total Moisture 287.9 gm

Filter Number(s)	MRC #
47348	1922011-13

METHOD 5 NOMOGRAPH (HP-65)

PLANT Mound

DATE 1/29/85 USED ON RUN NO.: 5 & 6

SAMPLING LOCATION Scrubber Outlet CALCULATOR: CD

Solvent Runs (liquid)

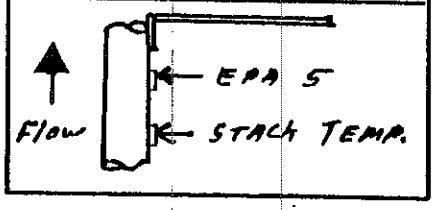
STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Run card			-
2	Initialize program		C	0.00
3	Enter average T_m (meter temp.) °F If meter temp. unknown, use ambient + 20°F	90 °F	R/S	T_m
4	Enter P_{bar} (Barometric pressure at meter)	29.4 In Hg	R/S	T_m/P_m
5	Enter P_s (static pressure in stack) [P_{bar} ± [.073x stack gauge pressure in In. H_2O] + .30	29.42 In Hg	STO 2	
6	Enter average T_s (stack temperature) °F	~~90 100 200 210~~ 200 °F 180 - 220	STO 3	
7	Enter B_{ms} (mole fraction of (H_2O) vapor in gas stream)	120 130 140 150 Fraction of H_2O ~~12%~~ 14% ~~16%~~ ~~20%~~	STO 4	
8	Enter M_d (molecular weight of dry gas)	29.4 lbs/lb mole	STO 5	
9	Enter C_p (type "S" pitot tube coefficient)	0.99	STO 6	
10	Enter average Δ_p	.35 In. H_2O	STO 7	
11	Enter $\Delta H_@$ (Calibrated pressure differential across orifice)	1.90 In. H_2O	STO 8	
12	"A"		A	D_n theo. .26 (nozzle dia. in inches)
13	Enter actual D_n ~~90-126~~	.314 In.	STO 9	
14	"B"	12% 14% 17% 20% 10.42 10.03 9.46 8.90	B	K factor
	"D" - Molecular Weight of stack gas (M_s) (90-127)	90-127 128-135 136-145 146 155	D	lbs/lb moles

EPA M.. 10D 5
FIELD DATA

PLANT Mound
DATE JAN 29, 1985
SAMPLING LOCATION WD - Scrub. Out
SAMPLE TYPE Modified EPA 5
RUN NUMBER 5 - Part. - Out
OPERATOR Malone
AMBIENT TEMPERATURE 75 °F
BAROMETRIC PRESSURE 29.41 "Hg
STATIC PRESSURE, (P_s) ____ "H_2O
FILTER NUMBER (s) 47344
PITOT TUBE No. & Cp. Annubar & "P" TYPE

Scrubber Outlet

Waste - "D"
Temp. -
Feed Rate -



PROBE LENGTH AND TYPE 2 Ft. S.S.
NOZZLE I.D. .314
ASSUMED MOISTURE, % Saturated Exit Mist. Est.
SAMPLE BOX NUMBER 3
METER BOX NUMBER ESC-2
METER ΔH@ 1.90
K FACTOR HP85 - See Below
PRE-TEST LEAK CHECK RATE .001 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE .001 CFM @ 9 "Hg
REFERENCE Δp of 1 = ΔH of (See Below)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Clock time→	11:10	11:12
CO_2	4%	4.5%
O_2	17.5%	17.7%

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O Anubar	VELOCITY HEAD (Δp_s), in. H_2O EPA 5	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F Probe	STACK TEMPERATURE (T_s), °F Mist.	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	IMPINGER TEMPERATURE, °F Static	PROBE TEMPERATURE, °F	"P"
Single	0	10:46	782.977	.47	.28	2.9	2.9	166	111	67	61	4.0	256	66	+.64	247	.27
point	5		787.144	.47	.32	3.3	3.3	169	112	75	62	4.6	256	64	.61	239	.28
	10		791.310	.47	.33	3.4	3.4	174	115	81	63	4.9	254	66	.58	237	.28
Center	15		796.135	.46	.33	3.4	3.4	176	115	86	65	5.2	252	67	.57	239	.28
of stack	20		801.010	.46	.34	3.5	3.5	178	116	90	67	5.8	250	68	.55	241	.28
	25		805.955	.47	.35	3.6	3.6	180	117	92	69	6.2	249	69	.38	242	.29
	30		810.015	.48	.35	3.6	3.6	183	119	93	71	6.5	249	69	.38	244	.30
	35		815.985	.48	.34	3.5	3.5	184	122	95	72	7.0	248	69	.37	245	.29
	40		820.995	.47	.33	3.4	3.4	186	125	96	74	7.3	247	70	.37	248	.28
	45		825.920	.46	.34	3.5	3.5	188	128	97	76	7.8	248	71	.37	250	.29
	50		830.915	.46	.34	3.5	3.5	190	130	97	78	8.1	247	72	.37	250	.29
	55		835.890	.46	.33	3.4	3.4	191	130	98	79	8.5	247	73	.36	251	.28
	60		840.919														
			57.942		.576		3.4	120	120		74.3				.46		

SCRUBBER OUTLET

CLEAN-UP DATA

Plant MOUND Comments: TRAIN COLLECTS HCl AND H_2O

Date JAN 24, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIFIED

Run Number 5 - PART - OUT #5

Sample Box Number ESC

Clean-up Man Malone

IMPINGERS

100 ml 0.1 N NaOH

empty

	#1	#2	#3	#4	#5
Final Vol.	722.3 gm	626.7 gm	505.2 gm	ml	ml
Initial Vol.	604.1 gm	579.6 gm	499.9 gm	ml	ml
Net Vol.	118.2 gm	35.10 gm	5.3 gm	ml	ml

Total Net Volume in Impingers 158.6 gm

SILICA GEL

Final Weight	775.6 gm	g	g
Initial Weight	759.0 gm	g	g
Net Weight	gm	g	g

Total Net Weight in Silica Gel 16.60 gm

Total Moisture 175.2 gm

		MRC #
Filter Number(s)	47344	1922011-9

MRC 7/73

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Monroe
DATE Nov 29, 1985
SAMPLING TIME (24-hr CLOCK) 1110 – 1112
SAMPLING LOCATION Scrubber Outlet - WD Bldg.
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) _____
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE ~ 75°F
OPERATOR CD.

COMMENTS:

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2		4.0		4.5			4.25	44/100	1.87
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)		17.5		17.7			17.6	32/100	5.63
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							78.15	28/100	21.88
								TOTAL	29.38

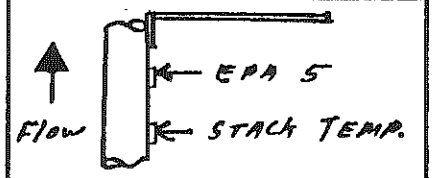
EPA (Dur) 230
4/72

EPA METHOD 5
FIELD DATA

SCRUBBER OUTLET

PLANT MOUND
DATE JAN 29, 1985
SAMPLING LOCATION WD-SCRUB. OUT
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 6 - PART. - OUT
OPERATOR Malone
AMBIENT TEMPERATURE 92 °F
BAROMETRIC PRESSURE 29.41 "Hg
STATIC PRESSURE, (P_s) ____ "H_2O
FILTER NUMBER (s) 47351
PITOT TUBE No. & Cp. ANNUBAR & "P" TYPE

WASTE - "D"
TEMP. - ____
FEED RATE - ____



PROBE LENGTH AND TYPE 2 FT. S.S.
NOZZLE I.D. .314
ASSUMED MOISTURE, % SATURATED EXIT MIST. E
SAMPLE BOX NUMBER 3
METER BOX NUMBER ESC-2
METER ΔH@ 1.90
K FACTOR HP85 - SEE BELOW
PRE-TEST LEAK CHECK RATE .001 CFM @ 10 "Hg
POST TEST LEAK CHECK RATE .001 CFM @ 8 "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Clock time→	14:36	15:22
CO_2	4.5%	4.5
O_2	16.5%	15.2

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O Annubar	VELOCITY HEAD (Δp_s), in. H_2O EPA 5	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F/MPP Boat	STACK TEMPERATURE (T_s), °F/MPP Mist.	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	IMPINGER TEMPERATURE, °F Static	PROBE TEMPERATURE, °F	"P"
Single	0	14:24	841.719	.68	.49	4.7	4.7	202	140	106	91	4.9	252	72	.54	260	.44
point	5	:5	846.760	.68	.49	4.7	4.7	202	140	110	92	5.4	259	71	.54	257	.44
	10		852.615	.67	.49	4.7	4.7	203	141	108	93	5.8	259	75	.53	251	.44
Center	15		858.485	.67	.48	4.3	4.3	203	142	103	94	5.9	258	79	.53	247	.44
of stack	20		860.550	.67	.48	4.3	4.3	203	142	102	94	6.2	255	81	.53	244	.44
	25		869.963	.67	.49	4.5	4.5	203	142	100	94	7.0	252	82	.53	247	.45
	30		875.290	.67	.49	4.5	4.5	203	143	99	93	7.8	249	83	.54	248	.45
	35	14 59	881.022		End of	Test -		Inlet	Filter			clogged -					
	~~40~~				filter	was	loading		quickly.								
	~~45~~																
	~~50~~																
	~~55~~																
	~~60~~																
			39.308		.70		4.5	202.7	141.4		98.5				.53		

SCRUBBER OUTLET

CLEAN-UP DATA

Plant MOUND
Date JAN 29, 1985
Sampling Location INCINERATOR
Sample Type EPA 5 - MODIFIED
Run Number 6 - PART - OUT
Sample Box Number ESC
Clean-up Man Malone

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ml 0.1 N NaOH → #1, #2
empty → #3
#4, #5

	#1	#2	#3	#4	#5
Final Vol.	759.8 gm	642.5 gm	507.3 gm	ml	ml
Initial Vol.	603.8 gm	593.2 gm	500.0 gm	ml	ml
Net Vol.	156.0 gm	49.30 gm	7.3 gm	ml	ml

Total Net Volume in Impingers 212.6 gm

SILICA GEL

Final Weight	762.3 gm	g	g
Initial Weight	746.4 gm	g	g
Net Weight	gm	g	g

Total Net Weight in Silica Gel 15.90 gm

Total Moisture 228.5 gm

Filter Number(s)		MRC #
	47351	1922062-3

MRC 7/73

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Monaco -
DATE June 29, 1985
SAMPLING TIME (24-hr CLOCK) 1436 - 1522
SAMPLING LOCATION Scrubber Outlet - WD BLDG.
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) _____
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE 92° F
OPERATOR CD

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2		4.5		4.5			4.5	44/100	1.98
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)		16.5		15.2			15.85	32/100	5.07
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							79.65	28/100	22.30
								TOTAL	29.35

EPA (Dur) 230
4/72

EPA METHOD 5 NOMOGRAPH (HP-65)

PLANT Mound USED ON RUN NO.: ~~6~~ 7 →

DATE 1/30/85 CALCULATOR: CD

SAMPLING LOCATION Scrubber ~~Exit~~ outlet (Sludge Run)

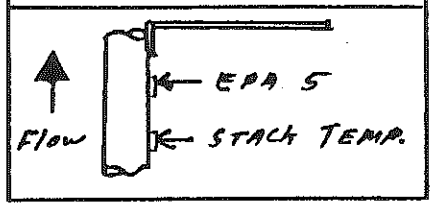
STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Run card			-
2	Initialize program		C	0.00
3	Enter average T_m (meter temp.) °f If meter temp. unknown, use ambient + 20°F	90 °f	R/S	T_m
4	Enter P_{bar} (Barometric pressure at meter)	29.37 In.Hg	R/S	T_m/P_m
5	Enter P_s (static pressure in stack) [$P_{bar} \pm .073 \times$ stack gauge pressure in In. H_2O]	29.37 In.Hg	STO 2	
6	Enter average T_s (stack temperature) °f	120 °f	STO 3	
7	Enter B_{ms} (mole fraction of (H_2O) vapor in gas stream)	.06 Fraction of H_2O	STO 4	
8	Enter M_d (molecular weight of dry gas)	29.1 lbs/lb mole	STO 5	
9	Enter C_p (type "S" pitot tube coefficient)	0.99	STO 6	
10	Enter average Δ_p	.10 In. H_2O	STO 7	
11	Enter $\Delta H_@$ (Calibrated pressure differential across orifice)	1.90 In. H_2O	STO 8	
12	"A"		A	D_n theo. .24 (nozzle dia. in inches)
13	Enter actual D_n	.382 In.	STO 9	
14	"B"	28.90	B	K factor
	"D" - Molecular Weight of stack gas (M_s)		D	lbs/lb moles

EPA M OD 5
FIELD DATA

SCRUBBER OUTLET

PLANT MOUND
DATE JAN 30, 1985
SAMPLING LOCATION WD-SCRUB. OUT
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 7 - PART. - OUT
OPERATOR Malone
AMBIENT TEMPERATURE 70 °F
BAROMETRIC PRESSURE 29.37 "Hg
STATIC PRESSURE, (P_s) See below "H_2O
FILTER NUMBER (s) 47349
PITOT TUBE No. & Cp. ANNUBAR & "P" TYPE

WASTE - "A"
TEMP. -
FEED RATE -



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 2 FT. S.S.
NOZZLE I.D. ~~.314~~ .382 (7.96E-4 ft²)
ASSUMED MOISTURE, % SATURATED EXIT MIST. E
SAMPLE BOX NUMBER 3
METER BOX NUMBER ESC-2
METER ΔH@ 1.90
K FACTOR HP85 - SEE BELOW
PRE-TEST LEAK CHECK RATE .001 CFM @ 10 "Hg
POST TEST LEAK CHECK RATE .001 CFM @ 6 "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

Clock time →	14:06	14:08
CO_2 →	2.5%	2.5%
O_2 →	20%	20.6%

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O Ann-ubar	VELOCITY HEAD (Δp_s), in. H_2O EPA-5	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F Port	STACK TEMPERATURE (T_s), °F NAPP Mist.	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	IMPINGER TEMPERATURE, °F static	PROBE TEMPERATURE, °F	"P"
	0	13:55	881.384	.07	.04	1.2	1.2	115	83	70	70	2.6	249	69	±.06	273	.04
Single	5		885.305	.07	.04	1.2	1.2	114	84	77	73	2.7	250	62	.06	256	.04
point	10		888.295	.07	.04	1.2	1.2	114	84	78	70	2.7	249	62	.06	248	.04
	15		891.200	.07	.04	1.2	1.2	114	85	83	71	2.8	249	63	.06	241	.04
Center	20		894.190	.07	.04	1.2	1.2	113	87	84	71	3.0	248	63	.06	238	.04
of stack	25		897.165	.07	.04	1.2	1.2	113	86	85	71	3.0	248	63	.06	241	.04
	30		900.175	.07	.04	1.2	1.2	113	86	86	72	3.1	247	63	.06	242	.04
	35		903.165	.07	.04	1.2	1.2	112	86	87	72	3.3	248	63	.06	247	.04
	40		906.120	.07	.04	1.2	1.2	113	86	87	73	3.5	247	63	.06	247	.04
	45		909.125	.07	.04	1.2	1.2	112	86	87	73	3.8	248	63	.06	249	.04
	50		912.105	.07	.04	1.2	1.2	113	86	87	73	3.9	248	63	.06	250	.04
	55		915.140	.07	.04	1.2	1.2	113	86	87	73	4.0	248	63	.06	250	.04
	60		918.170	.07	.04	1.2	1.2	114	88	87	74	4.1	248	64	.06	249	.04
	65		921.160	.07	.04	1.2	1.2	114	87	88	74	4.2	248	63	.06	250	.04
	70		924.150	.07	.04	1.2	1.2	114	88	88	74	4.4	249	63	.06	250	.04

PLANT Mound DATE Jan 30, 1985 RUN NO. 7 - PART. - OUT

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O Ann-Ubor	VELOCITY HEAD (Δp_s), in. H_2O EPA-5	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F Port	STACK TEMPERATURE (T_s), °F Mist	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	IMPINGER TEMPERATURE, °F Static	PROBE TEMPERATURE, °F	"P"
Single	75		927.130	.06	.04	1.2	1.2	114	88	88	75	4.5	249	63	+.06	249	.04
point	80		930.185	.06	.04	1.2	1.2	114	88	88	75	4.7	249	64	.06	248	.04
	85		933.175	.06	.04	1.2	1.2	115	89	88	75	4.8	249	64	.06	249	.04
Center	90		936.180	.06	.04	1.2	1.2	115	90	88	75	4.9	250	65	.06	248	.04
of stack	95		939.165	.06	.04	1.2	1.2	115	90	88	75	5.0	250	65	.06	248	.04
	100		942.210	.06	.04	1.2	1.2	116	90	88	75	5.0	250	66	.06	248	.0
	105		945.245	.06	.04	1.2	1.2	116	91	88	75	5.1	250	66	.06	247	.0
	110		948.270	.06	.04	1.2	1.2	116	92	88	76	5.1	249	66	.06	248	.04
	115		951.270	.06	.04	1.2	1.2	116	92	89	76	5.2	250	66	.06	249	.04
	120		954.280	.06	.04	1.2	1.2	117	93	89	76	5.3	251	67	.06	248	.04
	125	1600	957.312		End	of Test											
25			75.928		$\sqrt{.20}$		1.2	114.2	87.6		79.6				.06		.04

CO_2

2.5 x .44 + 20.3 x .32 + 77.2 x .28 = 29.21

Md.

SCRUBBER OUTLET

CLEAN-UP DATA

Plant MOUND
Date JAN 29, 1985
Sampling Location INCINERATOR
Sample Type EPA 5 - MODIFIED
Run Number 7 - PART - OUT
Sample Box Number ESC
Clean-up Man Malone

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ml 0.1 N NaOH; empty

	#1	#2	#3	#4	#5
Final Vol.	599.2 gm	~~599.2~~ 601.1 gm	501.7 gm	ml	ml
Initial Vol.	603.3 gm	591.1 gm	499.5 gm	ml	ml
Net Vol.	− 4.1 gm	10.0 gm	2.2 gm	ml	ml

Total Net Volume in Impingers 8.1 gm

SILICA GEL

Final Weight	777.2 gm	g	g
Initial Weight	762.3 gm	g	g
Net Weight	14.9 gm	g	g

Total Net Weight in Silica Gel 14.9 gm

Total Moisture 23.0 gm

Filter Number(s)	MRC #
47349	1922062-1

MRC 7/73

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Mound
DATE Mar 30, 1985
SAMPLING TIME (24-hr CLOCK) 1406 – 1415
SAMPLING LOCATION Scrubber Outlet (Run 2)
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS)
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE 70°F
OPERATOR CD

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2		2.5		2.5			2.5	44/100	1.1
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)		20		20.6			20.3	32/100	6.5
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)							–	28/100	–
N_2 (NET IS 100 MINUS ACTUAL CO READING)							77.2	28/100	21.62
								TOTAL	29.21

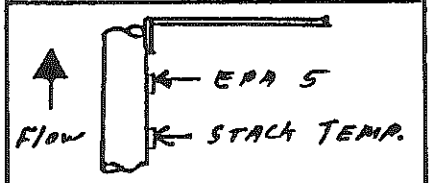
EPA (Dur) 230
4/72

EPA M OD 5
FIELD DATA

SCRUBBER OUTLET

PLANT Mound
DATE JAN 31, 1985
SAMPLING LOCATION WD-SCRUB. OUT
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 8 - PART. - OUT
OPERATOR Malone
AMBIENT TEMPERATURE 68° °F
BAROMETRIC PRESSURE 29.21 "Hg
STATIC PRESSURE, (P_s) 10.06 "H2O
FILTER NUMBER (s) 47362
PITOT TUBE No. & Cp. ANNUBAR & "P" TYPE

WASTE - "A"
TEMP. -
FEED RATE -



PROBE LENGTH AND TYPE 2 FT. S.S.
NOZZLE I.D. .382
ASSUMED MOISTURE, % SATURATED EXIT MIST. E
SAMPLE BOX NUMBER 3
METER BOX NUMBER ESC-2
METER ΔH@ 1.90
K FACTOR HP85 - SEE BELOW
PRE-TEST LEAK CHECK RATE .001 CFM @ 9 "Hg
POST TEST LEAK CHECK RATE .001 CFM @ 11 "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

Clock time →	13:18	13:22
CO_2 →	0.5%	1.0
O_2 →	20.5%	21.0

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O Annubar	VELOCITY HEAD (Δp_s), in. H_2O EPA 5	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F Probe	STACK TEMPERATURE (T_s), °F Impg Mist.	DRY GAS METER TEMPERATURE, °F INLET ($T_{m\,in}$)	DRY GAS METER TEMPERATURE, °F OUTLET ($T_{m\,out}$)	PUMP VACUUM, In. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	"p" "c
Single	0	13:13	957.322	0.07	0.04	1.2	1.2	109	82	67	67	2.9	246	74	264	.04
point	5		960.235	.07	.04	1.2	1.2	109	82	69	67	2.2	242	64	248	.04
	10		963.210	.07	.04	1.2	1.2	109	82	74	67	2.3	240	63	241	.04
Center	15		966.200	.07	.04	1.2	1.2	109	81	78	67	2.5	240	63	240	.04
of stack	20		969.185	.07	.04	1.2	1.2	109	82	80	68	2.6	243	63	244	.04
	25		972.145	.07	.04	1.2	1.2	110	81	82	68	2.7	246	62	247	.04
	30		975.115	.07	.04	1.2	1.2	110	81	83	69	2.9	249	62	249	.04
	35		978.075	.07	.04	1.2	1.2	111	81	84	69	3.1	251	62	247	.04
	40		981.050	.07	.04	1.2	1.2	111	80	85	70	3.2	251	63	246	.04
	45		984.025	.07	.04	1.2	1.2	111	81	85	71	3.3	249	63	247	.04
	50		986.995	.07	.04	1.2	1.2	111	81	85	71	3.4	248	63	248	.04
	55		989.985	.07	.04	1.2	1.2	111	80	85	72	3.6	248	63	248	.04
	60		992.995	.07	.04	1.2	1.2	111	80	85	72	3.8	247	63	247	.04
	65	14:18	996.026													

SCRUBBER OUTLET

CLEAN-UP DATA

Plant MOUND

Date JAN 30, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIFIED

Run Number 8 - PART - OUT

Sample Box Number ESC

Clean-up Man Malone

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ml 0.1 N NaOH → #1, #2

empty → #3

	#1	#2	#3	#4	#5
Final Vol.	602.8 gm	596.1 gm	502.1 gm	ml	ml
Initial Vol.	600.0 gm	591.9 gm	499 gm	ml	ml
Net Vol.	-1.2 gm	4.2 gm	3.1 gm	ml	ml

Total Net Volume in Impingers 6.1 gm

SILICA GEL

Final Weight	784.5 gm	g	g
Initial Weight	777.2 gm	g	g
Net Weight	7.3 gm	g	g

Total Net Weight in Silica Gel 7.3 gm

Total Moisture 13.4 gm

		MRC #
Filter Number(s)	47362	1922062-22

MRC 7/73

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Monroe
DATE June 3, 1985
SAMPLING TIME (24-hr CLOCK) 1313 - 1418
SAMPLING LOCATION Scrubber Outlet (Run B)
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) _____
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE 70°F
OPERATOR CD

COMMENTS:

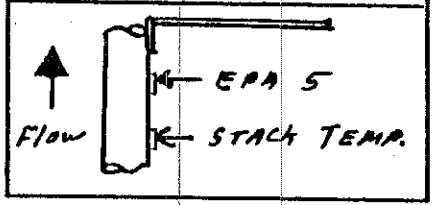
GAS \ RUN	1 1315		2 1322		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2		0.5		1.0			0.75	44/100	0.33
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)		20.5		21.0			20.75	32/100	6.64
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)							—	28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							78.50	28/100	21.98
								TOTAL	28.95

EPA [illegible] OD 5
FIELD DATA

PLANT Mound
DATE JAN 31, 1985
SAMPLING LOCATION WD-SCRUB. OUT
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 9 - PART. - OUT
OPERATOR Malone
AMBIENT TEMPERATURE 69 °F
BAROMETRIC PRESSURE 29.21 "Hg
STATIC PRESSURE, (P_s) [illegible] "H_2O
FILTER NUMBER (s) 47343
PITOT TUBE No. & Cp. ANNUBAR & "P" TYPE

SCRUBBER OUTLET

WASTE - "A"
TEMP. -
FEED RATE -



PROBE LENGTH AND TYPE 2 FT. S.S.
NOZZLE I.D. .382
ASSUMED MOISTURE, % SATURATED EXIT MIST. EL
SAMPLE BOX NUMBER 3
METER BOX NUMBER ESC-2
METER ΔH@ 1.90
K FACTOR HP85 - SEE BELOW
PRE-TEST LEAK CHECK RATE .001 CFM @ 8 "Hg
POST TEST LEAK CHECK RATE .001 CFM @ 12 "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

	17:38	17:41
O_2	20.0%	20.2%
CO_2	0.5%	1.0%

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O Annubar	VELOCITY HEAD (Δp_s), in. H_2O EPA 5	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F Port	STACK TEMPERATURE (T_s), °F Nam Mist.	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	IMPINGER TEMPERATURE, °F static	PROBE TEMPERATURE, °F	"P"
Single	0	17:18	996.149	.04	.02	.6	.6	114	80	76	70	2.0	259	75	+.05	280	.02
point	5		998.335	.04	.02	.6	.6	114	81	81	70	2.0	258	69	.05	272	.03
	10		000.510	.04	.02	.6	.6	113	81	83	70	2.0	257	68	.05	261	.03
Center	15		002.695	.15	.08	2.4	2.4	114	81	84	70	4.1	256	66	.14	252	.09
of stack	20		006.550	.15	.08	2.4	2.4	113	80	85	71	4.4	252	63	.14	241	.09
	25		010.730	.15	.08	2.4	2.4	112	80	85	71	4.6	249	64	.14	243	.09
	30		014.915	.15	.08	2.4	2.4	112	80	85	72	4.8	246	65	.14	244	.09
	35		019.110	.15	.08	2.4	2.4	112	80	86	72	5.0	244	65	.14	245	.09
	40		023.325	.15	.08	2.4	2.4	112	79	87	73	5.2	245	65	.14	247	.09
	45		027.520	.15	.08	2.4	2.4	112	79	87	73	5.4	244	65	.14	248	.09
	50		031.695	.15	.08	2.4	2.4	112	79	87	74	5.6	245	65	.14	249	.09
	55		035.865	.15	.08	2.4	2.4	111	80	87	74	5.9	248	65	.14	248	.09
	60	18:18	040.127														
			[illegible]		[illegible]		[illegible]	[illegible]			[illegible]				[illegible]		

SCRUBBER OUTLET

CLEAN-UP DATA

Plant MOUND

Date JAN 31, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIFIED

Run Number 9 - PART - OUT

Sample Box Number ESC

Clean-up Man Malone

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ml 0.1 N NaOH; empty

	#1	#2	#3	#4	#5
Final Vol.	601.2 gms	597.0 gms	501.1 gms	ml	ml
Initial Vol.	603.6 gms	591.2 gms	500.0 gms	ml	ml
Net Vol.	-2.4 gms	5.8 gms	1.1 gms	ml	ml

Total Net Volume in Impingers 4.5 gms

SILICA GEL

Final Weight	793.3 gm	g	g
Initial Weight	784.5 gm	g	g
Net Weight	8.8 gm	g	g

Total Net Weight in Silica Gel 8.8 gm

Total Moisture 13.3 gm

Filter Number(s)	47343	MRC # 1922011-8

MRC 7/73

PLANT: Mound LOCATION: Scrubber Inlet I.D. #

INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY)	PART. 3-INLET	HCL 3-INLET	PART. 4-INLET	HCL 4-INLET
				RUN #:				
Load EPA-5 (revised) Side 1				DATE:	1/24	→		→
Store variables				TIME:	1043	to 1147	1350 to	1450
Meter volume	V_m	ft^3	ENTER		47.366		48.621	
Barometric pressure	P_{bar}	In. Hg	ENTER		28.93		28.93	
Pressure diff. on orifice	ΔH	In. H_2O	ENTER		1.97		2.05	
Meter temperature	T_m	Deg F	A	V_m	82.0		91.1	
Meter calibration factor	Y		ENTER		1.00	→		→
Volume water in imp.	V_{wc}	ml	ENTER		44		51.9	
Volume water in sil gel	V_{wsg}	gm	ENTER		13.2		8.7	
Particulate collected	M_n	factor, mg	R/S	Y	1	→		→
Compute volume meter standard			B	$V_{m(std)}$	44.85		45.28	
Compute volume water standard			R/S	$V_{wc(std)}$	2.69		2.85	
Compute percent moisture			R/S	B_{ws}	0.06		0.06	
Compute mass loading factor	concentration	grn/DSCF/mg	R/S	C'_s	3.43E-4		3.40E-4	
factor	concentration	lb./DSCF/mg	R/S	C_s	4.92E-8		4.87E-8	
Load EPA-2								
Stack temperature	Ts AVG	Deg F	STO 2		1437		1432.2	
Average velocity head	$\sqrt{\Delta P}$		STO 3		0.92		0.94	
Pilot tube calibration	C_p		STO 4		0.84	→		→
Absolute stack pressure	P_s	In. Hg	STO 5		28.55		28.53	
Dry molecular weight	M_d		STO 6		29.37	→		→
Mole fraction H_2O	B_{wo}		STO 7		0.06		0.06	
Compute velocity	V_s	FPS	B	V_s AVG	100.6		102.6	
Stack area	A	ft^2	STO 9		0.18	→		→
Compute stack flow rate	Q_s	DSCFH	C	Q_s	16269		16638	
Dry Standard		DSCFM	Q ÷ 60		271		277	
Actual Vs x A x 60		ACFM			1086		1108	
Load EPA-5 (revised) side 2								
Store variables	B_{ws}		STO 5		0.06		0.06	
	$V_{m(std)}$		STO 7		44.85		45.28	
	lb./DSCF		STO 8		—		—	
Stack temperature	T_s	Deg F	ENTER		1437		1432.2	
Sampling time	θ	min	ENTER		60	→		→
Stack gas velocity	V_s	ft/sec	A		100.6		102.6	
Abs. stack gas pressure	P_s	In. Hg	ENTER		28.55		28.53	
Nozzle area	A_n	ft^2			4.91E-4	→		→
Percent Isokinetic		lb/dscf	R/S	%I	101.1		94.9	
Compute mass loading	concentration	gm./DSCF	B	C_s	9.45E-6		9.97E-6	
Emission Rate (lbs/hr)	Q_s (DSCFH)	X C_s (lbs/DSCF)			0.154	0.737	0.166	2.101
	Pollutant:							
Data Reduction By: (Initials)								

PLANT: MOUND - WD LOCATION: SCRUBBER INLET I.D. #

INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY)	PART 5-INLET	HCL 5-INLET	Part. 6-Inlet
Load EPA-5 (revised) Side 1				RUN #:			
Store variables				DATE:	1/29 →		1/29 →
				TIME:	10:44-11:44		1423 to 1453
Meter volume	V_m	ft^3	ENTER		54.297		28.479
Barometric pressure	P_{bar}	In. Hg	ENTER		29.41		29.41
Pressure diff. on orifice	ΔH	In. H_2O	ENTER		2.634		2.8
Meter temperature	T_m	Deg F	A	V_m	85.4		93.6
Meter calibration factor	Y		ENTER		1.00		1.00
Volume water in imp.	V_{wc}	ml	ENTER		32.8		26.8
Volume water in sil gel	V_{wsg}	gm	ENTER		11.3		7.5
Particulate collected	M_n	mg	R/S	Y	1		1
Compute volume meter standard			B	$V_{m(std)}$	52.02		26.89
Compute volume water standard			R/S	$V_{wc(std)}$	2.08		1.62
Compute percent moisture			R/S	B_{ws}	0.04		~~0.07~~ .06
Compute mass loading	concentration	grn/DSCF/mg	R/S	C's'	2.96E-4		5.73E-4
	concentration	lb./DSCF/mg	R/S	C_s	4.24E-8		8.20E-8
Load EPA-2							
Stack temperature	Ts AVG	Deg F	STO 2		1378.6		1388
Average velocity head	$\sqrt{\Delta P}$		STO 3		1.068		1.11
Pilot tube calibration	C_p		STO 4		0.84		0.84
Absolute stack pressure	P_s	In. Hg	STO 5		29.12		29.02
Dry molecular weight	M_d		STO 6		29.38		29.35
Mole fraction H_2O	B_{wo}		STO 7		0.04		0.06
Compute velocity	V_s	FPS	B	V_s AVG	113		118.8
Stack area	A	ft^2	STO 9		0.18	→	
Compute stack flow rate	Q_s	DSCFH	C	Q_s	19705		20057
Dry Standard		DSCFM	Q ÷ 60		328		334
Actual Vs x A x 60		ACFM			1224		1283
Load EPA-5 (revised) side 2							
Store variables	B_{ws}		STO 5		0.04		0.06
	$V_{m(std)}$		STO 7		52.02		26.89
	lb./DSCF		STO 8		—		—
Stack temperature	T_s	Deg F	ENTER		1378.6		1388
Sampling time	θ	min	ENTER		60	—	30 —
Stack gas velocity	V_s	ft/sec	A		113		118.8
Abs. stack gas pressure	P_s	In. Hg	ENTER		29.12		29.02
Nozzle area	A_n	ft^2			4.91E-4	→	
Percent Isokinetic		~~lb/dscf~~	R/S	%I	97.1		98.4
Compute mass loading	concentration	~~gm./DSCM~~	B	C"s"	9.79E-6		1.23E-5
Emission Rate (lbs/hr)	Q_s (DSCFH) X C_s (lbs/DSCF)				0.193	1.000	0.2475 1.289
	Pollutant:						
Data Reduction By: (Initials)							

PLANT: Mound-40 LOCATION: Scrubber Inlet I.D. #

INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY) RUN #:	Part 7-Inlet	HCl →	PART 8-INLET	HCl →
Load EPA-5 (revised) Side 1				DATE:	1-30	→	1-31	
Store variables				TIME:	13:59	16:04		
Meter volume	V_m	ft^3	ENTER		29.819		17.175	
Barometric pressure	P_{bar}	In. Hg	ENTER		29.37		29.21	
Pressure diff. on orifice	ΔH	In. H_2O	ENTER		0.11		0.17	
Meter temperature	T_m	Deg F	A	V_m	75.7		75.8	
Meter calibration factor	Y		ENTER		1.00		1.00	
Volume water in imp.	V_{wc}	ml	ENTER		257.9		73.5	
Volume water in sil gel	V_{wsg}	gm	ENTER		5.8		5.5	
Particulate collected	M_n	mg	R/S	Y	1		1	
Compute volume meter standard			B	$V_{m(std)}$	24.02		16.53	
Compute volume water standard			R/S	$V_{wc(std)}$	12.41		3.72	
Compute percent moisture			R/S	B_{ws}	0.34		0.18	
Compute mass loading	concentration	grn/DSCF/~~mg~~	R/S	C's'	6.41 E-4		9.31 E-4	
	concentration	lb./DSCF/~~mg~~	R/S	C_s	9.18 E-8		1.33E-7	
Load EPA-2								
Stack temperature	Ts AVG	Deg F	STO 2		1157.4		1128.4	
Average velocity head	$\sqrt{\Delta P}$		STO 3		0.203		0.198	
Pilot tube calibration	C_p		STO 4		0.84		0.84	
Absolute stack pressure	P_s	In. Hg	STO 5		29.08		28.96	
Dry molecular weight	M_d		STO 6		29.94		29.46	
Mole fraction H_2O	B_{wo}		STO 7		0.34		0.18	
Compute velocity	V_s	FPS	B	V_s AVG	21.37		20.12	
Stack area	A	ft^2	STO 9		0.18		0.18	
Compute stack flow rate	Q_s	DSCFH	C	Q_s	2900		3440	
Dry Standard		DSCFM	Q ÷ 60		48.3		57.3	
Actual Vs x A x 60		ACFM			231		217	
Load EPA-5 (revised) side 2								
Store variables	B_{ws}		STO 5		0.34		0.18	
	$V_{m(std)}$		STO 7		24.02		16.53	
	lb./DSCF		STO 8		—		—	
Stack temperature	T_s	Deg F	ENTER		1157.4		1128.4	
Sampling time	θ	min	ENTER		125		70	
Stack gas velocity	V_s	ft/sec	A		21.37		20.12	
Abs. stack gas pressure	P_s	In. Hg	ENTER		29.08		28.96	
Nozzle area	A_n	ft^2			4.91 E-4		8.47E-4	
Percent Isokinetic		~~lb/dscf~~	R/S	%I	145.8		87.6	
Compute mass loading	concentration	~~lbs/DSCF~~	B	C"s"	1.23E-4		3.76E-5	
Emission Rate (lbs/hr)	Q_s (DSCFH) X C_s (lbs/DSCF)				0.358	0.892	0.1295	0.394
	Pollutant:							
Data Reduction By: (Initials)								

PLANT: MOUND - WD LOCATION: SCRUBBER INLET I.D. #

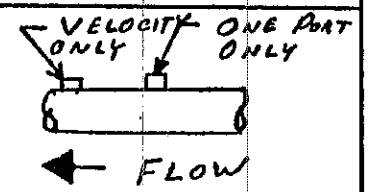
INSTRUCTIONS	(DATA)		(KEYS)	(DISPLAY) RUN #:	PART 9-INLET	HCL →
Load EPA-5 (revised) Side 1				DATE:	11/21/85 →	
Store variables				TIME:	1717 to 1817	
Meter volume	V_m	ft^3	ENTER		21.448	
Barometric pressure	P_{bar}	In. Hg	ENTER		29.21	
Pressure diff. on orifice	ΔH	In. H_2O	ENTER		0.33	
Meter temperature	T_m	Deg F	A	V_m	82.1	
Meter calibration factor	Y		ENTER		1.00	
Volume water in imp.	V_{wc}	ml	ENTER		64.8	
Volume water in sil gel	V_{wsg}	gm	ENTER		4.1	
Particulate collected	M_n	mg	R/S	Y	1	
Compute volume meter standard			B	$V_{m(std)}$	20.42	
Compute volume water standard			R/S	$V_{wc(std)}$	3.24	
Compute percent moisture			R/S	B_{ws}	0.137	
Compute mass loading	concentration	grn/DSCF/~~mg~~	R/S	C's'	0.001	
	concentration	lb./DSCF/~~lg~~	R/S	C_s	1.04E-7	
Load EPA-2						
Stack temperature	Ts AVG	Deg F	STO 2		1136	
Average velocity head	$\sqrt{\Delta P}$		STO 3		0.236	
Pilot tube calibration	C_p		STO 4		0.84	
Absolute stack pressure	P_s	In. Hg	STO 5		29.03	
Dry molecular weight	M_d		STO 6		29.4	
Mole fraction H_2O	B_{wo}		STO 7		0.16	
Compute velocity	V_s	FPS	B	V_s AVG	23.93	
Stack area	A	ft^2	STO 9		0.16	
Compute stack flow rate	Q_s	DSCFH	C	Q_s	4181	
Dry Standard		DSCFM	Q ÷ 60		69.7	
Actual Vs x A x 60		ACFM			258	
Load EPA-5 (revised) side 2						
Store variables	B_{ws}		STO 5		0.137	
	$V_{m(std)}$		STO 7		20.42	
	lb./DSCF		STO 8		—	
Stack temperature	T_s	Deg F	ENTER		1136	
Sampling time	θ	min	ENTER		60	
Stack gas velocity	V_s	ft/sec	A		23.93	
Abs. stack gas pressure	P_s	In. Hg	ENTER		29.03	
Nozzle area	A_n	ft^2			8.47E-4	
Percent Isokinetic		~~lb/DSCF~~	R/S	%I	101.1	
Compute mass loading	concentration	~~gm./DSCM~~	B	C "S"	1.32E-4	
Emission Rate (lbs/hr)	Q_s (DSCFH)	X C_s (lbs/DSCF)			0.552	1.938
	Pollutant:					
Data Reduction By: (Initials)						

EPA N. 5
FIELD DATA

PLANT MOUND
DATE JAN 22, 1985
SAMPLING LOCATION WD-SCRUB-IN
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 1 - PART. - IN
OPERATOR KATHERINE AKHSTROPG
AMBIENT TEMPERATURE 60 °F
BAROMETRIC PRESSURE 29.30 " Hg
STATIC PRESSURE, (P_s) = 4" H_2O " H_2O
FILTER NUMBER (s) 50185
PITOT TUBE No. & Cp. "S" TYPE
7 8 DIA DOWNSTREAM

SCRUBBER INLET

WASTE	C
TEMP.	2390 °F
FEED RATE	42 lb/hr



PROBE LENGTH AND TYPE 3 FT H_2O COOLED
NOZZLE I.D. 0.30
ASSUMED MOISTURE, % WILL VARY WITH WASTE
SAMPLE BOX NUMBER NAPP
METER BOX NUMBER NAPP
METER ΔH@ 1.86
K FACTOR N/A
PRE-TEST LEAK CHECK RATE .001 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE _____ CFM @ ___ "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F
	0	16:50	348.715	0.70	1.65	1.65	1383°F	73	70	4	202	64	245
	5		352.325	0.71	1.65	1.6	1392	76	70	4	223	62	268
	10		355.848	0.73	1.67	1.6	1388	78	72	4.3	230	63	261
	15		359.430	0.75	1.72	1.65	1389	80	74	4.5	245	65	254
	20		363.080	0.82	1.76	1.70	1387	82	76	5	244	65	258
	25		366.883	0.80	1.95	1.9	1387	84	77	5	244	66	262
	30		370.690	0.81	1.88	1.85	1382	84	78	5	246	67	264
	35		374.528	0.82	1.93	1.88	1386	86	80	5.5	248	68	265
	40		378.390	0.80	1.93	1.9	1388	86	80	5.5	250	69	267
	45		382.275	0.82	1.93	1.93	1385	87	81	6	257	61	265
	50		386.170	0.83	1.93	1.93	1381	87	82	6	252	60	266
	55		390.083	0.85	1.95	1.95	1385	88	83	6	253	62	268
	60	17:50	394.048		2.00								
			45.333	0.89		1.80	1386.08		81.0				

SINGLE POINT SAMPLING ~ CENTER OF DUCT

SCRUBBER INLET

CLEAN-UP DATA

Plant MOUND

Date JAN 22, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIED

Run Number 1 - PART - IN

Sample Box Number NAPP

Clean-up Man Malone

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ML 0.1 N $NaOH$

EMPTY

	#1	#2	#3	#4	#5
Final Vol.	559.0 gms	528.2 gms	418.9 gms		ml
Initial Vol.	534.4 gms	519.6 gms	416.5 gms		ml
Net Vol.	24.6 gms	8.6 gms	2.4 gms		ml

Total Net Volume in Impingers 35.6 ml

SILICA GEL

Final Weight	612.9 gm	g	g	
Initial Weight	603.4 gm	g	g	
Net Weight	9.5 gm	g	g	

Total Net Weight in Silica Gel 9.5 gm

Total Moisture 45.1 gm

Filter Number(s) 50185

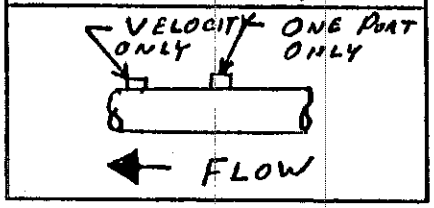
MRC 7/73

EPA METHOD 5
FIELD DATA

PLANT MOUND
DATE JAN 23, 1985
SAMPLING LOCATION WD-SCRUB-IN
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 2 - PART. - IN
OPERATOR KATHERIDGE ARMSTRONG
AMBIENT TEMPERATURE 59 °F
BAROMETRIC PRESSURE 29.28 " Hg
STATIC PRESSURE, (P_s) 6 " H_2O
FILTER NUMBER (s) 50183
PITOT TUBE No. & Cp. "S" TYPE

SCRUBBER INLET

WASTE TEMP. C ~2380°F
FEED RATE ~4716 #/hr



PROBE LENGTH AND TYPE 3 FT H_2O COOLED
NOZZLE I.D. 0.30 "
ASSUMED MOISTURE, % WILL VARY WITH WASTE
SAMPLE BOX NUMBER NAPP
METER BOX NUMBER NAPP
METER ΔH@ 1.86
K FACTOR N/A
PRE-TEST LEAK CHECK RATE 0.005 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE 0.25 CFM @ 6 "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

due to. melted filter - Balance started at end of run & this is why ?

7 8 DIA DOWNSTREAM SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

B-100

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	STATIC
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F					
1	0	13:55	314.139	0.57		1.27	1456	70	68		215		231	6
2	5	1	397.346	0.56	1.27	1.27	1462	73	69	4	229		236	5-6
3	10		400.604	0.56	1.27	1.25	1463	76	71	4.5	234		245	5-2
4	15		409.937	0.56	1.27	1.27	1465	79	73	5	240		251	5.6
5	20		407.244	0.55	1.27	1.27	1467	80	75	5	243		255	5.6
6	25		410.527	0.55	1.23	1.23	1468	83	77	5	245		257	5.2
7	30		413.793	0.55	1.23	1.23	1468	84	78	5	248		259	5.6
8	35		417.018	0.55	1.23	1.23	1470	85	80	5.5	250		260	5.6
9	40		420.364	0.56	1.23	1.23	1473	86	82	5.5	250		261	5.6
10	45		423.688	0.56	1.27	1.27	1473	88	83	6	251		262	5.6
11	50		427.032	0.56	1.27	1.27	1473	89	84	6	254		263	6
12	55		430.365	0.57	1.27	1.27	1470	89	85	6	252		264	6
	60	14:55	433.708		1.27									
				Avg 0.75										
			39.569	~~0.795~~		1.255	1467.3		79.5					

SCRUBBER INLET

CLEAN-UP DATA

Plant MOUND

Date JAN 23, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIED

Run Number 2 - PART - IN

Sample Box Number NAPP

Clean-up Man CO

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ML 0.1 N $NaOH$

	#1	#2	#3	#4	#5
			EMPTY		
Final Vol.	578.5 gm	528.2 gm	421.1 gm	~~X~~ ml	~~X~~ ml
Initial Vol.	534.4 gm	520.2 gm	417.5 gm	ml	ml
Net Vol.	44.1 gm	8.0 gm	3.6 gm	ml	ml

Total Net Volume in Impingers 55.7 ml

SILICA GEL

Final Weight	520.4 gm	~~X~~ g	~~X~~ g
Initial Weight	512.9 gm	g	g
Net Weight	7.5 gm	g	g

Total Net Weight in Silica Gel 7.5 gm

Total Moisture 63.2 gm

Filter Number(s) 50183

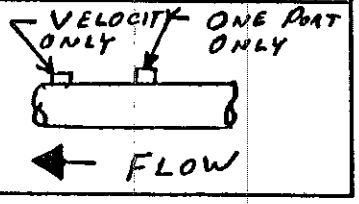
MRC 7/73

EPA METHOD 5
FIELD DATA

PLANT MOUND
DATE JAN 24, 1985
SAMPLING LOCATION WD-SCRUB-IN
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 3 - PART. - IN
OPERATOR KATHERINE ARMSTRONG
AMBIENT TEMPERATURE 68 °F
BAROMETRIC PRESSURE 28.93 "Hg
STATIC PRESSURE, (P_s) SEE BELOW "H_2O
FILTER NUMBER (s) 50182
PITOT TUBE No. & Cp. "S" TYPE
7 8 DIA DOWNSTREAM

SCRUBBER INLET

WASTE TEMP. FEED RATE — D — 2398°F



PROBE LENGTH AND TYPE 3 FT H_2O COOLED
NOZZLE I.D. .030 AVG.
ASSUMED MOISTURE, % WILL VARY WITH WASTE
SAMPLE BOX NUMBER NAPP
METER BOX NUMBER NAPP
METER ΔH@ 1.86
K FACTOR N/A
PRE-TEST LEAK CHECK RATE .005 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE 0.015 CFM @ 9 "Hg
REFERENCE Δp OF LEAK CHECK OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	STATIC
	0	10:43	435.177	0.86		2.0	1434	71	69	5.5	211		220	6
1	5		438.982	0.84	2.0	1.9	1433	76	72	5.5	218		233	5
2	10		442.897	0.83	2.0	1.95	1433	79	74	5.5	229		262	5
3	15		446.758	0.81	1.93	1.93	1433	82	75	5.5	236		261	4.6
4	20		450.620	0.80	1.90	1.90	1436	84	77	6	239		261	4.6
1	25	* FLOW INCREASE	454.516	0.87	2.04	2.00	1431	85	79	6.5	242		260	5.4
2	30		458.513	0.86	2.04	2.00	1435	88	81	7	245		262	5
3	35		462.482	0.85	2.00	1.95	1443	88	83	7.5	247		263	5
4	40		466.456	0.83	2.00	1.95	1439	89	84	8	248		264	5
	45		470.390	0.83	1.95	1.93	1438	90	85	8	250		265	5
1	50	* FLOW INCREASE	474.313	0.89	2.09	2.05	1439	91	86	8.5	251		265	5.6
2	55		478.457	0.88	2.09	2.06	1441	92	87	9	252		267	5.6
3	60		482.543		2.07									
4														
			47.366	0.920		1.968	1436.8		81.96					5.2

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SCRUBBER INLET

CLEAN-UP DATA

Plant MOUND

Date JAN 23, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIED

Run Number 3 - PART - IN

Sample Box Number NAPP

Clean-up Man CO, HM

Comments: TRAIN COLLECTS HCL AND H_2O

IMPINGERS

100 ML 0.1 N NaOH

#1 → #2 → #3 EMPTY → #4 → #5

	#1	#2	#3	#4	#5
Final Vol.	569.9 gm	526.5 gm	420.2 gm	ml	ml
Initial Vol.	534.4 gm	520.8 gm	417.4 gm	ml	ml
Net Vol.	35.5 gm	5.7 gm	2.8 gm	ml	ml

Total Net Volume in Impingers 44.0 ml

SILICA GEL

Final Weight	689.3 gm	g	g
Initial Weight	676.1 gm	g	g
Net Weight	13.2 gm	g	g

Total Net Weight in Silica Gel 13.2 gm

Total Moisture 57.20 gm

Filter Number(s) 50182

EPA METHOD 5
FIELD DATA

PLANT MOUND
DATE JAN 24, 1985
SAMPLING LOCATION WD-SCRUB-IN
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 4 - PART. - IN
OPERATOR KATHERINE ARMSTRONG
AMBIENT TEMPERATURE 75 °F
BAROMETRIC PRESSURE 28.93 " Hg
STATIC PRESSURE, (P_s) SEE BELOW " H_2O
FILTER NUMBER (s) 50181
PITOT TUBE No. & Cp. "S" TYPE

SCRUBBER INLET

WASTE TEMP. D
FEED RATE 2450 #

VELOCITY ONLY — ONE PORT ONLY
FLOW

PROBE LENGTH AND TYPE 3 FT H_2O COOLED
NOZZLE I.D. 0.80 "
ASSUMED MOISTURE, % WILL VARY WITH WASTE
SAMPLE BOX NUMBER NAPP
METER BOX NUMBER NAPP
METER ΔH@ 1.86
K FACTOR N/A
PRE-TEST LEAK CHECK RATE 0.005 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE 0.010 CFM @ 9 "Hg
REFERENCE Δp OF 1 = Δ H OF (SEE BELOW)

7 8 DIA DOWNSTREAM SCHEMATIC OF TRAVERSE POINT LAYOUT

6% CO_2 @ 14:40
15.5% O_2

READ AND RECORD ALL DATA EVERY 5 MINUTES

B-104

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	STATIC
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F					
	0	13:50	482.782	0.88	2.07	2.07	1440	86	85	5	~~204~~		~~202~~	5.6
SAMPLE PORT A	5		486.700	0.88	2.07	2.0	1429	91	87	5.5	204		262	5.6
	10		490.739	0.88	2.07	2.05	1426	93	87	6	217		268	5.2
	15		494.813	0.88	2.07	2.05	1427	93	88	6	224		265	5.2
	20		498.875	0.87	2.07	2.05	1424	94	89	6	229		264	5.6
SAMPLE PORT B	25		502.937	0.87	2.04	2.05	1428	94	89	6.5	235		264	5.6
	30		506.988	0.87	2.04	2.05	1430	95	89	7	239		264	5.6
	35		511.047	0.89	2.04	2.05	1434	95	90	7	241		266	5.6
SAMPLE PORT C	40		515.126	0.88	2.09	2.05	1436	96	90	7	245		267	5.6
	45		519.200	0.87	2.07	2.05	1434	95	90	7.5	245		268	
	50		523.264	0.89	2.04	2.04	1442	96	90	7.5	248		269	
SAMPLE PORT D	55		527.322	0.88	2.04	2.05	1436	95	90	8	248		270	5
	60	1460	531.408		~~2.07~~									
			48.621	0.937		2.047	1432.2		91.1					

SCRUBBER INLET

CLEAN-UP DATA

Plant MOUND

Date JAN 24, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIED

Run Number 4- PART - IN

Sample Box Number NAPP

Clean-up Man CD, JM

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ML 0.1 N NaOH

5 EMPTY

	#1	#2	#3	#4	#5
Final Vol.	577.1 gms	530.0 gms	420.4 gms	ml	ml
Initial Vol.	536.0 gms	523.1 gms	416.5 gms	ml	ml
Net Vol.	41.1 gms	6.9 gms	3.9 gms	ml	ml

Total Net Volume in Impingers 51.90 ml

SILICA GEL

Final Weight	698.0 gm	g	g	g
Initial Weight	689.3 gm	g	g	g
Net Weight	8.7 gm	g	g	g

Total Net Weight in Silica Gel 8.7 gm

Total Moisture 60.6 gm

Filter Number(s) 50181

MRC 7/73

EPA MI D 5
FIELD DATA

PLANT MOUND
DATE JAN 29, 1985
SAMPLING LOCATION WD-SCRUB-IN
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 4 - PART. - IN
OPERATOR KATHLEEN - ARNELCOG
AMBIENT TEMPERATURE 65 °F
BAROMETRIC PRESSURE 29.41 " Hg
STATIC PRESSURE, (P_s) SEE BELOW " H_2O
FILTER NUMBER (s) 5018C
PITOT TUBE No. & Cp. "S" TYPE

SCRUBBER INLET

WASTE TEMP. D
FEED RATE (50%) 2376°F
32 lb/hr (N)

VELOCITY ONLY — ONE PART ONLY
FLOW

PROBE LENGTH AND TYPE 3 FT - H_2O COOLED
NOZZLE I.D. 0.30 "
ASSUMED MOISTURE, % WILL VARY WITH WASTE
SAMPLE BOX NUMBER NAPP
METER BOX NUMBER NAPP
METER ΔH@ 1.86
K FACTOR N/A
PRE-TEST LEAK CHECK RATE 0.010 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE 0.012 CFM @ 9 "Hg
REFERENCE Δp OF 1 = Δ H OF (SEE BELOW)

7 8 DIA DOWNSTREAM SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

B-106

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	STACK
					DESIRED	ACTUAL		INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F					
	0	10:44	531.781	1.2	2.96	2.76	1351	76	74	6	206		217	4.6
	5		535.876	1.2	2.76	2.63	1367	80	76	6	223		256	4.4
	10		540.335	1.2	2.82	2.8	1354	84	77	7	229		259	4.6
	15		545.014	1.2	2.82	2.8	1377	86	78	7.5	236		261	4.6
	20		549.710	1.2	2.82	2.82	1390	88	81	8	242		264	4
	25		554.408	1.2	2.82	2.8	1383	90	83	8	247		266	4.2
	30		559.082	1.15	2.8	2.75	1380	91	84	8	260		268	3.6
	35		563.675	1.1	2.70	2.6	1384	92	85	8	250		267	4
	40		568.217	1.1	2.59	2.58	1388	92	87	8	252		268	3.6
	45		572.737	1.05	2.59	2.5	1386	94	88	8	253		268	3.6
	50		577.207	1.05	2.47	2.45	1391	94	88	8.5	253		268	3.6
	55		581.660	1.05	2.47	2.45	1392	95	88	8.5	255		268	3.6
	60		586.078											
			64.397	1.068		2.634	1378.6		85.4					

SAMPLE LINE - P_0 12" DIA. DUCT

SCRUBBER INLET

CLEAN-UP DATA

Plant MOUND

Date JAN 24, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIED

Run Number 5 - PART - IN

Sample Box Number NAPP

Clean-up Man CD, J.M

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ML 0.1 N NaOH

EMPTY

	#1	#2	#3	#4	#5
Final Vol.	565.4 gm	531.1 gm	421.1 gm	ml	ml
Initial Vol.	537.3 gm	527.9 gm	419.6 gm	ml	ml
Net Vol.	28.10 gm	3.2 gm	1.5 gm	ml	ml

Total Net Volume in Impingers 32.8 ml

SILICA GEL

Final Weight	709.3 gm	g	g
Initial Weight	698.0 gm	g	g
Net Weight	11.3 gm	g	g

Total Net Weight in Silica Gel 11.3 gm

Total Moisture 44.10 gm

Filter Number(s) 50180

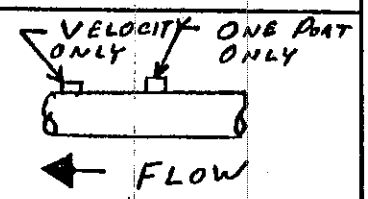
MRC 7/73

EPA METHOD 5
FIELD DATA

PLANT MOUND
DATE JAN 29, 1985
SAMPLING LOCATION WD-SCRUB-IN
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 6 - PART. - IN
OPERATOR KATHERINE ARMSTRONG
AMBIENT TEMPERATURE 78 °F
BAROMETRIC PRESSURE 29.41 " Hg
STATIC PRESSURE, (P_s) SEE BELOW H_2O
FILTER NUMBER (s) 50179
PITOT TUBE No. & Cp. "S" TYPE
7 8 DIA DOWNSTREAM

SCRUBBER INLET

WASTE	D
TEMP.	2600°F
FEED RATE (60%) 65	



PROBE LENGTH AND TYPE 3 FT H_2O COOLED
NOZZLE I.D. 0.30"
ASSUMED MOISTURE, % WILL VARY WITH WASTE
SAMPLE BOX NUMBER NAPP
METER BOX NUMBER NAPP
METER ΔH@ 1.86
K FACTOR N/A
PRE-TEST LEAK CHECK RATE 0.010 CFM @ 15 "Hg.
POST TEST LEAK CHECK RATE 0.020 CFM @ 15 "Hg
REFERENCE Δp OF 1 = ΔH OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	STATIC
SINGLE POINT SAMPLING IN CENTER OF DUCT	0	14:23	586.355	1.25	2.82	2.82	1365	88	88	6.5	—	Iced	—	6
	5		590.966	1.2	2.82	2.75	1383	96	91	7	207	Down	292	5.6
	10		595.754	1.25	2.94	2.95	1399	97	92	7.5	223		274	5
	15		600.580	1.25	2.94	2.85	1396	98	92	8	235		261	5
	20		605.356	1.25	2.94	2.8	1394	98	92	8.5	243		258	5.4
	25		610.124	1.2	2.94	2.85	1390	98	93	9.5	249		257	5
	30		614.834		~~2.82~~									
	~~35~~													
	~~40~~													
			28.479	1.111		1.837	1387.8		93.6					

SCRUBBER INLET

CLEAN-UP DATA

Plant MOUND

Date JAN 29, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIED

Run Number 6- PART - IN

Sample Box Number NAPP

Clean-up Man CD, U.M

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ML 0.1 N NaOH

EMPTY

	#1	#2	#3	#4	#5
Final Vol.	~~556.0~~ gm	~~525.5~~ gm	419.1 gm	ml	ml
Initial Vol.	~~530.8~~ gm	~~523.4~~ gm	418.4 gm	ml	ml
Net Vol.	gm	2.5 gm	0.7 gm	ml	ml
	121.5 ml	105.3 ml			
	~~100.0~~ ml	~~100.0~~ ml			
	NET → 21.5 ml	5.3 ml			

Total Net Volume in Impingers 26.8 ml

used volume

SILICA GEL

Final Weight	637.8 gm	g	g	
Initial Weight	630.3 gm	g	g	
Net Weight	7.5 gm	g	g	

Total Net Weight in Silica Gel 7.5 gm

Total Moisture 34.7 gm

Filter Number(s) 50179

MRC 7/73

EPA ML D 5
FIELD DATA

PLANT MOUND
DATE JAN 30, 1985
SAMPLING LOCATION WD-SCRUB-IN
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 7 - PART. - IN
OPERATOR KATTERING ARMSTRONG
AMBIENT TEMPERATURE 52 °F
BAROMETRIC PRESSURE 29.37 " Hg
STATIC PRESSURE, (P_s) SEE BELOW " H_2O
FILTER NUMBER (s) 50178
PITOT TUBE No. & Cp "S" TYPE
7 8 DIA DOWNSTREAM

SCRUBBER INLET

WASTE A
TEMP. 237°F
FEED RATE 134 lb/hr

VELOCITY ONLY — ONE PORT ONLY

FLOW

SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 3 FT - H_2O COOLED
NOZZLE I.D. 0.30"
ASSUMED MOISTURE, % WILL VARY WITH WASTE
SAMPLE BOX NUMBER NAPP
METER BOX NUMBER NAPP
METER ΔH@ 1.86
K FACTOR D/A
PRE-TEST LEAK CHECK RATE 0.005 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE 0.002 CFM @ 6 "Hg
REFERENCE Δp OF 1 = Δ H OF (SEE BELOW)

~~237~~	14:15	18% O_2	13% O_2 @ 14:17
		9% CO_2	9% CO_2

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	STATIC H_2O
					DESIRED	ACTUAL		INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F					
	0	13:59	615.289	0.06	0.16	0.16	1192	65	63	2	192		202	
	5		616.482	0.055	0.16	0.15	1184	67	64	2.5	212		191	3.8
	10		617.608	0.05	0.16	0.16	1178	69	67	2.5	217		241	~~4~~
	15		618.746	0.055	0.16	0.15	1177	70	109	2.5	220		257	4
	20		619.844	0.05	0.16	0.14	1179	73	72	2.5	219		235	4
	25		620.932	0.05	0.14	0.13	1175	73	73	3	223		246	4
	30		622.075	0.05	0.13	0.125	1173	73	74	3	225		252	3.9
	35		623.026	0.045	0.13	0.12	1170	74	74	3	227		254	3.9
	40		624.076	0.045	0.13	0.13	1165	75	75	3.5	227		255	3.9
	45		625.092	0.045	0.12	0.12	1159	76	76	3	225		254	3.9
	50		626.092	0.04	0.11	0.11	1156	76	77	3	225		254	3.9
	55		627.073	0.04	0.11	0.11	1153	77	78	3.5	227		251	3.8
	60		628.038	0.01	0.11	0.11	1155	78	79	3.5	225		251	3.9
	65		628.993	0.04	0.11	0.10	1153	75	77	3.5	227		252	3.9
	~~65~~ 70		629.942	0.04	0.11	0.105	1157	75	77	3.7	224		257	3.9

B-110

PLANT MOUND DATE JAN 30, 1985 RUN NO. 7 - PART. - IN

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	STATIC
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F					
	75		630.910	0.035	0.11	0.105	1148	75	77	4	228		250	3.9
	80		631.873	0.035	0.10	0.105	1146	77	78	4	225		249	3.9
	85		632.812	0.035	0.10	0.10	1143	77	79	4	225		249	3.8
	90		633.749	0.035	0.10	0.10	1145	79	80	4	224		249	3.8
	95		634.678	0.035	0.10	0.10	1142	79	81	4	225		248	3.8
	100		635.626	0.035	0.10	0.095	1141	81	81	4	225		249	3.8
	105		636.574	0.035	0.10	0.10	1139	80	81	4	225		248	3.8
	110		637.468	0.030	0.84	0.086	1137	80	82	4	225		248	3.8
	115		638.317	0.03	0.084	0.080	1136	81	83	4.5	222		247	3.8
	120		639.233	0.03	0.084	0.080	1133	82	83	4.5	222		247	3.8
	125	1604	640.108		~~0.084~~									
25														
								O_2			CO_2	N_2		
								(12.5%×.32) +			(9%×.44)	+ (78.5%×.28)	= 29.84	
														mf
			24.819	0.2034		0.1148	1157.4		75.7					

B-111

* Impinger #1 was Green, # 2 clear after run.

SCRUBBER INLET

CLEAN-UP DATA

Plant MOUND

Date JAN 30, 1985

Sampling Location INCINERATOR

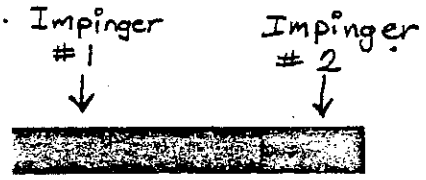
Sample Type EPA 5 - MODIED

Run Number 7 - PART - IN

Sample Box Number NAPP

Clean-up Man Malone

Comments: TRAIN COLLECTS HCL AND H_2O



IMPINGERS

100 ML 0.1 N $NaOH$

#1 #2 EMPTY #3 #4 #5

	#1	#2	#3	#4	#5
Final Vol. *	790.09 gms	527.3 gms	417.69 gms	ml	ml
Initial Vol.	537.1 gms	522.8 gms	417.1 gms	ml	ml
Net Vol.	252.9 gms	4.5 gms	0.5 gms	ml	ml

Total Net Volume in Impingers 257.9 ml

SILICA GEL

Final Weight	643.6 gm	g	g	g
Initial Weight	637.8 gm	g	g	g
Net Weight	5.8 gm	g	g	g

Total Net Weight in Silica Gel 5.8 gm

Total Moisture 263.7 gm

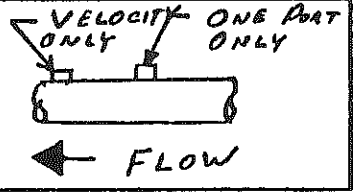
Filter Number(s) 50178

EPA MM D 5
FIELD DATA

PLANT Mound
DATE JAN 9, 1985
SAMPLING LOCATION WD-SCRUB-IN
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 5 - PART. - IN
OPERATOR [illegible]
AMBIENT TEMPERATURE 60's °F
BAROMETRIC PRESSURE 29.21 " Hg
STATIC PRESSURE, (P_s) SEE BELOW H_2O
FILTER NUMBER (s) 50177
PITOT TUBE No. & Cp. "S" TYPE
7 8 DIA DOWNSTREAM

SCRUBBER INLET

WASTE TEMP. 243°F
FEED RATE 89 lb/hr



PROBE LENGTH AND TYPE 3 FT - H_2O COOLED
NOZZLE I.D. 0.394 "
ASSUMED MOISTURE, % WILL VARY WITH WASTE
SAMPLE BOX NUMBER DAPP
METER BOX NUMBER NAPP
METER ΔH@ 1.86
K FACTOR N/A
PRE-TEST LEAK CHECK RATE 0.001 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE 0.001 CFM @ 6 "Hg
REFERENCE Δp OF 1 = Δ H OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

@ 13:12 | 18½ O_2 | 4½ CO_2
@ 13:26 | 18½ O_2 | 4½ CO_2

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	STAT N_2
					DESIRED	ACTUAL		INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F					
	0	13:19	640.267	0.05	0.21	0.21	1148	68	65		205		212	3.2
	5		641.508	0.06	0.21	0.21	1147	70	67	4	211		215	
	10		642.952	0.05	0.21	0.205	1143	71	68	4	214		230	3.2
20	15	13:33	644.											
1	20		644.472	Pump stopped due to				Moisex	XAD		takes**	changed XAD heater no leak check prior to		Metal
2	25	20 13:50	645.714	0.04	0.17	0.17	1135	77	76	3.5	214		252	3.4
3	25		646.954	0.04	0.17	0.17	1137	77	76	3.5	216		249	3.4
4	30	1400	648.190	0.04	0.17	0.17	1134	77	77	3.5	216		246	3.4
1	35		649.423	0.04	0.17	0.17	1128	78	77	3.5	216		246	3.4
2	40		650.662	0.04	0.17	0.17	1130	78	78	3.5	217		248	3.4
3	45		651.906	0.035	0.17	0.17	1119	78	79	3.5	218		252	3.0
4	50		653.080	0.03	0.15	0.145	1115	78	79	3.5	218		253	3.0
1	55		654.176	0.03	0.13	0.13	1112	79	80	3	218		257	3.0
2	100		655.266	0.03	0.13	0.125	1111	79	80	3	217		248	3.0
3	105	1435	656.346	0.03	0.13	0.13	1110	79	80	3.5	218		246	3.0
				0.198		0.11.7	1128.4		78.8					

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PLANT MOUND DATE JAN 31, 1985 RUN NO. 8 - PART. - IN

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F				
	70		657.462		0.13								

B-114

SCRUBBER INLET

CLEAN-UP DATA

Plant MOUND

Date JAN 31, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIED

Run Number 8 - PART - IN

Sample Box Number NAPP

Clean-up Man Malone

Comments: TRAIN COLLECTS HCl AND H_2O

IMPINGERS

100 ML 0.1 N NaOH

EMPTY

	#1	#2	#3	#4	#5
Final Vol.	605.8 gm	522.2 gm	420.0 gm	ml	ml
Initial Vol.	534.6 gm	520.6 gm	419.3 gm	ml	ml
Net Vol.	71.2 gm	1.6 gm	0.7 gm	ml	ml

Total Net Volume in Impingers 73.5 ml

SILICA GEL

Final Weight	649.1 gm	g	g
Initial Weight	643.6 gm	g	g
Net Weight	5.5 gm	g	g

Total Net Weight in Silica Gel 5.5 gm

Total Moisture _____ gm

Filter Number(s) 50177

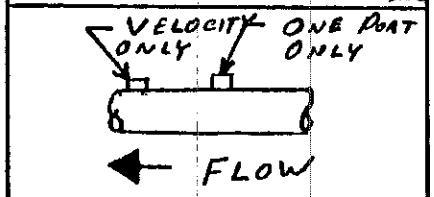
MRC 7/73

EPA MI D 5
FIELD DATA

PLANT MOUND
DATE JAN 31, 1985
SAMPLING LOCATION WD-SCRUB-IN
SAMPLE TYPE MODIFIED EPA 5
RUN NUMBER 1 - PART. - IN
OPERATOR KATHERINE APHISBORO
AMBIENT TEMPERATURE 68 °F
BAROMETRIC PRESSURE 29.21 " Hg
STATIC PRESSURE, (P_s) SEE BELOW H_2O
FILTER NUMBER (s) 50176
PITOT TUBE No. & Cp. "S" TYPE
7 8 DIA DOWNSTREAM

SCRUBBER INLET

WASTE TEMP. FEED RATE — A 1833°F 5616 lb/hr



PROBE LENGTH AND TYPE 3 FT - H_2O COOLED
NOZZLE I.D. 0.394 in
ASSUMED MOISTURE, % WILL VARY WITH WASTE
SAMPLE BOX NUMBER NAPP
METER BOX NUMBER NAPP
METER ΔH@ 1.86
K FACTOR N/A
PRE-TEST LEAK CHECK RATE 0.001 CFM @ 15 "Hg
POST TEST LEAK CHECK RATE ____ CFM @ ____ "Hg
REFERENCE Δp OF I = Δ H OF (SEE BELOW)

SCHEMATIC OF TRAVERSE POINT LAYOUT

@ 17:40	19% O_2	4% CO_2
17:43	19% O_2	3.5% CO_2
AVG	19.0	3.75

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	PROBE TEMPERATURE, °F	STATIC H_2O
	0	17:17	657.602	0.03	0.18	0.18	1101	79	79		200		218	2.8
	5		658.865	0.03	0.18	0.17	1089	82	81	3.5	203		245	2.6
	10	FUEL BLOW	661.362	0.03 0.065	0.18	0.39	1157	82	80	4	209		248	
	15		663.096	0.06	0.36	0.36	1152	83	81	4	212		260	2.4
	20		664.845	0.07	0.36	0.35	1153	82	82	4	214		245	2.6
	25		666.634	0.06	0.36	0.36	1152	83	82	4.5	213		231	2.4
	30		668.464	0.06	0.36	0.35	1149	83	82	4.5	215		248	2.4
	35		670.175	0.06	0.36	0.35	1148	83	82	5	216		258	2.4
	40		671.963	0.06	0.36	0.36	1147	83	83	5	217		261	2.4
	45		673.722	0.06	0.36	0.34	1145	83	83	5	218		263	2.4
	50		675.498	0.06	0.36	0.36	1145	84	83	5.5	219		262	2.4
	55		677.277	0.06	0.36	0.36	1146	83	83	5.5	219		262	2.4
	60		679.050											
			21.448	0.236		0.328	1136.2		82.1					

SINGLE POINT AT CENTER OF DUCT

B-116

SCRUBBER INLET

CLEAN-UP DATA

Plant MOUND

Date JAN 31, 1985

Sampling Location INCINERATOR

Sample Type EPA 5 - MODIED

Run Number 9 - PORT - IN

Sample Box Number NAPP

Clean-up Man

Comments: TRAIN COLLECTS HCL AND H_2O

IMPINGERS

100 ML 0.1 N $NaOH$

EMPTY

	#1	#2	#3	#4	#5
Final Vol.	597.7 gms	523.4 gms	419.8 gms	ml	ml
Initial Vol.	535.7 gms	521.3 gms	419.1 gms	ml	ml
Net Vol.	62.0 gms	2.1 gms	0.7 gms	ml	ml

Total Net Volume in Impingers 64.8 ml

SILICA GEL

Final Weight	652.6 gm	g	g
Initial Weight	648.5 gm	g	g
Net Weight	4.1 gm	g	g

Total Net Weight in Silica Gel 4.1 gm

Total Moisture 68.9 gm

Filter Number(s) 50176 (Beaker) 47350 (Filter)

MRC 7/73

FRONT TUBE 51
BACK TUBE 1-16

VOST SAMPLING DATA FORM

Plant name Monsanto Mound
City Miamisburg
Sample location Scrubber Outlet
Date 1-16-85
Operator J. Peters
Sample number 1-VOST-FIELD BLANK
29.56
− 0.016 grav
− 0.089 temp
29.46
Barometric pressure, mm (in.) Hg 29.46
Probe length m (ft) 2 ft Teflon
Probe material Teflon
Probe heater setting N/A
Meter box number #2
Meter calibration factor (Y) ~~1.000~~ 1.019
Ambient temperature, °C (°F) 65°F
Sample point location TP-6
Initial leak check 20 mL/min @ 10 in Hg
Sample purge time, min N/A
Final leak check
Remarks

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Impinger temp, °C (°F)
Total		Total		$\Delta V_{m\ avg}$	Avg dev	Avg	Max temp

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

B-118

SAMPLING DATA FORM

Plant name Monsanto Mound
City Miamisburg OH
Sample location Scrubber Outlet
Date 1-22-85
Operator JAP
Sample number 2-VOST
Barometric pressure, mm (in.) Hg 29.30
Probe length m (ft) 2 ft.
Probe material Teflon
Probe heater setting N/A
Meter box number 2
Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) (0)
Sample point location TP-6
Initial leak check 20 mL/min @ 17 in Hg
Sample purge time, min N/A
Final leak check 10 mL/min @ 16 in Hg
Remarks FRONT #2107 ; BACK #10

Synthetic waste w/ ACN AN H_2O

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft³)	Sample flow rate setting, ℓ/min (ft³/min)	Sample volume metered (ΔV_m), ℓ (ft³)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Impinger temp, °C (°F)	Vacuum in Hg
0	1540	078.898	~0.5			46	N/A	
5	1545	78.920	~0.5	0.022	80	47		
10	1550	79.000	~0.5	0.080	27	47		8
15	1555	79.137	~0.75	0.137	-25	48		8
20	1600	79.275	~0.75	0.138	-25	51		9
25	1605	79.414	~0.75	0.139	-26	53		8
30	1610	79.560	~0.75	0.146	-33	55		8
35	1615	79.690	~0.75	0.130	-18	56		8
Total		Total 0.79		$\Delta V_{m\,avg}$ 0.11	Avg dev	Avg 50.4	Max temp	

22.43 L

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\,avg}}{\Delta V_{avg_m}} 100.$

SAMPLING DATA FORM

Plant name Mound | City Miamisburg OH
Sample location Scrubber Outlet | Date 1-22-85
Operator JLP | Sample number 3-VOST
Barometric pressure, mm (in.) Hg 29.30 | Probe length m (ft) 2 ft.
Probe material Teflon | Probe heater setting N/A
Meter box number 2 | Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 60 | Sample point location TP-6
Initial leak check 15 mL/min @ 15 in Hg | Sample purge time, min N/A
Final leak check 0 mL/min @ 15 in Hg | Remarks FRONT # 55 ; BACK # 2121

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Vacuum Impinger temp, in Hg °C (°F)
0	1700	79.701	~0.75			63	8
5	1705	79.799	~0.75	0.098	-3	66	8
10	1710	79.920	~0.75	0.121	-27	66	8
15	1715	80.007	~0.75	0.087	8	67	7
20	1720	80.082	~0.7	0.075	21	68	7
25	1725	80.177	~0.7	0.095	0	68	7
30	1730	80.267	~0.6	0.090	5	70	7
35	1735	80.364	~0.6	0.097	-2	72	7
Total		Total 0.663		$\Delta V_{m\,avg}$ 0.095	Avg dev	Avg 67.5	Max temp

18.78 L

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\,avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound — City Miamisburg OH

Sample location Scrubber Outlet — Date 1-23-85

Operator JAP — Sample number 4-VOST (Waste Run #2)

Barometric pressure, mm (in.) Hg 29.38 — Probe length m (ft) 2

Probe material Teflon — Probe heater setting N/A

Meter box number 2 — Meter calibration factor (Y) 1.019

Ambient temperature, °C (°F) 70 — Sample point location TP6

Initial leak check 10mL/min @ 15 in Hg — Sample purge time, min N/A

Final leak check 15mL/min @15 in Hg — Remarks FRONT # 1785, BACK # 1801

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger temp~~ in Hg ~~°C (°F)~~
0	1345	80.374	~0.6	—	—	49	6
5	1350	80.450	~0.5	0.076		50	7
10	1355	80.545	~0.5	0.095		51	7
15	1400	80.622	~0.5	0.077		52	7
20	1405	80.745	~0.5	0.123		55	7
25	1410	80.832	~0.5	0.087		57	8
30	1415	80.922	~0.5	0.090		59	8
35	1420	81.005	~0.5	0.083		60	8
Total		Total 0.631		$\Delta V_{m\ avg}$ 0.090	Avg dev	Avg 54.1	Max temp

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound Lab — City Miamisburg OH
Sample location Scrubber Outlet — Date 1-23-85
Operator JAP — Sample number 5-VOST
Barometric pressure, mm (in.) Hg 29.28 — Probe length m (ft) 2
Probe material Teflon — Probe heater setting N/A
Meter box number 2 — Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 70 — Sample point location TP-6
Initial leak check 5mL/min @15 in Hg — Sample purge time, min N/A
Final leak check 0mL/min @15 in Hg — Remarks FRONT # 2123 ; BACK # 2072

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, (ℓ/min) (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Vacuum Impinger temp, in Hg °C (°F)
0	1500	81.015	~0.5	—		66	7
5	1505	81.122	0.5	0.107		67	7
10	1510	81.216	0.5	0.094		69	7
15	1515	81.318	0.5	0.102		70	8
20	1520	81.411	0.5	0.093		72	8
25	1525	81.505	0.5	0.094		72	8
30	1530	81.597	0.5	0.092		73	8
35	1535	81.690	0.5	0.093		74	8
Total		Total 0.675		ΔV_m avg 0.096	Avg dev	Avg 70.4	Max temp

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Different feed rate from Runs 4&5

Plant name Mound Lab
City Miamisburg OH
Sample location Scrubber Outlet
Date 1-23-85
Operator JAP
Sample number 6-VOST
Barometric pressure, mm (in.) Hg 29.28
Probe length m (ft) 2
Probe material Teflon
Probe heater setting N/A
Meter box number 2
Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 75
Sample point location TP-6
Initial leak check 0 mL/min @15 in Hg
Sample purge time, min N/A
Final leak check 5 mL/min @15 in Hg
Remarks FRONT # 2026 ; BACK # 36

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger temp~~, in Hg ~~°C (°F)~~
0	1630	81.700	~0.5	—		85	5
5	1635	81.761	~0.5	0.061		85	5
10	1640	81.834	~0.5	0.073		86	5
15	1645	81.909	~0.5	0.075		86	5
20	1650	82.020	~0.5	0.111		87	5
25	1655	82.073	~0.5	0.053		87	5
30	1700	82.168	~0.5	0.095		88	5
35	1705	82.256	~0.5	0.088		88	5
Total		Total 0.556		$\Delta V_{m\ avg}$ 0.079	Avg dev	Avg 86.5	Max temp

$s = 0.020$

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}} 100.$

SAMPLING DATA FORM

Plant name Mound | City Miamisburg OH

Sample location Scrubber Outlet | Date 1-24-85

Operator JAP | Sample number 7-VOST

Barometric pressure, mm (in.) Hg 28.93 | Probe length m (ft) 2

Probe material Teflon | Probe heater setting N/A

Meter box number 2 | Meter calibration factor (Y) 1.019

Ambient temperature, °C (°F) 65 | Sample point location TP-6

Initial leak check 5 mL/min @ 15 in Hg | Sample purge time, min N/A

Final leak check 10 mL/min @ 15 in Hg | Remarks FRONT # 2018, BACK # 2143

Kerosene cocktail w/ scint. fluid added

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger temp~~, in Hg ~~°C (°F)~~
0	1045	82.264	~0.5	—		52	5
5	1050	82.313		0.049		53	5
10	1055	82.378		0.065		54	7
15	1100	82.446		0.068		55	7
20	1105	82.515		0.069		56	7
25	1110	82.585		0.070		58	7
30	1115	82.654		0.069		60	7
35	1120	82.720	↓	0.066		62	8
Total		Total 0.456	= 13.005 L	$\Delta V_{m\,avg}$ 0.065	Avg dev	Avg 56.3	Max temp

S = 0.007

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\,avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound
City Miamisburg OH
Sample location Scrubber Outlet
Date 1-24-85
Operator JAP
Sample number 8-VOST
Barometric pressure, mm (in.) Hg 28.93
Probe length m (ft) 2
Probe material Teflon
Probe heater setting N/A
Meter box number 2
Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 70.
Sample point location TP-6
Initial leak check 5 mL/min @ 15 in Hg
Sample purge time, min N/A
Final leak check 5 mL/min @ 15 in Hg
Remarks FRONT #5 ; BACK # 2097

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger~~, ~~temp~~, in Hg ~~°C (°F)~~
0	1240	82.735	~0.5	—		71	5
5	1245	82.784		0.049		71	5
10	1250	82.874		0.090		72	5
15	1255	82.956		0.082		73	5
20	1300	83.044		0.088		74	5
25	1305	83.127		0.083		76	5
30	1310	83.199		0.072		77	5
35	1315	83.277		0.078		79	5
Total		Total 0.542	= 14.943 L	$\Delta V_{m\,avg}$ 0.077	Avg dev	Avg 74.1	Max temp

S = 0.014

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\,avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound | City Miamisburg OH
Sample location Scrubber Outlet | Date 1-24-85
Operator JAP | Sample number 9-VOST
Barometric pressure, mm (in.) Hg 28.93 | Probe length m (ft) 2
Probe material Teflon | Probe heater setting N/A
Meter box number 2 | Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 75 | Sample point location TP-6
Initial leak check <5 mL/min @15 in Hg | Sample purge time, min N/A
Final leak check 5 mL/min @15 in Hg | Remarks FRONT #79 ; BACK #29

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger~~ temp, in. Hg °C (°F)
0	1430	83.289	~0.5	—		80	9
5	1435	83.407		0.118		80	8
10	1440	83.539		0.132		80	8
15	1445	83.646		0.107		80	9
20	1450	83.762		0.116		81	9
25	1455	83.878		0.116		81	9
30	1500	83.992		0.114		82	9
35	1505	84.103		0.111		82	9
Total		Total 0.814	= 22.166 L	ΔV_m avg 0.116	Avg dev	Avg 80.75	Max temp

S = 0.008

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound
City Miamisburg OH
Sample location Scrubber Outlet
Date 1-24-85
Operator Jar
Sample number 10-VOST
Barometric pressure, mm (in.) Hg 28.93
Probe length m (ft) 2
Probe material Teflon
Probe heater setting N/A
Meter box number 2
Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 75
Sample point location TP-6
Initial leak check 10 mL/min @ 15 in Hg
Sample purge time, min N/A
Final leak check 0 mL/min @ " "
Remarks FRONT #72; BACK #1-24

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Percent deviation,[a] %	Dry gas meter temp, °C (°F)	Vacuum Impinger temp, °C (°F)
0	1555	84.114	~0.5	—		83	7
5	1600	84.195		0.081		83	7
10	1605	84.245		0.050		83	5
15	1610	84.305		0.060		83	5
20	1615	84.358		0.053		83	5
25	1620	84.404		0.046		84	5
30	1625	84.453		0.049		85	5
35	1630	84.503		0.050		86	5
Total		Total 0.389	= 10.534 L	ΔV_m avg 0.056	Avg dev	Avg 83.75	Max temp

S = 0.012

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound Lab
Sample location Scrubber Outlet
Operator JAP
Barometric pressure, mm (in.) Hg 29.41
Probe material Teflon
Meter box number 2
Ambient temperature, °C (°F) 65
Initial leak check 0 mL/min @ 15 inHg
Final leak check

City Miamisburg OH
Date 1-29-85
Sample number 11-VOST-FIELD BLANK
Probe length m (ft) 2
Probe heater setting N/A
Meter calibration factor (Y) 1.019
Sample point location TP-6
Sample purge time, min N/A
Remarks FRONT # 56, BACK # 2081

Synthetic waste of Kerosene w/ CCl_4, phenol, Cl-benzene.

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Gas Temp ~~Percent deviation~~,[a] inlet to front tube °F	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger temp~~, inHg ~~°C (°F)~~
0							
5							
10							
15							
20							
25							
30							
35							
Total		Total		ΔV_m avg	Avg dev	Avg	Max temp

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_m \text{ avg}}{\Delta V \text{ avg}_m}$ 100.

SAMPLING DATA FORM

Plant name Mound Lab — City Miamisburg OH
Sample location Scrubber Outlet — Date 1-29-85
Operator JLP — Sample number 12-VOST
Barometric pressure, mm (in.) Hg 29.41 — Probe length m (ft) 2
Probe material Teflon — Probe heater setting N/A
Meter box number 2 — Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 65 — Sample point location TP-6
Initial leak check 20 mL/min @ 15 in Hg — Sample purge time, min N/A
Final leak check 15 mL/min " " — Remarks FRONT # 1783, BACK # 1778

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Gas Temp in ~~Percent deviation~~, [a] tube °F %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger temp~~, in Hg ~~°C (°F)~~
0	1045	84.514	~0.5	—	54	46	5
5	1050	84.581	~0.4	0.067	46	46	5
10	1055	84.678	~0.5	0.097	46	47	5
15	1100	84.761	~0.5	0.083	47	48	5
20	1105	84.845	~0.5	0.084	47	48	5
25	1110	84.931	~0.5	0.086	48	51	6
30	1115	85.011	~0.5	0.080	50	54	6
35	1120	85.093	~0.5	0.082	48	54	5
Total		Total 0.579	= 17.019 L	ΔV_m avg 0.083	Avg dev	Avg 49.25	Max temp

S = 0.009

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound Lab — City Miamisburg OH
Sample location Scrubber Outlet — Date 1-29-85
Operator JAP — Sample number 13-VOST
Barometric pressure, mm (in.) Hg 29.41 — Probe length m (ft) 2
Probe material Teflon — Probe heater setting N/A
Meter box number 2 — Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 80 — Sample point location TP-6
Initial leak check 5 mL/min @ 15 in Hg — Sample purge time, min N/A
Final leak check 0 " " " — Remarks FRONT #1757, BACK #44

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Gas Temp ~~Percent deviation~~,[a] inlet to first tube °C °F	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger temp~~, °C (°F)
0	1250	85.106	~0.5	—	61	68	5
5	1255	85.150		0.044	51	69	6
10	1300	85.250		0.100	47	70	8
15	1305	85.320		0.070	48	70	8
20	1310	85.393		0.073	49	72	8
25	1315	85.464		0.071	49	73	8
30	1320	85.536		0.072	50	75	8
35	1325	85.610	↓	0.074	51	76	8
Total		Total 0.504	= 14.192 ℓ	ΔV_m avg 0.072	Avg dev	Avg 71.6	Max temp

S = 0.016

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound Lab
Sample location Scrubber Outlet
Operator JLP
Barometric pressure, mm (in.) Hg 29.41
Probe material Teflon
Meter box number 2
Ambient temperature, °C (°F) 85
Initial leak check 0 mL/min @15 in Hg
Final leak check 10 mL/min @15 in Hg

City Miamisburg OH
Date 1-29-85
Sample number 14-VOST
Probe length m (ft) 2
Probe heater setting N/A
Meter calibration factor (Y) 1.019
Sample point location TP-6
Sample purge time, min N/A
Remarks FRONT #1777, BACK # 2144

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Gas Temp ~~Percent~~ ~~deviation~~ inlet to fuke °F °C [a]	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger temp~~, in Hg ~~°C (°F)~~
0	1435	85.620	~0.5	—	68	80	6
5	1440	85.672		0.052	68	80	6
10	1445	85.744		0.072	63	80	6
15	1450	85.836		0.092	57	80	6
20	1455	85.931		0.095	58	80	7
25	1500	86.014		0.083	60	82	7
30	1505	86.099		0.085	56	82	7
35	1510	86.182	↓	0.083	59	84	7
Total		Total 0.562	= 15.550 L	$\Delta V_{m\,avg}$ 0.080	Avg dev	Avg 81	Max temp

S: 0.014

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\,avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

SLUDGE FEED

Plant name Mound Lab — City Miamisburg OH
Sample location Scrubber Outlet — Date 1-30-85
Operator JAP — Sample number 15-VOST
Barometric pressure, mm (in.) Hg 29.37 — Probe length m (ft) 2
Probe material Teflon — Probe heater setting N/A
Meter box number 2 — Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 71 — Sample point location TP-6
Initial leak check 0 mL/min @10 in Hg — Sample purge time, min N/A
Final leak check 0 mL/min @11 in Hg — Remarks FRONT # 39, BACK # 1-30

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Gas Temp ~~Percent deviation~~ [a] Inlet to Tube °F %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger~~ temp, in Hg ~~°C (°F)~~
0	1340	86.212	~0.5	—	55	55	5
5	1345	86.255	|	0.043	51	55	5
10	1350	86.364	|	0.109	47	55	7
15	1355	86.408	|	0.044	49	56	5
20	1400	86.481	|	0.073	50	57	5
25	1405	86.547	|	0.066	51	57	6
30	1410	86.612	|	0.065	52	58	6
35	1415	86.681	↓	0.069	53	59	6
Total		Total 0.469	= 13.5714 L	$\Delta V_{m\,avg}$ 0.067	Avg dev	Avg 56.5	Max temp

S = 0.022

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\,avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound Lab
City Miamisburg OH
Sample location Scrubber Outlet
Date 1-30-85
Operator JRP
Sample number 16-VOST
Barometric pressure, mm (in.) Hg 29.37
Probe length m (ft) 2
Probe material Teflon
Probe heater setting N/A
Meter box number 2
Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 66
Sample point location TP-6
Initial leak check 5 mL/min @ 15 in Hg
Sample purge time, min N/A
Final leak check 5 mL/min @ 15 in Hg
Remarks FRONT #1 2062, ~~BACK~~ #1 2-30

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Gas Temp ~~Percent deviation~~[a] inlet to tube °F %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger~~ temp, °C (°F)
0	1445	86.693	0.5	—	65	60	7
5	1450	86.857	↓	0.164	55	61	8
10	1455	87.019		0.162	51	61	8
15	1500	87.180		0.161	50	62	8
20	1505	87.335		0.155	50	63	8
25	1510	87.490		0.155	51	64	8
30	1515	87.648		0.158	52	65	8
35	1520	87.799		0.151	52	66	8
Total		Total 1.106	= 31.628	$\Delta V_{m\ avg}$ 0.158	Avg dev	Avg 62.75	Max temp

s = 0.005

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound Lab — City Miamisburg OH
Sample location Scrubber Outlet — Date 1-30-85
Operator JAP — Sample number 17-VOST
Barometric pressure, mm (in.) Hg 29.37 — Probe length m (ft) 2
Probe material Teflon — Probe heater setting N/A
Meter box number 2 — Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 69 — Sample point location TP-6
Initial leak check 10 mL/min @ 15 inHg — Sample purge time, min N/A
Final leak check 0 mL/min " " — Remarks FRONT # 2099 ; BACK # 2163

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft³)	Sample flow rate setting, ℓ/min (ft³/min)	Sample volume metered (ΔV_m), ℓ (ft³)	Gas Inlet ~~Percent deviation~~,[a] °F %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger temp~~, °C (°F)
0	1555	87.808	0.5	—	62	70	5
5	1600	87.897	↓	0.089	54	71	6
10	1605	88.001		0.104	53	71	6
15	1610	88.076		0.075	52	72	5
20	1615	88.182		0.106	52	72	5
25	1620	88.247		0.065	54	73	6
30	1625	88.335		0.088	52	74	6
35	1630	88.427	↓	0.092	53	74	6
Total		Total 0.619	= 17.390 L	ΔV_m avg 0.088	Avg dev	Avg 72.1	Max temp

S = 0.015

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

Plant name Mound Lab
City Miamisburg OH
Sample location Scrubber Outlet
Date 1-31-85
Operator JAP
Sample number 18-VOST
Barometric pressure, mm (in.) Hg 29.21
Probe length m (ft) 2
Probe material Teflon
Probe heater setting N/A
Meter box number 2
Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 68
Sample point location TP-6
Initial leak check 5 mL/min @15 in Hg
Sample purge time, min N/A
Final leak check <5 mL/min " "
Remarks FRONT # 1789 BACK # 2135T

SLUDGE FEED

very slow burn

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Gas Temp Percent deviation,[a] inlet % °F	Dry gas meter temp, °C (°F)	Vacuum Impinger temp, °C (°F)
0	1320	88.433	0.5	—	57	54	6
5	1325	88.520		0.087	53	54	6
10	1330	88.615		0.095	52	55	6
15	1335	88.695		0.080	52	55	6
20	1340	88.775		0.080	54	56	7
25	1345	88.849		0.074	54	56	13
30	1350	88.898		0.049	56	57	14
35	1355	88.937		0.039	57	58	15
Total		Total 0.504	= 14.533L	$\Delta V_{m\,avg}$ 0.072	Avg dev	Avg 55.6	Max temp

S = 0.020

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\,avg}}{\Delta V_{m\,avg}} 100.$

SAMPLING DATA FORM

Plant name Mound Lab
City Miamisburg OH
Sample location Scrubber Outlet
Date 1-31-85
Operator JAP
Sample number 19-VOST
Barometric pressure, mm (in.) Hg 29.21
Probe length m (ft) 2.
Probe material Teflon
Probe heater setting N/A
Meter box number 2
Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 69
Sample point location TP-6
Initial leak check 0 mL/min @ 15 in Hg
Sample purge time, min N/A
Final leak check 15 " " "
Remarks FRONT # 1753 BACK # 1791

very slow burn

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ℓ/min (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	Gas Temp Percent deviation,[a] inlet to tube °F %	Dry gas meter temp, °C (°F)	Vacuum ~~Impinger~~ temp, °C (°F)
0	1420	88.942	0.5	—	61	60	6
5	1425	89.048		0.106	57	60	5
10	1430	89.147		0.099	58	60	5
15	1435	89.255		0.108	56	61	5
20	1440	89.360		0.105	55	62	5
25	1445	89.459		0.099	54	63	5
30	1450	89.565		0.106	55	64	5
35	1455	89.666		0.101	55	65	5
Total		Total 0.724	= 20.625 L	ΔV_m avg 0.103	Avg dev	Avg 61.9	Max temp

S = 0.004

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\ avg}}{\Delta V_{avg_m}}$ 100.

SAMPLING DATA FORM

SLUDGE FEED
Organic burning noted!

Plant name Mound Lab
City Miamisburg OH
Sample location Scrubber Outlet
Date 1-31-85
Operator JAP
Sample number 20-VOST
Barometric pressure, mm (in.) Hg 29.21
Probe length m (ft) 2
Probe material Teflon
Probe heater setting N/A
Meter box number 2
Meter calibration factor (Y) 1.019
Ambient temperature, °C (°F) 68
Sample point location TP-6
Initial leak check 0 mL/min @15 in Hg
Sample purge time, min N/A
Final leak check < 5 " " "
Remarks FRONT # 1802 BACK # 2100

Sampling time, min	Clock time, 24 h	Sample volume, ℓ (ft^3)	Sample flow rate setting, ~~ℓ/min~~ (ft^3/min)	Sample volume metered (ΔV_m), ℓ (ft^3)	~~Percent deviation~~ Gas Temp °F [a] %	Dry gas meter temp, °C (°F)	~~Impinger temp~~ Vacuum, °C (°F)
0	1740	89.676	0.5	—	58	62	5
5	1745	89.775	↓	0.099	58	62	5
10	1750	89.881		0.106	60	62	5
15	1800	89.985		0.104	59	62	5
20	1805	90.084		0.099	60	62	5
25	1810	90.190		0.106	62	63	5
30	1815	90.288		0.098	64	63	5
35	1820	90.386	↓	0.098	65	64	5
Total		Total 0.710	= 20.203 L	$\Delta V_{m\,avg}$ 0.101	Avg dev	Avg 62.5	Max temp

S = 0.004

[a] Percent deviation = $\frac{\Delta V_m - \Delta V_{m\,avg}}{\Delta V_{avg_m}}$ 100.

SOURCE SAMPLING PROCEDURE – EPA METHOD 7 – NOx

Date JAN 29, 1981

Company MOUND

Project

Sample Point SCRUBBER OUTLET

Analyst

24 Hr Clock Sample Day	Time	No.	Flask No.	Initial Bar. Press. in. Hg	Initial Flask Vacuum in. Hg	Initial Temp. °F	Clean Up Analysis Day	Clean Up Analysis Time	Final Bar. Press. in Hg	Final Flask Vacuum in Hg	Final Temp. °F	ABS @ 420	TOTAL Dil. ml	FLASK Vol.-ABS ml	NOx Conc. lb/scf	NOx Conc. ppm
1/29	1400	1-A (5,6)	2/2	29.41	27.56	66	1-30	10:00	29.37	-1.5	65°					
	1420	1-B (5,6)	3/3	29.41	27.30	66	1-30		29.37	-0.5	65°					
	~~1450~~ 1505	1-C (5,6)	4/4	29.41	27.30	66	1-30		29.37	-0.4	65°					
	1520	1-D	27/27	29.41	27.30	66	1-30		29.37	0.8	65°					
1/30	1420	2-A (7)	2/2	29.37	27.35	64	1-30		29.37	0.4	64°					
	1450	2-B (7)	3/3	29.37	27.30	64	1-30		29.37	0.6	64°					
	1600	2-C (7)	4/4	29.37	27.35	64	1-30		29.37	0.2	64°					
	1518	2-D (7)	27/27	29.37	27.30	64	1-30		29.37	0.3	64°					
1/31	1334	2-A (8)	2/2	29.21	27.30	64	1/31		29.52	0.7	65					
	1406	(8)	3/3	29.21	26.00	64	1/31		29.52	1.0	65					
	1413	(8)	4/4	29.21	27.10	64	1/31		29.52	0.7	65					
	1428	(8)	27/27	29.21	26.80	64	1/31		29.52	0.6	65					

APPENDIX B

ANALYSIS REPORTS

ANALYSIS REQUEST

DATE: 2-5-85

LOG NO.: 1-85-02-12-EC-02

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER**: J. A. Faber

CHARGE NO.**: 760

REPORT RESULTS TO**: FILES / ~~KULIK~~
Mead
Sherman
Ivory
J. A. Faber

ANALYSIS REQUEST TO: FILES
J. Lee
R. Ivory
P. Sherman
J. A. Faber

SAMPLES FOR:
J. Lee

SAMPLE LOCATION
Lab 21

SAMPLE DESCRIPTION | NUMBER OF BOTTLES: | NUMBER OF SAMPLES ** 16

Vial #	Tube #
7	2013, 2143
8	5, 2097
9	29, 79
10	72, 1-24
11	36, 2021
12	1782, 1778
13	44, 1757
14	1777, 21414

RECORDED BY: Quinn

REQUIRED ANALYSIS**

GC/MS Analysis for CCl_4, chlorobenzene, phenol, and toluene in the scintillation fluid. (toluene + xylenes)

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ____
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☒ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL ____ SEMIQUANT. ____ QUANT. ____

COMPLETION DATE 2-15-85

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☒ DISCARD ☐ RETURN B-141 HOLD FOR ☐ 30 DAYS ☐ 60 DAYS ____ OT

** THIS INFORMATION MUST BE SUPPLIED BY ANALYSIS REQUEST ORIGINATOR

ANALYSIS REQUEST

DATE 2-5-85 | LOG NO. 1-85-02-12-85-02

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** J. A. Peters | CHARGE NO.** 760

SAMPLE DESCRIPTION | NUMBER OF BOTTLES: | NUMBER OF SAMPLES ** 12

VOST RUN #	Tube #
15	39, 1-30
16	2062, 2-30
17	2099, 2163
18	1729, 2135
19	1753, 1791
20	1802, 2100

RECORDED BY: Amlee

REPORT RESULTS TO:
FILES /KULIK
Nees
Sherman
Ivery
J. A. Peters

ANALYSIS REQUEST FILES
J. Lee
R. Ivery
P. Sherman
J. A. Peters

SAMPLES FOR:
J. Lee

SAMPLE LOCATION
Lab 21

REQUIRED ANALYSIS**

GC/MS for CCl_4, chlorobenzene, phenol, acrylonitrile

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE 2/27/85

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER _____
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☑ GC/MS
- ☐ AUTO ANALYZER

QUAL. _____ SEMIQUANT. _____ QUANT. _____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL AFTER REPORT COMPLETE: ☑ DISCARD ☐ RETURN B-142 HOLD FOR ☐ 30 DAYS ☐ 60 DAYS _____ 0

** THIS INFORMATION MUST BE SUPPLIED BY ANALYSIS REQUEST ORIGINATOR

ANALYSIS REQUEST

DATE 2-5-85 | LOG NO. 1-85-02-12-X02

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** J.A. Peters

CHARGE NO.** 760

SAMPLE DESCRIPTION | NUMBER OF BOTTLES: | NUMBER OF SAMPLES ** 3

Sludge feed (Run # 7)

Sludge feed (Run #4)

Scintillation Fluid

RECORDED BY: T Lee

REPORT RESULTS TO**
FILES ~~/KULIK~~
Mees
Ivory
Sherman
J.A Peters

ANALYSIS REQUEST TO
FILES
J. Lee
F. Ivory
F. Sherman
J. Peters

SAMPLES FOR:
J Lee

SAMPLE LOCATION
Lab 21

REQUIRED ANALYSIS**
Sludges: GC/MS for CCl4, chlorobenzene, [illegible] Metals (ICP), TOX, [illegible]
Scintillation Fluid [illegible]

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE 2/28/85

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER _____
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☒ ICP
- ☐ ATOMIC ABSORPTION
- ☒ MASS SPEC
- ☒ GC/MS
- ☐ AUTO ANALYZER

QUAL. _____ SEMIQUANT. _____ QUANT. _____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☒ DISCARD ☐ RETURN B-143 HOLD FOR ☐ 30 DAYS ☐ 60 DAYS _____ OTH

** THIS INFORMATION MUST BE SUPPLIED BY ANALYSIS REQUEST ORIGINATOR

ANALYSIS REQUEST

DATE: 2-6-85

LOG NO.: 1-85-02-12-02

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER**: J.A. Peters

CHARGE NO.**: 760

REPORT RESULTS TO FILES /~~KULIK~~: Mees, Ivory, Sherman, J.A. Peters

ANALYSIS REQUEST FILES: J. Lee, R. Ivory, P. Sherman, J.A. Peters

SAMPLES FOR: J. Lee

SAMPLE LOCATION: Lab 21

SAMPLE DESCRIPTION | NUMBER OF BOTTLES: | NUMBER OF SAMPLES **: 5

XAD-2 Resin Tubes (2)
Run #8
Blank

EPA 5 Filters (2)
Run #8
Blank

EPA 5 MeCl rinse residue (1)
Run #8 (in locker)

RECORDED BY: T. Lee

REQUIRED ANALYSIS**

Total Ion Scan (GC/MS) for std mixture of PAH compounds

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

See B. Mason Hughes

COMPLETION DATE 2/28/85

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER _____
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☒ GC/MS
- ☐ AUTO ANALYZER

QUAL. _____ SEMIQUANT. _____ QUANT. _____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☒ DISCARD ☐ RETURN B-144 HOLD FOR ☐ 30 DAYS ☐ 60 DAYS _____ 0

** THIS INFORMATION MUST BE SUPPLIED BY ANALYSIS REQUEST ORIGINATOR

ANALYSIS REQUEST

DATE: 2-5-85

LOG NO.: 1-85-09-12-02

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER**: J.A. Peters

CHARGE NO.**: 760

REPORT RESULTS TO: FILES ~~KULEK~~
Mees
[illegible]
[illegible]
J.A. Peters

SAMPLE DESCRIPTION

NUMBER OF BOTTLES:

NUMBER OF SAMPLES ** 12

VOST Run #	Tub #
1	1-10,21
2	10,2107
3	2121.55
4	1301.1785
5	[illegible]
6	[illegible]

RECORDED BY: [illegible]

ANALYSIS REQUEST TO FILES
J. Lee
R. [illegible]
R. [illegible]
J.A. Peters

SAMPLES FOR:
J. Lee

SAMPLE LOCATION
Lab 21

REQUIRED ANALYSIS**

GC/MS for acrylonitrile, acetonitrile

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE [illegible]

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER _____
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☑ GC/MS
- ☐ AUTO ANALYZER

QUAL. _____ SEMIQUANT. _____ QUANT. _____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☑ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS _____ OTH

** THIS INFORMATION MUST BE SUPPLIED BY ANALYSIS REQUEST ORIGINATOR

Time Stamp - <851203.1249>

ANALYSIS REPORT

DATE: November 21, 1985

LOG NUMBER: 1-85-02-12-02 PROJECT NO: 760.18-760

TO: Jim Peters/Mound
Monsanto Company
U4D
St. Louis, Missouri

FROM: Janet Lee Wuebbels
Environmental Sciences Center
Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, Mo. 63167

Phone No: (314) 694-1464

Title: Analysis of Samples Collected in Mound Incineration Study by GC/MS.

ABSTRACT

Air samples collected on Tenax tubes and XAD resins, and samples of the sludge fed to the incinerator were submitted for identification by GC/MS of selected organic compounds. The samples were collected during a trial burn at the incinerator at the Mound Laboratory at Dayton, Ohio. The results were reported to Jim Peters of ESC, who was responsible for the experimental design and administered the sample collection.

INTRODUCTION

Fourty Tenax tubes were received from Jim Peters on February 5, 1985, for the analysis of selected volatile compounds. The samples were collected on the paired Tenax tubes using a VOST sampling aparatus. The first six sets of tubes were analyzed for acrylonitrile and acetonitrile. The remainder of the Tenax tubes were to be analyzed for the compounds acrylonitrile, carbon tetrachloride, chlorobenzene and phenol.

In addition, two samples of sludge feeds were received for the analysis of the compounds listed above. The sludges were sent to the Physical Sciences Center for the analysis of water content, metals by ICP, TOX, and BTU content. Two XAD resins sampled from the VOST sampling aparatus were submitted for the analysis of PAH compounds. EPA-5 filters were included on the original request but these samples were not received. Two beakers were received that were labeled as methylene chloride rinse residue, one #50743, the other #50746. A sample of the scintillation fluid that was added to the sludges was also submitted for analysis by GC/MS for organic characterization.

SUMMARY

The VOST run samples #1-6 were analyzed for the compounds acrylonitrile and acetonitrile. Selected ion mass spectrometry was used to optimize sensitivity and selectivity to these compounds. The analytical method is described in the attached method file, MSAN09. These compounds were identified in some samples and the results are shown in Tables 1-7. The limit of detection was 10 nanograms for these compounds.

The VOST run samples #7-20 were analyzed for acrylonitrile, carbon tetrachloride, chlorobenzene, phenol, and xylenes. Again, selected ion mass spectrometry was used and the method is described in MSAN13, attached. The results are shown in Tables 7-19.

The sludges were analyzed by capillary GC/MS. A portion of the sludges were weighed into methylene chloride, sonicated to completely mix, diluted 1/5 in solvent and injected. The analytical method is described in MSAN01. The results are shown in Table 20. Phenol was found in both sludges in addition to an unknown compound. Also listed are the results of the analyses of the sludges for water content, BTU, and qualitative x-ray flourescence. The results of the iductively coupled plasma analysis are shown in Table 21.

The scintillation fluid was injected on the capillary GC/MS for organic characterization. The primary compounds found were xylene isomers, both at approximately 5%. Table 22 further elaborates the results of this assay.

Table 23 discusses the results of the widescan analysis of the methylene chloride residues. No organic compounds were identified in these extracts.

QC RESULTS

In the analysis of the VOST collected Tenax tubes, the following QC procedure was followed: Each day of the analysis, a blank Tenax tube (that had been heated to 280C and securely capped until use) was injected with a solution of the internal standard, d6-benzene. The tube was desorbed using the same procedure that was used for each sample. In the case that the blank tube showed the presence of one of the analytes of interest, the analysis was discontinued until the source of the contamination could be found.

Each day, a blank tube was spiked with a solution of the analytes of interest at the level of 10 ng. in addition to being spiked with the internal standard solution at 10 ng. The response factor was calculated daily from the ratio of the area of the analyte base peak to the ratio of the area of the base peak of the internal standard spectra. The response ratios were compared on a day to day basis. If the ratios deviated greatly from the average, the analysis of the standard was repeated.

Two samples were received from each VOST run, although these represented the front and back tube in the sampling train, and were not duplicate samples. The nature of this type of sample prevents the performance of duplicates, since the samples is completely desorbed from the Tenax in one analysis. Spiking studies were also not done for this reason, since there were no duplicate or extra samples.

In the analysis of the scintillation fluid, the sludges, and the methylene chloride residues, the Good Laboratory Practices Guidelines were followed.

COMMENTS

The extraction and analysis of the XAD-5 resin from Run #8 was delayed during the move to St. Louis and the lab set-up. This sample will be analyzed and an addition to this report will be generated with the results.

DETAILS

Standard Analysis Method No(s): MSAN01, MSAN09, MSAN13

Final Report File No(s): A76051

Table File No(s): B76051, C76051, D76051, E76051, F76051, G76051, H76051, I76051, J76051, K76051, L76051, M76051, N76051, O76051, P76051, Q76051, R76051, S76051, T76051, U76051, V76051, X76051, Z76051.

ANALYST(S): Shirley Barksdale, Kathy Blaine, Janet Lee Wuebbels

ANALYST APPROVAL: Janet Lee Wuebbels

Time Stamp - <851202.1023>

TABLE 1. Analysis of Acrylonitrile and Acetonitrile in Tenax Tubes from Mound

ESC Project No: 760 Date: June 15, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION CONCENTRATION (ng.) VOST RUN #1 Front #1-16	SAMPLE IDENTIFICATION CONCENTRATION (ng.) VOST RUN #1 Back # 51
			FIELD BLANK	
Acrylonitrile	MSAN09	10	ND	ND
Acetonitrile	MSAN09	10	ND	ND

DOCUMENTATION

ESC Extraction Method	NA	NA
ESC Analysis Method	MSAN09	MSAN09
Date of GC/MS Analysis	5-17-85	5-17-85
MS FRN	17474	17473

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: B76051:JL:59

Time Stamp - <851202.1023>

TABLE 2. Analysis of Acrylonitrile and Acetonitrile in Tenax Tubes from Mound

ESC Project No: 760 Date: June 15, 1985

			SAMPLE IDENTIFICATION	
			VOST RUN #2 Front # 10	VOST RUN #2 Back #2107
ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	CONCENTRATION (ng.)	
Acrylonitrile	MSAN09	10	27	Tube was broken
Acetonitrile	MSAN09	10	261	" " "
DOCUMENTATION				
ESC Extraction Method			NA	NA
ESC Analysis Method			MSAN09	MSAN09
Date of GC/MS Analysis			5-20-85	5-17-85
MS FRN			17477	Lost

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: C76051:JL:59

Time Stamp - <851202.1023>

TABLE 3. Analysis of Acrylonitrile and Acetonitrile in Tenax Tubes from Mound

ESC Project No: 760 Date: June 15, 1985

	SAMPLE IDENTIFICATION	
	VOST RUN #3 Front #2121	VOST RUN #3 Back # 55

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	CONCENTRATION (ng.)	
Acrylonitrile	MSAN09	10	ND	ND
Acetonitrile	MSAN09	10	12	23

DOCUMENTATION

ESC Extraction Method	NA	NA
ESC Analysis Method	MSAN09	MSAN09
Date of GC/MS Analysis	5-20-85	5-20-85
MS FRN	17479	17478

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: D76051:JL:59

Time Stamp - <851202.1023>

TABLE 4. Analysis of Acrylonitrile and Acetonitrile in Tenax Tubes from Mound

ESC Project No: 760 Date: June 15, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: VOST RUN #4 Front #1801	SAMPLE IDENTIFICATION: VOST RUN #4 Back #1785
			CONCENTRATION (ng.)	
Acrylonitrile	MSAN09	10	Tube was broken	ND
Acetonitrile	MSAN09	10	" " "	Estimated 20-50ng.

DOCUMENTATION

ESC Extraction Method	NA	NA
ESC Analysis Method	MSAN09	MSAN09
Date of GC/MS Analysis	5-20-85	5-20-85
MS FRN	Lost	17480

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

Note: The concentration of acetonitrile in tube 1785 could not be quantitated due to interferences present at the retention time of the internal standard, d6-benzene.

TABLE FILE NO: E76051:JL:59

Time Stamp - <851202.1024>

TABLE 5. Analysis of Acrylonitrile and Acetonitrile in Tenax Tubes from Mound

ESC Project No: 760 Date: June 15, 1985

		SAMPLE IDENTIFICATION	
		VOST RUN #5 Front #2123-F	VOST RUN #5 Back #2072
ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	CONCENTRATION (ng.)
Acrylonitrile	MSAN09	10	ND	ND
Acetonitrile	MSAN09	10	33	31

DOCUMENTATION

ESC Extraction Method	NA	NA
ESC Analysis Method	MSAN09	MSAN09
Date of GC/MS Analysis	5-22-85	5-22-85
MS FRN	17485	17486

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: F76051:JL:59

Time Stamp - <851202.1024>

TABLE 6. Analysis of Acrylonitrile and Acetonitrile in Tenax Tubes from Mound

ESC Project No: 760 Date: June 15, 1985

		SAMPLE IDENTIFICATION	
		VOST RUN #5 Front # 36-F	VOST RUN #5 Back #2026B
ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	CONCENTRATION (ng.)
Acrylonitrile	MSAN09	10	ND ND
Acetonitrile	MSAN09	10	13 32

DOCUMENTATION

ESC Extraction Method	NA	NA
ESC Analysis Method	MSAN09	MSAN09
Date of GC/MS Analysis	5-22-85	5-22-85
MS FRN	17487	17488

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: G76051:JL:59

Time Stamp - <851202.1024>

TABLE 7. Analysis of Acrylonitrile and Acetonitrile in Tenax Tubes from Mound

ESC Project No: 760 Date: June 15, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: Blank Tube #2104 — CONCENTRATION (ng.)	SAMPLE IDENTIFICATION: Blank Tube #2014 — CONCENTRATION (ng.)
			← LAB BLANKS →	
Acrylonitrile	MSAN09	10	ND	ND
Acetonitrile	MSAN09	10	ND	ND

DOCUMENTATION

ESC Extraction Method	QC	QC
ESC Analysis Method	MSAN09	MSAN09
Date of GC/MS Analysis	5-22-85	5-17-85
MS FRN	17489	17470

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: H76051:JL:59

Time Stamp - <851203.1301>

TABLE 8. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

			SAMPLE IDENTIFICATION		
			Blank Tube #17	VOST RUN #7 TUBE #2104	VOST RUN #7 TUBE #2018
			LAB BLANK	BACK	FRONT
ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	CONCENTRATION (ng.)		
Acrylonitrile	MSAN13	10	ND	ND	ND
Carbon Tetrachloride	MSAN13	10	<10	<10	<10
Chlorobenzene	MSAN13	10	<10	<10	<10
Phenol	MSAN13	10	<10	<10	11
Xylenes	MSAN13	10	<10	<10	15

DOCUMENTATION

ESC Extraction Method	QC	NA	NA
ESC Analysis Method	MSAN13	MSAN13	MSAN13
Date of GC/MS Analysis	7-10-85	7-10-85	7-10-85
MS FRN	17614	17611	17612

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: I76051:JL:59

Time Stamp - <851203.1250>

TABLE 9. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: VOST RUN #8 TUBE #5 (FRONT) CONCENTRATION (ng.)	VOST RUN #8 TUBE # 2097 (BACK) CONCENTRATION (ng.)	BLANK TUBE #17 (LAB BLANK) CONCENTRATION (ng.)
Acrylonitrile	MSAN13	10	ND	SAMPLE WAS	ND
Carbon Tetrachloride	MSAN13	10	<10	BROKEN IN	102
Chlorobenzene	MSAN13	10	<10	TRANSIT	ND
Phenol	MSAN13	10	<10		ND
Xylenes	MSAN13	10	17		<10

DOCUMENTATION

ESC Extraction Method	NA	NA	QC
ESC Analysis Method	MSAN13	MSAN13	MSAN13
Date of GC/MS Analysis	7-10-85	7-10-85	7-11-85
MS FRN	17613		17615

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: J76051:JL:59

Time Stamp - <851203.1250>

TABLE 10. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: VOST RUN #9 TUBE #79 (FRONT) CONCENTRATION (ng.)	SAMPLE IDENTIFICATION: VOST RUN #9 TUBE #29 (BACK) CONCENTRATION (ng.)
Acrylonitrile	MSAN13	10	ND	ND
Carbon Tetrachloride	MSAN13	10	ND	<10
Chlorobenzene	MSAN13	10	<10	<10
Phenol	MSAN13	10	<10	<10
Xylenes	MSAN13	10	15	<10

DOCUMENTATION

ESC Extraction Method	NA	NA
ESC Analysis Method	MSAN13	MSAN13
Date of GC/MS Analysis	7-11-85	7-11-85
MS FRN	17619	17618

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: K76051:JL:59

Time Stamp - <851203.1250>

TABLE 11. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: BLANK TUBE #17	VOST RUN #10 TUBE #1-24 BACK	VOST RUN #10 TUBE #72 FRONT
			CONCENTRATION (ng.)		
Acrylonitrile	MSAN13	10	ND	<10	ND
Carbon Tetrachloride	MSAN13	10	<10	<10	ND
Chlorobenzene	MSAN13	10	ND	<10	ND
Phenol	MSAN13	10	ND	ND	ND
Xylenes	MSAN13	10	<10	<10	18

DOCUMENTATION

ESC Extraction Method	NA	NA	NA
ESC Analysis Method	MSAN13	MSAN13	MSAN13
Date of GC/MS Analysis	7-16-85	7-16-85	7-18-85
MS FRN	17628	17630	17633

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: L76051:JL:59

Time Stamp - <851203.1250>

TABLE 12. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: VOST RUN #11 TUBE #2081 (FIELD BLANK)	VOST RUN #11 TUBE #56 (BACK)	VOST RUN #12 TUBE #1778
			CONCENTRATION (ng.)		
Acrylonitrile	MSAN13	10	ND	ND	ND
Carbon Tetrachloride	MSAN13	10	<10	<10	<10
Chlorobenzene	MSAN13	10	<10	ND	ND
Phenol	MSAN13	10	<10	<10	<10
Xylenes	MSAN13	10	<10	<10	<10

DOCUMENTATION

ESC Extraction Method	NA	NA	NA
ESC Analysis Method	MSAN13	MSAN13	MSAN13
Date of GC/MS Analysis	7-19-85	7-19-85	7-19-85
MS FRN	17637	17638	17639

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: M76051:JL:59

Time Stamp - <851203.1251>

TABLE 13. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

			SAMPLE IDENTIFICATION		
			BLANK TUBE #17	VOST RUN #13 TUBE #1757	VOST RUN #13 TUBE #44
				FRONT	BACK
ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	CONCENTRATION (ng.)		
Acrylonitrile	MSAN13	10	ND	ND	ND
Carbon Tetrachloride	MSAN13	10	<10	ND	ND
Chlorobenzene	MSAN13	10	ND	17	<10
Phenol	MSAN13	10	<10	<10	<10
Xylenes	MSAN13	10	<10	424	<10

DOCUMENTATION

ESC Extraction Method	NA	NA	NA
ESC Analysis Method	MSAN13	MSAN13	MSAN13
Date of GC/MS Analysis	7-22-85	7-22-85	7-22-85
MS FRN	17641	17642	17643

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: N76051:JL:59

Time Stamp - <851203.1251>

TABLE 14. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: VOST RUN #14 TUBE #2144 BACK	SAMPLE IDENTIFICATION: BLANK TUBE #17	SAMPLE IDENTIFICATION: VOST RUN #14 TUBE #1777 FRONT
			CONCENTRATION (ng.)		
Acrylonitrile	MSAN13	10	ND	ND	ND
Carbon Tetrachloride	MSAN13	10	ND	<10	ND
Chlorobenzene	MSAN13	10	ND	ND	ND
Phenol	MSAN13	10	ND	ND	ND
Xylenes	MSAN13	10	<10	<10	ND

DOCUMENTATION

ESC Extraction Method	NA	NA	NA
ESC Analysis Method	MSAN13	MSAN13	MSAN13
Date of GC/MS Analysis	7-22-85	8-8-85	8-8-85
MS FRN	17644	17659	17660

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: 076051:JL:59

Time Stamp - <851203.1255>

TABLE 15. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

			SAMPLE IDENTIFICATION		
			VOST RUN #15 TUBE # 39	BLANK TUBE # 17	VOST RUN #15 TUBE #1-30
			FRONT		BACK
ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	CONCENTRATION (ng.)		
Acrylonitrile	MSAN13	10	ND	ND	<10
Carbon Tetrachloride	MSAN13	10	<10	ND	<10
Chlorobenzene	MSAN13	10	86	ND	<10
Phenol	MSAN13	10	83	ND	<10
Xylenes	MSAN13	10	41	ND	<10

DOCUMENTATION

ESC Extraction Method	NA	NA	NA
ESC Analysis Method	MSAN13	MSAN13	MSAN13
Date of GC/MS Analysis	8-8-85	8-9-85	8-9-85
MS FRN	17661	17663	17664

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: P76051:JL:59

Time Stamp - <851203.1255>

TABLE 16. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: VOST RUN #16 TUBE #2062 FRONT (CONCENTRATION (ng.))	VOST RUN #16 TUBE #2-30 BACK (CONCENTRATION (ng.))	BLANK TUBE #17 LAB BLANK (CONCENTRATION (ng.))
Acrylonitrile	MSAN13	10	<10	<10	ND
Carbon Tetrachloride	MSAN13	10	<10	<10	ND
Chlorobenzene	MSAN13	10	72	<10	ND
Phenol	MSAN13	10	12	<10	ND
Xylenes	MSAN13	10	20	<10	ND

DOCUMENTATION

ESC Extraction Method	NA	NA	NA
ESC Analysis Method	MSAN13	MSAN13	MSAN13
Date of GC/MS Analysis	8-9-85	8-15-85	8-15-85
MS FRN	17665	17666	17663

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: Q76051:JL:59

Time Stamp - <851203.1255>

TABLE 17. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION CONCENTRATION (ng.) VOST RUN #17 TUBE #2099 FRONT	VOST RUN #18 TUBE #2135 BACK	VOST RUN #18 TUBE #1789 FRONT
Acrylonitrile	MSAN13	10	ND	<10	ND
Carbon Tetrachloride	MSAN13	10	13	<10	<10
Chlorobenzene	MSAN13	10	29	ND	31
Phenol	MSAN13	10	ND	ND	<10
Xylenes	MSAN13	10	329	ND	287

DOCUMENTATION

ESC Extraction Method	NA	NA	NA
ESC Analysis Method	MSAN13	MSAN13	MSAN13
Date of GC/MS Analysis	8-9-85	8-9-85	8-15-85
MS FRN	17670	17671	17672

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: R76051:JL:59

Time Stamp - <851203.1256>

TABLE 18. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: VOST RUN #19 TUBE #1791 (BACK) CONCENTRATION (ng.)	SAMPLE IDENTIFICATION: VOST RUN #19 TUBE #1753 (FRONT) CONCENTRATION (ng.)
Acrylonitrile	MSAN13	10	ND	ND
Carbon Tetrachloride	MSAN13	10	<10	<10
Chlorobenzene	MSAN13	10	ND	160
Phenol	MSAN13	10	ND	<10
Xylenes	MSAN13	10	ND	432

DOCUMENTATION

ESC Extraction Method	NA	NA
ESC Analysis Method	MSAN13	MSAN13
Date of GC/MS Analysis	8-15-85	8-15-85
MS FRN	17673	17674

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: S76051:JL:59

Time Stamp - <851203.1300>

TABLE 19. Analysis of Selected Compounds in Tenax Tubes from Mound

ESC Project No: 760 Date: October 7, 1985

ANALYTE	ESC ANALYTICAL METHOD	LOD(ng.)	SAMPLE IDENTIFICATION: VOST RUN #20 TUBE #1802 FRONT — CONCENTRATION (ng.)	SAMPLE IDENTIFICATION: VOST RUN #20 TUBE #2100 BACK — CONCENTRATION (ng.)
Acrylonitrile	MSAN13	10	13	13 ←
Carbon Tetrachloride	MSAN13	10	<10	<10
Chlorobenzene	MSAN13	10	109	ND
Phenol	MSAN13	10	<10	ND
Xylenes	MSAN13	10	222	<10

DOCUMENTATION

ESC Extraction Method	NA	NA
ESC Analysis Method	MSAN13	MSAN13
Date of GC/MS Analysis	8-15-85	8-15-85
MS FRN	17675	17676

EXPLANATION OF ABBREVIATIONS:

LOD = limit of detection in nanograms, estimated from standard analyzed under the same conditions, that has been spiked with the same level of the internal standard

ND = none detected with a detection limit given by the LOD value

NA = not aplicable

TABLE FILE NO: T76051:JL:59

Time Stamp - <851203.1256>

TABLE 20. Analysis of Sludge Feed

ESC Project No: 760 Date: October 7, 1985

Sludge Feed was analyzed for carbon tetrachloride, chlorobenzene, phenol, acrylonitrile, water content, metals (ICP), TOX, and BTU content.

COMPOUND	SAMPLE Sludge Run #7	Sludge Run #8&9
Carbon tetrachloride	ND, LOD=10ppm	ND, LOD=10ppm
Chlorobenzene	ND, LOD=10ppm	ND, LOD=10ppm
Phenol	7321 ppm	24,200 ppm
Unidentified chlorinated compound, MW=136 — probably chlorobenzene di- or tri-	7300 ppm	4800 ppm
Water Content [1]	50.43%,43.2%(dup)	46.0%,43.47%(dup)
TOX	(Results have not been received from PSC)	
BTU Content [2]	1217 BTU/LB 1162 (dup)	1111 BTU/LB 1181 (dup)
Qualitative X-ray Flourescence [3]	Silicon, sulfur, calcium, caduim at high levels in both samples Potassium, titanium, manganese, iron, strontium, lead at low levels in both sample Aluminum and barium are possibly present	

1. Better precision would require a smaller sample size.

2. Analysis performed at Industrial Testing Labs.

3. Qualitative x-ray fluorescence analysis was run on two insoluble materials that remained after the sludge feed samples were acid digested. The samples were digested with sulfuric and nitric acids. Both insolubles had similar compositions.

Table File No.: U76051

Time Stamp - <851203.1256>

TABLE 21. Results of Inductively Coupled Argon Plasma-Optical Emission Spectroscopy

ESC Project No: 760 Date: October 7, 1985

Analysis Performed by Monsanto Physical Sciences Center

Element	Sample	
	Sludge Run #7	Sludge Run #8&9
AG	49.4, 42.4 ppm	18, 24 ppm
AL	0.3%, 0.2%	0.3%, 0.3%
BA	1.8, 1.7 ppm	3.4, 4.0 ppm
BE	0.2, 0.2 ppm	0.2, 0.2 ppm
CA	0.7%, 0.5%	0.5%, 0.5%
CD	328, 261 ppm	631, 607 ppm
CR	49.8, 47.3 ppm	32, 32.7 ppm
CU	492, 397 ppm	387, 431 ppm
FE	0.5%, 0.4%	0.4%, 0.4%
MG	1.4%, 1.4%	1.2%, 1.2%
MN	<126, <103 ppm	<94, <100 ppm
MO	9.3, 8 ppm	6.9, 7.7 ppm
NA	<206, <176 ppm	138, 155 ppm
NI	<104, <95 ppm	64, 69 ppm
P	<0.3%, 0.2%	<0.2%, <0.2%
SI	23, 25 ppm	19.4, 22.8 ppm
SN	30, 26 ppm	30.3, 36.6 ppm
DR	21, 16 ppm	10.0, 9.8 ppm
TI	363, 336 ppm	219, 285 ppm
ZN	432, 390 ppm	217, 239 ppm
K	750, 751 ppm	713, 788 ppm

Note: All values indicated are semi-quantitative. Large amount of precipitate was observed. This was analyzed by qualitative x-ray fluorescence, the results are shown in Table 20.

Table File No.: V76051

Time Stamp - <851203.1256>

TABLE 22. Analysis of Scintillation Fliud for Organic Characterization

ESC Project No: 760 Date: October 7, 1985

Two xylene isomers were identified in the widescan GC/MS analysis of the scintillation fluid. The xylene isomers were identified by comparison with a reference spectra and also a standard made of a mixture of otho-, meta-, and para- xylene. The specific xylene isomers found in the scintillation fluid were not identified. The concentrations were 5.8% and 5.3% for a total xylene concentration calculated to be 11.1%. An unidentified compound was present at a concentration of 1% in the scintillation fluid.

The analysis method is further described in MSAN01.
The data file is stored in FRN 10681.

Table File No.: W76051

Time Stamp - <851212.0927>

TABLE 25. Results of the Total Organic Halide Analysis (TOX) by the Monsanto Physical Sciences Center

ESC Project No: 760 Date: December 12, 1985

Sample	Total Chlorine	Total Bromine	Flouride	Iodide
1-85-021202 Feed Bin Sludge Feed Run 7	0.57%, 0.65%	120, 128 ppm	<30 ppm	<5 ppm
1-85-021202 Waste Feed Sludge Run 8 & 9	0.63%, 0.64%	122, 112 ppm	<30 ppm	<5 ppm

Sample	Free Chloride	Free Bromide
1-85-021202 Feed Bin Sludge Feed Run 7	0.31%, 0.36%	70, 62 ppm
1-85-021202 Waste Feed Sludge Run 8 & 9	0.44%, 0.31%	85, 72 ppm

Note: The oxygen bomb was used for sample decomposition for total halide determination. All results were obtained by ion selective electrode. The less than (<) figures are based on approximate detection limit of the electrode and sample weight used.

Table File No.: AAA760

Time Stamp - <851203.1005>

TABLE 23. Analysis of Methylene Chloride Residues for PAH Compounds

ESC Project No: 760 Date: October 7, 1985

The dried residues were received in 250 ml. beakers. The beakers were covered with aluminum foil after they were received and stored in this condition until the time of analysis. HPLC grade methylene chloride was used to rinse the residue from the beaker. The rinse solution was collected in a volumetric and brought to a volume of 5 mls. with methylene chloride. An aliquot of this solution was mixed with an equal volume of d10-anthracene at 100 ug/ml and analyzed by widescan GC/MS technique as described in MSAN09.

No organic compounds were found in the methylene chloride residue samples at a level of 1 ug/ml or greater.

Table File No.: X76051

The following pages describe Analytical Request Information generated for this project.

Time Stamp - <851202.1021>

MONSANTO COMPANY/DAYTON LABORATORY

ENVIRONMENTAL SCIENCES CENTER

ANALYSIS REQUEST

DATE:. 2-5-85 LOG NO: 1-85-02-12-02

REQUESTER: J.A.PETERS/MOUND PROJECT NO: 760

REPORT RESULTS TO: FILES/MEES, SHERMAN, IVORY, J.A.PETERS

ANALYSIS REQUESTS SENT TO: FILES, J.LEE, IVORY, SHERMAN, J.A.PETERS

SAMPLE PICKUP BY: J.M.LEE

LOCATION: REFRIGERATOR IN LAB 21

SAMPLE DESCRIPTION FOR --- SAMPLES

SAMPLE IDENTIFICATION		NUMBER OF BOTTLES	ESC NUMBER(S)
VOST RUN # 1	TUBE #1-16, 51	2	
2	10, 2107	2	
3	2121, 55	2	ANALYZE FOR CMPDS "A"
4	1801, 1785	2	
5	2123, 2072	2	
6	36, 2026	2	
7	2018, 2143	2	
8	5, 2097	2	
9	29, 79	2	
10	72, 1-24	2	
11	56, 2081	2	
12	1783, 1778	2	ANALYZE FOR CMPDS "B"
13	44, 1757	2	
14	1777, 2144	2	
15	39, 1-30	2	
16	2062, 2-30	2	
17	2099, 2163	2	ANALYZE FOR CMPDS "C"
18	1789, 2135	2	
19	1753, 1791	2	
20	1802, 2100	2	
SLUDGE FEED (RUN#7)		1	ANALYZE FOR CMPDS "D"
SLUDGE FEED (RUN#9)		1	
SCINTILLATION FLUID		1	ORGANIC CHARACTERIZATION

XAD-2 RESIN TUBE (BLANK)	1	PAH COMPOUNDS
XAD-S RESIN TUBE (RUN#8)	1	" "
EPA-5 FILTERS (BLANK)	1	" "
EPA-5 FILTERS (RUN#8)	1	" "
EPA-5 METHYLENE CHLORIDE RINSE RESIDUE (RUN#8)	1	" "

RECORDED BY: J.M.LEE

REQUIRED ANALYSES: GC/MS AS LISTED UNDER "COMMENTS"

ANALYTICAL TECHNIQUES:

TECHNIQUE (EN)	DATE COMPLETED
X-- GC/MS (51)	

QUALITATIVE: X SEMIQUANTITATIVE: X QUANTITATIVE:

REQUIRED QA/QC: SEE GOOD LABORATORY PRACTICES MANUAL

COMPLETION DATE REQUESTED:

COMMENTS:

COMPOUNDS "A" ARE: ACRYLONITRILE, ACETONITRILE

COMPOUNDS "B" ARE: CARBON TETRACHLORIDE, CHLOROBENZENE, PHENOL, AND WHATEVER IS IN THE SCINTILLATION FLUID

COMPOUNDS "C" ARE: CARBON TETRACHLORIDE, CHLOROBENZENE, PHENOL, AND ACRYLONITRILE

COMPOUNDS "D" ARE: CARBON TETRACHLORIDE, CHLOROBENZENE, PHENOL, ACRYLONITRTILE, WATER CONTENT, METALS (ICP), TOX, AND BTU CONTENT

SAMPLE DISPOSITION: HOLD FOR 30 DAYS

SAFETY PRECAUTIONS: SEE SAFE LABORATORY PRACTICES MANUAL

ANALYSIS REQUEST FILE NAME: AA760

The following pages describe Standard Extraction Methods and Standard Analysis Methods used for this project.

ESC Standard Analysis Method (SAM) — ESC Standard Analysis Method No:
TITLE: Organic Compounds in Solvents — MSAN01

ANALYTICAL INSTRUMENT AND MODE OF OPERATION: HP-5985/5987 Capillary GC/MS-Scanning with RTE-VI operating system.

Typical Run Time:	3 - 40 min.
Typical Multiplier Voltage:	1800 - 2400 eV
Typical Threshold:	100 counts
Typical Mass Range:	10 - 500 amu
Typical Scan Rate:	2/second

TYPICAL ANALYTE	TYPICAL INSTRUMENT LEVEL OF DETECTION (LOD) (ug/ml)	TYPICAL PRECISION @ 10X LOD (%)	TYPICAL ACCURACY @ 10X LOD (%)
Organic Compounds eluting between toluene and n-C34-ane	1	30	30

INTERFERENCES AND LIMITATIONS: Analyte must either be chromatrographically resolved from other organic compounds, or co-eluting, interferring compounds must not be present at concentrations greater than 100 X the analyte of interest.

CHROMATOGRAPHIC COLUMN: 30-meter fused silica J&W DB-5 (0.25 uM) with wide bore (0.32 mm)

COLUMN TEMPERATURE PROGRAM: 50(4)/8/300 — INJECTION TYPE: Splitless

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CALIBRATION AND STANDARDIZATION:

Quantitative: Use internal standard quantitation technique and calibrate instrument response factors from authentic analyte of interest.

Qualitative: Mass spectra of unknown compounds are compared to standard mass spectra in the NBS/EPA Mass Spectral Library which contains over 30,000 compounds. Positive identification is made only after a trained mass spectroscopist has visually compared the unknown compound mass spectrum with those identified as most probable compounds based upon their Match Factor.

CALCULATIONS: Analyte concentration =

$$[\text{analyte RRF}][(\text{analyte area})/(\text{internal standard area})]$$

where: Analyte area is the appropriate characteristic ion area.
RRF is the relative response factor for the appropriate characteristic ion of the analyte.

SAFETY PRECAUTIONS: See PCB handling protocols in laboratory safety manual.

DATE OF METHOD CREATION: 10/31/83 — Time Stamp - <851202.1043>

ESC Standard Analysis Method (SAM) ESC Standard Analysis Method No:
TITLE: Analysis of Volatiles on Tenax Tubes MSAN09

ANALYTICAL INSTRUMENT AND MODE OF OPERATION: HP 5983 GC/MS Electron Impact Ionization, Selected Ion Mode

---

TYPICAL ANALYTE	TYPICAL INSTRUMENT LEVEL OF DETECTION (LOD) (nanograms)	TYPICAL PRECISION @ 10X LOD (%)	TYPICAL ACCURACY @ 10X LOD (%)
Xylene	10	30	30
Acrylonitrile	10	30	30
Acetonitrile	10	30	30

INTERFERENCES AND LIMITATIONS: Interfering compounds that elute at the same retention time as the compound of interest may give strong signal that obscures the identification and quantitation of the analyte.

An additional problem with this assay is that the concentration varies so greatly from one sample to another that it is difficult to predict the appropriate detector gain in advance. A setting too high will cause detector saturation, however if the gain is set too low may sacrifice the limit of detection of the analyte of interest.

CHROMATOGRAPHIC COLUMN: Six foot x 1/8 inch stainless steel column packed with 0.1% SP-1000 on Carbopack B

COLUMN TEMPERATURE PROGRAM: -40(0)/8/225 and -40(0)/10/225(4)

INJECTION TYPE: Direct Desorption

CALIBRATION AND STANDARDIZATION: An aliquot of a standard in methanol of the analyte of interest is injected onto a blank Tenax tube. In addition, 10 nanograms of d6-benzene were added to each sample as an internal standard. A vacuum is pulled on the tube using a water aspirator. The tube is then desorbed by passing the helium carrier gas through the trap while heating the trap to 200 degrees centigrade for ten minutes. The GC column is kept at -40 C during desorption.

A positive confirmation of analyte in the sample tube requires a peak at the same retention time as the peak in the analyte standard at the two ions (m/e 52,53) characteristic of the acrylonitrile spectrum, and

two ions (m/e 39,41) characteristic of the acetonitrile spectrum. The ratios of the intensities of the peaks at these ions must also be similar to the ratios for the analyte in the standard.

CALCULATIONS: $\frac{\text{AREA}_{\text{analyte}} \times \text{CONC}_{\text{internal std}}}{\text{AREA}_{\text{internal std}} \times \text{RESPONSE FACTOR}_{\text{analyte}}}$

The area of the analyte is calculated from the Selected Ion Chromatogram using a characteristic ion of the analyte. The area of the internal standard is calculated in the same manner. The response factor must be calculated from the same masses as are used for calculation of the analyte concentration.

SAFETY PRECAUTIONS: General laboratory safety precautions should be observed.

DATES OF METHOD CREATION AND METHOD UPDATES: June 12, 1985.

ESC Standard Analysis Method (SAM)
TITLE: Analysis of Volatiles Collected on Tenax Tubes

ESC Standard Analysis Method No: MSAN13

ANALYTICAL INSTRUMENT AND MODE OF OPERATION: HP 5983 GC/MS Electron Impact Ionization, Selected Ion Mode

---

TYPICAL ANALYTE	TYPICAL INSTRUMENT LEVEL OF DETECTION (LOD) (ug/ml)	TYPICAL PRECISION @ 10X LOD (%)	TYPICAL ACCURACY @ 10X LOD (%)
Acrylonitrile	10	30	30
Carbon Tetrachloride	10	30	30
Chlorobenzene	10	30	30
Phenol	10	30	30
Xylenes	10	30	30

INTERFERENCES AND LIMITATIONS: Interfering compounds that elute at the same retention time as the compound of interest may give strong signal that obscures the identification and quantitation of the analyte.

CHROMATOGRAPHIC COLUMN: Six foot x 1/8 inch stainless steel column packed with 0.1% SP-1000 on Carbopack B

COLUMN TEMPERATURE PROGRAM: -40(0)/10/225H

INJECTION TYPE: Direct Desorption

CALIBRATION AND STANDARDIZATION: An aliquot of a standard in methanol of the analyte of interest in injected onto a blank Tenax tube. In addition, 10 nanograms of d6-benzene were added to each sample as an internal standard. A vacuum is pulled on the tube using a water aspirator. The tube is then desorbed by passing the helium carrier gas through the trap while heating the trap to 200 degrees centigrade for ten minutes. The GC column is kept at -40C during desoption.

A positive confimation of analyte in the samle tube requires a peak at the same retention time as the peak in the analyte standard at the four ions (m/e 50, 51, 52, 53) characteristeric of the acrylonitrile spectrum, four ions (m/e 82, 117, 119, 121) characteristic of the carbon tetrachloride spectrum, two ions (m/e 77, 112) characteristic of the chlorobenzene spectrum, two ions (m/e 65, 94) characteristic of the phenol spectrum, and four ions (m/e 77, 91, 105, 106) characteristic of the spectrum of the xylenes.

CALCULATIONS:

$$\frac{\text{AREA}_{\text{analyte}} \times \text{CONC}_{\text{internal std}}}{\text{AREA}_{\text{internal std}} \times \text{RESPONSE FACTOR}_{\text{analyte}}}$$

The area of the analyte is calculated from the Selected Ion Chromatogram using a characteristic ion of the analyte. The area of the internal standard is calculated in the same manner, using the ion of 84 for the area of the internal standard. The response factor must be calculated from the same masses as are used for calculation of the analyte concentration.

SAFETY PRECAUTIONS: General laboratory safety precautions should be observed.

DATES OF METHOD CREATION AND METHOD UPDATES: October 9, 1985.

---

pcs/lab
Pollution Control Science, Inc.
6015 Manning Road, Miamisburg, Ohio 45342
(513) 866-5908 TLX 288-348

Report Date: 7-3-85
Date Rec'd:
PCS Sample#: 50176-47398
Client P.O.#: RG 02142X
Inv#/Acct#/PN: 9166 321

MR. CHARLES DUNCAN
ESC/CORPORATE R&D STAFF
800 N. LINDBERGH BLVD.
ST. LOUIS, MO 63167

ACCREDITED BY THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION
OHIO EPA APPROVED LABORATORY
MEMBER OF THE AMERICAN COUNCIL OF INDEPENDENT LABORATORIES

	PCS#	SAMPLE ID	INITIAL WEIGHT	FINAL WEIGHT
9 IN –	50176		485.3 mg	1 226.3 mg
8 IN –	50177		488.0 mg	753.5 mg
7 IN –	50178		488.1 mg	1 481.8 mg
	50179		488.1 mg	585.2 mg
	50180		489.2 mg	638.8 mg
	50181		484.3 mg	621.6 mg
	50182		486.8 mg	634.6 mg
	50183		492.2 mg	545.7 mg
	50184		491.1 mg	
	50185		486.3 mg	517.6 mg
	50645		495.0 mg	
	50646		497.5 mg	
	50647		499.4 mg	
	50648		493.9 mg	
	50649		492.1 mg	
	50650		494.2 mg	
	50651		489.3 mg	
	50652		491.5 mg	
	50653		490.4 mg	
	50654		492.9 mg	
	47326	1922011-4	410.9 mg	
	47327	1922011-5	420.3 mg	
	47328	192010-10	423.4 mg	
	47329	1922010-11	417.8 mg	
	47330	1922010-12	413.1 mg	
	47331	1922010-13	421.4 mg	
	47332	1922010-14	417.2 mg	

PROCEDURES IN ACCORDANCE WITH 40 CRF Part 136 October 16, 1973 (38 FR 28758), and amendments.

David B. Fraser
LABORATORY SUPERVISOR

The information contained herein is the confidential property of our clients. Disclosure of such data, statement or conclusion requires written approval.

pcs/lab

	PCS#	SAMPLE ID	INITIAL WEIGHT	FINAL WEIGHT
	47333	206673-18	384.1 mg	*
	47334	206673-19	384.2 mg	
	47335	206673-20	386.4 mg	
	47336	206673-21	420.6 mg	
	47337	206673-23	425.9 mg	
	47338	206673-24	425.8 mg	425.8 mg*
	47339	206673-25	419.9 mg	419.5 mg*
	47340	206673-26	422.5 mg	*
	47341	1922011-6	421.8 mg	
	47342	1922011-7	426.1 mg	
9 out →	47343	1922011-8	417.3 mg	540.1 mg
	47344	1922011-9	423.0 mg	498.6 mg
	47345	1922011-10	426.2 mg	
	47346	1922011-11	425.3 mg	
	47347	1922011-12	423.2 mg	
→	47348	1922011-13	418.9 mg	488.4 mg
7-out →	47349	1922062-1	424.1 mg	674.8 mg
	47350	1922062-2	413.5 mg	483.6 mg
	47351	1922062-3	424.3 mg	476.6 mg
	47352	1922062-4	416.8 mg	
	47353	1922062-13	421.0 mg	
	47354	1922062-14	414.3 mg	
	47355	1922062-15	431.0 mg	
	47356	1922062-16	426.4 mg	
	47357	1922062-17	427.3 mg	
	47358	1922062-18	416.7 mg	
	47359	1922062-19	416.6 mg	
	47360	1922062-20	445.0 mg	
	47361	1922062-21	418.6 mg	438.0 mg
5 out →	47362	1922062-22	455.7 mg	554.3 mg
	47363	1922062-23	417.2 mg	
	47364	1922062-24	428.1 mg	462.3 mg
	47365	1922062-25	420.5 mg	
	47366	1922062-26	419.8 mg	
	47367	1920062-27	426.2 mg	
	47368	1922062-28	422.2 mg	
	47369	1922062-29	422.2 mg	
	47370	1922062-30	425.9 mg	
	47371	1922062-31	417.1 mg	
	47372	1922062-32	423.5 mg	
	47373	1922062-33	421.0 mg	

* Small hole in filter

pcs/lab

PCS#	SAMPLE ID	INITIAL WEIGHT	FINAL WEIGHT
47374	1922062-34	420.2 mg	
47375	1922062-35	419.7 mg	
47376	1922062-36	416.2 mg	
47377	1922062-37	430.8 mg	
47378	1922062-38	423.2 mg	
47379	1922062-39	425.0 mg	
47380	1922062-69	425.1 mg	
47381	1922062-70	420.6 mg	
47382	1922062-71	420.4 mg	
47383	1922062-72	424.0 mg	
47384	1922062-73	413.6 mg	
47385	1922062-74	418.5 mg	
47386	1922062-75	426.1 mg	
47387	1922062-76	417.6 mg	
47388	1922062-77	430.4 mg	
47389	1922062-78	421.8 mg	
47390	1922062-79	411.6 mg	
47391	1922062-80	420.3 mg	
47392	1922062-81	496.3 mg	
47393	1922062-82	423.5 mg	
47394	1922062-98	428.7 mg	
47395	1922062-99	428.5 mg	
47396	1922062-100	424.4 mg	
47397	1922062-101	427.3 mg	
47398	1922062-102	420.5 mg	

pcs/lab
Pollution Control Science, Inc.
6015 Manning Road, Miamisburg, Ohio 45342
(513) 866-5908 TLX 288-348

Report Date: 6-18-85
Date Rec'd: 2-1-85
PCS Sample#: See Below
Client P.O.#: RG Ø2142X
Inv#/Acct#/PN: 9166 321

MR. CHARLES DUNCAN
MONSANTO COMPANY
ESC/CORPORATE R&D STAFF
8ØØ N. LINDBERGH BLVD.
ST. LOUIS, MO 63167

ACCREDITED BY THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION
OHIO EPA APPROVED LABORATORY
MEMBER OF THE AMERICAN COUNCIL OF INDEPENDENT LABORATORIES

EPA 5 Particulates
ACETONE/FILTERS

PCS #	SAMPLE I.D.	Acetone Volume ml	-Total Particulate- Acetone mg	Filter mg
47361	Run #1 Outlet, Part-out 1/22	21Ø	11.Ø	19.4
5Ø185	Run #1 Inlet, Part-in 1/22	185	32.2	31.3
47364	Run #2 Outlet, Part-out 1/23	32Ø	1Ø.2	34.2
5Ø183	Run #2 Inlet, Part-in 1/23	24Ø	68.6	53.5
47350	Run #3 Outlet, Part-out 1/24	165	6.9	7Ø.1
5Ø182	Run #3 Inlet, Part-in 1/24	165	44.2	147.8
47348	Run #4 Outlet, Part-out 1/24	215	1Ø.2	~~418.9~~ 69.5

PROCEDURES IN ACCORDANCE WITH 40 CRF Part 136 October 16, 1973 (38 FR 28758), and amendments.

David Robinson
LABORATORY SUPERVISOR

The information contained herein is the confidential property of our clients. Disclosure of such data, statement or conclusion requires written approval.

pcs/lab

EPA 5 Particulates
ACETONE/FILTERS

PCS #	SAMPLE I.D.	Total ml	-Total Particulate- Acetone mg	Filter mg
50730	Run #4 Inlet, Part-in 1/24	185	67.4	137.3
47344	Run #5 Outlet, Part-out 1/29	140	8.1	75.6
50180	Run #5 Inlet, Part-in 1/29	210	81.4	149.6
47351	Run #6 Outlet, Part-out 1/29	205	8.0	52.3
50179	Run #6 Inlet, Part-in 1/29	280	53.4	97.1
47349 ✓	Run #7 Outlet, Part-out 1/30	175	19.7	250.8
50178 ✓	Run #7 Inlet, Part-in 1/30	210	351.5	993.4
47362 ✓	Run #8 Outlet, Part-out 1/31	115	10.8	98.6
50177 ✓	Run #8 ~~Outlet~~ INLET, Part-in PAH	-	~~no sample~~	265.5
50743	Run #8 ~~Outlet~~ INLET, Part-~~out~~ in 1/31 PAH	170 Lost	17.6*	~~missing filter~~
47343	Run #9 Outlet, Part-out 2/1	-	sample bottle broke assume 15.3 avg of 7+8	122.8
50176 ✓	Run #9 Inlet, Part-in 2/1	480	482.1	741.0
50744	Acetone Blank Scrubber Outlet	165	2.3	-
50746	$MeCl_2$ Blank Scrubber Outlet	133	1.4*	-

*** Methylene Chloride**

EPA 5 Particulate
ACETONE/FILTERS

PCS #	SAMPLE I.D.	Total ml	Acetone mg	Filter mg
47339	Blank Outlet Part-out, ICP metals 1/3	-	-	-Ø.4
47338	Blank Outlet Part-out Arsenic, Mercury	-	-	Ø.Ø

*** Methylene Chloride**

pcs/lab
Pollution Control Science, Inc.
6015 Manning Road, Miamisburg, Ohio 45342
(513) 866-5908 TLX 288-348

Report Date: 6-18-85
Date Rec'd: 2-1-85
PCS Sample#: See Below
Client P.O.#: RG 02142X
Inv#/Acct#/PN: 9166 321

MR. CHARLES DUNCAN
ESC/CORPORATE R&D STAFF
800 N. LINDBERGH BLVD.
ST. LOUIS, MO 63167

ACCREDITED BY THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION
OHIO EPA APPROVED LABORATORY
MEMBER OF THE AMERICAN COUNCIL OF INDEPENDENT LABORATORIES

HYDROCHLORIC ACID SAMPLES

PCS #	SAMPLE I.D.	Total ml	Total mg Hydrochloric Acid
50724	Run #1 Inlet HCL-In 1/22/85	350	<0.72
50725	Run #1 Outlet HCL-Out 1/22/85	800	4.93
50726	Run #2 Inlet HCL-In 1/23	480	1.97
50727	Run #2 Outlet HCL-Out 1/23	740	<1.52
50728	Run #3 Inlet HCL-In 1/24	380	921.5
50729	Run #3 Outlet HCL-Out 1/24	740	<1.52
50181	Run #4 Inlet HCL-In 1/24	360	2 593.5
50731	Run #4 Outlet HCL-Out 1/24	790	1.62

PROCEDURES IN ACCORDANCE WITH 40 CRF Part 136 October 16, 1973 (38 FR 28758), and amendments.

David T. Robinson
LABORATORY SUPERVISOR

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pcs/lab

HYDROCHLORIC ACID SAMPLES

PCS #	SAMPLE I.D.	Total ml	Total mg Hydrochloric Acid
50732	Run #5 Inlet HCL-In 1/29	400	1 196.6
50733	Run #5 Outlet HCL-Out 1/29	450	<0.93
50734	Run #6 Inlet HCL-In 1/29	370	783.54
50735	Run #6 Outlet HCL-Out 1/29	630	<1.30
50736	Run #7 Inlet HCL-In 1/30	690	3 349.4
50737	Run #7 Outlet, HCL-Out 1/30	340	7.69
50738	Run #8 ~~Outlet~~ Inlet HCL-In 1/31	510	860.34
50739	Run #8 Outlet HCL-Out 1/31	320	3.29
50740	Run #9 Inlet HCL-In 2/1	710	4 291.7
50741	Run #9 Outlet HCL-Out 2/1	370	15.60
50745	Blank		
50747	Blank		

pcs/lab
Pollution Control Science, Inc.
6015 Manning Road, Miamisburg, Ohio 45342
(513) 866-5908 TLX 288-348

Report Date: 6-18-85
Date Rec'd: 2-1-85
PCS Sample#: See Below
Client P.O.#: RG Ø2142X
Inv#/Acct#/PN: 9166 321

MR. CHARLES DUNCAN
ESC/Corporate R&D Staff
8ØØ N. Lindbergh Blvd.
St. Louis, MO 63167

ACCREDITED BY THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION
OHIO EPA APPROVED LABORATORY
MEMBER OF THE AMERICAN COUNCIL OF INDEPENDENT LABORATORIES

NO_x

PCS #	SAMPLE I.D.	Total ug NO_2
5Ø683	Blank Scrubber Inlet & Outlet, JSM	5.85
5Ø684	1-A Scrubber Outlet, JSM	15Ø.7
5Ø685	1-B Scrubber Outlet, JSM	29.96
5Ø686	1-C Scrubber Outlet, JSM	38.Ø3
5Ø687	1-D Scrubber Outlet, JSM	46.81
5Ø688	2-A Scrubber Outlet, JSM	251.6
5Ø689	2-B Scrubber Outlet, JSM	187.2
5Ø69Ø	2-C Scrubber Outlet, JSM	219.4
5Ø691	2-D Scrubber Outlet, JSM	231.1
5Ø692	3-A Scrubber Outlet, JSM	13Ø.2

PROCEDURES IN ACCORDANCE WITH 40 CRF Part 136 October 16, 1973 (38 FR 28758), and amendments.

LABORATORY SUPERVISOR

The information contained herein is the confidential property of our clients. Disclosure of such data, statement or conclusion requires written approval.

NO_x

PCS #	SAMPLE I.D.	Total ug NO_2
50693	3-B Scrubber Outlet, JSM	115.6
50694	3-C Scrubber Outlet, JSM	134.6
50695	3-D Scrubber Outlet, JSM	65.83

Method Federal Register - Method 7- Determination of Nitrogen Oxide Emissions From Stationary Source

INDUSTRIAL TESTING LABORATORIES inc.

Chemists
Engineers
Metallurgists

2350 Seventh Blvd. • St. Louis, Missouri 63104 | 314/771-7111

Report No. 85-6-306 October 4, 1985

Examination of thirty-five (35) particulate samples submitted marked "Job-Mound".

Monsanto Company
800 North Lindbergh Blvd.
St. Louis, MO. 63167

P.O.: RCX 52
Chg. No. 07-000-760.16-132-760
Attn: Mr. James A. Peters

TEST REPORT

A. FILTERS:

	Blank filter 47338	Blank filter 47339	filter 9-out 47343	5-out 47344	4-out 47348	9-N 47350
Arsenic, µg	*5	*5	*5	*5	*5	6.0
Selenium, µg	*5	*5	*5	*5	*5	*5
Tellurium, µg	*5	*5	*5	*5	*5	*5
Lead, µg	*5	*5	464	900	850	1,790
Cadmium, µg	*5	*5	27,000	910	1,120	81,000
Nickel, µg	*5	*5	10	15	17	42
Manganese, µg	*5	*5	11	5.0	6.1	16
Chromium, µg	*5	*5	51	97	162	45
Copper, µg	*5	*5	1,050	190	200	1,840

*less than.

A FILTERS: (con't.)

	3-OUT 47350	6-OUT 47351	1-OUT 47361	8-OUT 47362	3-IN 50177	7-IN 50178
Arsenic, µg	*5	*5	*5	*5	105	140
Selenium, µg	*5	*5	*5	*5	*5	*5
Tellurium, µg	*5	*5	*5	*5	*5	11
Lead, µg	1,050	563	107	500	1,390	7,940
Cadmium, µg	1,460	470	11	35,000	89,000	200,000
Nickel, µg	25	11	20	6.6	17	83
Manganese, µg	7.2	*5	5.0	*5	10	41
Chromium, µg	230	28	170	76	130	130
Copper, µg	250	120	28	790	1,920	7,030

	6-IN 50179	5-IN 50180	4-IN 50181	3-IN 50182	50182	1-IN 50185
Arsenic, µg	*5	*5	*5	*5	57	*5
Selenium, µg	*5	*5	*5	*5	*5	*5
Tellurium, µg	*5	*5	*5	*5	*5	*5
Lead, µg	470	1,010	1,200	1,870	360	170
Cadmium, µg	470	980	1,520	6,130	63	300
Nickel, µg	14	104	18	14	21	*5
Manganese, µg	*5	17	*5	*5	6.7	*5
Chromium, µg	72	230	210	350	1,600	300
Copper, µg	250	430	460	530	75	34

*less than.

B. BEAKERS:

	5-OUT 47344	4-OUT 47348	7-OUT 47349	3-OUT 47350	6-OUT 47351	1-OUT 47361
Arsenic, /ug	*5	*5	*5	*5	*5	*5
Selenium, /ug	*5	*5	*5	*5	*5	*5
Tellurium, /ug	*10	*10	*10	*10	*10	*10
Lead, /ug	18	11	110	10	19	8
Cadmium, /ug	32	18	4,100	18	28	17
Nickel, /ug	54	22	31	38	48	70
Manganese, /ug	*5	*5	*5	6	*5	6
Chromium, /ug	51	20	21	56	36	130
Copper, /ug	7	*5	90	5	6	5

	8-OUT 47362	2-OUT 47364	3-IN 50176	7-IN 50178	6-IN 50179	5-IN 50180
Arsenic, /ug	*5	*5	36	22	*10	*10
Selenium, /ug	*5	*5	*20	*20	*20	*20
Tellurium, /ug	*10	*10	*10	*10	*10	*10
Lead, /ug	26	14	85	139	15	24
Cadmium, /ug	1,200	19	52,000	59,000	590	740
Nickel, /ug	39	77	66,000	11,000	120	180
Manganese, /ug	*5	*5	300	70	33	24
Chromium, /ug	21	51	2,900	2,300	520	660
Copper, /ug	28	*5	2,400	2,300	170	210

*less than.

B. BEAKERS: (con't.)

	3-IN 50182	2-IN 50183	1-IN 50185	50730	50744
Arsenic, ug	*10	16	*10	*5	*5
Selenium, ug	*20	*20	*20	*5	*5
Tellurium, ug	*10	*10	*10	*10	*10
Lead, ug	20	16	26	24	*5
Cadmium, ug	760	800	580	1,300	*5
Nickel, ug	85	310	170	130	*5
Manganese, ug	13	40	22	35	*5
Chromium, ug	460	1,600	610	660	*5
Copper, ug	140	65	23	170	*5

*less than.

Containers for filter pads identified as "47364" and "50176" were broken upon receipt.

Respectfully submitted,

INDUSTRIAL TESTING LABORATORIES, INC.

Allan M. Siegel, P.E.,
Director

Lab No. 60738
WL/hj

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

4277

Requested by: LARRY KLINGLER Mail Station: BLDG 79 Phone: 3078, 3070

Product Code or Project No.: C-55999 Q.C. No.: _____ Requested Completion Date: ASAP

Type of Sample (or Service): ~~COMPLETE INORGANIC, QUANTITATIVE ANALYSIS~~ GLASS

Requestor Sample ID's: BEFORE MONSANTO RUN: GS-1A ; GS-1B; AFTER MONSANTO RUN: GS-2A ; GS-2B

Sample Disposition: ☒ Discard ☐ Return

If request is for product/material quality control, enter the specification drawing number. If not, enter none:

Analysis Desired, Comments: COMPLETE INORGANIC, QUANTITATIVE ANALYSIS RESULTS IN WT. % (SPECIAL INTEREST IN CADMIUM)

SLIGHT β, γ CONTAMINATION

TO BE FILLED OUT BY REQUESTOR

Anal. Sample ID's: 765 – 768

Results:	765 GS-1A	Range of dupl.	766 GS-1B	Range of dupl.	767 GS-2A	Range of dupl.	768 GS-2B	Range of dupl.
SiO_2	67.3	4.8	67.1	1.2	64.6	0.3	64.8	3.7
Al_2O_3	1.83	0.30	1.80	0.01	2.54	0.17	2.47	1.3
CaO	12.2	0.9	12.0	3.5	13.8	0.2	13.9	2.6
MgO	3.41	0.02	3.44	0.33	3.96	0.22	4.17	0.0
Na_2O	12.5	0.1	12.9	0.1	11.0	0.2	10.8	0.7
→ Cd	ND <0.01		ND <0.01		ND <0.01		ND <0.01	
Trace	—		—		—		—	
As	ND <0.01		ND <0.01		ND <0.01		ND <0.01	
Co	ND <0.01		ND <0.01		ND <0.01		ND <0.01	
Hg	ND <0.01		ND <0.01		ND <0.01		ND <0.01	
→ Pb	ND <0.01		ND <0.01		ND <0.01		ND <0.01	
K_2O	0.29	0.04	0.33	0.06	0.20	0.03	0.19	0.03
ZnO_2	0.41	0.02	0.39	0.05	0.53	0.05	0.47	0.12
Fe_2O_3	2.08	0.03	2.06	0.03	3.41	0.07	3.44	0.22
→ Cr	.02		.02		.03		.03	
→ Cu	<.01		<.01		.01		.01	
Ti	.05		.05		.07		.07	
Zn	.02		.01		.03		.03	

DISTRIBUTION:
WHITE COPY - REQUESTOR
YELLOW COPY - DATA PROCESSING — GR. LEADER
PINK COPY - ANALYTICAL LOG BOOK
GOLDENROD COPY - REQUESTOR'S RECEIPT

Received by: _____

Analyzed by: BDL 9/9/85

MRC-ML-1527 (7-82)
17-1394

pcs/lab
Pollution Control Science, Inc.
6015 Manning Road, Miamisburg, Ohio 45342
(513) 866-5908 TLX 288-348

Report Date: 6-18-85
Date Rec'd: 2-1-85
PCS Sample#: See Below
Client P.O.#: RG 02142X
Inv#/Acct#/PN: 9166 321

MR. CHARLES DUNCAN
ESC/Corporate R&D Staff
Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, MO 63167

ACCREDITED BY THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION
OHIO EPA APPROVED LABORATORY
MEMBER OF THE AMERICAN COUNCIL OF INDEPENDENT LABORATORIES

METALS

PCS #	SAMPLE I.D.	Total* ml	Total Arsenic mg	Total Mercury mg
50696	1-SS Scrubber H_2O Start Scrubber Top 1/22	885	<0.004	0.025
50697	1-SF Scrubber H_2O Finish Scrubber Top 1/22	905	0.029	<0.002
50698	2-SF Scrubber H_2O Scrubber Top 1/23	785	0.010	<0.002
50699	Run 3(day 3) and 4 Scrubber H_2O Finish Scrubber Top 1/24	629	0.029	<0.002
50700	6-SF Scrubber H_2O Finish Scrubber Top 1/29	855	0.037	<0.002

PROCEDURES IN ACCORDANCE WITH 40 CRF Part 136 October 16, 1973 (38 FR 28758), and amendments.

LABORATORY SUPERVISOR

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pcs/lab

METALS

PCS #	SAMPLE I.D.	Total* ml	Total Arsenic mg	Total Mercury mg
50701	7-SF Scrubber H_2O Finish Scrubber^{2}Top 1/30	583	0.004	0.015
50702	9-SF Scrubber H_2O Finish Scrubber^{2}Top 1/31	573	0.010	<0.001

*Total Volume of Sample (Includes PCS Volume Plus Volume Sent to Industrial Testing Lab.)

INDUSTRIAL TESTING LABORATORIES inc.

Chemists
Engineers
Metallurgists

2350 Seventh Blvd. • St. Louis, Missouri 63104 | 314/771-7111

Report No. 85-2-142 March 6, 1985

Examination of seven (7) samples submitted 2/11/85.

Monsanto Company
800 North Lindbergh Blvd.
St. Louis, MO. 63166

P.O.: RCX 52
Chg. No.
Attn: Mr. James A. Peters

TEST REPORT

	1-SS 50696	1-SF 50697	2-SF 50698	3,4-SF 50699
ICP ANALYSIS:				
Arsenic, mg.	*0.05	*0.05	*0.05	0.10
Selenium, mg.	*0.05	*0.05	*0.05	*0.05
Molybdenum, mg.	0.36	0.57	0.40	0.32
Antimony, mg.	*0.2	*0.2	*0.2	*0.2
Zinc, mg.	0.24	*0.05	0.25	0.22
Lead, mg.	0.09	0.11	*0.05	*0.05
Cadmium, mg.	*0.05	*0.05	*0.05	*0.05
Cobalt, mg.	*0.05	*0.05	*0.05	*0.05
Nickel, mg.	*0.05	*0.05	*0.05	*0.05
Tin, mg.	*0.05	*0.05	*0.05	*0.05
Boron, mg.	1.1	0.12	0.90	0.75
Manganese, mg.	*0.05	*0.05	*0.05	*0.05
Iron, mg.	0.49	*0.05	0.06	0.07
Chromium, mg.	*0.05	*0.05	0.12	0.08
Vanadium, mg.	*0.05	*0.05	*0.05	*0.05
Aluminum, mg.	1.0	0.12	0.97	0.65

*less than.

	50696	50697	50698	50699
ICP ANALYSIS: (con't.)				
Beryllium, mg.	*0.05	*0.05	*0.05	*0.05
Copper, mg.	0.06	0.10	0.06	0.09
Titanium, mg.	*0.05	*0.05	*0.05	*0.05
Strontium, mg.	0.08	0.08	0.07	*0.05
Barium, mg.	0.15	*0 .05	0.05	*0.05
Sample Volume Received, ml.	385	405	285	234

Analysis reported in Total Milligrams per sample volume received.

*less than.

INDUSTRIAL TESTING LABORATORIES inc.

Report No. 85-2-142

	50700	50701	50702
ICP ANALYSIS:			
Arsenic, mg.	0.07	*0.05	*0.05
Selenium, mg.	*0.05	*0.05	*0.05
Molybdenum, mg.	0.94	0.39	0.43
Antimony, mg.	*0.2	*0.2	*0.2
Zinc, mg.	0.66	0.25	0.29
Lead, mg.	0.06	*0.05	0.06
Cadmium, mg.	*0.05	0.21	0.16
Cobalt, mg.	*0.05	*0.05	*0.05
Nickel, mg.	*0.05	*0.05	*0.05
Tin, mg.	*0.05	*0.05	*0.05
Boron, mg.	1.4	0.71	1.0
Manganese, mg.	*0.05	*0.05	*0.05
Iron, mg.	0.11	0.07	0.12
Chromium, mg.	0.14	*0.05	*0.05
Vanadium, mg.	*0.05	*0.05	*0.05
Aluminum, mg.	1.5	0.75	1.00
Beryllium, mg.	*0.05	*0.05	*0.05
Copper, mg.	0.34	0.18	0.31
Titanium, mg.	*0.05	*0.05	*0.05
Strontium, mg.	0.11	0.07	0.09
Barium, mg.	0.15	*0.05	*0.05
Sample Volume Received, ml.	410	238	268

Analysis reported in Total Milligrams per sample volume received.

*less than.

Respectfully submitted,

INDUSTRIAL TESTING LABORATORIES, INC.

Allan M. Siegel, P.E.
Director

cc: Pollution Control Science

Lab No. 57331-37
LB10852
WL/hj

pcs/lab
Pollution Control Science, Inc.
6015 Manning Road, Miamisburg, Ohio 45342
(513) 866-5908 TLX 288-348

Report Date: 9-30-84
Date Rec'd: 8-20-84
PCS Sample#: 44762-44764
Client P.O.#: 253.001
Inv#/Acct#/PN: 321

EASTERN UTILITIES SPECIALIST/MONSANTO MOUND
ATTN: MR. BILL HUFFMAN/MRC

ACCREDITED BY THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION
OHIO EPA APPROVED LABORATORY
MEMBER OF THE AMERICAN COUNCIL OF INDEPENDENT LABORATORIES

#44762 (Sludge #1, Drying Bed)

Total Solids	18.08% by weight
Total Volatile Solids	31.52% of the Total Solids
Cadmium	12.7 ug/g dry wt.
Chromium	121 ug/g dry wt.
Copper	1 618 ug/g dry wt.
Lead	15.0 ug/g dry wt.
Nickel	146 ug/g dry wt.
Silver	12.5 ug/g dry wt.
Zinc	1 298 ug/g dry wt.
Antimony	<32 ug/g dry wt.
Beryllium	<3.0 ug/g dry wt.
Arsenic	2.6 ug/g dry wt.
Selenium	<0.6 ug/g dry wt.
Mercury	5.1 ug/g dry wt.

PROCEDURES IN ACCORDANCE WITH 40 CRF Part 136 October 16, 1973 (38 FR 28758), and amendments.

David T. Robinson/by [illegible]
LABORATORY SUPERVISOR

#44763 (Sludge #2, Drying Bed)

Total Solids	27.56% by weight
Total Volatile Solids	31.14% of the Total Solids
Cadmium	18.4 ug/g dry wt.
Chromium	116 ug/g dry wt.
Copper	1 768 ug/g dry wt.
Lead	185 ug/g dry wt.
Nickel	206 ug/g dry wt.
Silver	349 ug/g dry wt.
Zinc	2 151 ug/g dry wt.
Antimony	<31 ug/g dry wt.
Beryllium	<3.0 ug/g dry wt.
Arsenic	0.8 ug/g dry wt.
Selenium	<0.6 ug/g dry wt.
Mercury	6.0 ug/g dry wt.

#44764 (Sludge #3, Drying Bed)

Total Solids	12.63% by weight
Total Volatile Solids	56.9% of the Total Solids
Cadmium	18.2 ug/g dry wt.
Chromium	262 ug/g dry wt.
Copper	3 438 ug/g dry wt.
Lead	394 ug/g dry wt.
Nickel	309 ug/g dry wt.
Silver	286 ug/g dry wt.
Zinc	3 204 ug/g dry wt.
Antimony	<56 ug/g dry wt.
Beryllium	<5.0 ug/g dry wt.
Arsenic	<1.0 ug/g dry wt.
Selenium	<1.0 ug/g dry wt.
Mercury	22.2 ug/g dry wt.

ALL ANALYSES WERE PERFORMED IN ACCORDANCE WITH THE STANDARD METHOD-15TH EDITION AS FOLLOWS:

Total Dissolved Solids--Gravimetric 209C
Total Dissolved Volatile--Gravimetric 209E
Cadmium--Digestion, flame AA, 302D
Chromium--Digestion, flame AA, 302D
Copper--Digestion, flame AA, 302D
Lead--Digestion, flame AA, 302D
Nickel--Digestion, flame AA, 302D
Silver--Digestion, flame AA, 302D
Zinc--Digestion, flame AA, 302D
Antimony--Digestion, flame AA, 302 D
Beryllium--Digestion, flame AA, 302D
Arsenic--Hydride, AA, 404A
Selenium--Hydride, AA, 303E
Mercury--Cold Vapor, AA, 303F

APPENDIX C

FURNACE OPERATING DATA PRINTOUTS

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0016 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16

100 --GLASS FURNACE POWER---/----GAS PARAMETERS----/

200 KW AB KW BC KW CD CHBR T1 CHBR T2 AMB T BAR P AIR DPN OFGS T1 OFGS T2 DLUG DT MST DT EXH DT DLUG P VNTR DP AIR AMB

300 JAN 22, 1985

400 /----------GAS PARAMETERS CONT----------/----LIQUID PARAMETERS----/

500 02 COMBUS CO CO2 NOX HE INT HE DT RAD INT RAD DT CSTC PH SCRB IT DLG RTN VNT RTN

600

11:26:22	25.7K	24.9K	23.3K	2367 F	2369 F	87.7F	0.00	4.9M	923 F	923 F	55.3F	178.4F	53.9F	0.1	-0.4	63.8M
500	-6.2P	-1.3P	-1.2P	0.24P			45.1F	44.7F	75.9F	71.3F	1.0	55.7F	58.7F	53.7F		
15:17:11	25.4K	24.6K	23.1K	2321 F	2330 F	90.0F	0.00	4.5M	923 F	923 F	60.2F	164.8F	51.2F	0.1	-0.4	67.3M
500	-6.3P	-1.3P	0.8P	0.08P			45.7F	34.0F	48.1F	44.1F	1.0	64.7F	64.5F	51.7F		
17:03:54	25.8K	24.8K	23.4K	2319 F	2325 F	89.8F	0.00	4.4M	923 F	923 F	61.3F	173.9F	52.2F	0.1	-0.4	63.7M
500	-6.3P	-1.3P	0.5P	0.20P			46.5F	35.9F	46.5F	42.0F	1.0	65.2F	65.0F	52.9F		
08:43:23	26.1K	26.3K	23.6K	2373 F	2382 F	88.4F	0.00	4.4M	923 F	923 F	56.3F	173.6F	49.7F	0.1	-0.4	64.0M
500	-6.3P	-1.3P	-0.3P	0.40P			47.5F	42.2F	53.3F	49.3F	1.0	60.2F	59.8F	51.1F		
14:01:11	25.0K	25.0K	22.9K	2379 F	2402 F	88.7F	29.30	4.5M	923 F	923 F	51.1F	192.3F	47.7F	0.1	-0.5	64.8M
500	-6.3P	-1.3P	-0.4P	0.30P			47.0F	38.4F	72.1F	69.2F	1.0	46.9F	47.2F	46.8F		
Run #1		1/20/85		19:05												
14:17:00	25.3K	25.6K	24.0K	1788 F	1808 F	50.0F	29.30	1.3M	1314 F	1249 F	120.0F	117.2F	109.4F	9.4	33.6	64.8M
500	0.0P	0.0P	6.7P	1.04P			48.6F	43.8F	74.7F	70.0F	1.0	50.0F	124.7F	95.4F		
14:19:00	25.5K	25.8K	24.1K	1752 F	1782 F	50.0F	29.30	1.1M	1304 F	1251 F	122.8F	114.9F	120.2F	9.5	33.0	66.1M
500	0.0P	0.0P	5.6P	0.84P			48.7F	44.3F	74.5F	70.5F	1.0	50.3F	127.7F	98.9F		
14:21:00	25.6K	25.9K	24.1K	1722 F	1759 F	50.4F	29.30	0.9M	1319 F	1267 F	123.3F	113.1F	127.7F	11.4	32.1	66.6M
500	0.0P	0.0P	5.1P	0.90P			48.7F	44.7F	75.2F	70.3F	1.0	50.7F	129.9F	100.6F		
14:23:00	25.4K	26.0K	24.2K	2350 F	1867 F	50.7F	29.30	0.7M	1419 F	1351 F	132.9F	115.3F	134.0F	10.5	33.4	67.4M
500	0.0P	0.0P	1.7P	3.80P			48.8F	45.1F	75.3F	70.8F	1.0	51.4F	137.4F	108.2F		
14:25:00	25.1K	26.1K	24.3K	2313 F	1872 F	51.1F	29.30	0.6M	1434 F	1369 F	134.5F	117.9F	140.5F	10.1	33.0	67.9M
500	0.0P	0.0P	0.1P	3.96P			49.4F	45.5F	75.0F	70.6F	1.0	52.6F	140.3F	112.3F		
14:27:00	24.9K	26.2K	24.4K	2359 F	1858 F	51.9F	29.30	0.5M	1437 F	1376 F	135.3F	116.1F	145.5F	10.1	33.6	68.8M
500	0.0P	0.0P	0.2P	4.00P			38.1F	39.5F	75.9F	71.2F	1.0	43.1F	141.6F	110.3F		
14:29:00	24.7K	26.2K	24.5K	2362 F	1866 F	52.2F	29.30	0.5M	1439 F	1380 F	133.3F	109.2F	149.1F	9.9	33.8	69.9M
500	0.0P	0.0P	0.2P	3.92P			38.5F	40.7F	75.0F	70.8F	1.0	38.1F	141.1F	102.4F		
11:31:00	24.6K	26.2K	24.6K	2351 F	1874 F	52.1F	29.30	0.5M	1439 F	1379 F	133.7F	108.8F	152.0F	11.1	33.3	69.5M
500	0.0P	0.1P	0.2P	3.80P			42.7F	44.7F	75.5F	70.9F	1.0	41.7F	141.1F	103.3F		

2 5	NRC-MOVHD	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0022	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CNBR T1	CNBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	QSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
14:33:00	24.6K	26.3K	24.7K	2366 F	1855 F	52.5F	29.30	0.4M	1440 F	1380 F	134.3F	109.4F	154.6F	10.0	33.5	69.8M
500	0.0P	0.1P	0.2P	3.80P			46.8F	48.6F	75.5F	71.0F	1.0	45.3F	141.4F	104.2F		
14:35:00	24.5K	26.3K	24.9K	2376 F	1884 F	52.9F	29.30	0.4M	1436 F	1377 F	135.1F	111.1F	156.9F	10.3	33.3	70.0M
500	0.0P	0.2P	0.2P	3.82P			50.7F	52.4F	75.5F	70.8F	1.0	49.1F	142.5F	106.2F		
14:37:00	24.5K	26.4K	24.9K	2381 F	1879 F	53.2F	29.30	0.3M	1442 F	1378 F	136.2F	112.8F	158.9F	9.3	33.2	70.0M
500	0.0P	0.2P	0.3P	3.82P			54.6F	56.3F	76.1F	71.3F	1.0	52.9F	142.6F	108.0F		
14:39:00	24.4K	26.4K	25.1K	2380 F	1866 F	54.0F	29.30	0.3M	1439 F	1378 F	136.8F	114.5F	160.9F	10.0	33.1	70.0M
500	0.0P	0.2P	0.3P	3.82P			58.4F	60.2F	75.7F	71.6F	1.0	56.4F	143.2F	109.7F		
14:41:00	24.4K	26.5K	25.3K	2356 F	1861 F	54.4F	29.30	0.3M	1439 F	1376 F	137.4F	115.6F	162.6F	9.3	32.5	69.6M
500	0.0P	0.2P	0.3P	3.74P			62.1F	63.8F	76.1F	71.5F	1.0	60.2F	143.2F	111.6F		
14:43:00	24.3K	26.5K	25.3K	2394 F	1870 F	55.1F	29.30	0.2M	1435 F	1374 F	137.8F	116.6F	164.4F	10.0	32.8	69.4M
500	0.0P	0.2P	0.3P	3.74P			65.6F	67.3F	75.7F	71.7F	1.0	63.8F	143.5F	113.3F		
14:45:00	24.3K	26.6K	25.3K	2356 F	1841 F	55.2F	29.30	0.2M	1433 F	1373 F	138.6F	118.0F	166.0F	9.2	32.2	68.8M
500	0.0P	0.2P	0.3P	3.76P			69.1F	70.7F	76.2F	71.6F	1.0	67.1F	144.5F	115.0F		
14:47:00	24.3K	26.6K	25.4K	2407 F	1860 F	54.9F	29.30	0.3M	1435 F	1374 F	140.2F	119.4F	167.5F	8.3	32.2	68.1M
500	0.0P	0.2P	0.4P	3.78P			71.9F	73.4F	75.5F	71.2F	1.0	70.3F	144.9F	116.7F		
14:49:00	24.3K	26.6K	25.3K	2424 F	1862 F	55.1F	29.30	0.3M	1437 F	1373 F	141.6F	121.0F	169.2F	8.2	32.2	67.3M
500	0.0P	0.2P	0.2P	4.00P			74.1F	75.8F	76.1F	71.0F	1.0	72.9F	145.4F	118.5F		
14:51:00	24.3K	26.7K	25.4K	2445 F	1849 F	55.4F	29.30	0.3M	1432 F	1373 F	144.7F	122.0F	170.3F	8.3	31.8	66.7M
500	0.0P	0.2P	0.4P	3.88P			76.8F	78.5F	75.6F	71.8F	1.0	75.2F	145.7F	119.6F		
14:53:00	24.2K	26.7K	25.5K	2397 F	1868 F	55.7F	29.30	0.2M	1435 F	1373 F	144.0F	123.3F	171.6F	7.9	31.8	66.4M
500	0.0P	0.2P	0.3P	3.86P			79.2F	81.1F	75.7F	71.5F	1.0	77.7F	145.7F	121.0F		
14:55:00	24.2K	26.7K	25.5K	2409 F	1852 F	55.3F	29.30	0.2M	1434 F	1371 F	146.0F	124.3F	172.8F	8.2	31.4	65.1M
500	0.0P	0.2P	0.2P	3.88P			81.5F	83.4F	76.1F	71.2F	1.0	80.0F	146.3F	121.9F		
14:57:00	24.5K	26.7K	25.4K	2409 F	1861 F	54.7F	29.30	0.2M	1440 F	1374 F	179.5F	125.5F	174.0F	8.4	31.2	64.8M
500	0.0P	0.2P	0.2P	3.88P			83.8F	85.6F	75.1F	71.3F	1.0	82.3F	146.4F	123.1F		
15:25	NRC-MOVHD	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0022	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CNBR T1	CNBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	QSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
15:07:00	24.5K	26.7K	25.4K	2410 F	1848 F	54.9F	29.30	0.2M	1440 F	1374 F	179.5F	126.0F	174.0F	8.4	31.0	63.9M
500	0.0P	0.2P	0.2P	3.88P			86.1F	87.9F	75.1F	71.3F	1.0	84.5F	146.5F	125.0F		

NRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
	--GLASS FURNACE POWER---							GAS PARAMETERS								
	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PM	SCRB IT	DLG RTN	VNT RTN		
15:03:00	24.5K	26.8K	25.6K	2413 F	1857 F	55.1F	29.30	0.2M	1437 F	1373 F	152.9F	129.1F	177.3F	7.4	32.2	62.1M
500	0.0P	0.2P	0.3P	3.96P			90.6F	92.4F	75.4F	71.1F	1.0	89.0F	147.4F	126.8F		
15:05:00	24.5K	26.8K	25.6K	2433 F	1844 F	55.5F	29.30	0.2M	1435 F	1372 F	163.0F	130.0F	178.1F	7.9	32.4	61.4M
500	0.0P	0.2P	0.3P	3.94P			92.7F	94.6F	75.3F	71.6F	1.0	91.2F	147.7F	127.8F		
15:07:00	24.5K	26.9K	25.7K	2418 F	1849 F	55.5F	29.30	0.2M	1430 F	1369 F	199.0F	130.8F	178.9F	7.9	32.0	60.8M
500	0.0P	0.2P	0.2P	3.92P			94.8F	96.5F	75.6F	71.6F	1.0	93.2F	148.0F	128.6F		
15:09:00	24.7K	27.0K	25.8K	2428 F	1854 F	55.7F	29.30	0.2M	1431 F	1369 F	192.9F	131.9F	179.8F	7.6	32.3	59.7M
500	0.0P	0.2P	0.2P	3.94P			96.7F	98.5F	76.5F	71.8F	1.0	95.2F	148.0F	129.6F		
15:11:00	24.7K	27.0K	25.8K	2401 F	1850 F	55.2F	29.30	0.2M	1431 F	1368 F	201.2F	132.6F	180.6F	7.9	31.6	58.9M
500	0.0P	0.3P	0.3P	3.96P			98.2F	100.1F	75.8F	71.3F	1.0	96.9F	148.5F	130.2F		
15:13:00	24.8K	27.1K	26.0K	2448 F	1853 F	55.1F	29.30	0.2M	1434 F	1370 F	197.4F	133.4F	181.2F	7.2	31.0	58.2M
500	0.0P	0.3P	0.1P	3.96P			100.0F	101.9F	75.8F	71.3F	1.0	98.6F	148.5F	131.0F		
15:15:00	24.5K	27.2K	26.0K	2447 F	1850 F	55.2F	29.30	0.2M	1432 F	1367 F	189.1F	134.2F	181.9F	0.0	31.5	57.4M
500	0.0P	0.3P	0.2P	4.00P			101.7F	103.7F	76.0F	71.3F	1.0	100.1F	148.7F	131.8F		
15:17:00	24.5K	27.2K	26.1K	2449 F	1841 F	55.9F	29.30	0.2M	1434 F	1369 F	197.6F	134.8F	182.3F	7.0	30.9	56.3M
500	0.0P	0.3P	0.2P	4.02P			103.3F	105.2F	76.2F	71.5F	1.0	101.7F	149.0F	132.4F		
15:19:00	24.5K	27.3K	26.1K	2497 F	1845 F	56.2F	29.30	0.1M	1436 F	1369 F	194.8F	135.6F	183.0F	7.3	31.4	55.9M
500	0.0P	0.3P	0.1P	4.08P			104.8F	106.7F	76.0F	71.5F	1.0	103.0F	148.8F	133.1F		
15:21:00	24.5K	27.2K	26.1K	2480 F	1843 F	56.6F	29.30	0.2M	1431	1368 F	190.9F	136.3F	183.5F	7.2	30.7	54.7M
500	0.0P	0.2P	0.1P	4.10P			106.3F	108.0F	76.6F	72.1F	1.0	104.7F	149.2F	133.7F		
15:23:00	24.8K	27.2K	26.1K	2412 F	1849 F	56.6F	29.30	0.2M	1433 F	1369 F	199.4F	136.9F	184.1F	6.6	30.5	54.5M
500	0.0P	0.3P	10.1P	4.04P			107.3F	109.1F	76.5F	71.8F	1.0	106.1F	149.3F	134.2F		
15:25:00	24.8K	27.2K	26.1K	2460 F	1849 F	56.5F	29.30	0.2M	1430 F	1365 F	193.7F	137.4F	184.5F	6.7	30.5	53.4M
500	0.0P	0.3P	51.6P	4.04P			108.4F	110.1F	75.9F	71.3F	1.0	107.2F	149.3F	134.7F		
15:27:00	24.9K	27.3K	26.1K	2440 F	1847 F	56.3F	29.30	0.1M	1431 F	1367 F	186.2F	137.9F	184.9F	6.9	30.4	52.5M
500	0.0P	0.3P	84.5P	4.10P			109.5F	111.4F	76.0F	71.3F	1.0	108.3F	149.7F	135.2F		

0022	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CNBR T1	CNBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
15:29:00	24.9K	27.3K	26.1K	2471 F	1834 F	56.3F	29.30	0.2M	1431 F	1360 F	197.5F	138.5F	185.4F	6.4	30.4	51.9M
500	0.0P	0.3P	-0.4P	2.56P			110.5F	112.4F	75.4F	71.2F	1.0	109.5F	149.9F	135.6F		
15:31:00	24.9K	27.3K	26.1K	2434 F	1839 F	55.7F	29.30	0.2M	1430 F	1364 F	196.1F	138.8F	185.8F	6.5	30.2	51.4M
500	0.0P	0.3P	-0.4P	3.90P			111.3F	113.0F	75.5F	70.6F	1.0	110.3F	149.9F	136.0F		
15:33:00	25.1K	27.2K	26.2K	2474 F	1841 F	55.3F	29.30	0.2M	1433 F	1364 F	197.1F	139.2F	186.1F	6.2	30.1	50.6M
500	0.0P	0.3P	-0.3P	3.92P			112.3F	114.1F	75.2F	70.6F	1.0	111.1F	150.1F	136.3F		
15:35:00	25.1K	27.2K	26.2K	2450 F	1850 F	55.0F	29.30	0.3M	1431 F	1364 F	200.0F	139.4F	186.4F	5.7	29.7	49.2M
500	0.0P	0.3P	-0.3P	3.96P			112.8F	114.8F	75.2F	70.1F	1.0	111.9F	150.0F	136.6F		
15:37:00	25.1K	27.2K	26.2K	2477 F	1841 F	54.5F	29.30	0.4M	1431 F	1366 F	197.5F	139.9F	186.6F	5.8	29.5	49.3M
500	0.0P	0.3P	-0.2P	4.12P			113.4F	115.3F	74.5F	70.0F	1.0	112.5F	150.2F	137.0F		
15:39:00	25.2K	27.2K	26.2K	2472 F	1845 F	54.3F	29.30	0.5M	1430 F	1364 F	197.8F	140.4F	186.9F	5.2	29.4	48.2M
500	0.0P	0.3P	-0.3P	4.10P			114.3F	116.2F	75.2F	70.1F	1.0	113.1F	150.0F	137.1F		
15:41:00	25.3K	27.3K	26.3K	2494 F	1859 F	54.3F	29.30	0.4M	1435 F	1368 F	196.1F	140.5F	187.2F	6.0	29.0	47.4M
500	0.0P	0.3P	-0.3P	4.04P			114.9F	116.8F	75.2F	70.3F	1.0	113.9F	150.3F	137.5F		
15:43:00	25.2K	27.3K	26.3K	2487 F	1842 F	54.1F	29.30	0.4M	1426 F	1364 F	196.9F	141.2F	187.6F	5.9	30.1	46.9M
500	0.0P	0.3P	-0.4P	3.96P			115.5F	117.4F	74.9F	70.3F	1.0	114.6F	150.3F	137.8F		
15:45:00	25.1K	27.3K	26.3K	2410 F	1844 F	54.4F	29.30	0.4M	1431 F	1365 F	199.6F	141.4F	187.8F	6.3	29.8	46.3M
500	0.0P	0.3P	-0.3P	4.02P			116.3F	118.1F	75.7F	70.4F	1.0	115.3F	150.6F	138.1F		
15:47:00	25.2K	27.4K	26.3K	2374 F	1853 F	54.4F	29.30	0.3M	1432 F	1368 F	196.7F	141.7F	188.0F	6.5	29.7	45.7M
500	0.0P	0.2P	-0.3P	4.10P			116.9F	118.6F	75.3F	70.4F	1.0	116.0F	150.6F	138.5F		
15:49:00	25.1K	27.4K	26.3K	2366 F	1871 F	54.7F	29.30	0.2M	1436 F	1366 F	193.2F	141.9F	188.1F	6.7	28.8	44.9M
500	0.0P	0.2P	-0.4P	4.14P			117.6F	119.2F	75.5F	70.7F	1.0	116.5F	150.7F	138.6F		
15:51:00	25.2K	27.4K	26.4K	2343 F	1855 F	55.2F	29.30	0.1M	1437 F	1371 F	200.0F	142.3F	188.3F	6.3	28.9	44.3M
500	0.0P	0.2P	-0.3P	4.16P			118.4F	119.8F	75.7F	70.7F	1.0	117.2F	150.7F	138.9F		
15:53:00	25.2K	27.4K	26.4K	2331 F	1870 F	55.5F	29.30	0.2M	1440 F	1371 F	190.2F	142.6F	188.3F	6.2	28.6	44.0M
500	0.0P	0.2P	-0.3P	4.18P			119.7F	120.3F	75.7F	70.8F	1.0	117.9F	150.8F	139.2F		

0022	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								/
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-							/	
500	O2	CONBUS	CO	CO2	NOX			HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
600																
15:55:00	25.2K	27.5K	26.4K	2370 F	1887 F	55.4F	29.30	0.3M	1436 F	1372 F	196.5F	142.7F	188.4F	6.4	28.6	42.9M
500	0.0P	0.2P	-0.3P	4.20P			119.2F	120.7F	75.9F	70.9F	1.0	118.4F	150.8F	139.4F		
15:57:00	25.2K	27.5K	26.5K	2435 F	1881 F	55.4F	29.30	0.2M	1441 F	1371 F	197.4F	142.9F	188.5F	6.1	28.2	42.2M
500	0.0P	0.2P	-0.3P	4.20P			119.7F	121.1F	75.5F	71.0F	1.0	118.7F	150.7F	139.4F		
15:59:00	25.3K	27.5K	26.5K	2374 F	1875 F	55.6F	29.30	0.2M	1437 F	1371 F	191.4F	143.0F	188.7F	6.1	28.4	41.5M
500	0.0P	0.2P	-0.3P	4.22P			119.9F	121.3F	76.0F	71.0F	1.0	119.2F	150.9F	139.7F		
16:01:00	25.3K	27.5K	26.6K	2429 F	1878 F	55.6F	29.30	0.1M	1444 F	1375 F	188.8F	143.3F	188.9F	5.7	27.8	41.3M
500	0.0P	0.2P	-0.1P	4.16P			120.5F	121.1F	75.7F	70.8F	1.0	119.7F	151.0F	139.9F		
16:03:00	25.5K	27.5K	26.6K	2397 F	1874 F	55.8F	29.30	0.2M	1443 F	1373 F	177.1F	143.5F	189.1F	5.4	27.7	40.5M
500	0.0P	0.3P	-0.4P	4.26P			121.0F	122.0F	75.9F	71.1F	1.0	120.1F	151.0F	140.0F		
16:05:00	25.5K	27.5K	26.6K	2412 F	1876 F	56.0F	29.30	0.2M	1442 F	1373 F	182.0F	143.5F	189.2F	5.2	27.2	39.9M
500	0.0P	0.3P	-0.1P	4.18P			121.5F	122.4F	75.5F	71.1F	1.0	120.6F	151.3F	140.1F		
16:07:00	25.4K	27.5K	26.7K	2452 F	1874 F	56.2F	29.30	0.2M	1444 F	1372 F	182.0F	143.8F	189.3F	5.0	26.8	39.2M
500	0.0P	0.3P	0.0P	4.20P			121.9F	122.6F	76.3F	71.4F	1.0	121.2F	151.4F	140.4F		
16:09:00	25.5K	27.5K	26.7K	2499 F	1865 F	56.2F	29.30	0.2M	1438 F	1372 F	194.1F	144.2F	189.5F	5.1	27.1	38.7M
500	0.0P	0.3P	-0.1P	4.46P			122.1F	122.8F	75.8F	71.1F	1.0	121.5F	151.6F	141.0F		
16:11:00	25.5K	27.5K	26.7K	2405 F	1894 F	56.5F	29.30	0.2M	1441 F	1372 F	192.1F	144.4F	189.6F	6.2	27.0	38.2M
500	0.0P	0.3P	0.0P	4.18P			122.4F	123.2F	75.8F	71.3F	1.0	121.7F	151.6F	141.2F		
16:13:00	25.3K	27.5K	26.8K	2402 F	1891 F	56.5F	29.30	0.2M	1441 F	1371 F	189.2F	144.5F	189.6F	5.1	26.8	37.5M
500	0.0P	0.3P	-0.1P	4.26P			122.5F	123.7F	75.3F	71.1F	1.0	121.8F	151.7F	141.3F		
16:15:00	25.4K	27.5K	26.8K	2499 F	1884 F	56.3F	29.30	0.4M	1440 F	1371 F	189.7F	144.6F	189.8F	5.7	26.5	37.2M
500	0.0P	0.3P	0.3P	4.24P			122.8F	124.0F	75.3F	70.6F	1.0	122.3F	151.6F	141.4F		
16:17:00	25.4K	27.5K	26.8K	2479 F	1882 F	56.0F	29.30	0.4M	1441 F	1372 F	190.9F	144.6F	189.9F	4.9	26.3	36.4M
500	0.0P	0.3P	0.2P	4.28P			123.0F	124.3F	75.3F	70.6F	1.0	122.3F	151.7F	141.3F		
16:19:00	25.4K	27.5K	26.7K	2483 F	1884 F	55.5F	29.30	0.4M	1440 F	1371 F	186.0F	144.9F	190.1F	6.0	26.0	36.0M
500	0.0P	0.3P	0.3P	4.28P			123.3F	124.6F	75.2F	70.3F	1.0	122.7F	151.6F	141.5F		

0022	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/						GAS PARAMETERS									
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DPM	DFGS T1	DFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/						LIQUID PARAMETERS									
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
16:21:00	25.4K	27.5K	26.8K	2425 F	1862 F	55.3F	29.30	0.5M	1444 F	1372 F	190.5F	144.9F	190.1F	5.3	25.7	35.7M
500	0.0P	0.3P	0.2P	4.32P			123.5F	124.9F	74.8F	69.9F	1.0	122.9F	151.7F	141.5F		
16:23:00	25.4K	27.6K	26.7K	2457 F	1881 F	55.1F	29.30	0.5M	1439 F	1370 F	189.8F	145.0F	190.1F	4.0	26.0	34.7M
500	0.0P	0.3P	0.4P	4.34P			123.5F	124.8F	74.6F	69.5F	1.0	123.1F	151.7F	141.6F		
16:25:00	25.4K	27.6K	26.7K	2446 F	1872 F	55.1F	29.30	0.5M	1438 F	1371 F	192.8F	145.1F	189.8F	5.8	26.3	34.2M
500	0.0P	0.3P	0.7P	4.28P			123.9F	124.8F	74.2F	69.6F	1.0	123.2F	151.8F	141.7F		
16:27:00	25.4K	27.5K	26.7K	2509 F	1876 F	55.0F	29.30	0.5M	1437 F	1369 F	186.6F	145.2F	189.8F	4.9	25.7	33.9M
500	0.0P	0.3P	0.4P	4.34P			124.1F	125.3F	74.3F	69.5F	1.0	123.4F	151.8F	141.8F		
16:29:00	25.4K	27.5K	26.7K	2492 F	1890 F	55.0F	29.30	0.4M	1441 F	1371 F	190.6F	145.3F	189.6F	4.5	25.4	33.4M
500	0.0P	0.3P	0.9P	4.36P			124.1F	125.5F	74.3F	69.3F	1.0	123.5F	151.5F	141.8F		
16:31:00	25.6K	27.5K	26.8K	2517 F	1881 F	54.9F	29.30	0.4M	1441 F	1370 F	191.2F	145.4F	189.6F	5.1	25.0	32.6M
500	0.0P	0.3P	1.0P	4.46P			124.4F	125.8F	74.5F	69.5F	1.0	123.8F	151.8F	141.9F		
16:33:00	25.5K	27.5K	26.9K	2537 F	1883 F	54.9F	29.30	0.4M	1440 F	1369 F	173.5F	145.5F	189.5F	5.2	24.3	31.7M
500	0.0P	0.3P	1.0P	4.48P			124.5F	126.0F	74.2F	69.5F	1.0	124.0F	151.8F	142.0F		
16:35:00	25.4K	27.5K	26.9K	2478 F	1890 F	54.9F	29.30	0.4M	1453 F	1377 F	186.0F	145.4F	189.1F	5.2	23.2	31.6M
500	0.0P	0.3P	0.6P	4.58P			124.3F	125.8F	74.2F	69.3F	1.0	123.9F	151.7F	141.8F		
16:37:00	25.5K	27.5K	26.9K	2471 F	1892 F	54.9F	29.30	0.3M	1454 F	1379 F	178.7F	145.3F	188.9F	5.6	22.4	30.8M
500	0.0P	0.3P	0.5P	4.72P			124.4F	125.3F	73.4F	69.2F	1.0	123.8F	151.9F	141.9F		
16:39:00	25.4K	27.4K	26.8K	2525 F	1896 F	55.0F	29.30	0.2M	1459 F	1383 F	156.5F	145.4F	188.6F	4.7	21.7	29.9M
500	0.0P	0.3P	0.3P	4.70P			124.3F	125.3F	73.8F	69.1F	1.0	123.8F	151.8F	141.7F		
16:41:00	25.4K	27.4K	26.8K	2527 F	1897 F	55.0F	29.30	0.2M	1455 F	1381 F	155.7F	145.4F	188.5F	4.7	21.1	29.6M
500	0.0P	0.3P	0.2P	4.82P			124.4F	125.3F	73.7F	68.9F	1.0	123.9F	151.8F	141.7F		
16:43:00	25.3K	27.4K	26.8K	2528 F	1911 F	55.3F	29.30	0.3M	1464 F	1386 F	153.2F	145.7F	188.5F	4.6	20.4	29.0M
500	0.0P	0.3P	0.8P	5.22P			124.7F	125.6F	73.2F	69.1F	1.0	124.1F	152.2F	142.0F		
16:45:00	25.3K	27.4K	26.8K	2547 F	1905 F	55.7F	29.30	0.3M	1460 F	1384 F	154.6F	145.7F	188.2F	4.8	20.9	28.8M
500	0.0P	0.3P	0.9P	4.94P			124.9F	125.6F	73.8F	69.3F	1.0	124.3F	152.1F	142.0F		

0022	U1	U2	U3	U4	U5	U6	U7	U8	U9	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/----------GAS PARAMETERS----------															
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/----------LIQUID PARAMETERS----------/															
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
16:47:00	25.3K	27.4K	26.8K	2540 F	1921 F	55.9F	29.30	0.4M	1466 F	1389 F	152.6F	145.7F	187.8F	3.7	20.3	27.8M
500	0.0P	0.3P	0.3P	4.92P			124.9F	125.7F	73.6F	68.8F	1.0	124.5F	152.1F	142.0F		
16:49:00	25.3K	27.4K	26.8K	2536 F	1911 F	55.9F	29.30	0.3M	1455 F	1379 F	154.3F	145.8F	187.4F	5.2	22.1	27.4M
500	0.0P	0.3P	0.3P	4.92P			125.0F	125.4F	73.5F	68.7F	1.0	124.4F	152.2F	142.1F		
16:51:00	25.3K	27.4K	26.8K	2518 F	1908 F	55.9F	29.30	0.2M	1457 F	1383 F	154.6F	146.0F	187.3F	5.1	22.0	26.9M
500	0.0P	0.3P	0.3P	4.78P			125.1F	125.7F	73.5F	68.5F	1.0	124.5F	152.1F	142.2F		
16:53:00	25.3K	27.4K	26.8K	2542 F	1919 F	55.8F	29.30	0.2M	1458 F	1384 F	154.7F	146.0F	187.1F	5.0	22.2	26.3M
500	0.0P	0.3P	0.5P	4.78P			125.2F	125.8F	73.3F	68.8F	1.0	124.7F	152.2F	142.3F		
16:55:00	25.3K	27.4K	26.8K	2454 F	1902 F	56.0F	29.30	0.2M	1462 F	1389 F	194.1F	146.3F	187.2F	5.2	22.6	25.8M
500	0.0P	0.3P	0.9P	4.76P			125.5F	125.9F	73.3F	68.6F	1.0	124.9F	152.3F	142.6F		
16:57:00	25.3K	27.4K	26.8K	2449 F	1895 F	56.1F	29.30	0.2M	1463 F	1388 F	186.0F	146.4F	187.0F	5.0	22.6	25.2M
500	0.0P	0.3P	0.0P	4.68P			125.5F	126.2F	73.1F	68.5F	1.0	125.1F	152.4F	142.7F		
16:59:00	25.4K	27.5K	26.8K	2424 F	1909 F	56.1F	29.30	0.2M	1461 F	1389 F	184.8F	146.5F	187.0F	5.5	23.5	25.0M
500	0.0P	0.3P	0.3P	4.70P			125.6F	125.9F	73.2F	68.4F	1.0	125.1F	152.2F	142.7F		
17:01:00	25.4K	27.5K	26.8K	2487 F	1902 F	56.4F	29.30	0.1M	1470 F	1395 F	184.5F	146.7F	187.3F	5.3	23.7	24.1M
500	0.0P	0.3P	0.2P	4.72P			126.0F	126.3F	73.0F	68.5F	1.0	125.4F	152.9F	143.0F		
17:03:00	25.4K	27.5K	26.8K	2469 F	1900 F	56.6F	29.30	0.1M	1466 F	1393 F	177.9F	146.9F	187.3F	6.1	24.9	24.0M
500	0.0P	0.3P	0.2P	4.80P			125.8F	126.2F	72.6F	68.3F	1.0	125.6F	153.1F	143.3F		
17:05:00	25.3K	27.4K	26.7K	2390 F	1896 F	56.5F	29.30	0.1M	1465 F	1391 F	179.0F	146.9F	187.3F	6.0	24.4	22.8M
500	0.0P	0.3P	0.2P	4.60P			125.3F	125.9F	72.2F	68.0F	1.0	125.4F	152.9F	143.1F		
17:07:00	26.2K	27.1K	26.9K	2384 F	1896 F	56.0F	29.30	0.2M	1462 F	1392 F	191.6F	147.0F	187.3F	6.7	25.1	23.0M
500	0.0P	0.3P	0.1P	4.64P			124.5F	125.4F	72.6F	67.7F	1.0	124.8F	152.5F	143.0F		
17:09:00	26.2K	27.1K	26.9K	2403 F	1893 F	55.5F	29.30	0.1M	1459 F	1387 F	190.9F	146.5F	187.0F	8.1	27.5	22.7M
500	0.0P	0.3P	0.3P	4.38P			123.7F	124.6F	72.3F	67.4F	1.0	124.0F	152.5F	142.7F		
17:11:00	26.1K	27.2K	26.9K	2431 F	1885 F	55.2F	29.30	0.2M	1462 F	1388 F	136.8F	146.2F	187.1F	8.1	27.0	21.9M
500	0.0P	0.3P	0.4P	4.38P			123.0F	124.0F	72.1F	67.2F	1.0	123.2F	152.4F	142.3F		

0022	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR ANB
300																
400	GAS PARAMETERS CONT---							LIQUID	PARAMETERS							
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	PLG RTN	VNT RTN		
600																
17:13:00	26.1K	27.2K	26.9K	2335 F	1876 F	55.0F	29.30	0.1M	1455 F	1384 F	194.3F	145.9F	186.8F	6.6	26.1	21.4M
500	0.0P	0.3P	0.3P	4.38P			122.6F	123.7F	71.7F	67.2F	1.0	122.7F	152.2F	142.0F		
17:15:00	26.1K	27.2K	26.9K	2337 F	1881 F	54.8F	29.30	0.1M	1456 F	1383 F	192.9F	145.7F	187.0F	6.8	26.0	21.7M
500	0.0P	0.3P	0.5P	4.42P			122.4F	123.7F	72.0F	67.1F	1.0	122.4F	152.1F	141.9F		
17:17:00	26.1K	27.2K	26.9K	2374 F	1878 F	55.1F	29.30	0.1M	1458 F	1386 F	192.7F	145.4F	187.1F	7.6	26.3	20.7M
500	0.0P	0.3P	0.2P	4.38P			122.3F	123.5F	71.9F	67.2F	1.0	122.1F	152.0F	141.6F		
17:19:00	26.0K	27.3K	26.9K	2355 F	1881 F	55.2F	29.30	0.1M	1454 F	1383 F	189.9F	145.5F	187.4F	7.4	26.4	20.5M
500	0.0P	0.3P	0.3P	4.36P			122.2F	123.5F	72.1F	67.3F	1.0	122.1F	152.0F	141.7F		
17:21:00	26.0K	27.3K	26.9K	2365 F	1883 F	55.0F	29.30	0.1M	1457 F	1385 F	194.2F	145.4F	187.7F	7.7	26.5	20.0M
500	0.0P	0.3P	-0.1P	4.32P			122.1F	123.5F	71.6F	67.2F	1.0	122.0F	152.0F	141.7F		
17:23:00	26.0K	27.3K	26.9K	2365 F	1872 F	54.9F	29.30	0.1M	1464 F	1388 F	196.6F	145.5F	188.0F	7.4	26.6	18.6M
500	0.0P	0.3P	0.5P	4.36P			121.8F	123.4F	71.9F	67.2F	1.0	121.8F	152.3F	141.7F		
17:25:00	26.1K	27.3K	26.9K	2377 F	1886 F	54.9F	29.30	0.1M	1458 F	1385 F	199.1F	145.6F	188.2F	7.7	26.8	19.4M
500	0.0P	0.3P	0.8P	4.60P			121.9F	123.3F	71.9F	67.4F	1.0	121.7F	152.7F	141.9F		
17:27:00	26.1K	27.3K	26.9K	2389 F	1890 F	54.9F	29.30	0.1M	1456 F	1385 F	198.5F	145.3F	188.1F	7.4	26.6	19.3M
500	0.0P	0.3P	0.3P	4.54P			121.8F	123.1F	71.6F	67.6F	1.0	121.6F	152.2F	141.8F		
17:29:00	26.0K	27.3K	26.9K	2371 F	1880 F	55.2F	29.30	0.2M	1458 F	1387 F	191.4F	145.3F	188.3F	7.2	26.4	18.8M
500	0.0P	0.3P	0.2P	4.42P			122.0F	123.3F	71.6F	67.6F	1.0	121.7F	152.1F	141.6F		
17:31:00	26.1K	27.3K	27.0K	2364 F	1882 F	55.6F	29.30	0.2M	1457 F	1384 F	197.3F	145.4F	188.4F	7.4	26.7	18.8M
500	0.0P	0.3P	-0.2P	4.38P			122.0F	123.2F	71.8F	68.1F	1.0	121.7F	152.1F	141.6F		
17:33:00	26.0K	27.3K	27.0K	2374 F	1877 F	55.7F	29.30	0.1M	1454 F	1385 F	197.9F	145.3F	188.4F	5.9	26.6	17.8M
500	0.0P	0.3P	-0.3P	4.38P			121.5F	122.6F	72.0F	68.1F	1.0	121.6F	151.7F	141.6F		
17:35:00	26.0K	27.3K	27.0K	2424 F	1876 F	55.5F	29.30	0.0M	1455 F	1382 F	201.3F	145.2F	188.6F	8.0	26.7	18.3M
500	0.0P	0.3P	0.1P	4.36P			120.8F	121.8F	72.1F	67.7F	1.0	121.2F	151.9F	141.5F		
17:37:00	26.0K	27.3K	27.0K	2362 F	1878 F	55.4F	29.30	0.1M	1450 F	1379 F	197.2F	145.0F	188.6F	7.5	26.5	17.7M
500	0.0P	0.3P	-0.3P	4.34P			120.0F	120.8F	72.5F	67.7F	1.0	120.4F	151.7F	141.3F		

	--GLASS FURNACE POWER---/							----------GAS PARAMETERS----------									
100	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB	
200																	
300																	
400	/----------GAS PARAMETERS CONT--------/							----------LIQUID PARAMETERS----------									
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																	
17:39:00	26.0K	27.3K	27.0K	2369 F	1873 F	55.6F	29.30	0.2M	1452 F	1381 F	201.3F	144.8F	188.7F	7.1	27.1	17.0M	
500	0.0P	0.3P	0.2P	4.32P			119.0F	120.2F	72.2F	67.7F	1.0	119.7F	151.6F	141.1F			
17:41:00	26.0K	27.3K	27.0K	2350 F	1866 F	55.4F	29.30	0.1M	1456 F	1386 F	203.2F	144.5F	188.9F	7.3	27.1	17.2M	
500	0.0P	0.3P	0.0P	4.32P			117.9F	118.8F	72.5F	67.9F	1.0	118.6F	151.7F	140.7F			
17:43:00	26.0K	27.4K	27.0K	2335 F	1869 F	55.3F	29.30	0.2M	1452 F	1383 F	200.3F	144.0F	189.0F	7.9	27.0	16.5M	
500	0.0P	0.3P	-0.1P	4.30P			116.4F	117.5F	72.5F	67.4F	1.0	117.3F	151.6F	140.4F			
17:45:00	26.1K	27.4K	27.0K	2331 F	1873 F	55.3F	29.30	0.1M	1454 F	1382 F	201.9F	143.4F	188.9F	7.7	27.1	16.1M	
500	0.0P	0.3P	-0.2P	4.22P			115.3F	116.5F	72.5F	67.8F	1.0	116.1F	151.6F	139.9F			
17:47:00	26.0K	27.4K	27.0K	2365 F	1868 F	55.6F	29.30	0.1M	1452 F	1383 F	204.3F	142.9F	188.7F	7.4	27.2	16.1M	
500	0.0P	0.3P	0.3P	4.22P			114.4F	115.4F	72.3F	68.0F	1.0	115.0F	151.3F	139.3F			
17:49:00	26.0K	27.4K	27.0K	2351 F	1872 F	56.0F	29.30	0.2M	1456 F	1385 F	198.6F	142.7F	188.8F	7.7	27.3	16.1M	
500	0.0P	0.3P	0.0P	4.42P			113.8F	114.9F	72.9F	68.0F	1.0	114.3F	151.6F	139.1F			
17:51:00	26.0K	27.4K	27.1K	2375 F	1873 F	56.4F	29.30	0.1M	1453 F	1381 F	203.2F	142.5F	188.8F	8.1	27.4	15.4M	
500	0.0P	0.3P	0.4P	4.32P			113.5F	114.7F	72.7F	68.4F	1.0	113.8F	151.5F	138.9F			
17:53:00	26.1K	27.4K	27.1K	2333 F	1869 F	56.4F	29.30	0.0M	1450 F	1379 F	197.8F	142.1F	188.9F	7.3	27.3	15.3M	
500	0.0P	0.3P	-0.3P	4.24P			113.2F	114.5F	72.0F	68.2F	1.0	113.2F	151.1F	138.6F			
17:55:00	26.1K	27.5K	27.1K	2304 F	1873 F	56.9F	29.30	0.1M	1441 F	1372 F	201.0F	142.1F	189.0F	8.2	27.7	15.2M	
500	0.0P	0.3P	0.0P	4.22P			113.4F	114.9F	72.9F	68.4F	1.0	113.1F	151.3F	138.5F			
17:57:00	26.0K	27.4K	27.1K	2339 F	1870 F	57.0F	29.30	0.2M	1439 F	1370 F	169.8F	141.9F	188.9F	7.7	27.4	14.7M	
500	0.0P	0.3P	0.1P	4.28P			113.1F	114.6F	73.3F	68.7F	1.0	113.1F	150.9F	138.4F			
17:59:00	26.1K	27.4K	27.1K	2334 F	1867 F	57.0F	29.30	0.1M	1443 F	1374 F	186.0F	142.0F	188.9F	8.1	27.3	14.6M	
500	0.0P	0.3P	-0.3P	4.28P			113.3F	114.9F	72.9F	68.3F	1.0	113.2F	151.1F	138.4F			
18:01:00	26.1K	27.5K	27.2K	2370 F	1854 F	56.7F	29.30	0.1M	1440 F	1373 F	202.3F	141.9F	188.7F	7.0	27.3	14.4M	
500	0.0P	0.3P	0.0P	4.28P			113.5F	115.1F	73.0F	68.1F	1.0	113.3F	151.0F	138.4F			
18:03:00	25.2K	27.8K	27.0K	2354 F	1864 F	57.1F	29.30	0.2M	1440 F	1374 F	138.8F	142.0F	188.8F	8.3	27.3	14.6M	
500	0.0P	0.3P	-0.4P	4.28P			113.8F	115.4F	72.8F	68.0F	1.0	113.6F	151.1F	138.4F			

0022	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/								GAS PARAMETERS							
200	KW AB	KW BC	KW CO	CNBR T1	CNBR T2	AMB T	BAR P	AIR DPM	OFGS T1	OFGS T2	SLUG DT	MST DT	EXH DT	SLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/								LIQUID PARAMETERS							
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	OLG RTN	VNT RTN		
600																
18:05:00	25.2K	27.7K	27.0K	2357 F	1865 F	57.1F	29.30	0.2M	1439 F	1370 F	700.0F	142.1F	188.9F	7.9	27.8	14.6M
500	0.0P	0.3P	-0.3P	4.24P			114.2F	116.0F	72.6F	67.8F	1.0	113.9F	151.0F	138.5F		
18:07:00	25.3K	27.8K	27.0K	1911 F	1773 F	56.9F	29.30	0.2M	1336 F	1302 F	695.3F	140.5F	188.7F	8.0	26.9	14.0M
500	0.0P	0.3P	-0.1P	4.26P			114.5F	116.2F	72.1F	67.8F	1.0	114.1F	147.9F	137.3F		
18:09:00	25.4K	27.8K	27.1K	1683 F	1681 F	56.9F	29.30	0.1M	1304 F	1268 F	681.5F	136.1F	188.6F	9.6	26.6	13.5M
500	0.0P	0.3P	89.5P	0.62P			115.0F	116.8F	72.7F	67.5F	1.0	114.7F	142.5F	132.0F		
18:11:00	25.6K	27.9K	27.0K	1602 F	1790 F	56.7F	29.30	0.1M	1252 F	1224 F	639.9F	133.3F	176.7F	9.3	9.8	13.4M
500	0.0P	0.3P	22.6P	0.46P			114.9F	116.1F	71.8F	66.8F	1.0	114.6F	139.4F	127.4F		
RUN #1 END 18:13 STOP TIME																
18:13:00	25.8K	28.0K	27.0K	1620 F	1831 F	56.8F	29.30	0.0M	1274 F	1225 F	635.5F	131.1F	168.1F	8.9	8.7	13.7M
500	0.0P	0.3P	8.8P	0.46P			114.8F	115.8F	71.1F	66.5F	1.0	114.7F	136.5F	124.9F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

122	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG OT	MST OT	EXH OT	DLUG P	VNTR DP	AIR ANB
300																
400	/----------GAS PARAMETERS CONT--------/						----------LIQUID PARAMETERS----------									
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
18:29:31	27.4K	27.9K	27.4K	1553 F	1757 F	49.5F	29.30	0.0M	1243 F	1195 F	130.1F	128.9F	149.6F	9.2	0.3	12.3M
500	0.0P	0.3P	-2.5P	-0.04P			112.8F	114.0F	68.6F	64.7F	1.0	113.1F	132.9F	121.6F		
18:30:30	28.0K	27.7K	27.0K	1811 F	1918 F	51.4F	29.30	0.1M	1226 F	1148 F	142.4F	130.5F	146.7F	0.5	0.0	12.5M
500	0.0P	0.3P	-3.4P	-0.06P			112.7F	111.8F	68.7F	64.7F	1.0	110.9F	125.2F	121.5F		
18:32:02	28.2K	27.7K	27.0K	1971 F	1999 F	58.0F	29.30	0.7M	1115 F	1061 F	137.2F	131.6F	141.8F	0.0	-0.3	12.8M
500	-6.3P	-1.3P	95.5P	5.12P			110.0F	108.4F	68.3F	64.7F	1.0	105.3F	119.4F	119.9F		

zeros FOR RUN #1

purge

6% CO2

JAN 23, 1985

D... #2 1/23/85 Wooltype C 12:30 start (delay turning on recorder)

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0023	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	--GAS PARAMETERS CONT---							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
600																
09:24:53	25.5K	25.6K	23.2K	2390 F	2393 F	88.0F	29.30	4.3M	923 F	923 F	53.5F	217.6F	52.9F	0.1	-0.4	61.4M
500	-6.3P	-1.3P	14.1P	4.98P			39.4F	32.6F	71.5F	68.0F	1.0	54.2F	59.3F	51.9F		
09:25:31	24.4K	25.1K	23.5K	2386 F	2392 F	87.0F	29.23	4.5M	923 F	923 F	53.2F	214.2F	52.8F	0.1	-0.4	61.8M
500	-6.3P	-1.3P	14.2P	5.02P			42.1F	32.9F	71.8F	67.2F	1.0	52.9F	60.4F	52.8F		
12:42:00	25.2K	25.6K	24.1K	2353 F	2135 F	60.3F	29.23	0.4M	1498 F	1404 F	131.7F	108.7F	142.5F	5.1	46.6	65.8M
500	-6.3P	-1.3P	-3.4P	5.46P			67.2F	68.5F	76.3F	72.2F	1.0	66.3F	139.8F	99.5F		
12:44:00	25.2K	25.6K	24.1K	2377 F	2138 F	60.6F	29.23	0.4M	1498 F	1404 F	132.3F	109.8F	145.6F	5.1	46.3	65.8M
500	-6.3P	-1.3P	-3.5P	5.54P			69.1F	70.4F	76.5F	72.4F	1.0	68.0F	140.9F	100.9F		
12:46:00	25.2K	25.6K	24.1K	2375 F	2143 F	60.7F	29.23	0.4M	1501 F	1408 F	132.7F	110.7F	148.0F	5.0	46.4	65.7M
500	-6.3P	-1.3P	-3.0P	5.58P			70.5F	71.9F	76.8F	72.5F	1.0	69.6F	141.0F	102.4F		
12:48:00	25.2K	25.7K	24.2K	2399 F	2142 F	60.8F	29.23	0.4M	1502 F	1409 F	133.2F	111.6F	150.2F	5.0	46.1	65.7M
500	-6.3P	-1.3P	-2.2P	5.62P			71.1F	72.9F	77.0F	72.8F	1.0	70.9F	142.2F	103.6F		
12:50:00	25.2K	25.7K	24.2K	2412 F	2144 F	61.1F	29.23	0.4M	1504 F	1411 F	134.0F	112.5F	152.3F	5.5	46.2	65.5M
500	-6.3P	-1.3P	-3.5P	5.72P			72.0F	73.4F	76.9F	73.2F	1.0	71.8F	142.2F	104.4F		
12:52:00	25.2K	25.7K	24.3K	2411 F	2147 F	61.3F	29.23	0.3M	1504 F	1415 F	134.0F	113.0F	154.0F	4.6	46.1	64.5M
500	-6.3P	-1.3P	-3.3P	5.72P			73.1F	74.6F	77.2F	73.3F	1.0	72.7F	143.0F	105.2F		
12:54:00	25.2K	25.7K	24.3K	2485 F	2150 F	61.6F	29.23	0.3M	1510 F	1411 F	134.3F	113.8F	155.7F	5.0	45.8	63.8M
500	-6.3P	-1.3P	-3.1P	5.72P			73.8F	75.8F	77.5F	73.3F	1.0	73.4F	143.1F	106.1F		
12:56:00	25.2K	25.7K	24.3K	2429 F	2154 F	62.1F	29.23	0.3M	1511 F	1414 F	134.8F	114.5F	157.3F	5.0	45.9	63.6M
500	-6.3P	-1.3P	-2.5P	5.80P			75.3F	77.4F	77.6F	73.4F	1.0	74.6F	143.5F	107.0F		
12:58:00	25.1K	25.6K	24.3K	2522 F	2179 F	62.3F	29.23	0.3M	1520 F	1418 F	135.9F	115.6F	158.7F	5.2	45.9	63.3M
500	-6.3P	-1.3P	-4.4P	-0.12P			76.6F	78.4F	77.3F	73.4F	1.0	76.0F	144.7F	108.6F		
13:00:00	24.9K	25.6K	24.4K	2546 F	2190 F	62.1F	29.23	0.3M	1527 F	1422 F	136.9F	116.3F	160.0F	4.9	45.7	62.5M
500	-6.3P	-1.3P	-0.7P	-0.02P			78.1F	80.2F	77.1F	73.4F	1.0	77.3F	144.5F	109.6F		
13:02:00	24.7K	25.6K	24.3K	2522 F	2206 F	62.1F	29.23	0.3M	1529 F	1426 F	136.2F	116.4F	161.2F	5.0	45.8	61.7M
500	-6.3P	-1.3P	99.1P	5.20P			79.5F	81.6F	76.8F	73.4F	1.0	78.8F	144.7F	110.5F		

4 5	RMC-HOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS						GLASS FURNACE AND CYCLONE INCINERATOR								
0023	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---			/----------				GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT---------/							LIQUID PARAMETERS								
500	D2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	LSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
13:04:00	24.5K	25.6K	24.3K	2540 F	2211 F	62.0F	29.23	0.3M	1530 F	1427 F	136.6F	116.0F	162.2F	4.5	46.2	61.2M
500	-6.3P	-1.3P	50.0P	6.90P			80.7F	82.8F	77.5F	73.4F	1.0	80.1F	144.9F	111.3F		
13:06:00	24.3K	25.5K	24.3K	2567 F	2219 F	61.9F	29.23	0.3M	1532 F	1426 F	137.0F	117.3F	163.2F	4.9	45.7	60.5M
500	-6.3P	-1.3P	1.9P	6.84P			82.2F	84.4F	77.9F	73.3F	1.0	81.3F	145.2F	112.2F		
13:08:00	24.2K	25.5K	24.3K	2608 F	2216 F	61.7F	29.23	0.3M	1533 F	1430 F	137.4F	117.8F	164.0F	4.4	45.6	59.7M
500	-6.3P	-1.3P	2.0P	7.06P			83.0F	85.9F	77.5F	73.3F	1.0	82.0F	145.2F	113.1F		
13:10:00	24.1K	25.4K	24.3K	2617 F	2231 F	61.8F	29.23	0.3M	1535 F	1433 F	138.1F	118.6F	164.8F	4.5	45.6	59.4M
500	-6.3P	-1.3P	1.0P	7.10P			83.5F	87.4F	77.4F	73.5F	1.0	84.4F	145.5F	114.3F		
13:12:00	24.0K	25.4K	24.2K	2574 F	2252 F	61.7F	29.23	0.3M	1541 F	1439 F	139.2F	119.7F	166.2F	5.5	50.3	58.3M
500	-6.3P	-1.3P	2.2P	7.36P			86.8F	88.7F	77.3F	73.4F	1.0	85.9F	146.1F	115.9F		
13:14:00	24.0K	25.4K	24.1K	2514 F	2240 F	61.6F	29.23	0.3M	1541 F	1444 F	139.7F	121.1F	167.7F	5.9	54.1	57.6M
500	-6.3P	-1.3P	2.0P	7.18P			88.0F	89.9F	77.4F	73.5F	1.0	87.3F	145.3F	117.7F		
13:16:00	24.0K	25.4K	24.1K	2431 F	2239 F	61.3F	29.23	0.2M	1544 F	1453 F	141.3F	124.4F	167.9F	0.0	48.3	56.6M
500	-6.3P	-1.3P	0.9P	0.62P			89.0F	90.5F	77.0F	73.4F	1.0	88.2F	146.9F	121.7F		
13:18:00	24.0K	25.3K	24.1K	2430 F	2246 F	61.2F	29.23	0.3M	1541 F	1453 F	141.2F	125.5F	167.8F	0.7	47.7	55.5M
500	-6.3P	-1.3P	1.2P	0.06P			89.9F	90.8F	76.2F	73.6F	1.0	89.1F	145.7F	122.8F		
13:20:00	23.9K	25.3K	24.1K	2438 F	2243 F	61.3F	29.23	0.3M	1543 F	1453 F	141.7F	126.3F	168.5F	0.5	47.9	55.0M
500	-6.3P	-1.3P	0.2P	0.10P			90.7F	91.9F	76.5F	73.6F	1.0	90.2F	146.8F	123.5F		
13:22:00	24.0K	25.3K	24.1K	2428 F	2254 F	61.3F	29.23	0.2M	1541 F	1454 F	141.7F	126.7F	168.8F	0.5	47.9	54.4M
500	-6.3P	-1.3P	0.9P	0.16P			91.9F	93.1F	75.6F	73.8F	1.0	91.2F	147.3F	124.1F		
13:24:00	23.9K	25.2K	24.1K	2367 F	2246 F	61.4F	29.23	0.2M	1539 F	1452 F	142.2F	127.4F	169.4F	0.7	47.7	53.7M
500	-6.3P	-1.3P	0.5P	0.42P			93.1F	94.3F	76.7F	73.9F	1.0	92.6F	146.7F	124.7F		
13:26:00	23.9K	25.2K	24.0K	2424 F	2255 F	61.5F	29.23	0.2M	1537 F	1452 F	142.7F	128.0F	169.9F	0.2	47.8	52.3M
500	-6.3P	-1.3P	0.2P	0.58P			94.3F	95.4F	76.6F	73.9F	1.0	93.8F	148.0F	125.5F		
13:28:00	24.0K	25.2K	24.0K	2419 F	2244 F	61.5F	29.23	0.2M	1544 F	1453 F	143.1F	128.5F	170.3F	0.3	47.4	51.9M
500	-6.3P	-1.3P	0.2P	0.84P			95.4F	96.7F	76.4F	74.0F	1.0	94.8F	145.8F	126.0F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0023																
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								/
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	UNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-							/	
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	UNT RTN		
600																
13:30:00	23.6K	25.5K	24.5K	2428 F	2259 F	61.6F	29.23	0.3M	1543 F	1452 F	143.1F	128.9F	170.6F	8.7	47.4	51.0M
500	-6.3P	-1.3P	1.2P	1.10P			96.3F	97.7F	75.8F	73.7F	1.0	95.9F	145.5F	126.6F		
13:32:00	23.6K	25.4K	24.4K	2500 F	2263 F	61.7F	29.23	0.2M	1543 F	1453 F	143.7F	129.5F	170.8F	8.3	48.0	50.5M
500	-6.3P	-1.3P	0.7P	1.30P			97.7F	98.8F	76.7F	74.5F	1.0	97.0F	146.0F	127.3F		
13:34:00	23.6K	25.4K	24.4K	2443 F	2255 F	62.0F	29.23	0.3M	1545 F	1454 F	143.8F	130.0F	171.2F	9.0	47.7	48.8M
500	-6.3P	-1.3P	0.3P	1.50P			98.8F	100.0F	76.9F	74.2F	1.0	98.2F	146.3F	127.8F		
13:36:00	23.6K	25.3K	24.3K	2432 F	2261 F	62.3F	29.23	0.1M	1544 F	1455 F	144.2F	130.7F	171.8F	8.3	47.4	48.7M
500	-6.3P	-1.3P	0.9P	1.74P			99.8F	101.0F	77.3F	74.4F	1.0	99.4F	146.5F	128.6F		
13:38:00	23.5K	25.3K	24.3K	2452 F	2265 F	62.4F	29.23	0.2M	1547 F	1455 F	144.3F	131.3F	172.1F	7.8	47.9	47.7M
500	-6.3P	-1.3P	0.8P	1.92P			100.9F	102.1F	77.4F	74.7F	1.0	100.4F	147.1F	129.0F		
13:40:00	23.5K	25.3K	24.3K	2432 F	2262 F	62.3F	29.23	0.3M	1544 F	1456 F	144.5F	131.7F	172.7F	7.6	47.3	47.1M
500	-6.3P	-1.3P	0.8P	2.18P			101.7F	102.9F	77.2F	74.4F	1.0	101.4F	147.6F	129.6F		
13:42:00	23.5K	25.2K	24.2K	2433 F	2264 F	62.5F	29.23	0.3M	1545 F	1456 F	145.2F	132.2F	173.0F	7.7	47.4	46.7M
500	-6.3P	-1.3P	1.2P	2.06P			102.5F	103.8F	77.5F	74.6F	1.0	102.1F	147.0F	130.0F		
13:44:00	23.5K	25.2K	24.3K	2445 F	2269 F	62.5F	29.23	0.2M	1545 F	1453 F	145.4F	132.5F	173.4F	7.8	47.8	45.8M
500	-6.3P	-1.3P	1.1P	2.54P			103.4F	104.7F	77.4F	75.0F	1.0	103.0F	147.1F	130.4F		
13:46:00	23.8K	24.9K	23.8K	2429 F	2269 F	62.7F	29.23	0.1M	1544 F	1457 F	145.3F	133.0F	173.8F	7.6	47.2	45.2M
500	-6.3P	-1.3P	1.0P	2.66P			104.2F	105.5F	77.5F	75.0F	1.0	103.9F	147.8F	130.8F		
13:48:00	23.7K	24.9K	23.8K	2440 F	2268 F	62.9F	29.23	0.3M	1545 F	1455 F	145.6F	133.3F	174.1F	8.3	47.3	44.5M
500	-6.3P	-1.3P	1.2P	3.02P			105.2F	106.3F	77.8F	75.2F	1.0	104.8F	148.3F	131.3F		
13:50:00	23.7K	24.9K	23.8K	2440 F	2270 F	63.3F	29.23	0.3M	1549 F	1460 F	145.9F	133.8F	174.5F	7.8	47.5	43.3M
500	-6.3P	-1.3P	1.5P	3.54P			106.1F	107.4F	77.8F	75.5F	1.0	105.6F	148.2F	131.8F		
13:52:00	23.3K	25.1K	24.2K	2444 F	2274 F	63.7F	29.23	0.2M	1553 F	1457 F	146.6F	134.3F	174.8F	7.8	47.2	42.9M
500	-6.3P	-1.3P	1.3P	3.96P			106.8F	108.1F	77.3F	75.3F	1.0	106.6F	148.7F	132.4F		
13:54:00	23.3K	25.1K	24.2K	2497 F	2259 F	63.8F	29.23	0.2M	1560 F	1457 F	146.7F	134.7F	174.9F	7.7	47.4	42.2M
500	-6.3P	-1.3P	1.2P	3.82P			107.3F	108.6F	78.0F	75.6F	1.0	107.2F	148.0F	132.7F		

Z 5	ANL-MUUMU	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0023	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRN	DFGS T1	DFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX			ME INT	ME DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
600																
13:56:00	23.3K	25.1K	24.2K	2434 F	2270 F	63.7F	29.23	0.2M	1567 F	1468 F	147.1F	135.1F	175.2F	7.9	46.9	41.5M
500	-6.3P	-1.3P	1.1P	3.34P			107.9F	109.0F	78.4F	75.8F	1.0	107.6F	149.2F	133.1F		
13:58:00	23.3K	25.0K	24.2K	2433 F	2280 F	63.7F	29.23	0.3M	1563 F	1467 F	147.1F	135.4F	175.4F	7.5	47.2	41.1M
500	-6.3P	-1.3P	1.4P	3.58P			108.2F	109.6F	78.0F	75.7F	1.0	108.1F	148.8F	133.3F		
14:00:00	23.3K	25.0K	24.2K	2428 F	2273 F	63.8F	29.23	0.3M	1566 F	1467 F	147.3F	135.6F	175.7F	7.2	47.1	40.4M
500	-6.3P	-1.3P	1.5P	3.58P			109.0F	110.3F	78.1F	75.6F	1.0	108.7F	148.8F	133.6F		
14:02:00	23.2K	25.0K	24.1K	2486 F	2269 F	63.8F	29.23	0.3M	1562 F	1464 F	147.7F	135.8F	176.1F	8.0	47.1	39.5M
500	-6.3P	-1.3P	1.2P	3.78P			109.7F	110.8F	78.4F	75.7F	1.0	109.3F	149.2F	133.9F		
14:04:00	23.2K	24.9K	24.1K	2443 F	2277 F	64.1F	29.23	0.2M	1565 F	1465 F	147.8F	136.1F	176.4F	7.3	46.8	38.9M
500	-6.3P	-1.3P	1.4P	4.02P			110.2F	111.5F	78.3F	75.8F	1.0	109.8F	150.2F	134.1F		
14:06:00	23.2K	25.0K	24.1K	2454 F	2268 F	64.0F	29.23	0.3M	1565 F	1470 F	147.7F	136.5F	176.7F	7.6	46.8	38.5M
500	-6.3P	-1.3P	1.5P	3.90P			110.3F	111.8F	78.4F	76.1F	1.0	110.4F	149.5F	134.5F		
14:08:00	23.1K	24.9K	24.0K	2455 F	2277 F	64.1F	29.23	0.2M	1567 F	1467 F	148.0F	136.7F	177.1F	7.5	46.9	37.7M
500	-6.3P	-1.3P	1.3P	4.22P			110.9F	112.2F	77.7F	76.0F	1.0	110.8F	149.6F	134.8F		
14:10:00	23.1K	24.9K	24.1K	2458 F	2279 F	64.1F	29.23	0.3M	1565 F	1465 F	147.9F	136.8F	177.4F	7.6	46.9	36.9M
500	-6.3P	-1.3P	1.5P	4.50P			110.8F	112.3F	78.6F	75.7F	1.0	111.1F	149.8F	134.9F		
14:12:00	23.1K	24.9K	24.0K	2496 F	2282 F	63.8F	29.23	0.2M	1567 F	1467 F	148.1F	136.9F	177.7F	8.4	46.8	36.6M
500	-6.3P	-1.3P	1.7P	4.52P			110.5F	112.0F	78.6F	75.9F	1.0	111.0F	149.5F	135.0F		
14:14:00	23.1K	24.8K	24.0K	2468 F	2278 F	63.7F	29.23	0.2M	1564 F	1470 F	147.8F	136.8F	177.9F	7.4	46.9	35.5M
500	-6.3P	-1.3P	1.5P	4.52P			110.3F	111.6F	78.3F	75.6F	1.0	110.6F	149.6F	135.0F		
14:16:00	23.1K	24.8K	24.0K	2462 F	2275 F	63.8F	29.23	0.2M	1569 F	1466 F	147.7F	136.5F	178.0F	6.6	46.6	34.8M
500	-6.3P	-1.3P	1.0P	4.66P			110.5F	111.9F	78.0F	75.8F	1.0	110.6F	149.7F	134.8F		
14:18:00	23.1K	24.8K	24.0K	2506 F	2283 F	64.0F	29.23	0.2M	1571 F	1470 F	147.8F	136.8F	178.4F	7.2	46.8	33.9M
500	-6.3P	-1.3P	1.5P	4.74P			110.5F	111.7F	78.3F	76.1F	1.0	110.8F	149.8F	134.9F		
14:20:00	23.1K	24.7K	23.9K	2463 F	2280 F	64.0F	29.23	0.2M	1569 F	1468 F	147.9F	136.8F	178.6F	7.1	46.8	33.2M
500	-6.3P	-1.3P	1.9P	4.76P			109.9F	111.0F	77.9F	75.5F	1.0	110.5F	149.8F	134.9F		

2 3	ARC-AGOMD	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0023	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							-GAS PARAMETERS-								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	SLUG DT	MST DT	EXH DT	SLUG P	VNTR DP	AIR ANB
300																
400	-GAS PARAMETERS CONT-							-LIQUID PARAMETERS-								
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	QSTC PH	SCRB IT	DLG RTH	VNT RTH	
600																
14:22:00	23.0K	24.7K	24.0K	2501 F	2281 F	64.0F	29.23	0.2M	1569 F	1465 F	147.9F	136.7F	178.7F	7.5	47.0	32.0M
500	-6.3P	-1.3P	1.6P	4.72P			109.6F	110.5F	78.3F	75.9F	1.0	110.1F	149.5F	134.9F		
14:24:00	23.0K	24.7K	24.0K	2470 F	2289 F	64.0F	29.23	0.2M	1569 F	1469 F	147.8F	136.6F	178.9F	7.0	47.2	31.9M
500	-6.3P	-1.3P	1.4P	4.64P			109.0F	109.7F	78.3F	76.2F	1.0	109.7F	149.5F	134.8F		
14:26:00	23.0K	24.7K	24.0K	2476 F	2287 F	64.5F	29.23	0.2M	1570 F	1471 F	147.8F	136.5F	179.2F	6.9	46.8	30.7M
500	-6.3P	-1.3P	1.2P	4.52P			108.6F	109.2F	78.6F	76.1F	1.0	109.3F	150.3F	134.8F		
14:28:00	23.0K	24.8K	24.0K	2477 F	2286 F	64.8F	29.23	0.2M	1570 F	1467 F	147.6F	136.2F	179.4F	7.4	47.0	30.5M
500	-6.3P	-1.3P	1.6P	4.62P			107.8F	108.2F	78.2F	76.3F	1.0	108.6F	149.8F	134.5F		
14:30:00	23.0K	24.8K	24.0K	2505 F	2286 F	64.8F	29.23	0.2M	1571 F	1473 F	147.7F	135.7F	179.3F	7.1	46.9	29.8M
500	-0.1P	-1.3P	1.7P	5.64P			106.4F	107.0F	78.7F	76.0F	1.0	107.7F	149.9F	134.1F		
14:32:00	23.3K	24.5K	23.4K	2488 F	2295 F	64.7F	29.23	0.2M	1573 F	1470 F	147.1F	135.4F	179.4F	7.2	46.9	29.3M
500	-0.1P	0.2P	2.2P	6.60P			105.4F	105.9F	78.5F	76.1F	1.0	106.8F	149.2F	133.8F		
14:34:00	23.2K	24.4K	23.4K	2466 F	2289 F	64.7F	29.23	0.3M	1574 F	1475 F	147.2F	134.9F	179.5F	7.2	46.9	28.9M
500	-0.1P	0.2P	1.9P	6.64P			104.6F	104.8F	78.4F	76.3F	1.0	105.7F	149.0F	133.4F		
14:36:00	23.2K	24.4K	23.4K	2458 F	2293 F	64.9F	29.23	0.2M	1570 F	1472 F	146.6F	134.5F	179.6F	7.9	47.2	27.9M
500	-0.1P	0.2P	2.0P	6.54P			103.3F	103.8F	78.7F	75.9F	1.0	104.8F	149.4F	132.8F		
14:38:00	23.2K	24.4K	23.4K	2567 F	2290 F	64.7F	29.23	0.2M	1572 F	1473 F	146.4F	134.0F	179.8F	7.0	47.1	27.5M
500	-0.1P	0.2P	2.5P	6.52P			102.6F	103.1F	78.4F	76.0F	1.0	103.9F	149.2F	132.4F		
14:40:00	23.1K	24.4K	23.4K	2471 F	2297 F	64.7F	29.23	0.2M	1572 F	1473 F	146.2F	133.7F	179.8F	7.5	47.0	26.6M
500	-0.1P	0.3P	2.1P	6.54P			102.3F	102.4F	78.9F	76.2F	1.0	103.1F	148.6F	132.1F		
14:42:00	23.1K	24.4K	23.4K	2463 F	2284 F	65.0F	29.23	0.2M	1570 F	1472 F	145.7F	133.4F	179.7F	7.1	46.8	25.9M
500	0.0P	0.3P	2.3P	6.52P			101.7F	102.1F	77.9F	76.3F	1.0	102.6F	148.6F	131.8F		
14:44:00	23.0K	24.4K	23.4K	2447 F	2290 F	65.2F	29.23	0.2M	1571 F	1472 F	146.0F	133.1F	179.9F	7.6	46.8	25.7M
500	0.0P	0.3P	1.9P	6.48P			101.5F	101.9F	78.4F	76.6F	1.0	102.3F	148.3F	131.4F		
14:46:00	23.0K	24.3K	23.4K	2461 F	2293 F	65.2F	29.23	0.1M	1573 F	1474 F	145.6F	132.8F	179.9F	6.9	47.1	24.7M
500	0.0P	0.3P	2.4P	6.46P			101.2F	102.0F	79.5F	76.7F	1.0	102.2F	148.1F	131.3F		

2 5	MRC-NOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0023	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---			/----------				-GAS PARAMETERS----------								/
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	SLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS----------								/
500	02	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
600	----------							----------								
14:48:00	23.0K	24.3K	23.5K	2458 F	2289 F	65.2F	29.23	0.2M	1571 F	1474 F	145.7F	132.7F	179.9F	7.9	47.1	24.1M
500	0.0P	0.3P	2.3P	6.50P			101.3F	102.1F	79.5F	76.6F	1.0	101.6F	148.4F	131.1F		
14:50:00	23.0K	24.3K	23.4K	2532 F	2294 F	65.2F	29.23	0.1M	1570 F	1468 F	145.5F	132.6F	179.9F	8.2	47.2	23.9M
500	0.0P	0.3P	2.6P	6.48P			101.7F	102.2F	79.3F	76.5F	1.0	102.1F	148.4F	131.1F		
14:52:00	23.0K	24.3K	23.5K	2483 F	2294 F	65.4F	29.23	0.3M	1567 F	1472 F	145.5F	132.8F	180.1F	7.5	47.2	23.6M
500	0.0P	0.2P	2.0P	6.46P			102.0F	103.0F	79.1F	76.0F	1.0	102.2F	147.9F	131.2F		
14:54:00	23.0K	24.3K	23.5K	2459 F	2290 F	65.5F	29.23	0.2M	1564 F	1471 F	146.3F	133.0F	180.2F	7.6	47.2	23.2M
500	-0.1P	0.3P	2.4P	6.44P			102.3F	102.9F	79.1F	76.9F	1.0	102.6F	148.7F	131.2F		
14:56:00	23.1K	24.2K	23.5K	2460 F	2288 F	65.6F	29.23	0.2M	1564 F	1471 F	146.1F	133.2F	180.6F	7.7	47.4	22.9M
500	0.0P	0.3P	2.2P	6.44P			102.6F	103.7F	79.3F	77.0F	1.0	103.2F	148.8F	131.6F		
14:58:00	23.0K	24.3K	23.3K	2483 F	2291 F	65.1F	29.23	0.2M	1564 F	1470 F	146.1F	133.3F	180.5F	7.4	47.2	21.9M
500	0.0P	0.3P	2.6P	6.44P			102.5F	103.6F	79.1F	76.2F	1.0	103.3F	148.8F	131.6F		
15:00:00	23.0K	24.3K	23.4K	2457 F	2286 F	65.0F	29.23	0.1M	1564 F	1472 F	146.0F	133.3F	180.6F	7.6	46.8	21.3M
500	0.0P	0.3P	2.7P	6.44P			103.2F	104.2F	78.7F	76.3F	1.0	103.3F	148.6F	131.8F		
15:02:00	22.6K	24.5K	23.9K	2492 F	2294 F	64.9F	29.23	0.1M	1565 F	1470 F	146.0F	133.6F	180.9F	7.3	46.9	21.3M
500	0.0P	0.3P	3.4P	6.42P			103.7F	104.9F	79.1F	76.4F	1.0	104.1F	148.5F	131.8F		
15:04:00	22.6K	24.4K	23.9K	2473 F	2294 F	64.9F	29.23	0.2M	1564 F	1470 F	145.8F	133.7F	180.7F	7.7	47.1	20.7M
500	0.0P	0.3P	3.1P	6.44P			104.6F	105.5F	79.5F	76.6F	1.0	104.2F	148.6F	132.2F		
15:06:00	22.6K	24.4K	23.6K	2486 F	2297 F	65.0F	29.23	0.2M	1564 F	1468 F	146.0F	134.1F	181.0F	7.5	46.9	20.4M
500	0.0P	0.3P	3.0P	6.48P			104.9F	106.1F	79.7F	77.3F	1.0	105.0F	149.1F	132.4F		
15:08:00	22.6K	24.4K	23.6K	2471 F	2296 F	65.0F	29.23	0.2M	1562 F	1471 F	146.2F	134.3F	181.4F	7.4	47.4	20.1M
500	0.0P	0.3P	3.1P	6.50P			105.4F	106.4F	79.7F	76.8F	1.0	105.3F	148.9F	132.7F		
15:10:00	22.6K	24.4K	23.8K	2502 F	2299 F	65.0F	29.23	0.1M	1563 F	1470 F	146.8F	134.5F	181.4F	7.4	47.5	19.8M
500	0.0P	0.3P	2.9P	6.46P			105.7F	106.9F	79.3F	77.0F	1.0	105.9F	148.7F	132.9F		
15:12:00	22.5K	24.4K	23.7K	2501 F	2293 F	65.1F	29.23	0.2M	1562 F	1468 F	146.7F	134.7F	182.0F	7.8	47.1	19.3M
500	0.0P	0.3P	3.2P	6.54P			106.1F	107.3F	79.4F	76.8F	1.0	106.7F	149.4F	133.1F		

2 5 RKC-MUUND DEVELUPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0023	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								/
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR ANB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID	PARAMETERS-----					/		
500	02	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	PSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
15:14:00	22.5K	24.4K	23.0K	2511 F	2292 F	65.4F	29.23	0.2M	1565 F	1470 F	147.1F	134.8F	181.4F	7.7	47.5	18.8M
500	0.0P	0.3P	3.2P	6.50P			106.7F	107.7F	79.7F	77.1F	1.0	106.7F	149.8F	133.2F		
15:16:00	22.5K	24.4K	23.7K	2486 F	2294 F	65.8F	29.23	0.2M	1563 F	1470 F	146.9F	135.2F	181.7F	7.5	47.0	18.1M
500	0.0P	0.3P	2.9P	6.54P			107.3F	108.5F	79.7F	77.1F	1.0	107.4F	149.2F	133.5F		
15:18:00	22.5K	24.4K	23.6K	2497 F	2297 F	65.9F	29.23	0.2M	1561 F	1467 F	146.9F	135.2F	181.6F	6.9	47.1	17.5M
500	0.0P	0.3P	3.3P	6.56P			107.8F	108.6F	79.0F	76.8F	1.0	108.0F	149.6F	133.9F		
15:20:00	22.5K	24.4K	23.7K	2493 F	2287 F	65.8F	29.23	0.2M	1563 F	1469 F	147.2F	135.6F	181.9F	7.5	47.4	17.3M
500	0.0P	0.3P	3.7P	6.56P			107.8F	109.0F	79.1F	76.7F	1.0	108.2F	149.1F	134.0F		
15:22:00	23.0K	24.1K	23.3K	2492 F	2295 F	65.5F	29.23	0.2M	1562 F	1473 F	147.2F	135.6F	181.8F	6.9	47.0	16.8M
500	0.0P	0.3P	3.6P	6.54P			107.8F	109.0F	79.3F	76.6F	1.0	108.4F	149.1F	134.0F		
15:24:00	23.0K	24.1K	23.3K	2485 F	2298 F	65.1F	29.23	0.2M	1562 F	1467 F	147.2F	135.8F	182.0F	7.5	47.0	16.5M
500	0.0P	0.3P	3.8P	6.52P			107.6F	109.0F	78.9F	76.3F	1.0	108.4F	149.3F	134.1F		
15:26:00	23.0K	24.0K	23.3K	2503 F	2287 F	64.7F	29.23	0.2M	1560 F	1467 F	147.2F	135.6F	182.1F	7.5	47.0	16.4M
500	0.0P	0.3P	3.4P	6.52P			107.7F	109.0F	78.9F	76.5F	1.0	108.2F	149.9F	134.0F		
15:28:00	22.9K	24.0K	23.3K	2488 F	2290 F	64.7F	29.23	0.1M	1561 F	1470 F	147.2F	135.7F	182.4F	6.7	46.7	16.1M
500	0.0P	0.3P	3.2P	6.54P			107.9F	109.2F	79.1F	76.4F	1.0	108.3F	149.1F	134.0F		
15:30:00	23.0K	24.1K	23.3K	2512 F	2306 F	64.7F	29.23	0.1M	1561 F	1471 F	147.2F	135.8F	182.3F	6.8	46.9	15.8M
500	0.0P	0.3P	3.5P	6.52P			108.3F	109.5F	78.7F	77.0F	1.0	108.4F	149.8F	133.9F		
15:32:00	23.0K	24.1K	23.3K	2494 F	2292 F	64.8F	29.23	0.2M	1560 F	1469 F	147.2F	135.9F	182.5F	6.9	46.8	15.3M
500	0.0P	0.3P	3.6P	6.50P			108.9F	109.8F	79.6F	77.0F	1.0	108.9F	149.7F	134.1F		
15:34:00	22.9K	24.0K	23.3K	2514 F	2299 F	64.8F	29.23	0.2M	1561 F	1466 F	147.3F	136.2F	182.6F	7.5	47.2	15.1M
500	0.0P	0.3P	3.8P	6.54P			108.7F	110.0F	79.0F	76.6F	1.0	109.2F	149.8F	134.5F		
15:36:00	23.0K	24.0K	23.3K	2489 F	2301 F	64.4F	29.23	0.2M	1558 F	1469 F	147.2F	136.2F	182.7F	6.9	46.9	14.8M
500	0.0P	0.3P	3.7P	6.60P			108.6F	110.0F	79.0F	76.3F	1.0	109.2F	149.9F	134.4F		
15:38:00	22.9K	24.0K	23.3K	2497 F	2291 F	64.2F	29.23	0.2M	1560 F	1467 F	147.5F	136.1F	182.8F	7.3	46.6	14.2M
500	0.0P	0.3P	3.9P	6.54P			108.9F	109.8F	78.8F	76.3F	1.0	109.2F	149.4F	134.4F		

2 5 NRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0023	--GLASS FURNACE POWER---							--GAS PARAMETERS								
100	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	SLUG DT	MST DT	EXH DT	SLUG P	VNTR DP	AIR AMB
200																
300																
400	--GAS PARAMETERS CONT--							--LIQUID PARAMETERS--								
500	02	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB TT	DLG RTN	VNT RTN	
600																
15:40:00	22.8K	24.0K	23.3K	2491 F	2294 F	64.1F	29.23	0.1M	1560 F	1469 F	147.4F	136.2F	182.8F	7.0	46.9	14.1M
500	0.0P	0.3P	4.1P	6.56P				109.1F	110.2F	78.6F	76.2F	1.0	109.1F	149.7F	134.4F	
15:42:00	22.8K	24.0K	23.3K	2502 F	2300 F	64.1F	29.23	0.2M	1561 F	1465 F	147.2F	136.1F	182.7F	7.1	46.9	14.1M
500	0.0P	0.3P	4.0P	6.58P				109.2F	110.2F	77.8F	76.2F	1.0	109.5F	149.8F	134.6F	
15:44:00	22.8K	23.9K	23.3K	2514 F	2299 F	64.0F	29.23	0.1M	1559 F	1470 F	147.5F	136.4F	182.9F	6.8	46.9	13.8M
500	0.0P	0.3P	3.9P	6.58P				109.3F	110.5F	78.5F	75.8F	1.0	109.7F	150.0F	134.7F	
15:46:00	23.0K	24.0K	23.3K	2093 F	2163 F	63.8F	29.23	0.1M	1491 F	1393 F	142.1F	134.3F	183.0F	7.7	45.9	13.1M
500	0.0P	0.3P	4.4P	5.52P				109.1F	110.3F	78.1F	75.7F	1.0	109.7F	145.7F	133.1F	
15:48:00	23.1K	24.1K	23.3K	1851 F	2051 F	63.8F	29.23	0.1M	1380 F	1335 F	138.5F	130.0F	183.5F	8.2	45.7	12.8M
500	0.0P	0.3P	3.3P	0.58P				109.9F	111.4F	78.7F	75.6F	1.0	110.2F	140.2F	127.5F	
15:50:00	23.3K	24.2K	23.4K	1799 F	1995 F	63.8F	29.23	0.1M	1353 F	1309 F	137.3F	128.9F	183.6F	8.3	45.9	12.6M
500	0.0P	0.3P	3.0P	0.50P				110.5F	112.1F	78.2F	75.8F	1.0	110.7F	138.6F	126.3F	
15:52:00	23.5K	24.4K	23.4K	1760 F	1976 F	63.8F	29.23	0.1M	1340 F	1294 F	136.7F	128.6F	183.8F	8.3	45.7	12.3M
500	0.0P	0.3P	4.9P	0.46P				110.9F	112.7F	79.4F	75.5F	1.0	111.2F	138.1F	125.7F	
15:54:00	23.7K	24.5K	23.6K	1742 F	1945 F	63.8F	29.23	0.1M	1330 F	1283 F	135.9F	128.1F	183.7F	8.4	45.7	11.8M
500	0.0P	0.3P	3.8P	0.44P				111.1F	112.7F	78.2F	75.5F	1.0	111.4F	139.1F	125.2F	
15:56:00	23.4K	24.6K	23.6K	2337 F	2174 F	64.0F	29.23	0.1M	1497 F	1410 F	145.2F	134.3F	183.7F	7.6	47.1	11.5M
500	0.0P	0.3P	3.6P	6.54P				111.4F	112.8F	78.7F	75.8F	1.0	111.6F	149.1F	131.7F	
15:58:00	23.2K	24.6K	23.6K	2433 F	2217 F	63.9F	29.23	0.2M	1526 F	1433 F	147.0F	136.2F	183.6F	6.9	47.1	11.6M
500	0.0P	0.3P	3.2P	6.80P				111.0F	112.3F	78.6F	75.6F	1.0	111.4F	151.0F	134.0F	
16:00:00	22.9K	24.6K	23.6K	2457 F	2232 F	63.6F	29.23	0.2M	1535 F	1446 F	147.3F	136.8F	183.4F	7.2	47.1	11.7M
500	0.0P	0.3P	3.8P	6.90P				110.7F	111.7F	78.4F	75.5F	1.0	111.1F	151.7F	134.6F	
16:02:00	22.8K	24.5K	23.6K	2506 F	2243 F	63.6F	29.23	0.1M	1543 F	1452 F	147.8F	136.9F	183.5F	7.2	47.1	11.1M
500	0.0P	0.3P	3.6P	6.94P				110.5F	111.4F	77.7F	75.8F	1.0	111.1F	151.9F	135.0F	
16:04:00	22.9K	24.5K	23.6K	2500 F	2258 F	63.7F	29.23	0.1M	1547 F	1457 F	147.8F	136.8F	183.4F	6.9	47.2	10.8M
500	0.0P	0.3P	4.1P	6.96P				110.2F	111.2F	77.8F	75.6F	1.0	110.7F	151.8F	135.0F	

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0023	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB
300																
400	----------GAS PARAMETERS CONT--------							LIQUID PARAMETERS								
500	DZ	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
16:06:00	22.5K	24.5K	23.6K	2570 F	2263 F	63.7F	29.23	0.1M	1548 F	1463 F	148.1F	137.1F	183.5F	5.6	48.1	10.7M
500	0.0P	0.3P	3.6P	6.94P			110.3F	111.1F	78.2F	76.2F	1.0	110.9F	152.5F	135.1F		
16:08:00	22.4K	24.5K	23.7K	2771 F	2241 F	63.6F	29.23	0.2M	1566 F	1477 F	150.0F	139.7F	183.9F	6.5	42.3	10.3M
500	0.0P	0.3P	4.2P	5.98P			110.7F	111.6F	79.0F	76.6F	1.0	111.0F	151.3F	137.9F		
16:10:00	22.5K	24.5K	23.7K	2660 F	2187 F	63.6F	29.23	0.1M	1540 F	1458 F	149.3F	139.8F	185.0F	7.4	42.2	10.3M
500	0.0P	0.3P	3.6P	4.70P			111.5F	112.8F	79.6F	76.4F	1.0	111.5F	150.7F	137.7F		
16:12:00	22.9K	24.5K	23.8K	2524 F	2084 F	63.1F	29.23	0.1M	1480 F	1412 F	146.5F	137.5F	185.4F	7.2	41.8	9.9M
500	0.0P	0.3P	3.1P	2.62P			112.1F	113.8F	80.1F	76.5F	1.0	112.2F	147.3F	135.4F		
16:14:00	23.1K	24.7K	23.8K	2361 F	2047 F	63.6F	29.23	0.1M	1464 F	1397 F	146.0F	137.1F	186.1F	6.5	41.4	9.8M
500	0.0P	0.3P	3.1P	2.48P			112.7F	114.6F	80.4F	76.6F	1.0	112.7F	146.8F	135.0F		
16:16:00	23.3K	24.8K	23.9K	2377 F	2034 F	63.6F	29.23	0.2M	1457 F	1392 F	146.3F	137.1F	186.3F	6.9	41.8	9.6M
500	0.0P	0.3P	3.3P	2.76P			113.0F	115.0F	80.6F	76.5F	1.0	113.0F	146.7F	135.1F		
16:18:00	23.4K	25.0K	24.0K	2428 F	2019 F	63.2F	29.23	0.2M	1452 F	1387 F	145.7F	137.2F	186.5F	7.1	41.5	9.3M
500	0.0P	0.3P	3.3P	2.80P			113.1F	115.3F	80.0F	76.5F	1.0	113.2F	147.1F	135.2F		
16:20:00	23.5K	25.1K	24.1K	2305 F	2010 F	63.5F	29.23	0.1M	1442 F	1376 F	145.9F	137.2F	187.0F	7.2	41.6	8.9M
500	0.0P	0.3P	3.0P	2.68P			113.7F	115.8F	80.6F	76.6F	1.0	113.5F	147.0F	135.0F		
16:22:00	23.6K	25.2K	24.1K	2398 F	1997 F	63.4F	29.23	0.1M	1447 F	1382 F	146.2F	137.4F	187.1F	7.2	41.6	8.4M
500	0.0P	0.3P	3.1P	2.82P			113.6F	116.0F	80.9F	76.6F	1.0	113.8F	146.6F	135.3F		
16:24:00	23.6K	25.4K	24.2K	2410 F	1997 F	63.7F	29.23	0.1M	1440 F	1379 F	146.2F	137.5F	187.4F	7.2	41.6	8.0M
500	0.0P	0.3P	2.4P	2.84P			114.2F	116.6F	81.1F	76.8F	1.0	114.2F	146.9F	135.4F		
16:26:00	23.7K	25.5K	24.3K	2364 F	1989 F	64.0F	29.23	0.2M	1437 F	1374 F	146.6F	137.7F	187.6F	7.1	41.7	7.9M
500	0.0P	0.3P	3.2P	2.86P			114.5F	116.7F	81.1F	76.6F	1.0	114.4F	147.1F	135.4F		
16:28:00	23.7K	25.6K	24.5K	2443 F	1979 F	63.3F	29.23	0.1M	1436 F	1371 F	145.9F	137.2F	187.4F	6.7	41.5	7.9M
500	0.0P	0.3P	2.8P	2.78P			114.3F	116.7F	80.5F	76.0F	1.0	114.6F	146.3F	135.2F		
16:30:00	23.9K	25.7K	24.5K	2317 F	1961 F	63.4F	29.23	0.2M	1429 F	1368 F	146.3F	137.6F	187.9F	7.5	41.5	7.8M
500	0.0P	0.3P	3.6P	2.78P			114.5F	116.8F	80.4F	75.8F	1.0	114.6F	146.7F	135.2F		

2 5	ARC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0023	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CHBR T1	CHBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	02	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
16:32:00	24.0K	25.7K	24.6K	2276 F	1966 F	63.1F	29.23	0.1M	1427 F	1364 F	145.8F	137.5F	188.1F	7.0	41.5	7.7M
500	0.0P	0.3P	3.9P	2.78P			114.6F	117.0F	79.6F	75.9F	1.0	114.6F	146.6F	135.3F		
16:34:00	24.0K	25.8K	24.7K	2261 F	1956 F	63.1F	29.23	0.1M	1424 F	1363 F	146.1F	137.4F	188.2F	6.9	41.4	7.2M
500	0.0P	0.3P	3.6P	2.78P			114.6F	116.9F	80.5F	76.0F	1.0	114.7F	146.7F	135.1F		
16:36:00	24.1K	25.9K	24.8K	2350 F	1941 F	62.9F	29.23	0.2M	1422 F	1362 F	145.8F	137.3F	188.3F	7.3	41.5	7.0M
500	0.0P	0.3P	3.0P	2.74P			114.3F	116.7F	80.1F	75.7F	1.0	114.6F	146.4F	135.0F		
16:38:00	24.2K	26.0K	24.8K	2324 F	1935 F	62.9F	29.23	0.1M	1420 F	1356 F	146.0F	137.3F	188.4F	6.8	41.5	7.0M
500	0.0P	0.3P	2.4P	2.74P			114.6F	117.0F	80.4F	76.2F	1.0	114.6F	146.2F	135.0F		
16:40:00	24.1K	26.0K	24.9K	2376 F	1933 F	63.1F	29.23	0.2M	1418 F	1358 F	145.9F	137.2F	188.3F	7.2	41.9	6.8M
500	0.0P	0.3P	2.6P	2.76P			114.6F	116.8F	80.1F	76.1F	1.0	114.7F	146.2F	134.9F		
16:42:00	24.2K	26.1K	25.0K	2319 F	1920 F	63.6F	29.23	0.1M	1415 F	1356 F	145.9F	137.3F	188.5F	7.0	41.4	6.5M
500	0.0P	0.3P	2.1P	2.72P			114.8F	117.2F	81.1F	76.0F	1.0	115.0F	145.9F	134.9F		
16:44:00	24.3K	26.1K	25.0K	2256 F	1918 F	63.5F	29.23	0.1M	1413 F	1351 F	145.9F	137.3F	188.7F	6.8	41.3	6.4M
500	0.0P	0.3P	2.5P	2.70P			114.4F	117.0F	80.3F	76.0F	1.0	114.9F	146.1F	134.9F		
16:46:00	24.3K	26.2K	25.1K	2334 F	1918 F	63.1F	29.23	0.1M	1410 F	1351 F	145.5F	137.1F	188.7F	6.4	41.4	6.0M
500	0.0P	0.3P	2.7P	2.68P			114.4F	116.8F	80.4F	75.7F	1.0	114.8F	145.7F	134.7F		
16:48:00	24.4K	26.2K	25.2K	2286 F	1909 F	62.8F	29.23	0.1M	1406 F	1345 F	145.2F	137.0F	188.8F	6.7	41.3	6.2M
500	0.0P	0.3P	2.5P	2.68P			114.4F	116.9F	80.5F	75.6F	1.0	114.7F	145.9F	134.7F		
16:50:00	24.4K	26.3K	25.2K	2283 F	1896 F	62.3F	29.23	0.1M	1403 F	1344 F	145.2F	136.8F	188.8F	7.2	41.7	6.0M
500	0.0P	0.3P	2.7P	2.66P			114.1F	116.5F	79.1F	75.2F	1.0	114.4F	145.5F	134.5F		
16:52:00	24.5K	26.4K	25.3K	2359 F	1897 F	62.2F	29.23	0.1M	1405 F	1347 F	145.1F	136.7F	188.9F	6.9	41.7	5.8M
500	0.0P	0.3P	2.3P	2.62P			113.9F	116.4F	79.3F	75.0F	1.0	114.2F	145.8F	134.2F		
16:54:00	24.6K	26.4K	25.3K	2332 F	1905 F	62.0F	29.23	0.0M	1408 F	1349 F	145.4F	136.9F	188.8F	7.0	41.3	5.3M
500	0.0P	0.3P	2.1P	2.90P			113.7F	116.3F	79.9F	75.1F	1.0	114.1F	146.0F	134.3F		
16:56:00	24.6K	26.5K	25.4K	2325 F	1912 F	62.0F	29.23	0.1M	1406 F	1347 F	145.3F	136.9F	188.8F	6.7	41.3	5.0M
500	0.0P	0.3P	2.4P	2.92P			113.6F	116.0F	78.0F	74.9F	1.0	113.9F	145.5F	134.4F		

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0023																
100	--GLASS FURNACE POWER---						GAS PARAMETERS									
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRN	OFGS T1	OFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT						LIQUID PARAMETERS									
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
16:58:00	24.6K	26.6K	25.5K	2375 F	1902 F	61.9F	29.23	0.1M	1408 F	1347 F	145.3F	136.7F	188.7F	7.2	41.5	5.2M
500	0.0P	0.3P	2.3P	2.88P			113.6F	116.0F	79.5F	74.9F	1.0	113.8F	145.9F	134.4F		
17:00:00	24.8K	26.6K	25.6K	2344 F	1894 F	62.1F	29.23	0.1M	1406 F	1345 F	145.6F	136.8F	189.0F	7.0	41.7	5.3M
500	0.0P	0.3P	2.5P	2.88P			113.6F	116.1F	79.4F	75.0F	1.0	113.8F	145.4F	134.3F		
17:02:00	24.8K	26.7K	25.6K	2366 F	1890 F	61.9F	29.23	0.0M	1402 F	1343 F	145.2F	136.7F	188.8F	7.0	41.3	5.3M
500	0.0P	0.3P	2.3P	2.84P			113.8F	116.0F	79.7F	75.2F	1.0	113.8F	145.9F	134.2F		
17:04:00	24.9K	26.8K	25.7K	2298 F	1896 F	62.0F	29.23	0.0M	1403 F	1344 F	145.0F	136.9F	188.9F	6.8	41.9	4.7M
500	0.0P	0.3P	2.7P	2.84P			113.9F	116.3F	80.0F	75.3F	1.0	114.0F	145.6F	134.3F		
17:06:00	25.0K	26.8K	25.8K	2298 F	1883 F	62.1F	29.23	0.1M	1403 F	1344 F	145.3F	136.6F	188.6F	7.0	41.4	5.0M
500	0.0P	0.3P	2.0P	2.86P			114.1F	116.4F	79.9F	75.2F	1.0	114.1F	145.2F	134.3F		
17:08:00	24.9K	26.9K	25.9K	2326 F	1885 F	62.3F	29.23	0.1M	1400 F	1341 F	145.1F	136.9F	188.8F	7.2	41.6	4.7M
500	0.0P	0.3P	2.5P	2.88P			114.1F	116.4F	79.4F	75.2F	1.0	114.2F	145.9F	134.4F		
17:10:00	25.0K	26.9K	25.9K	2237 F	1877 F	62.5F	29.23	0.1M	1398 F	1342 F	145.2F	137.0F	189.0F	6.8	41.6	4.6M
500	0.0P	0.3P	2.1P	2.86P			114.0F	116.5F	79.8F	75.1F	1.0	114.3F	145.5F	134.4F		
17:12:00	24.9K	27.0K	26.0K	1676 F	1789 F	62.4F	29.23	0.1M	1280 F	1250 F	139.6F	133.7F	188.9F	7.5	40.8	4.4M
500	0.0P	0.3P	25.3P	0.44P			114.1F	116.5F	79.7F	74.8F	1.0	114.2F	141.1F	130.7F		
17:14:00	25.1K	27.0K	26.0K	1592 F	1737 F	62.4F	29.23	0.1M	1256 F	1227 F	137.6F	131.6F	188.8F	7.9	41.0	4.2M
500	0.0P	0.3P	-0.2P	0.02P			113.9F	116.5F	79.5F	74.7F	1.0	114.2F	138.0F	128.5F		
17:16:00	25.2K	27.1K	26.1K	1567 F	1718 F	62.1F	29.23	0.1M	1241 F	1211 F	136.7F	130.8F	188.6F	8.0	40.9	4.1M
500	0.0P	0.3P	98.7P	4.94P			113.9F	116.4F	79.1F	74.6F	1.0	114.1F	136.8F	127.5F		
17:18:00	25.4K	27.1K	26.1K	1560 F	1736 F	62.0F	29.23	0.2M	1235 F	1203 F	135.8F	130.5F	187.9F	10.9	32.9	4.0M
500	-6.3P	-1.3P	98.3P	4.90P			114.0F	115.6F	79.3F	74.4F	1.0	114.3F	135.8F	127.1F		
17:20:00	25.6K	27.3K	26.1K	1629 F	1885 F	62.3F	29.23	0.0M	1254 F	1212 F	132.7F	128.9F	172.1F	8.1	14.2	3.7M
500	-6.3P	-1.3P	98.3P	4.86P			113.4F	114.4F	78.4F	74.3F	1.0	113.6F	136.0F	124.1F		

2EBA

CALIB CHECK

STMS GAS CALIB CHECK

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

Run on JAN 24, 1985 Waste Type C

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
	--GLASS FURNACE POWER---							GAS PARAMETERS								
	KV AB	KV BC	KV CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	OLUG DT	MST DT	EXH DT	OLUG P	VNTR DP	AIR AMB
	GAS PARAMETERS CONT---							LIQUID PARAMETERS								
	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	OLG RTN	VNT RTN		
08:58:42	24.9K	24.8K	22.9K	2397 F	2406 F	94.4F	28.95	4.2M	923 F	923 F	58.4F	228.2F	57.0F	0.1	-0.4	55.1M
500	-6.3P	-1.3P	14.3P	4.62P			45.1F	34.0F	77.9F	74.7F	1.0	58.9F	64.3F	57.6F		
10:17:00	24.7K	25.6K	24.2K	2405 F	2006 F	61.0F	28.95	0.5M	1484 F	1421 F	166.8F	128.8F	152.7F	7.7	44.6	59.1M
500	-6.3P	-1.3P	14.3P	4.42P			86.1F	33.8F	80.5F	76.1F	1.0	90.5F	147.3F	121.5F		
10:19:00	24.7K	25.7K	24.3K	2436 F	2018 F	61.5F	28.95	0.4M	1492 F	1427 F	172.8F	129.4F	155.9F	7.3	44.4	59.2M
500	-6.3P	-1.3P	0.0P	0.56P			88.8F	32.7F	80.2F	76.3F	1.0	92.9F	148.4F	123.3F		
10:21:00	24.7K	25.7K	24.3K	2473 F	2027 F	61.5F	28.95	0.4M	1494 F	1430 F	178.0F	129.9F	158.4F	7.3	44.7	59.3M
500	-6.3P	-1.3P	0.3P	4.66P			91.2F	32.1F	80.7F	76.3F	1.0	95.3F	145.8F	125.1F		
10:23:00	24.6K	25.7K	24.4K	2469 F	2014 F	61.6F	28.95	0.4M	1491 F	1427 F	142.6F	123.5F	160.6F	8.3	43.7	59.0M
500	-6.3P	-1.3P	0.0P	4.56P			64.2F	58.5F	81.1F	76.5F	1.0	59.0F	147.8F	119.8F		
10:25:00	24.8K	25.5K	24.2K	2442 F	2023 F	61.7F	28.95	0.4M	1496 F	1433 F	144.3F	106.2F	160.9F	9.9	44.8	58.2M
500	-6.3P	-1.3P	0.0P	4.46P			59.3F	65.8F	80.4F	76.6F	1.0	56.9F	144.5F	98.7F		
10:27:00	24.7K	25.5K	24.2K	2404 F	2029 F	62.0F	28.95	0.4M	1499 F	1436 F	143.9F	109.4F	161.7F	10.3	45.4	57.8M
500	-6.3P	-1.3P	0.1P	4.80P			67.3F	71.3F	80.8F	76.6F	1.0	65.2F	143.4F	103.4F		
10:29:00	24.6K	25.5K	24.3K	2405 F	2043 F	62.4F	28.95	0.4M	1501 F	1434 F	157.9F	113.1F	162.9F	9.1	45.0	57.7M
500	0.0P	0.1P	0.1P	4.80P			73.1F	77.2F	80.5F	76.0F	1.0	71.8F	146.8F	108.5F		
10:31:00	24.6K	25.5K	24.3K	2430 F	2035 F	63.0F	28.95	0.3M	1501 F	1436 F	168.9F	116.0F	163.5F	9.0	45.2	56.8M
500	0.0P	0.2P	0.2P	4.86P			76.0F	79.4F	81.2F	76.8F	1.0	75.5F	146.9F	112.2F		
10:33:00	24.6K	25.5K	24.4K	2429 F	2051 F	63.6F	28.95	0.3M	1499 F	1437 F	155.5F	117.4F	164.6F	8.7	44.8	56.2M
500	0.0P	0.3P	0.3P	4.86P			78.6F	81.6F	81.3F	76.9F	1.0	78.1F	147.5F	114.2F		
10:35:00	24.6K	25.5K	24.4K	2481 F	2045 F	64.0F	28.95	0.3M	1502 F	1439 F	172.3F	118.7F	165.5F	8.3	44.9	55.5M
500	0.0P	0.3P	0.0P	4.86P			80.7F	83.8F	80.7F	76.9F	1.0	80.1F	147.6F	116.0F		
10:37:00	24.6K	25.6K	24.5K	2452 F	2027 F	64.1F	28.95	0.2M	1502 F	1437 F	171.3F	120.0F	166.6F	8.4	44.9	55.1M
500	0.0P	0.3P	0.3P	4.80P			83.7F	86.3F	80.2F	77.0F	1.0	82.8F	148.3F	117.6F		
10:39:00	24.4K	25.8K	24.6K	2462 F	2041 F	64.3F	28.95	0.3M	1499 F	1435 F	169.8F	121.4F	167.4F	8.1	44.8	54.0M
500	0.0P	0.3P	0.2P	4.80P			86.7F	89.1F	80.9F	77.1F	1.0	85.3F	148.6F	119.2F		

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 2  5    MRC-MOUND      DEVELOPMENTAL WASTE PROCESSING SYSTEMS   GLASS FURNACE AND CYCLONE INCINERATOR
0024      01      02      03      04      05      06      07      08      09      10      11      12      13      14      15      16
100      --GLASS FURNACE POWER---/-------------------------------GAS PARAMETERS-------------------------------------------------------/
200      KW AB    KW BC   KW CD   CMBR T1 CMBR T2  AMB T BAR P   AIR ORM  OFGS T1 OFGS T2 DLUG OT MST OT  EXH OT  DLUG P  VNTR DP AIR ANB
300
400      /-----------GAS PARAMETERS CONT--------/-----------------LIQUID PARAMETERS-----------------------------------/
500        O2    COMBUS    CO     CO2     NOX            HE INT  HE OT   RAD INT RAD OT  CSTC PH SCRB IT DLG RTN VNT RTN
600      ------------------------------------------------------------------------------------------------------------------------

10:47:00  24.4K   25.8K   24.7K  2485 F  2024 F   65.4F  20.95     0.3M  1503 F  1435 F  153.3F  127.5F  171.8F    7.0    44.5    50.9M
500        0.0P    0.3P    0.3P   4.78P                   97.5F  101.0F   81.9F   77.9F    1.0    96.0F  150.1F  126.0F
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2 5 NRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0024								GAS PARAMETERS								
100	--GLASS FURNACE POWER---															
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	UNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	UNT RTN		
600																
10:49:00	24.4K	25.9K	24.7K	2497 F	2034 F	65.1F	28.95	0.3M	1504 F	1434 F	169.3F	128.5F	172.4F	7.3	44.5	49.7M
500	0.0P	0.3P	-0.1P	4.80P			99.0F	102.4F	82.3F	77.7F	1.0	97.7F	150.8F	127.1F		
10:51:00	24.4K	25.9K	24.8K	2555 F	2036 F	65.3F	28.95	0.2M	1505 F	1430 F	148.0F	129.2F	172.9F	7.2	43.8	49.4M
500	0.0P	0.3P	0.3P	4.78P			100.5F	103.2F	82.3F	77.7F	1.0	99.3F	150.7F	127.9F		
10:53:00	24.3K	26.0K	24.8K	2501 F	2034 F	65.6F	28.95	0.3M	1504 F	1431 F	151.8F	129.9F	173.3F	6.9	44.4	48.4M
500	0.0P	0.3P	0.0P	4.80P			101.7F	104.1F	82.3F	77.8F	1.0	100.8F	150.7F	128.7F		
10:55:00	24.3K	25.9K	24.8K	2540 F	2023 F	65.3F	28.95	0.3M	1501 F	1436 F	155.2F	130.5F	173.7F	6.5	44.4	47.2M
500	0.0P	0.3P	0.1P	4.78P			102.8F	105.0F	81.9F	77.5F	1.0	101.9F	151.0F	129.3F		
10:57:00	24.3K	26.0K	24.9K	2503 F	2029 F	65.6F	28.95	0.3M	1501 F	1433 F	167.9F	131.1F	174.3F	6.6	44.2	46.2M
500	0.0P	0.3P	0.3P	4.80P			103.8F	105.8F	82.2F	77.8F	- 1.0	103.2F	150.6F	130.0F		
10:59:00	24.3K	26.0K	24.8K	2542 F	2026 F	65.7F	28.95	0.3M	1504 F	1432 F	162.1F	131.5F	174.8F	7.6	44.2	45.0M
500	0.0P	0.3P	-0.1P	4.80P			104.7F	106.6F	82.0F	77.7F	1.0	104.1F	151.1F	130.6F		
11:01:00	24.3K	26.0K	24.8K	2513 F	2027 F	65.6F	28.95	0.2M	1507 F	1433 F	150.6F	132.2F	175.4F	6.5	43.8	45.1M
500	0.0P	0.4P	0.4P	4.84P			105.6F	107.5F	81.2F	77.7F	1.0	105.1F	151.3F	131.2F		
11:03:00	24.3K	25.9K	24.9K	2499 F	2024 F	65.2F	28.95	0.3M	1504 F	1436 F	149.6F	132.7F	176.0F	6.6	44.3	43.7M
500	0.0P	0.4P	0.2P	4.86P			106.6F	108.5F	82.4F	77.8F	1.0	106.0F	151.5F	131.7F		
11:05:00	24.2K	25.9K	24.8K	2427 F	2032 F	64.8F	28.95	0.3M	1501 F	1434 F	160.9F	134.1F	176.8F	7.8	40.9	43.3M
500	0.0P	0.4P	0.3P	4.60P			107.4F	109.3F	82.3F	77.9F	1.0	106.9F	151.5F	133.2F		
11:07:00	24.4K	25.7K	24.7K	2438 F	2031 F	64.3F	28.95	0.2M	1508 F	1437 F	182.5F	135.0F	177.3F	7.5	41.0	42.6M
500	0.0P	0.4P	0.8P	4.94P			108.2F	110.0F	82.0F	77.9F	1.0	107.6F	152.1F	133.9F		
11:09:00	24.4K	25.7K	24.7K	2486 F	2042 F	64.1F	28.95	0.3M	1510 F	1438 F	181.7F	135.4F	177.8F	7.6	41.0	41.6M
500	0.0P	0.4P	0.4P	4.94P			108.9F	110.7F	82.0F	77.9F	1.0	108.4F	152.3F	134.5F		
11:11:00	24.3K	25.7K	24.7K	2456 F	2036 F	64.4F	28.95	0.2M	1507 F	1437 F	142.1F	135.9F	178.4F	7.5	40.6	41.2M
500	0.0P	0.4P	0.3P	4.96P			109.7F	111.5F	81.9F	78.1F	1.0	109.4F	152.5F	135.0F		
11:13:00	24.3K	25.8K	24.7K	2480 F	2028 F	65.1F	28.95	0.2M	1510 F	1438 F	180.3F	136.3F	179.0F	7.7	40.8	39.9M
500	0.0P	0.4P	0.6P	4.92P			110.5F	112.2F	82.2F	78.0F	1.0	110.1F	152.7F	135.3F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	OLUG DT	MST DT	EXH DT	OLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	OLG RTN	VNT RTN		
600																
11:15:00	24.3K	25.8K	24.8K	2448 F	2031 F	64.4F	28.95	0.3M	1510 F	1439 F	182.4F	136.6F	179.4F	7.4	40.7	39.0M
500	0.0P	0.4P	0.2P	4.98P			111.2F	112.9F	81.9F	78.0F	1.0	110.7F	152.6F	135.7F		
11:17:00	24.3K	25.8K	24.8K	2477 F	2038 F	65.7F	28.95	0.3M	1514 F	1442 F	164.6F	137.1F	180.0F	7.6	40.5	38.4M
500	0.0P	0.4P	0.6P	4.94P			111.9F	113.7F	82.5F	78.0F	1.0	111.4F	152.9F	136.1F		
11:19:00	24.3K	25.8K	24.8K	2496 F	2039 F	65.2F	28.95	0.2M	1512 F	1437 F	181.4F	137.4F	180.4F	7.5	40.7	37.0M
500	0.0P	0.4P	0.3P	5.00P			112.3F	114.1F	82.0F	77.9F	1.0	112.0F	153.1F	136.4F		
11:21:00	24.2K	25.8K	24.8K	2491 F	2031 F	64.8F	28.95	0.2M	1514 F	1440 F	171.7F	137.7F	181.0F	7.3	40.2	36.4M
500	0.0P	0.4P	1.0P	4.94P			112.8F	114.8F	82.1F	78.0F	1.0	112.6F	153.1F	136.7F		
11:23:00	24.3K	25.8K	24.8K	2533 F	2024 F	64.5F	28.95	0.2M	1513 F	1439 F	180.3F	137.8F	181.3F	6.8	40.4	35.4M
500	0.0P	0.4P	1.2P	4.92P			113.4F	115.2F	81.7F	78.0F	1.0	113.0F	152.9F	136.8F		
11:25:00	24.2K	25.8K	24.8K	2503 F	2032 F	64.9F	28.95	0.2M	1510 F	1439 F	178.4F	138.0F	181.8F	7.5	40.6	34.9M
500	0.0P	0.4P	1.0P	4.90P			113.9F	115.8F	82.4F	78.2F	1.0	113.6F	153.1F	137.1F		
11:27:00	24.1K	25.8K	24.9K	2518 F	2029 F	65.1F	28.95	0.3M	1511 F	1442 F	185.7F	138.6F	182.4F	7.6	40.5	34.3M
500	0.0P	0.4P	0.8P	4.94P			114.5F	116.6F	82.2F	78.3F	1.0	114.2F	153.4F	137.5F		
11:29:00	24.2K	25.8K	24.9K	2521 F	2040 F	65.2F	28.95	0.3M	1514 F	1442 F	179.5F	138.8F	182.8F	7.7	39.5	33.4M
500	0.0P	0.4P	1.1P	5.02P			114.9F	116.8F	82.7F	78.3F	1.0	114.7F	153.3F	137.7F		
11:31:00	24.1K	25.7K	24.8K	2437 F	2029 F	65.1F	28.95	0.3M	1511 F	1441 F	186.1F	139.6F	183.5F	8.3	37.5	32.7M
500	0.0P	0.4P	0.8P	4.96P			115.1F	116.9F	81.5F	78.3F	1.0	115.1F	153.4F	138.6F		
11:33:00	24.2K	25.8K	24.8K	2481 F	2033 F	64.7F	28.95	0.2M	1512 F	1440 F	183.3F	139.7F	183.9F	8.0	37.5	31.8M
500	0.0P	0.4P	1.1P	4.94P			115.3F	117.1F	82.3F	78.3F	1.0	115.3F	153.7F	138.8F		
11:35:00	24.2K	25.8K	24.8K	2505 F	2031 F	64.3F	28.95	0.3M	1509 F	1439 F	184.2F	139.7F	184.2F	8.2	37.5	30.7M
500	0.0P	0.4P	1.0P	4.90P			115.7F	117.5F	81.9F	78.1F	1.0	115.5F	153.6F	138.8F		
11:37:00	24.2K	25.8K	24.9K	2454 F	2028 F	64.6F	28.95	0.3M	1514 F	1443 F	184.8F	140.2F	184.7F	8.2	37.5	30.4M
500	0.0P	0.4P	1.4P	4.88P			116.1F	117.8F	82.3F	78.4F	1.0	115.9F	153.4F	139.0F		
11:39:00	24.2K	25.8K	24.9K	2447 F	2026 F	64.6F	28.95	0.2M	1511 F	1439 F	183.9F	140.3F	185.0F	7.9	38.0	29.8M
500	0.0P	0.4P	1.1P	4.86P			116.4F	118.4F	82.0F	78.4F	1.0	116.4F	153.5F	139.2F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
11:41:00	24.1K	25.8K	24.9K	2450 F	2025 F	64.6F	28.95	0.2M	1510 F	1440 F	182.1F	140.4F	185.4F	8.1	37.4	28.3M
500	0.0P	0.4P	1.0P	4.86P			117.0F	118.5F	82.7F	78.5F	1.0	116.7F	153.8F	139.3F		
11:43:00	24.1K	25.8K	24.8K	2254 F	1995 F	65.1F	28.95	0.2M	1485 F	1417 F	184.6F	140.7F	185.7F	8.9	36.2	28.0M
500	0.0P	0.4P	1.5P	4.88P			117.2F	118.9F	82.5F	78.6F	1.0	117.2F	153.6F	139.5F		
11:45:00	24.2K	25.8K	24.9K	1749 F	1815 F	63.0F	28.95	0.3M	1302 F	1258 F	168.1F	134.7F	185.9F	6.0	38.0	27.2M
500	0.0P	0.4P	1.6P	0.46P			117.6F	119.4F	82.1F	78.4F	1.0	117.5F	144.5F	132.5F		
11:47:00	24.3K	25.9K	24.9K	1698 F	1781 F	65.1F	28.95	0.3M	1358 F	1319 F	151.9F	133.5F	186.0F	5.9	37.4	26.3M
500	0.0P	0.4P	1.5P	0.46P			117.9F	119.8F	82.3F	78.5F	1.0	117.8F	143.4F	131.3F		
11:49:00	24.2K	26.0K	24.9K	2359 F	1953 F	65.1F	28.95	0.2M	1467 F	1400 F	167.9F	139.5F	186.2F	8.1	37.5	25.4M
500	0.0P	0.4P	1.7P	4.72P			118.0F	119.8F	82.8F	78.2F	1.0	118.0F	152.2F	138.0F		
11:51:00	24.3K	26.0K	25.0K	2433 F	1983 F	64.4F	28.95	0.2M	1490 F	1416 F	180.2F	140.4F	186.5F	8.1	37.5	25.7M
500	0.0P	0.4P	1.8P	4.78P			117.9F	119.8F	82.9F	78.3F	1.0	118.0F	153.0F	139.0F		
11:53:00	24.3K	26.1K	25.0K	2447 F	1991 F	64.3F	28.95	0.2M	1491 F	1425 F	183.3F	140.8F	186.8F	8.7	37.5	24.5M
500	0.0P	0.4P	1.8P	4.86P			117.7F	119.6F	82.2F	78.3F	1.0	117.9F	153.2F	139.3F		
11:55:00	24.2K	26.1K	25.1K	2408 F	1994 F	64.3F	28.95	0.2M	1497 F	1426 F	183.2F	140.9F	187.0F	7.9	37.3	23.4M
500	0.0P	0.4P	1.3P	4.88P			117.8F	119.6F	82.3F	78.4F	1.0	117.9F	153.3F	139.5F		
11:57:00	24.2K	26.1K	25.1K	2477 F	1994 F	64.3F	28.95	0.2M	1499 F	1428 F	185.9F	141.0F	187.2F	8.1	37.7	23.1M
500	0.0P	0.4P	1.8P	4.88P			117.8F	119.7F	81.9F	78.4F	1.0	117.9F	153.2F	139.7F		
11:59:00	24.2K	26.0K	25.1K	2480 F	2021 F	64.4F	28.95	0.1M	1504 F	1434 F	187.3F	141.2F	187.5F	7.9	37.4	22.6M
500	0.0P	0.4P	1.8P	4.90P			118.2F	119.8F	82.0F	78.4F	1.0	118.1F	153.5F	139.8F		
12:01:00	24.2K	26.0K	25.1K	2490 F	2006 F	64.6F	28.95	0.2M	1504 F	1433 F	187.5F	141.3F	187.7F	7.8	37.4	21.5M
500	0.0P	0.4P	1.5P	4.86P			118.4F	120.1F	82.6F	78.4F	1.0	118.4F	153.5F	140.0F		
12:03:00	24.2K	26.1K	25.1K	2454 F	1995 F	65.2F	28.95	0.2M	1505 F	1435 F	186.8F	141.4F	187.8F	8.0	37.5	21.4M
500	0.0P	0.4P	1.7P	4.90P			118.7F	120.3F	82.3F	78.5F	1.0	118.7F	153.5F	140.1F		
12:05:00	24.1K	26.1K	25.1K	2473 F	2010 F	65.8F	28.95	0.2M	1506 F	1431 F	189.4F	142.4F	189.2F	8.2	37.5	20.4M
500	0.0P	0.4P	1.8P	4.82P			120.8F	124.6F	83.5F	79.4F	1.0	119.4F	154.3F	141.0F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0024	--GLASS FURNACE POWER---/							GAS PARAMETERS								
100	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRN	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
200																
300	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
400	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
500																
600																
12:07:00	24.2K	26.1K	25.2K	2472 F	2016 F	66.4F	28.95	0.3M	1507 F	1438 F	186.9F	142.9F	190.0F	7.6	37.3	19.7M
500	0.0P	0.4P	2.1P	4.80P			121.4F	126.3F	84.2F	79.1F	1.0	120.1F	154.8F	141.6F		
12:09:00	24.1K	26.1K	25.2K	2471 F	1998 F	66.9F	28.95	0.3M	1504 F	1436 F	169.9F	143.0F	190.3F	7.3	37.5	19.4M
500	0.0P	0.4P	2.3P	4.88P			121.6F	126.6F	84.5F	79.1F	1.0	120.3F	154.8F	141.8F		
12:11:00	24.1K	26.0K	25.2K	2434 F	1993 F	67.4F	28.95	0.3M	1501 F	1430 F	189.7F	143.0F	190.6F	7.9	37.1	18.8M
500	0.0P	0.4P	1.8P	4.64P			122.0F	127.2F	84.7F	79.0F	1.0	120.7F	154.7F	141.8F		
12:13:00	24.1K	26.1K	25.2K	2400 F	1990 F	67.4F	28.95	0.2M	1499 F	1429 F	185.6F	142.9F	190.7F	7.7	37.6	18.2M
500	0.0P	0.4P	2.2P	4.50P			122.3F	127.4F	84.8F	79.0F	1.0	120.9F	154.6F	141.6F		
12:15:00	23.9K	26.3K	25.3K	2521 F	2028 F	67.3F	28.95	0.2M	1507 F	1435 F	190.0F	143.3F	190.9F	7.5	37.8	17.6M
500	0.0P	0.4P	2.3P	4.98P			122.4F	127.4F	84.9F	79.2F	1.0	121.2F	155.0F	142.2F		
12:17:00	23.9K	26.2K	25.3K	2504 F	2005 F	67.2F	28.95	0.3M	1510 F	1436 F	188.7F	143.3F	190.9F	7.8	37.5	17.1M
500	0.0P	0.4P	1.8P	4.98P			122.1F	126.9F	84.1F	79.2F	1.0	121.0F	154.9F	142.2F		
12:19:00	23.9K	26.3K	25.3K	2470 F	2004 F	67.0F	28.95	0.3M	1506 F	1437 F	190.0F	143.3F	191.2F	7.7	37.3	16.7M
500	0.0P	0.4P	2.4P	4.86P			122.1F	126.9F	84.7F	78.9F	1.0	121.1F	154.9F	142.2F		
12:21:00	23.9K	26.3K	25.3K	2476 F	2011 F	66.5F	28.95	0.2M	1506 F	1436 F	189.9F	143.3F	191.3F	7.4	37.3	15.7M
500	0.0P	0.4P	1.9P	4.84P			122.1F	126.7F	84.4F	78.7F	1.0	121.1F	154.9F	142.1F		
12:23:00	23.9K	26.3K	25.2K	2464 F	2005 F	66.6F	28.95	0.2M	1505 F	1439 F	189.1F	143.3F	191.6F	7.8	37.7	15.2M
500	0.0P	0.4P	2.4P	4.80P			122.3F	127.1F	84.5F	78.9F	1.0	121.4F	154.9F	142.2F		
12:25:00	23.9K	26.2K	25.3K	2427 F	1998 F	66.4F	28.95	0.2M	1501 F	1433 F	188.5F	143.4F	191.8F	7.9	37.6	14.8M
500	0.0P	0.4P	2.3P	4.76P			122.2F	127.2F	84.8F	78.8F	1.0	121.5F	154.9F	142.2F		
12:27:00	23.9K	26.3K	25.2K	2525 F	2004 F	66.1F	28.95	0.2M	1503 F	1435 F	189.1F	143.4F	191.8F	7.6	37.4	14.3M
500	0.0P	0.4P	2.1P	4.82P			122.4F	127.4F	84.3F	78.6F	1.0	121.4F	154.9F	142.1F		
12:29:00	23.9K	26.2K	25.2K	2496 F	2014 F	65.6F	28.95	0.2M	1505 F	1433 F	189.3F	143.4F	191.9F	7.2	37.2	13.9M
500	0.0P	0.4P	2.3P	4.82P			122.2F	126.9F	83.5F	78.4F	1.0	121.5F	155.0F	142.2F		
12:31:00	23.9K	26.3K	25.2K	2527 F	2003 F	65.2F	28.95	0.1M	1503 F	1434 F	188.2F	143.2F	191.7F	7.3	37.8	13.1M
500	0.0P	0.4P	2.1P	4.82P			122.1F	126.3F	83.5F	78.3F	1.0	121.5F	154.8F	142.1F		

2 5	NRC-HOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	CLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
12:33:00	23.9K	26.3K	25.2K	2483 F	2023 F	65.5F	28.95	0.2M	1509 F	1440 F	186.9F	143.3F	191.7F	7.4	37.7	13.1M
500	0.0P	0.4P	2.3P	4.80P			122.2F	126.0F	83.4F	78.3F	1.0	121.6F	154.9F	142.1F		
12:35:00	23.9K	26.2K	25.2K	2484 F	2019 F	65.3F	28.95	0.2M	1509 F	1440 F	194.1F	143.9F	191.7F	7.8	35.8	12.5M
500	0.0P	0.4P	2.3P	5.00P			121.8F	125.4F	82.8F	78.1F	1.0	121.6F	155.0F	142.6F		
12:37:00	23.9K	26.2K	25.3K	2483 F	2019 F	65.7F	28.95	0.2M	1511 F	1440 F	193.5F	144.2F	191.4F	7.9	35.8	11.8M
500	0.0P	0.4P	2.6P	4.90P			122.0F	124.9F	83.3F	78.5F	1.0	121.6F	154.8F	142.6F		
12:39:00	23.9K	26.2K	25.3K	2466 F	2008 F	65.6F	28.95	0.2M	1510 F	1439 F	187.9F	143.9F	191.0F	8.5	35.3	11.7M
500	0.0P	0.4P	2.6P	4.90P			121.5F	123.7F	83.1F	78.1F	1.0	121.4F	154.2F	142.2F		
12:41:00	23.9K	26.2K	25.3K	2413 F	2018 F	65.4F	28.95	0.1M	1507 F	1437 F	183.0F	139.5F	190.5F	8.0	35.9	11.4M
500	0.0P	0.4P	2.2P	4.72P			120.3F	122.5F	83.1F	78.2F	1.0	121.0F	151.6F	137.4F		
12:43:00	23.9K	26.2K	25.3K	2494 F	2016 F	64.8F	28.95	0.1M	1513 F	1441 F	186.8F	142.8F	190.7F	9.0	34.9	10.7M
500	0.0P	0.4P	2.6P	5.10P			120.3F	122.2F	83.0F	78.2F	1.0	120.4F	153.8F	141.1F		
12:45:00	23.8K	26.2K	25.3K	2538 F	2017 F	64.7F	28.95	0.2M	1515 F	1442 F	189.3F	143.1F	190.7F	7.2	37.9	10.5M
500	0.0P	0.4P	2.5P	5.04P			120.3F	122.3F	83.2F	78.2F	1.0	120.5F	154.5F	141.4F		
12:47:00	23.9K	26.2K	25.3K	2512 F	2036 F	64.7F	28.95	0.2M	1511 F	1437 F	190.3F	143.1F	190.9F	7.3	37.7	9.7M
500	0.0P	0.4P	2.3P	5.04P			120.6F	122.4F	83.0F	78.1F	1.0	120.7F	154.5F	141.6F		
12:49:00	23.8K	26.2K	25.3K	2502 F	2015 F	65.0F	28.95	0.2M	1510 F	1439 F	188.4F	143.0F	190.9F	7.1	37.7	9.2M
500	0.0P	0.4P	2.2P	5.02P			120.7F	122.5F	82.9F	78.3F	1.0	120.9F	154.6F	141.6F		
12:51:00	23.8K	26.2K	25.3K	2512 F	2016 F	65.1F	28.95	0.2M	1510 F	1438 F	187.0F	143.2F	191.2F	7.6	37.7	8.9M
500	0.0P	0.4P	2.6P	5.02P			121.0F	122.7F	82.7F	78.3F	1.0	121.1F	154.4F	141.6F		
12:53:00	23.8K	26.2K	25.3K	2584 F	2036 F	65.1F	28.95	0.1M	1510 F	1437 F	190.1F	143.4F	191.3F	7.7	37.8	8.4M
500	0.0P	0.4P	2.5P	5.04P			121.0F	122.9F	83.3F	78.5F	1.0	121.3F	154.5F	141.7F		
12:55:00	23.8K	26.2K	25.4K	2554 F	2017 F	64.9F	28.95	0.1M	1516 F	1444 F	188.2F	143.4F	191.4F	7.4	37.6	7.9M
500	0.0P	0.4P	2.3P	5.06P			120.8F	122.6F	83.0F	78.4F	1.0	121.3F	154.5F	141.8F		
12:57:00	23.8K	26.2K	25.4K	2477 F	2022 F	64.8F	28.95	0.2M	1506 F	1436 F	189.0F	143.1F	191.5F	7.3	37.6	7.8M
500	0.0P	0.4P	2.2P	5.02P			120.9F	122.7F	82.8F	78.5F	1.0	121.1F	154.1F	141.6F		

2 5	MKC-MUUHD	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							-GAS PARAMETERS-								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR ANB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB LT	DLG RTN	VNT RTN		
600																
12:59:00	23.7K	26.2K	25.3K	2554 F	2023 F	65.1F	28.95	0.2M	1508 F	1440 F	185.9F	143.1F	191.7F	7.4	38.1	7.1M
500	0.0P	0.4P	2.6P	5.00P			121.0F	122.7F	83.0F	76.6F	1.0	121.2F	154.1F	141.5F		
13:01:00	23.8K	26.2K	25.4K	2557 F	2011 F	65.1F	28.95	0.1M	1510 F	1439 F	190.2F	143.1F	191.9F	7.0	37.9	7.0M
500	0.0P	0.4P	2.5P	5.02P			121.1F	123.0F	83.0F	78.9F	1.0	121.3F	154.2F	141.7F		
13:03:00	23.7K	26.2K	25.3K	2574 F	2034 F	65.5F	28.95	0.2M	1507 F	1435 F	190.0F	143.1F	192.0F	7.0	38.0	6.8M
500	0.0P	0.4P	2.7P	4.98P			121.4F	123.0F	82.4F	78.8F	1.0	121.3F	154.3F	141.7F		
13:05:00	23.9K	26.0K	25.2K	2543 F	2033 F	65.8F	28.95	0.1M	1510 F	1438 F	187.5F	143.2F	192.1F	7.7	38.1	6.5M
500	0.0P	0.4P	2.2P	4.98P			121.6F	123.2F	83.1F	78.7F	1.0	121.7F	154.4F	141.8F		
13:07:00	23.8K	26.2K	25.5K	2488 F	2009 F	65.7F	28.95	0.1M	1508 F	1438 F	189.2F	143.3F	192.1F	6.7	38.2	5.8M
500	0.0P	0.4P	2.7P	4.94P			121.6F	123.3F	83.3F	78.6F	1.0	121.7F	154.2F	141.8F		
13:09:00	23.9K	26.0K	25.2K	2534 F	2026 F	65.6F	28.95	0.1M	1507 F	1438 F	187.7F	143.2F	192.0F	7.1	38.0	6.0M
500	0.0P	0.4P	2.9P	4.94P			121.7F	123.4F	83.5F	78.7F	1.0	121.8F	154.5F	141.8F		
13:11:00	23.7K	26.2K	25.4K	2526 F	2020 F	66.4F	28.95	0.2M	1506 F	1434 F	187.8F	143.3F	192.2F	6.9	38.0	5.5M
500	0.0P	0.4P	2.9P	4.94P			121.8F	123.5F	83.4F	78.9F	1.0	122.1F	154.3F	141.8F		
13:13:00	23.7K	26.2K	25.4K	2507 F	2015 F	66.0F	28.95	0.2M	1504 F	1436 F	188.2F	143.3F	192.3F	7.2	38.1	5.2M
500	0.0P	0.4P	2.6P	4.92P			121.3F	123.1F	83.1F	78.6F	1.0	121.9F	154.3F	141.8F		
13:15:00	23.7K	26.2K	25.4K	2519 F	2042 F	65.7F	28.95	0.2M	1509 F	1441 F	189.1F	143.6F	192.5F	7.2	38.2	4.4M
500	0.0P	0.4P	2.7P	5.14P			121.5F	123.2F	83.3F	78.8F	1.0	121.7F	154.6F	142.0F		
13:17:00	23.7K	26.1K	25.4K	2519 F	2039 F	65.5F	28.95	0.2M	1519 F	1446 F	174.5F	143.6F	192.5F	7.0	38.2	4.4M
500	0.0P	0.4P	2.4P	5.18P			121.4F	123.3F	83.5F	78.7F	1.0	121.8F	154.8F	142.1F		
13:19:00	23.7K	26.2K	25.4K	2539 F	2040 F	65.1F	28.95	0.1M	1514 F	1444 F	189.3F	143.4F	192.6F	6.7	38.0	3.9M
500	0.0P	0.4P	2.8P	5.12P			121.3F	123.1F	83.4F	78.9F	1.0	121.7F	154.6F	141.9F		
13:21:00	23.7K	26.2K	25.3K	2526 F	2043 F	65.1F	28.95	0.2M	1512 F	1445 F	190.0F	143.5F	192.7F	7.3	38.2	3.6M
500	0.0P	0.4P	3.0P	5.16P			121.2F	123.0F	83.0F	78.9F	1.0	121.6F	154.6F	142.1F		
13:23:00	23.7K	26.2K	25.4K	2507 F	2035 F	64.9F	28.95	0.2M	1512 F	1447 F	192.9F	143.8F	192.7F	8.0	35.9	3.5M
500	0.0P	0.4P	2.9P	5.02P			121.2F	122.9F	82.9F	78.9F	1.0	121.3F	154.5F	142.3F		

2 5	MRC-MOUND		DEVELOPMENTAL WASTE PROCESSING SYSTEMS				GLASS FURNACE AND CYCLONE INCINERATOR								
0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								/
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								/
500	02	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
600																
13:25:00	23.7K	26.2K	25.4K	2479 F	2016 F	64.6F	28.95	0.2M	1509 F	1439 F	187.0F	144.0F	192.8F	7.8	35.6	2.9M
500	0.0P	0.4P	3.1P	5.08P			121.1F	122.8F	82.9F	78.6F	1.0	121.5F	154.6F	142.4F		
13:27:00	23.7K	26.2K	25.4K	2485 F	2020 F	64.7F	28.95	0.2M	1512 F	1443 F	193.6F	144.0F	192.9F	8.1	35.9	3.0M
500	0.0P	0.4P	2.4P	5.02P			121.0F	122.9F	83.1F	78.8F	1.0	121.5F	154.6F	142.4F		
13:29:00	23.7K	26.2K	25.4K	2508 F	2025 F	64.6F	28.95	0.2M	1511 F	1443 F	193.6F	143.8F	192.9F	7.8	35.5	2.5M
500	0.0P	0.4P	2.9P	4.96P			121.2F	123.0F	83.3F	78.8F	1.0	121.4F	154.5F	142.3F		
13:31:00	23.7K	26.2K	25.4K	2490 F	2028 F	64.6F	28.95	0.2M	1509 F	1438 F	193.3F	143.8F	192.9F	8.5	35.9	2.1M
500	0.0P	0.4P	2.8P	4.98P			121.2F	122.8F	83.4F	78.8F	1.0	121.5F	154.4F	142.4F		
13:33:00	23.7K	26.2K	25.4K	2475 F	2034 F	64.6F	28.95	0.2M	1509 F	1442 F	193.0F	143.8F	193.0F	7.7	36.1	2.2M
500	0.0P	0.4P	2.9P	4.96P			121.3F	123.1F	83.3F	78.9F	1.0	121.6F	154.3F	142.4F		
13:35:00	23.7K	26.2K	25.4K	2507 F	2027 F	64.5F	28.95	0.2M	1509 F	1441 F	182.3F	143.8F	193.1F	8.2	36.2	1.9M
500	0.0P	0.4P	2.7P	5.00P			121.4F	122.9F	83.0F	78.8F	1.0	121.5F	154.5F	142.3F		
13:37:00	23.7K	26.2K	25.4K	2492 F	2021 F	64.4F	28.95	0.2M	1510 F	1443 F	191.0F	143.9F	193.2F	8.7	36.3	1.8M
500	0.0P	0.4P	3.2P	5.06P			121.4F	123.2F	83.1F	78.8F	1.0	121.6F	154.4F	142.4F		
13:39:00	23.7K	26.2K	25.4K	2535 F	2021 F	64.4F	28.95	0.2M	1509 F	1440 F	193.1F	143.9F	193.3F	8.3	36.2	1.3M
500	0.0P	0.4P	2.4P	5.02P			121.4F	123.2F	83.2F	78.4F	1.0	121.7F	154.6F	142.4F		
13:41:00	23.6K	26.2K	25.4K	2501 F	2029 F	64.4F	28.95	0.1M	1509 F	1445 F	193.7F	144.0F	193.4F	7.8	36.4	1.0M
500	0.0P	0.4P	3.1P	5.08P			121.5F	123.2F	83.2F	78.5F	1.0	121.7F	154.6F	142.5F		
13:43:00	23.7K	26.2K	25.4K	1891 F	1869 F	64.4F	28.95	0.2M	1277 F	1245 F	181.5F	140.2F	193.4F	3.2	38.4	0.9M
500	0.0P	0.4P	3.2P	1.28P			121.5F	123.1F	83.3F	78.7F	1.0	121.8F	148.6F	138.4F		
13:45:00	23.8K	26.3K	25.5K	1704 F	1772 F	64.6F	28.95	0.3M	1319 F	1277 F	173.1F	137.5F	193.4F	8.3	35.3	0.4M
500	0.0P	0.4P	2.8P	0.48P			121.9F	123.7F	83.5F	78.5F	1.0	122.0F	144.6F	134.6F		
13:47:00	23.9K	26.3K	25.5K	2434 F	1952 F	64.7F	28.95	0.3M	1463 F	1388 F	135.6F	141.8F	193.3F	8.1	36.4	0.4M
500	0.0P	0.4P	3.9P	4.76P			122.1F	124.0F	83.2F	78.6F	1.0	122.2F	152.1F	140.1F		
13:49:00	23.5K	26.4K	25.5K	2583 F	1997 F	64.3F	28.95	0.2M	1483 F	1406 F	196.6F	143.1F	193.3F	7.5	36.2	0.1M
500	0.0P	0.4P	3.4P	5.30P			121.9F	123.7F	83.2F	78.4F	1.0	122.1F	153.8F	141.7F		

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								
	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
	D2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
13:51:00	23.6K	26.4K	25.4K	2600 F	2011 F	64.4F	28.95	0.2M	1492 F	1417 F	190.0F	143.5F	193.3F	7.6	36.2	0.1M
500	0.0P	0.4P	3.5P	5.20P			121.8F	123.4F	82.9F	78.1F	1.0	122.1F	154.2F	142.0F		
13:53:00	23.5K	26.3K	25.4K	2616 F	2014 F	64.3F	28.95	0.2M	1498 F	1426 F	191.4F	143.8F	193.4F	8.2	35.9	-0.1M
500	0.0P	0.4P	3.1P	5.20P			121.5F	123.2F	82.7F	78.5F	1.0	121.8F	154.6F	142.3F		
13:55:00	23.6K	26.3K	25.5K	2667 F	2016 F	64.4F	28.95	0.2M	1504 F	1432 F	190.1F	143.7F	193.5F	7.7	35.8	-0.3M
500	0.0P	0.4P	3.1P	5.22P			121.4F	123.0F	82.7F	78.4F	1.0	121.7F	154.7F	142.4F		
13:57:00	23.5K	26.3K	25.5K	2624 F	2009 F	64.5F	28.95	0.1M	1499 F	1427 F	188.6F	143.5F	193.6F	7.5	35.6	-0.6M
500	0.0P	0.4P	3.4P	4.92P			121.3F	123.1F	82.9F	78.4F	1.0	121.6F	154.5F	142.1F		
13:59:00	23.7K	26.3K	25.6K	2639 F	1998 F	64.5F	28.95	0.2M	1498 F	1427 F	188.0F	143.4F	193.3F	7.7	35.8	-0.5M
500	0.0P	0.4P	3.2P	4.90P			121.3F	123.0F	82.7F	78.4F	1.0	121.5F	154.3F	142.0F		
14:01:00	23.3K	26.3K	25.7K	2648 F	1998 F	64.8F	28.95	0.2M	1497 F	1427 F	187.6F	143.4F	193.5F	8.1	35.8	-1.0M
500	0.0P	0.4P	3.3P	4.90P			121.4F	123.2F	82.8F	78.4F	1.0	121.7F	154.2F	142.0F		
14:03:00	23.4K	26.3K	25.7K	2652 F	2005 F	64.7F	28.95	0.2M	1497 F	1426 F	188.4F	143.5F	193.6F	8.0	35.8	-1.4M
500	0.0P	0.4P	3.5P	4.86P			121.5F	123.2F	83.0F	78.5F	1.0	121.7F	154.4F	142.0F		
14:05:00	23.4K	26.4K	25.7K	2665 F	2005 F	64.8F	28.95	0.2M	1499 F	1426 F	188.6F	143.5F	193.6F	7.6	35.7	-1.4M
500	0.0P	0.4P	3.4P	4.84P			121.6F	123.2F	83.2F	78.3F	1.0	121.7F	154.4F	142.0F		
14:07:00	23.4K	26.4K	25.6K	2649 F	2008 F	65.1F	28.95	0.1M	1495 F	1428 F	187.2F	143.6F	193.7F	7.7	35.7	-1.0M
500	0.0P	0.4P	3.0P	4.84P			121.8F	123.4F	82.6F	78.5F	1.0	121.9F	154.2F	142.0F		
14:09:00	23.4K	26.3K	25.6K	2639 F	1997 F	65.6F	28.95	0.2M	1493 F	1427 F	183.0F	143.6F	193.8F	8.1	35.7	-2.1M
500	0.0P	0.4P	3.6P	4.82P			122.0F	123.6F	82.8F	78.5F	1.0	122.1F	154.4F	142.1F		
14:11:00	23.4K	26.3K	25.7K	2634 F	2001 F	65.4F	28.95	0.2M	1496 F	1426 F	189.9F	143.7F	194.1F	8.4	35.6	-2.1M
500	0.0P	0.4P	3.5P	4.86P			122.0F	123.7F	83.0F	78.5F	1.0	122.1F	154.3F	142.2F		
14:13:00	23.4K	26.3K	25.6K	2652 F	1995 F	65.3F	28.95	0.2M	1499 F	1428 F	193.3F	143.8F	194.1F	7.0	35.8	-1.8M
500	0.0P	0.4P	3.8P	4.86P			121.8F	123.5F	82.6F	78.6F	1.0	122.0F	153.6F	142.2F		
14:15:00	23.4K	26.4K	25.6K	2651 F	2000 F	65.4F	28.95	0.2M	1496 F	1432 F	183.8F	143.8F	194.1F	6.6	36.4	-2.2M
500	0.0P	0.4P	3.4P	4.82P			121.9F	123.6F	83.4F	78.8F	1.0	122.0F	153.1F	142.2F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/----------GAS PARAMETERS----------															
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/----------LIQUID PARAMETERS----------/															
500	O2	COMBUS	CO	CO2	HOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
14:17:00	23.4K	26.3K	25.6K	2665 F	2024 F	65.3F	28.95	0.2M	1502 F	1429 F	192.9F	144.0F	194.0F	7.8	35.6	-2.6M
500	0.0P	0.4P	3.8P	5.04P			121.8F	123.5F	83.0F	78.4F	1.0	121.9F	154.4F	142.3F		
14:19:00	23.4K	26.3K	25.6K	2668 F	2001 F	65.2F	28.95	0.2M	1503 F	1435 F	190.8F	144.1F	194.1F	7.5	35.8	-2.6M
500	0.0P	0.4P	3.9P	5.08P			121.8F	123.5F	82.9F	78.5F	1.0	122.0F	154.4F	142.5F		
14:21:00	23.4K	26.3K	25.6K	2666 F	2025 F	65.1F	28.95	0.1M	1506 F	1436 F	189.6F	144.2F	194.2F	8.1	36.0	-2.6M
500	0.0P	0.4P	3.8P	5.10P			122.0F	123.5F	83.1F	78.5F	1.0	122.1F	154.8F	142.6F		
14:23:00	23.7K	26.3K	25.5K	2664 F	2020 F	64.9F	28.95	0.1M	1500 F	1435 F	188.1F	144.2F	194.2F	8.1	36.2	-2.8M
500	0.0P	0.4P	3.7P	5.12P			122.0F	123.4F	82.6F	78.6F	1.0	122.1F	154.8F	142.6F		
14:25:00	23.6K	26.3K	25.5K	2657 F	2031 F	65.0F	28.95	0.1M	1507 F	1435 F	195.0F	144.1F	194.2F	7.6	36.0	-2.8M
500	0.0P	0.4P	4.0P	5.10P			122.1F	123.6F	83.1F	78.6F	1.0	122.1F	154.4F	142.5F		
14:27:00	23.3K	26.3K	25.7K	2686 F	2035 F	65.4F	28.95	0.2M	1511 F	1439 F	196.7F	144.1F	194.2F	7.7	35.7	-3.2M
500	0.0P	0.4P	4.2P	5.08P			122.1F	123.7F	82.8F	78.6F	1.0	122.2F	154.5F	142.5F		
14:29:00	23.3K	26.2K	25.7K	2667 F	2016 F	65.8F	28.95	0.2M	1505 F	1436 F	197.0F	144.3F	194.4F	7.8	35.8	-3.4M
500	0.0P	0.4P	4.2P	5.10P			122.4F	123.9F	83.3F	78.8F	1.0	122.5F	154.7F	142.8F		
14:31:00	23.3K	26.3K	25.7K	2676 F	2025 F	65.8F	28.95	0.1M	1502 F	1431 F	197.0F	144.2F	194.3F	7.2	36.0	-3.2M
500	0.0P	0.4P	3.9P	5.06P			122.4F	123.9F	83.1F	78.8F	1.0	122.4F	154.7F	142.7F		
14:33:00	23.3K	26.3K	25.7K	2671 F	2028 F	66.0F	28.95	0.2M	1505 F	1434 F	195.6F	144.3F	194.3F	7.2	35.8	-3.7M
500	0.0P	0.4P	4.1P	5.08P			122.4F	123.8F	82.8F	78.5F	1.0	122.4F	154.5F	142.6F		
14:35:00	23.3K	26.2K	25.7K	2662 F	2018 F	66.1F	28.95	0.1M	1504 F	1435 F	197.0F	144.3F	194.3F	7.6	35.9	-3.9M
500	0.0P	0.4P	4.2P	5.08P			122.3F	123.5F	82.8F	78.7F	1.0	122.6F	154.4F	142.7F		
14:37:00	23.3K	26.2K	25.7K	2639 F	2032 F	66.2F	28.95	0.2M	1508 F	1439 F	197.0F	144.3F	194.4F	7.9	36.0	-4.2M
500	0.0P	0.4P	4.1P	5.12P			121.9F	123.0F	82.9F	78.7F	1.0	122.3F	154.6F	142.7F		
14:39:00	23.3K	26.2K	25.7K	2634 F	2026 F	66.0F	28.95	0.2M	1506 F	1437 F	197.0F	144.1F	194.4F	7.4	35.7	-3.4M
500	0.0P	0.4P	3.7P	5.08P			121.3F	122.3F	82.6F	78.6F	1.0	121.8F	154.1F	142.6F		
14:41:00	23.3K	26.2K	25.7K	2668 F	2025 F	66.0F	28.95	0.1M	1504 F	1436 F	198.2F	143.8F	194.2F	7.2	36.2	-4.0M
500	0.0P	0.4P	4.4P	5.04P			120.6F	121.3F	82.6F	78.6F	1.0	121.2F	154.2F	142.3F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0024	--GLASS FURNACE POWER---							GAS PARAMETERS								
100	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
200																
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
14:49:00	23.5K	26.1K	25.6K	2644 F	2039 F	66.1F	28.95	0.2M	1506 F	1435 F	199.9F	142.5F	194.1F	7.0	36.6	-4.2M
500	0.0P	0.4P	4.7P	5.00P			116.2F	116.7F	83.1F	78.5F	1.0	117.2F	152.9F	141.0F		
14:51:00	23.5K	26.1K	25.5K	2684 F	2023 F	66.0F	28.95	0.1M	1504 F	1434 F	196.4F	141.9F	194.0F	8.3	36.4	-4.2M
500	0.0P	0.4P	4.8P	5.00P			114.8F	115.0F	83.0F	78.4F	1.0	115.9F	152.4F	140.3F		
14:53:00	23.5K	26.1K	25.5K	2678 F	2021 F	65.8F	28.95	0.1M	1505 F	1436 F	188.3F	141.4F	193.9F	7.4	36.5	-6.6M
500	0.0P	0.4P	4.8P	5.00P			113.5F	113.7F	83.0F	78.4F	1.0	114.4F	151.9F	139.7F		
14:55:00	23.4K	26.1K	25.5K	2684 F	2044 F	65.7F	28.95	0.2M	1515 F	1445 F	190.6F	141.1F	193.7F	8.0	36.6	-4.4M
500	0.0P	0.4P	5.0P	5.38P			112.3F	112.5F	82.8F	78.4F	1.0	113.5F	152.6F	139.8F		
14:57:00	23.5K	26.1K	25.5K	2679 F	2048 F	65.8F	28.95	0.2M	1513 F	1444 F	192.3F	140.8F	193.7F	8.3	36.8	-4.5M
500	0.0P	0.4P	5.1P	5.34P			111.2F	111.4F	82.7F	78.2F	1.0	112.2F	152.1F	139.3F		
14:59:00	23.4K	26.1K	25.5K	2642 F	2042 F	65.8F	28.95	0.2M	1513 F	1440 F	194.6F	140.5F	193.8F	8.0	37.0	-4.5M
500	0.0P	0.4P	5.2P	5.30P			110.3F	110.5F	82.1F	78.6F	1.0	111.3F	152.5F	139.0F		
15:01:00	23.3K	26.0K	25.4K	2655 F	2052 F	65.7F	28.95	0.2M	1514 F	1446 F	166.2F	139.9F	193.8F	8.0	36.9	-4.3M
500	0.0P	0.4P	4.8P	5.28P			108.6F	109.0F	82.8F	78.6F	1.0	110.1F	151.7F	138.4F		
15:03:00	23.4K	26.0K	25.5K	2660 F	2050 F	65.8F	28.95	0.1M	1508 F	1442 F	190.6F	139.2F	193.6F	8.5	36.9	-4.3M
500	0.0P	0.4P	5.3P	5.26P			106.9F	107.3F	83.0F	78.8F	1.0	108.4F	151.9F	137.8F		
15:05:00	23.3K	26.0K	25.5K	2600 F	2017 F	65.9F	28.95	0.2M	1507 F	1439 F	195.6F	138.1F	193.5F	8.3	36.7	-4.7M
500	0.0P	0.4P	5.1P	4.90P			105.5F	105.9F	83.1F	78.8F	1.0	106.9F	150.9F	136.7F		
15:07:00	23.1K	26.1K	25.7K	2659 F	2028 F	65.6F	28.95	0.1M	1505 F	1438 F	186.8F	137.5F	193.3F	7.0	30.7	-4.8M
500	0.0P	0.4P	5.3P	4.86P			104.3F	104.9F	82.7F	78.8F	1.0	105.7F	149.9F	135.4F		
15:09:00	23.1K	26.1K	25.6K	2662 F	2031 F	65.6F	28.95	0.2M	1504 F	1436 F	156.4F	131.9F	161.6F	5.3	26.5	-4.7M
500	0.0P	0.4P	5.5P	5.36P			103.0F	103.6F	82.8F	78.5F	1.0	104.3F	146.3F	132.2F		
15:11:00	23.1K	26.1K	25.6K	2652 F	2054 F	65.4F	28.95	0.2M	1507 F	1433 F	149.4F	130.2F	146.7F	4.3	23.8	-4.8M
500	0.0P	0.4P	5.3P	5.48P			101.8F	102.4F	82.4F	78.7F	1.0	103.1F	146.7F	130.9F		
15:13:00	23.1K	26.1K	25.7K	2663 F	2048 F	65.3F	28.95	0.4M	1511 F	1436 F	148.1F	129.6F	141.2F	5.1	25.3	-4.7M
500	0.0P	0.4P	5.4P	5.54P			101.0F	101.6F	82.9F	78.7F	1.0	102.4F	148.6F	130.4F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KV AB	KV BC	KV CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VHTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX			NE INT	NE OT	RAD INT	RAD OT	CSTC PH	SCRB TT	DLG RTN	VHT RTN	
600																
15:15:00	23.1K	26.0K	25.6K	2550 F	2037 F	65.1F	28.95	0.3M	1517 F	1443 F	154.3F	133.0F	139.6F	7.4	33.3	-4.9M
500	0.0P	0.4P	5.3P	4.92P			99.9F	100.1F	82.5F	78.7F	1.0	101.4F	153.3F	134.6F		
15:17:00	23.1K	26.1K	25.5K	2614 F	2051 F	64.9F	28.95	0.2M	1504 F	1433 F	183.0F	129.9F	137.2F	9.7	37.2	-4.6M
500	0.0P	0.4P	5.5P	4.70P			98.9F	99.6F	82.8F	78.4F	1.0	100.2F	151.5F	132.8F		
15:19:00	23.0K	26.1K	25.4K	2553 F	2013 F	64.6F	28.95	0.1M	1499 F	1431 F	196.6F	129.7F	136.0F	9.7	38.5	-5.2M
500	0.0P	0.4P	5.5P	4.62P			98.5F	99.2F	82.5F	78.4F	1.0	99.6F	151.3F	132.5F		
15:21:00	23.0K	26.1K	25.4K	2586 F	2025 F	64.8F	28.95	0.1M	1498 F	1431 F	200.2F	129.6F	136.7F	9.9	38.1	-4.8M
500	0.0P	0.4P	6.0P	4.62P			98.3F	99.3F	82.7F	78.4F	1.0	99.3F	151.5F	132.4F		
15:23:00	23.1K	26.2K	23.6K	2584 F	2007 F	64.9F	28.95	0.1M	1498 F	1430 F	196.3F	129.8F	138.4F	10.0	38.0	-4.4M
500	0.0P	0.4P	6.0P	4.62P			98.5F	99.6F	82.6F	78.5F	1.0	99.2F	151.4F	132.3F		
15:25:00	23.1K	26.2K	24.0K	2592 F	2003 F	64.9F	28.95	0.1M	1496 F	1427 F	197.2F	130.2F	144.7F	9.6	38.5	-4.4M
500	0.0P	0.4P	5.8P	4.62P			98.7F	99.9F	82.3F	78.4F	1.0	99.3F	148.7F	132.5F		
15:27:00	23.1K	26.3K	24.1K	2508 F	2016 F	64.8F	28.95	0.1M	1496 F	1429 F	201.1F	130.5F	150.0F	9.5	38.1	-4.9M
500	0.0P	0.4P	6.2P	4.64P			99.1F	100.5F	82.7F	78.4F	1.0	99.6F	149.3F	132.7F		
15:29:00	23.2K	26.3K	24.4K	1814 F	1819 F	64.7F	28.95	0.1M	1348 F	1316 F	183.4F	126.4F	162.4F	9.7	36.8	-5.0M
500	0.0P	0.4P	6.3P	0.74P			99.6F	101.1F	82.2F	78.2F	1.0	100.0F	142.3F	127.0F		
15:31:00	23.2K	26.3K	24.4K	2408 F	1944 F	64.7F	28.95	0.2M	1457 F	1391 F	161.2F	127.9F	166.0F	10.2	37.8	-5.0M
500	0.0P	0.4P	6.8P	4.04P			100.1F	102.1F	82.1F	78.2F	1.0	100.6F	144.3F	128.7F		
15:33:00	23.3K	26.3K	24.4K	2608 F	1985 F	64.7F	28.95	0.2M	1481 F	1415 F	187.3F	130.2F	169.7F	9.3	37.0	-4.8M
500	0.0P	0.4P	6.5P	4.88P			100.9F	102.8F	82.9F	78.4F	1.0	101.3F	148.3F	132.3F		
15:35:00	23.3K	26.3K	24.9K	2572 F	1974 F	64.7F	28.95	0.1M	1489 F	1424 F	162.6F	130.9F	172.4F	9.0	36.6	-4.7M
500	0.0P	0.4P	6.4P	4.90P			101.6F	103.4F	82.7F	78.1F	1.0	101.9F	149.1F	133.2F		
15:37:00	23.6K	26.3K	24.5K	2623 F	1990 F	64.8F	28.95	0.1M	1493 F	1431 F	193.3F	131.7F	174.9F	9.0	36.8	-4.8M
500	0.0P	0.4P	6.1P	4.94P			102.1F	103.9F	82.6F	78.1F	1.0	102.6F	149.6F	133.8F		
15:39:00	23.6K	26.3K	25.0K	2621 F	1999 F	65.0F	28.95	0.1M	1499 F	1436 F	195.2F	132.3F	176.7F	9.1	36.6	-4.6M
500	0.0P	0.4P	6.7P	5.00P			102.7F	104.5F	82.0F	78.3F	1.0	103.2F	150.0F	134.2F		

2 5	MRC-NOVHD	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KV AB	KV BC	KV CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR ANB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	02	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
15:41:00	23.6K	26.3K	25.3K	2642 F	2013 F	64.9F	28.95	0.1M	1498 F	1434 F	184.8F	132.9F	178.3F	8.9	36.7	-4.6M
500	0.0P	0.4P	6.9P	4.98P			103.5F	105.2F	82.7F	78.5F	1.0	103.8F	150.1F	134.7F		
15:43:00	23.6K	26.2K	25.4K	2617 F	2007 F	64.9F	28.95	0.1M	1496 F	1433 F	167.3F	133.3F	179.4F	9.3	36.8	-4.8M
500	0.0P	0.4P	7.1P	4.96P			103.8F	105.6F	82.6F	78.3F	1.0	104.2F	150.1F	134.8F		
15:45:00	23.6K	26.2K	25.2K	2629 F	2018 F	64.9F	28.95	0.2M	1498 F	1436 F	197.6F	133.9F	180.5F	8.6	36.1	-4.2M
500	0.0P	0.4P	7.0P	5.00P			104.3F	106.4F	82.3F	78.2F	1.0	104.8F	150.3F	135.0F		
15:47:00	23.6K	26.3K	25.3K	2616 F	2016 F	64.8F	28.95	0.1M	1500 F	1436 F	182.6F	134.2F	181.4F	8.5	36.2	-4.4M
500	0.0P	0.4P	7.0P	4.96P			104.0F	106.5F	82.3F	78.2F	1.0	105.2F	150.2F	135.3F		
15:49:00	23.5K	26.3K	25.2K	2636 F	2003 F	64.8F	28.95	0.1M	1499 F	1435 F	187.5F	134.6F	182.3F	8.6	36.4	-4.6M
500	0.0P	0.4P	7.2P	5.00P			105.3F	107.0F	82.4F	78.3F	1.0	105.8F	150.6F	135.6F		
15:51:00	23.4K	26.3K	25.2K	2638 F	2007 F	65.2F	28.95	0.1M	1500 F	1437 F	187.9F	135.1F	183.1F	8.6	36.5	-4.5M
500	0.0P	0.4P	6.8P	5.00P			106.1F	108.1F	82.6F	78.4F	1.0	106.4F	150.7F	135.9F		
15:53:00	23.5K	26.3K	25.1K	2607 F	2003 F	65.2F	28.95	0.0M	1500 F	1436 F	193.4F	135.6F	183.9F	8.6	36.2	-4.2M
500	0.0P	0.4P	7.3P	5.00P			106.7F	108.5F	82.9F	78.6F	1.0	107.2F	151.0F	136.2F		
15:55:00	23.4K	26.3K	24.9K	2581 F	2009 F	65.0F	28.95	0.1M	1499 F	1434 F	195.6F	135.9F	184.4F	8.8	36.3	-4.1M
500	0.0P	0.4P	7.3P	4.96P			107.1F	109.0F	81.9F	78.6F	1.0	107.3F	151.0F	136.3F		
15:57:00	23.5K	26.2K	25.2K	2672 F	2004 F	64.8F	28.95	0.1M	1500 F	1438 F	200.1F	136.0F	184.8F	8.9	36.2	-4.3M
500	0.0P	0.4P	7.7P	5.00P			107.6F	109.4F	82.7F	78.5F	1.0	107.9F	150.8F	136.6F		
15:59:00	23.4K	26.3K	25.3K	2675 F	2012 F	65.1F	28.95	0.0M	1501 F	1438 F	188.6F	136.4F	185.4F	8.5	36.1	-4.2M
500	0.0P	0.4P	7.6P	5.04P			108.2F	110.0F	82.9F	78.7F	1.0	108.5F	150.9F	136.9F		
16:01:00	23.4K	26.2K	25.4K	2614 F	2016 F	65.2F	28.95	0.1M	1499 F	1434 F	178.4F	136.7F	185.7F	9.0	36.5	-4.3M
500	0.0P	0.4P	7.9P	5.04P			108.6F	110.5F	82.8F	78.4F	1.0	109.1F	150.8F	137.1F		
16:03:00	23.5K	26.2K	25.4K	2655 F	2006 F	65.0F	28.95	0.1M	1502 F	1435 F	190.0F	136.9F	186.1F	8.3	36.5	-4.5M
500	0.0P	0.4P	7.9P	5.04P			108.9F	110.7F	82.5F	78.4F	1.0	109.5F	151.4F	137.3F		
16:05:00	23.4K	26.2K	25.4K	2635 F	2021 F	64.9F	28.95	0.1M	1500 F	1433 F	190.9F	137.0F	186.3F	8.5	36.0	-4.8M
500	0.0P	0.4P	8.0P	5.02P			109.2F	111.0F	82.8F	78.5F	1.0	109.6F	151.3F	137.4F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR	DRM	OFGS T1	OFGS T2	OLUG DT	MST DT	EXH DT	OLUG P	VNTR DP	AIR AMB
300																	
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	OLG RTN	VNT RTN			
600																	
16:07:00	23.5K	26.2K	25.4K	2623 F	2018 F	65.0F	28.95	0.2M	1503 F	1439 F	169.2F	137.2F	186.7F	0.3	36.2	-4.7M	
500	0.0P	0.4P	7.8P	5.04P			109.6F	111.5F	82.7F	78.4F	1.0	110.0F	151.3F	137.5F			
16:09:00	23.4K	26.2K	25.5K	2642 F	2019 F	65.2F	28.95	0.2M	1502 F	1437 F	186.8F	137.5F	187.1F	0.6	36.4	-4.4M	
500	0.0P	0.4P	8.1P	5.00P			110.1F	112.1F	82.9F	78.5F	1.0	110.6F	151.2F	137.7F			
16:11:00	23.4K	26.2K	25.4K	2650 F	2013 F	65.1F	28.95	0.2M	1501 F	1437 F	172.9F	137.7F	187.3F	0.1	36.3	-4.7M	
500	0.0P	0.4P	8.5P	5.02P			110.5F	112.4F	82.9F	78.3F	1.0	110.9F	151.4F	138.0F			
16:13:00	23.5K	26.2K	25.5K	2644 F	2025 F	65.0F	28.95	0.1M	1502 F	1434 F	195.5F	137.7F	187.5F	7.9	36.4	-5.1M	
500	0.0P	0.4P	8.3P	5.04P			110.8F	112.6F	82.6F	78.2F	1.0	111.4F	151.2F	138.1F			
16:15:00	23.4K	26.2K	25.5K	2637 F	2033 F	65.4F	28.95	0.1M	1502 F	1435 F	189.9F	138.1F	187.8F	8.2	36.2	-4.7M	
500	0.0P	0.4P	8.9P	5.02P			111.3F	113.2F	82.0F	78.3F	1.0	111.7F	151.7F	138.3F			
16:17:00	23.5K	26.2K	25.7K	2652 F	2020 F	65.1F	28.95	0.2M	1500 F	1439 F	196.8F	138.2F	187.9F	8.1	36.5	-5.3M	
500	0.0P	0.4P	9.2P	5.04P			111.4F	113.1F	82.6F	78.4F	1.0	111.9F	151.7F	138.5F			
16:19:00	23.5K	26.2K	25.7K	2638 F	2017 F	65.2F	28.95	0.2M	1503 F	1436 F	196.5F	138.4F	188.1F	8.6	36.2	-5.6M	
500	0.0P	0.4P	8.6P	5.08P			111.5F	113.4F	82.0F	78.4F	1.0	112.2F	151.4F	138.6F			
16:21:00	23.4K	26.2K	25.7K	2651 F	2027 F	65.4F	28.95	0.1M	1502 F	1437 F	192.7F	138.7F	188.5F	8.3	36.3	-5.5M	
500	0.0P	0.4P	8.6P	5.04P			112.0F	113.9F	82.5F	78.3F	1.0	112.5F	152.0F	138.8F			
16:23:00	23.4K	26.2K	25.7K	2655 F	2022 F	65.0F	28.95	0.1M	1500 F	1435 F	186.1F	138.7F	188.6F	8.6	36.3	-5.2M	
500	0.0P	0.4P	8.9P	5.06P			112.1F	114.0F	82.5F	78.3F	1.0	112.6F	151.7F	138.8F			
16:25:00	23.4K	26.2K	25.7K	2648 F	2033 F	65.1F	28.95	0.0M	1501 F	1435 F	174.4F	138.9F	188.8F	8.2	36.4	-5.5M	
500	0.0P	0.4P	9.3P	5.02P			112.6F	114.3F	82.6F	78.3F	1.0	112.9F	151.8F	138.9F			
16:27:00	23.4K	26.2K	25.7K	2656 F	2016 F	65.2F	28.95	0.2M	1499 F	1436 F	194.2F	139.0F	189.0F	7.6	36.5	-5.7M	
500	0.0P	0.4P	9.7P	5.02P			112.7F	114.6F	82.2F	78.0F	1.0	113.2F	151.5F	139.0F			
16:29:00	23.4K	26.2K	25.8K	2652 F	2010 F	65.0F	28.95	0.1M	1500 F	1435 F	180.9F	139.1F	189.2F	8.4	36.2	-5.6M	
500	0.0P	0.4P	9.6P	5.00P			112.9F	114.9F	82.3F	78.3F	1.0	113.5F	151.8F	139.1F			
16:31:00	23.4K	26.2K	25.8K	2640 F	2022 F	64.8F	28.95	0.1M	1496 F	1432 F	196.4F	139.1F	189.3F	8.2	36.2	-5.9M	
500	0.0P	0.4P	9.7P	5.00P			113.0F	115.0F	82.7F	78.0F	1.0	113.6F	151.8F	139.1F			

2 S	MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR															
0024	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	D2	COMBUS	CO	CO2	NOX			HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB LT	DLG RTN	VNT RTN	
600																
16:33:00	23.4K	26.2K	25.8K	2632 F	2016 F	64.9F	28.95	0.1M	1499 F	1436 F	169.7F	139.3F	189.6F	0.4	36.6	-5.6M
500	0.0P	0.4P	9.9P	5.02P			113.4F	115.3F	82.5F	78.3F	1.0	113.8F	151.7F	139.3F		
16:35:00	23.5K	26.3K	25.8K	1790 F	1936 F	65.2F	28.95	0.1M	1353 F	1318 F	145.9F	133.5F	179.1F	9.2	13.1	-6.1M
500	0.0P	0.4P	8.9P	0.62P			113.5F	113.8F	82.2F	78.4F	1.0	113.9F	143.0F	128.4F		
16:37:00	23.6K	26.4K	25.8K	1773 F	1938 F	65.4F	28.95	0.1M	1338 F	1299 F	139.8F	131.9F	170.2F	8.6	11.3	-5.8M
500	0.0P	0.4P	8.7P	0.64P			113.3F	112.9F	82.1F	78.1F	1.0	114.0F	139.9F	125.6F		
16:39:00	23.7K	26.5K	25.8K	1752 F	1930 F	65.1F	28.95	0.2M	1323 F	1283 F	134.6F	131.0F	165.6F	9.1	11.1	-5.9M
500	0.0P	0.4P	8.5P	0.64P			113.5F	112.6F	81.1F	77.9F	1.0	114.1F	139.0F	124.6F		
16:41:00	23.9K	26.6K	25.8K	1735 F	1912 F	64.3F	28.95	0.1M	1313 F	1277 F	133.7F	130.4F	162.0F	8.8	11.1	-6.7M
500	0.0P	0.4P	9.2P	0.62P			113.1F	113.2F	81.7F	77.6F	1.0	114.1F	138.7F	123.9F		
16:43:00	24.1K	26.7K	25.9K	1714 F	1903 F	63.6F	28.95	0.1M	1313 F	1270 F	133.2F	129.9F	159.2F	8.9	10.9	-6.2M
500	0.0P	0.4P	9.0P	0.60P			113.4F	113.5F	81.4F	77.6F	1.0	114.0F	138.2F	123.6F		
16:45:00	24.1K	26.7K	25.8K	1703 F	1888 F	63.0F	28.95	0.0M	1305 F	1265 F	133.3F	130.0F	157.1F	8.8	11.0	-6.7M
500	0.0P	0.4P	9.0P	0.58P			113.3F	113.4F	81.3F	77.4F	1.0	114.1F	137.0F	123.6F		
16:47:00	24.3K	26.7K	25.9K	1688 F	1888 F	62.4F	28.95	0.0M	1304 F	1262 F	133.1F	129.8F	155.1F	9.0	11.0	-6.8M
500	0.0P	0.4P	8.9P	0.56P			112.9F	113.1F	81.2F	77.2F	1.0	113.9F	136.7F	123.4F		
16:49:00	24.5K	26.8K	25.9K	1679 F	1874 F	61.7F	28.95	0.1M	1299 F	1256 F	132.9F	129.5F	153.5F	8.9	10.9	-6.3M
500	0.0P	0.4P	9.3P	0.58P			112.5F	112.7F	81.1F	77.0F	1.0	113.6F	136.5F	123.1F		
16:51:00	24.5K	26.8K	26.0K	1670 F	1863 F	61.4F	28.95	0.0M	1296 F	1256 F	132.6F	129.2F	152.2F	8.9	11.0	-6.7M
500	0.0P	0.4P	8.2P	-0.02P			112.0F	112.1F	80.6F	76.7F	1.0	113.1F	136.0F	122.7F		
16:53:00	24.6K	26.9K	26.1K	1660 F	1851 F	60.8F	28.95	0.0M	1290 F	1252 F	131.6F	128.6F	151.1F	9.0	10.9	-6.7M
500	0.0P	0.4P	7.9P	0.00P			111.7F	111.7F	81.1F	76.7F	1.0	112.7F	136.2F	122.0F		
16:55:00	24.7K	27.0K	26.1K	1653 F	1851 F	60.4F	28.95	0.0M	1289 F	1252 F	130.8F	128.2F	149.9F	9.0	10.9	-6.8M
500	0.0P	0.4P	7.4P	0.00P			111.3F	111.8F	80.6F	76.9F	1.0	112.3F	136.1F	121.6F		
16:57:00	24.8K	27.1K	26.2K	1307 F	1987 F	62.2F	28.95	0.0M	1262 F	1179 F	126.0F	128.1F	146.7F	0.4	0.1	-6.6M
500	0.0P	0.4P	7.9P	-0.04P			110.7F	111.1F	60.9F	76.9F	1.0	111.9F	126.2F	115.0F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0024																
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
17:01:17	24.7K	26.2K	~~25.0K~~	~~2146 F~~	2120 F	72.7F	28.95	1.8M	1036 F	1016 F	119.7F	131.8F	134.9F	-0.1	-0.4	-6.3M
500	0.0P	0.4P	7.3P	-0.04P			102.3F	97.4F	78.1F	75.7F	1.0	101.9F	112.4F	112.2F		
17:03:11	24.7K	26.3K	~~25.0K~~	2166 F	2149 F	75.0F	28.95	2.4M	1006 F	996 F	116.0F	132.9F	131.7F	-0.1	-0.4	-6.7M
500	0.0P	0.4P	105.2P	4.86P			98.7F	94.1F	78.0F	75.5F	1.0	97.8F	109.0F	111.2F		

~~ZERO CALIBRATION~~

SPAN GAS CALIBRATION

JAN 29, 1985 Waste type C

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0024																
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
10:25:35	27.1K	25.8K	24.4K	1608 F	1814 F	63.7F	28.95	3.5M	1214 F	1153 F	103.5F	103.7F	81.6F	12.8	41.0	58.8M
500	-6.3P	-1.3P	1.9P	0.32P			48.8F	48.0F	76.6F	71.6F	1.0	49.9F	90.5F	67.7F		

2 5	MRC-MOUND		DEVELOPMENTAL WASTE PROCESSING SYSTEMS				GLASS FURNACE AND CYCLONE INCINERATOR								
0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
10:26:00	27.1K	25.8K	24.5K	1573 F	1779 F	61.1F	28.95	3.2M	1212 F	1159 F	104.2F	101.1F	87.3F	11.9	41.7	59.0M
500	-6.3P	-1.3P	2.0P	0.34P			49.0F	47.7F	76.3F	71.6F	1.0	49.4F	96.0F	70.6F		
10:28:00	26.6K	25.8K	24.5K	2587 F	1942 F	58.4F	28.95	1.9M	1431 F	1343 F	130.5F	101.6F	106.2F	11.3	43.1	59.1M
500	-6.3P	-1.3P	2.0P	0.32P			50.5F	49.3F	76.1F	71.5F	1.0	50.5F	133.7F	90.9F		
10:30:00	25.5K	26.1K	24.5K	2394 F	1891 F	59.3F	28.95	1.3M	1430 F	1358 F	159.1F	103.4F	118.3F	10.2	43.2	59.0M
500	-6.3P	-1.3P	2.0P	0.14P			52.0F	51.2F	76.0F	71.9F	1.0	52.0F	139.0F	90.5F		
10:32:00	25.6K	26.2K	24.6K	2291 F	1866 F	59.8F	28.95	1.0M	1427 F	1363 F	135.1F	104.6F	126.0F	0.2	43.0	60.4M
500	-6.3P	-1.3P	2.0P	0.02P			53.5F	52.9F	76.9F	71.9F	1.0	53.4F	141.3F	102.8F		
10:34:00	25.5K	26.3K	24.6K	2556 F	1893 F	60.2F	28.95	0.9M	1451 F	1384 F	136.9F	106.0F	132.3F	0.0	43.4	60.7M
500	-6.3P	-1.3P	1.9P	0.02P			55.1F	54.7F	76.6F	72.0F	1.0	54.8F	143.8F	106.5F		
10:36:00	25.5K	26.3K	24.7K	2500 F	1876 F	61.7F	28.95	0.6M	1446 F	1391 F	138.5F	107.1F	137.7F	0.0	43.3	61.4M
500	-6.3P	-1.3P	1.8P	0.02P			56.6F	56.6F	77.3F	72.2F	1.0	56.3F	144.0F	108.5F		
10:38:00	25.5K	26.4K	24.8K	2393 F	1869 F	62.4F	28.95	0.7M	1438 F	1376 F	137.0F	107.7F	142.1F	0.4	43.0	61.6M
500	-6.3P	-1.3P	1.6P	0.02P			58.5F	58.7F	77.6F	72.5F	1.0	58.1F	144.5F	109.4F		
10:40:00	25.4K	26.2K	24.7K	2182 F	1829 F	62.9F	28.95	0.6M	1417 F	1359 F	137.8F	107.8F	146.9F	0.6	42.7	62.2M
500	-6.3P	-1.3P	1.6P	0.02P			60.6F	61.1F	77.5F	72.5F	1.0	60.0F	144.2F	109.0F		
10:42:00	25.4K	26.3K	24.8K	2462 F	1830 F	63.6F	28.95	0.5M	1433 F	1374 F	139.7F	108.8F	149.2F	0.1	42.6	62.1M
500	-6.3P	-1.3P	1.6P	0.02P			62.8F	63.7F	77.6F	72.6F	1.0	62.1F	144.6F	109.6F		
10:44:00	25.3K	26.3K	24.9K	2566 F	1849 F	64.3F	28.95	0.5M	1440 F	1378 F	142.0F	110.5F	151.8F	0.5	42.5	62.0M
500	-6.3P	-1.3P	10.7P	2.18P			65.4F	66.3F	77.5F	72.9F	1.0	64.5F	146.2F	112.5F		
10:46:00	25.5K	26.3K	25.0K	2434 F	1837 F	64.0F	28.95	0.5M	1430 F	1371 F	143.9F	111.5F	154.4F	0.4	42.1	61.6M
500	-6.3P	-1.3P	7.5P	0.24P			67.9F	69.0F	78.0F	72.8F	1.0	66.9F	146.0F	113.6F		
10:48:00	25.5K	26.5K	25.1K	2379 F	1837 F	64.5F	28.95	0.5M	1427 F	1366 F	145.5F	112.7F	156.6F	9.1	42.1	61.0M
500	-6.3P	-1.3P	93.8P	3.86P			70.5F	71.4F	77.8F	72.6F	1.0	69.3F	146.1F	114.7F		
10:48:33	25.5K	26.4K	25.1K	2282 F	1836 F	64.6F	28.95	0.4M	1428 F	1368 F	149.9F	113.1F	157.2F	0.6	42.0	61.0M
500	-6.3P	-1.3P	94.0P	4.90P			71.4F	72.6F	77.8F	72.8F	1.0	70.2F	146.4F	115.0F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
	--GLASS FURNACE POWER---							GAS PARAMETERS								
	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR	ORM	OFGS T1	OFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB
	GAS PARAMETERS CONT							LIQUID PARAMETERS								
	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
10:50:00	25.5K	26.5K	25.2K	2303 F	1825 F	63.1F	28.95	0.4M	1418 F	1360 F	189.1F	113.6F	158.6F	7.5	41.6	60.4M
500	0.0P	0.5P	4.0P	3.16P			70.1F	72.8F	78.3F	73.0F	1.0	72.1F	145.5F	115.6F		
10:52:00	25.5K	26.6K	25.3K	2220 F	1801 F	65.9F	28.95	0.4M	1410 F	1354 F	150.6F	113.4F	160.3F	8.0	41.4	60.1M
500	0.0P	0.3P	4.6P	3.00P			72.2F	73.0F	78.0F	73.2F	1.0	71.2F	145.9F	115.2F		
10:54:00	25.5K	26.6K	25.5K	2610 F	1870 F	66.2F	28.95	0.4M	1447 F	1383 F	147.2F	116.0F	162.0F	7.9	41.6	59.2M
500	0.0P	0.3P	4.3P	4.40P			71.6F	74.4F	77.9F	73.2F	1.0	72.8F	148.1F	118.4F		
10:56:00	25.5K	26.6K	25.5K	2586 F	1857 F	65.9F	28.95	0.3M	1444 F	1383 F	189.4F	116.0F	163.5F	7.2	41.5	58.0M
500	0.0P	0.3P	3.7P	4.06P			71.1F	74.7F	78.4F	73.3F	1.0	72.4F	147.9F	118.2F		
10:58:00	25.4K	26.6K	25.6K	2693 F	1878 F	65.9F	28.95	0.4M	1463 F	1395 F	188.8F	116.1F	164.6F	7.5	41.4	57.2M
500	0.0P	0.3P	3.4P	3.88P			71.3F	75.0F	78.2F	73.1F	1.0	72.4F	148.3F	118.0F		
11:00:00	25.4K	26.6K	25.7K	2676 F	1881 F	66.0F	28.95	0.4M	1460 F	1394 F	172.5F	116.9F	165.8F	7.2	40.8	56.3M
500	0.0P	0.3P	-1.4P	-0.18P			71.8F	75.6F	78.0F	72.9F	1.0	72.8F	148.9F	119.1F		
11:02:00	25.4K	26.6K	25.7K	2638 F	1876 F	65.8F	28.95	0.3M	1457 F	1393 F	157.5F	116.9F	166.8F	6.9	40.2	55.5M
500	0.0P	0.3P	2.5P	4.26P			72.7F	76.6F	77.7F	72.8F	1.0	73.5F	148.8F	119.0F		
11:04:00	25.4K	26.7K	25.8K	2557 F	1868 F	65.4F	28.95	0.3M	1449 F	1387 F	160.0F	117.0F	167.7F	7.4	40.1	54.5M
500	0.0P	0.3P	3.2P	4.16P			73.7F	77.7F	78.0F	72.7F	1.0	74.4F	148.2F	119.0F		
11:06:00	25.4K	26.7K	25.8K	2566 F	1859 F	65.5F	28.95	0.4M	1446 F	1383 F	193.9F	117.4F	168.5F	6.8	41.1	53.5M
500	0.0P	0.4P	2.8P	3.94P			75.1F	79.0F	77.9F	72.9F	1.0	75.6F	148.5F	119.4F		
11:08:00	25.4K	26.7K	25.8K	2626 F	1860 F	65.8F	28.95	0.4M	1446 F	1384 F	193.4F	118.1F	169.2F	7.0	40.5	52.7M
500	0.0P	0.4P	2.8P	4.08P			76.5F	80.4F	77.4F	72.8F	1.0	76.9F	148.3F	120.2F		
11:10:00	25.4K	26.8K	25.8K	2614 F	1865 F	66.0F	28.95	0.4M	1450 F	1386 F	188.1F	118.7F	170.0F	7.1	40.5	51.3M
500	0.0P	0.4P	2.6P	4.16P			78.1F	82.0F	78.0F	72.9F	1.0	78.3F	148.5F	120.7F		
11:12:00	25.4K	26.8K	25.9K	2563 F	1855 F	66.1F	28.95	0.6M	1443 F	1380 F	183.2F	119.3F	170.6F	7.3	40.0	50.7M
500	0.0P	0.4P	2.8P	4.02P			79.7F	83.2F	77.8F	72.8F	1.0	79.7F	148.4F	121.1F		
11:14:00	25.4K	26.9K	25.8K	2473 F	1861 F	66.3F	28.95	0.6M	1445 F	1391 F	195.9F	120.2F	171.5F	7.5	39.9	49.5M
500	0.0P	0.4P	3.0P	4.04P			82.0F	85.2F	78.4F	73.2F	1.0	81.8F	148.8F	122.1F		

2 5	MRC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	02	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
11:16:00	25.5K	26.9K	25.9K	2589 F	1862 F	66.9F	28.95	0.4M	1446 F	1385 F	182.0F	121.1F	172.1F	7.2	39.9	49.1M
500	0.0P	0.4P	2.7P	4.22P			84.0F	87.4F	78.0F	73.4F	1.0	83.5F	149.2F	122.8F		
11:18:00	25.4K	26.9K	25.9K	2534 F	1871 F	66.9F	28.95	0.2M	1446 F	1383 F	192.5F	122.4F	172.6F	7.6	39.8	47.7M
500	0.0P	0.4P	3.2P	4.24P			86.9F	89.7F	78.3F	73.3F	1.0	85.9F	149.1F	124.3F		
11:20:00	25.4K	26.9K	25.9K	2514 F	1863 F	66.9F	28.95	0.3M	1448 F	1386 F	198.5F	124.0F	173.3F	6.7	39.5	46.6M
500	0.0P	0.4P	3.2P	4.22P			89.4F	92.4F	78.7F	73.3F	1.0	88.5F	149.2F	125.9F		
11:22:00	25.5K	26.9K	26.0K	2657 F	1859 F	66.1F	28.95	0.5M	1448 F	1384 F	198.9F	125.3F	174.0F	6.9	39.6	46.0M
500	0.0P	0.4P	2.8P	4.24P			91.6F	94.2F	78.7F	73.4F	1.0	90.9F	149.9F	127.2F		
11:24:00	25.4K	27.0K	25.9K	2372 F	1839 F	66.3F	28.95	0.5M	1434 F	1373 F	190.3F	126.1F	174.4F	6.8	39.7	44.9M
500	0.0P	0.4P	2.9P	3.86P			93.4F	94.9F	78.3F	73.3F	1.0	92.7F	145.6F	127.8F		
11:26:00	25.4K	27.1K	25.8K	2361 F	1839 F	65.8F	28.95	0.5M	1436 F	1377 F	155.0F	127.1F	175.0F	6.1	39.2	44.3M
500	0.0P	0.4P	3.0P	3.88P			94.8F	96.2F	78.0F	73.3F	1.0	94.3F	145.4F	128.7F		
11:28:00	25.4K	27.1K	25.9K	2548 F	1884 F	65.7F	28.95	0.4M	1448 F	1387 F	196.6F	128.6F	175.7F	6.9	39.1	43.2M
500	0.0P	0.4P	3.9P	4.40P			96.0F	97.7F	78.4F	73.4F	1.0	95.8F	149.4F	130.1F		
11:30:00	25.3K	27.1K	25.9K	2657 F	1885 F	65.7F	28.95	0.4M	1450 F	1391 F	187.5F	129.5F	176.3F	6.5	38.8	42.7M
500	0.0P	0.4P	4.5P	4.70P			97.5F	98.7F	77.9F	73.2F	1.0	97.0F	151.0F	130.9F		
11:32:00	25.4K	27.2K	25.9K	2633 F	1893 F	66.0F	28.95	0.5M	1461 F	1393 F	199.3F	130.2F	176.8F	6.5	38.9	41.7M
500	0.0P	0.4P	4.3P	4.68P			98.9F	99.9F	78.6F	73.6F	1.0	98.4F	151.2F	131.0F		
11:34:00	25.4K	27.2K	26.0K	2623 F	1887 F	65.9F	28.95	0.5M	1458 F	1393 F	195.6F	130.9F	177.3F	6.6	39.1	41.1M
500	0.0P	0.4P	4.2P	4.68P			99.8F	100.9F	78.1F	73.6F	1.0	99.6F	151.3F	132.3F		
11:36:00	25.4K	27.2K	25.9K	2603 F	1883 F	65.5F	28.95	0.5M	1460 F	1393 F	201.4F	131.5F	177.8F	6.2	38.9	40.3M
500	0.0P	0.4P	3.8P	4.66P			100.6F	101.5F	78.1F	73.7F	1.0	100.5F	151.4F	132.7F		
11:38:00	25.4K	27.1K	25.9K	2614 F	1886 F	65.2F	28.95	0.4M	1451 F	1386 F	196.6F	131.6F	178.3F	6.0	38.8	39.6M
500	0.0P	0.4P	3.9P	4.38P			101.3F	102.0F	78.3F	73.6F	1.0	101.3F	151.2F	132.8F		
11:40:00	25.4K	27.1K	25.9K	2629 F	1879 F	64.9F	28.95	0.5M	1452 F	1391 F	201.2F	132.2F	178.8F	6.2	38.9	38.8M
500	0.0P	0.4P	3.8P	4.56P			102.4F	102.9F	77.9F	73.4F	1.0	102.1F	151.4F	133.3F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KV AB	KV BC	KV CD	CHBR T1	CHBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	----------GAS PARAMETERS CONT--------							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
600																
11:42:00	25.4K	27.1K	25.9K	2218 F	1856 F	64.8F		28.95	0.6M	1441 F	1379 F	199.8F	132.2F	179.2F	6.5	37.8	38.5M
500	0.0P	0.4P	4.2P	4.22P				102.8F	103.6F	78.1F	73.5F	1.0	102.8F	151.2F	133.3F		
11:44:00	25.4K	27.1K	26.0K	2574 F	1797 F	65.1F		28.95	0.7M	1417 F	1359 F	176.3F	127.9F	179.5F	7.2	38.7	37.6M
500	0.0P	0.4P.	7.1P	0.06P				103.4F	104.4F	77.8F	73.3F	1.0	103.4F	145.2F	126.5F		
11:46:00	25.4K	27.1K	26.1K	2726 F	1882 F	65.6F		28.95	0.5M	1452 F	1384 F	198.0F	133.3F	180.3F	6.1	39.1	36.9M
500	0.0P	0.4P	7.2P	5.08P				104.4F	105.3F	77.9F	73.6F	1.0	104.3F	151.7F	134.1F		
11:48:00	25.3K	27.0K	26.2K	2643 F	1894 F	66.4F		28.95	0.5M	1462 F	1398 F	198.5F	134.1F	180.8F	5.4	38.5	36.4M
500	0.0P	0.4P	6.3P	4.86P				105.4F	106.8F	78.4F	73.6F	1.0	105.1F	152.1F	135.1F		
11:50:00	25.3K	27.0K	26.2K	2696 F	1891 F	66.9F		28.95	0.5M	1462 F	1399 F	198.1F	134.5F	181.2F	6.1	39.1	35.6M
500	0.0P	0.4P	5.5P	4.76P				105.9F	107.5F	78.2F	73.6F	1.0	106.0F	152.3F	135.6F		
11:52:00	25.4K	26.9K	26.3K	2676 F	1880 F	67.1F		28.95	0.6M	1460 F	1399 F	200.8F	134.9F	181.7F	6.1	38.9	34.9M
500	0.0P	0.4P	5.7P	4.60P				106.6F	108.4F	78.5F	73.5F	1.0	106.7F	152.5F	135.8F		
11:54:00	25.4K	26.9K	26.3K	2719 F	1886 F	66.8F		28.95	0.6M	1458 F	1397 F	201.2F	135.1F	182.1F	6.2	38.7	34.3M
500	0.0P	0.4P	5.2P	4.60P				107.0F	108.6F	78.5F	73.5F	1.0	107.2F	152.6F	136.0F		
11:56:00	25.3K	26.9K	26.3K	2565 F	1885 F	66.4F		28.95	0.6M	1452 F	1392 F	197.7F	135.3F	182.5F	5.5	38.6	33.8M
500	0.0P	0.4P	5.5P	4.46P				107.7F	109.2F	78.4F	73.5F	1.0	107.7F	152.5F	136.1F		
11:58:00	25.2K	26.9K	26.3K	2649 F	1883 F	66.0F		28.95	0.5M	1456 F	1395 F	169.8F	135.5F	182.9F	5.6	38.6	33.0M
500	0.0P	0.4P	5.6P	4.42P				108.1F	110.0F	78.6F	73.2F	1.0	108.2F	152.5F	136.3F		
12:00:00	25.2K	26.8K	26.4K	2669 F	1873 F	63.6F		28.95	0.6M	1451 F	1390 F	199.7F	135.7F	183.4F	6.0	38.4	32.6M
500	0.0P	0.4P	6.4P	4.34P				108.6F	110.8F	78.2F	73.5F	1.0	108.6F	152.5F	136.4F		
12:02:00	25.2K	26.9K	26.3K	2673 F	1881 F	65.2F		28.95	0.6M	1451 F	1392 F	191.7F	135.9F	183.7F	6.6	39.4	31.8M
500	0.0P	0.4P	6.0P	4.38P				108.8F	110.9F	78.0F	73.4F	1.0	109.0F	152.5F	136.6F		
12:04:00	25.1K	26.9K	26.4K	2666 F	1886 F	65.3F		28.95	0.6M	1449 F	1389 F	199.8F	136.1F	184.0F	6.0	39.4	31.2M
500	0.0P	0.4P	6.2P	4.28P				109.3F	111.4F	78.3F	73.9F	1.0	109.4F	152.8F	136.8F		
12:06:00	25.2K	26.9K	26.4K	2654 F	1880 F	65.4F		28.95	0.6M	1450 F	1390 F	200.6F	136.2F	184.5F	5.7	39.2	30.4M
500	0.0P	0.4P	6.3P	4.20P				109.7F	111.8F	78.5F	73.7F	1.0	109.7F	152.7F	136.9F		

2 5	NRC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
12:08:00	25.2K	26.9K	26.4K	2607 F	1855 F	65.8F	28.95	0.6M	1447 F	1386 F	194.5F	136.2F	184.6F	5.7	38.8	29.9M
500	0.0P	0.4P	6.4P	4.12P			110.0F	112.2F	78.6F	73.6F	1.0	110.1F	152.5F	136.8F		
12:10:00	25.2K	26.9K	26.4K	2522 F	1854 F	66.4F	28.95	0.5M	1439 F	1381 F	198.9F	136.4F	185.0F	5.4	39.0	29.1M
500	0.0P	0.4P	6.4P	3.96P			110.4F	112.5F	78.5F	73.7F	1.0	110.6F	152.4F	136.8F		
12:12:00	25.3K	26.9K	26.4K	2580 F	1859 F	66.5F	28.95	0.5M	1433 F	1375 F	195.4F	136.3F	185.1F	5.7	38.8	28.5M
500	0.0P	0.4P	7.0P	3.90P			110.6F	112.9F	78.7F	73.5F	1.0	110.8F	152.3F	136.9F		
12:14:00	25.3K	27.1K	26.5K	2525 F	1834 F	66.2F	28.95	0.6M	1437 F	1378 F	198.2F	136.4F	185.4F	5.5	38.9	27.4M
500	0.0P	0.4P	7.0P	3.86P			110.9F	113.1F	78.4F	73.5F	1.0	111.0F	152.1F	136.8F		
12:16:00	25.4K	27.1K	26.5K	2582 F	1843 F	66.1F	28.95	0.6M	1433 F	1375 F	198.2F	136.6F	185.7F	5.8	39.2	26.7M
500	0.0P	0.4P	7.2P	3.92P			111.4F	113.5F	78.3F	73.5F	1.0	111.5F	152.1F	137.0F		
12:18:00	25.4K	27.1K	26.5K	2592 F	1843 F	66.2F	28.95	0.5M	1433 F	1373 F	197.7F	136.8F	186.0F	6.2	40.0	25.7M
500	0.0P	0.4P	8.3P	3.80P			111.6F	113.7F	78.7F	73.4F	1.0	111.8F	152.2F	137.1F		
12:20:00	25.4K	27.2K	26.6K	2575 F	1838 F	66.2F	28.95	0.4M	1434 F	1377 F	200.0F	136.9F	186.2F	6.1	41.2	25.0M
500	0.0P	0.4P	9.0P	3.82P			112.0F	114.0F	78.6F	73.6F	1.0	112.1F	152.3F	137.4F		
12:22:00	26.3K	26.9K	26.9K	2547 F	1839 F	66.1F	28.95	0.4M	1429 F	1371 F	193.3F	137.1F	186.2F	6.2	41.4	24.8M
500	0.0P	0.4P	9.3P	3.82P			112.3F	114.2F	78.7F	73.5F	1.0	112.4F	152.0F	137.5F		
12:24:00	26.2K	27.0K	26.9K	2676 F	1855 F	65.9F	28.95	0.4M	1440 F	1386 F	206.1F	137.9F	186.3F	6.1	41.4	23.9M
500	0.0P	0.4P	9.6P	4.60P			112.5F	114.4F	78.3F	73.5F	1.0	112.6F	153.1F	138.4F		
12:26:00	26.2K	26.9K	26.9K	2663 F	1868 F	65.6F	28.95	0.3M	1450 F	1391 F	204.5F	138.0F	186.3F	5.8	41.7	23.5M
500	0.0P	0.4P	9.5P	4.58P			112.6F	114.5F	78.6F	73.5F	1.0	112.8F	153.2F	138.6F		
12:28:00	26.2K	26.9K	26.9K	2587 F	1858 F	65.3F	28.95	0.4M	1450 F	1390 F	204.1F	138.1F	186.4F	5.9	41.3	22.5M
500	0.0P	0.4P	9.0P	4.52P			112.7F	114.7F	78.2F	73.7F	1.0	112.9F	153.2F	138.6F		
12:30:00	26.4K	26.9K	26.7K	2601 F	1865 F	65.6F	28.95	0.4M	1443 F	1387 F	200.3F	138.0F	186.5F	6.2	41.6	21.8M
500	0.0P	0.4P	9.4P	4.30P			112.8F	114.8F	78.0F	73.7F	1.0	113.0F	153.0F	138.5F		
12:32:00	26.2K	26.9K	26.9K	2646 F	1836 F	66.0F	28.95	0.4M	1439 F	1382 F	206.1F	138.0F	186.6F	6.4	41.1	21.4M
500	0.0P	0.4P	10.1P	4.12P			113.1F	115.0F	78.1F	73.5F	1.0	113.2F	152.8F	138.4F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	----------GAS PARAMETERS CONT--------							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
600																
12:34:00	26.1K	26.9K	27.0K	2515 F	1841 F	66.3F	28.95	0.4M	1433 F	1375 F	205.3F	137.8F	186.7F	6.4	41.4	20.6M
500	0.0P	0.4P	9.9P	3.88P			113.3F	115.2F	78.2F	73.3F	1.0	113.5F	152.5F	138.1F		
12:36:00	26.2K	26.9K	27.0K	2458 F	1815 F	65.8F	28.95	0.4M	1426 F	1368 F	196.8F	137.7F	186.7F	6.1	41.3	19.8M
500	0.0P	0.4P	10.3P	3.64P			113.4F	115.4F	78.3F	73.5F	1.0	113.6F	151.9F	137.9F		
12:38:00	26.3K	27.0K	27.1K	2621 F	1835 F	65.8F	28.95	0.3M	1447 F	1382 F	193.3F	138.3F	186.9F	6.5	41.3	19.3M
500	0.0P	0.4P	11.4P	4.20P			113.7F	115.8F	78.5F	73.5F	1.0	113.9F	152.8F	138.6F		
12:40:00	26.2K	27.1K	26.8K	2660 F	1865 F	66.1F	28.95	0.4M	1446 F	1385 F	202.2F	138.6F	186.8F	6.1	41.7	18.6M
500	0.0P	0.4P	4.3P	-0.36P			113.8F	115.9F	78.0F	73.6F	1.0	114.0F	153.1F	139.0F		
12:41:03	25.8K	26.9K	26.8K	2669 F	1844 F	66.3F	28.95	0.4M	1444 F	1384 F	204.2F	138.6F	186.8F	7.0	41.5	18.2M
500	0.0P	0.4P	-0.4P	-0.16P			114.0F	116.1F	78.9F	73.5F	1.0	114.3F	153.4F	139.0F		
12:42:00	26.4K	26.9K	26.8K	2554 F	1843 F	65.8F	28.95	0.3M	1442 F	1383 F	204.1F	138.7F	186.9F	6.9	40.9	17.8M
500	0.0P	0.4P	-0.7P	-0.16P			114.2F	116.5F	77.8F	73.7F	1.0	114.3F	153.0F	138.8F		
12:42:50	26.8K	27.1K	26.6K	2634 F	1851 F	66.4F	28.95	0.4M	1439 F	1383 F	205.5F	138.6F	187.0F	5.8	41.7	17.3M
500	0.0P	0.4P	97.3P	4.98P			114.5F	116.4F	77.8F	73.9F	1.0	114.6F	152.9F	138.9F		
12:44:00	25.7K	27.0K	27.0K	2599 F	1846 F	66.6F	28.95	0.5M	1435 F	1376 F	203.0F	138.4F	187.0F	5.7	41.4	17.2M
500	0.0P	0.4P	97.4P	5.02P			114.3F	116.4F	78.7F	73.8F	1.0	114.5F	152.7F	138.7F		
12:46:00	25.8K	27.0K	27.0K	2640 F	1835 F	66.2F	28.95	0.4M	1436 F	1378 F	203.8F	138.6F	186.9F	5.7	40.9	16.3M
500	0.0P	0.4P	6.8P	3.90P			114.1F	116.3F	78.3F	73.5F	1.0	114.3F	152.8F	138.8F		
12:48:00	25.7K	27.2K	27.1K	2677 F	1843 F	65.7F	28.95	0.3M	1433 F	1375 F	183.9F	138.7F	187.1F	6.8	42.8	15.7M
500	0.0P	0.4P	6.7P	4.10P			114.2F	115.4F	78.6F	73.8F	1.0	114.4F	152.9F	138.9F		
12:50:00	25.6K	27.7K	26.8K	2596 F	1832 F	65.8F	28.95	0.3M	1435 F	1378 F	200.2F	138.4F	187.4F	6.4	44.0	15.5M
500	0.0P	0.4P	7.1P	3.76P			114.3F	116.1F	78.6F	73.6F	1.0	114.7F	152.5F	138.6F		
12:52:00	26.2K	27.2K	26.9K	2608 F	1830 F	65.7F	28.95	0.3M	1443 F	1386 F	209.0F	140.5F	187.5F	10.6	35.7	14.8M
500	0.0P	0.4P	10.9P	3.42P			114.6F	116.2F	78.7F	73.7F	1.0	114.9F	152.9F	140.4F		
12:54:00	25.0K	27.3K	26.9K	2591 F	1837 F	65.6F	28.95	0.2M	1443 F	1386 F	192.4F	141.0F	187.7F	10.9	36.1	14.3M
500	0.0P	0.4P	10.6P	3.66P			114.5F	116.5F	78.3F	73.6F	1.0	115.0F	153.2F	140.8F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								/
200	KV AB	KV BC	KV CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR ANB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								/
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	OLG RTN	VNT RTN	
600																
12:56:00	25.7K	27.3K	26.9K	2483 F	1829 F	65.4F	28.95	0.1M	1438 F	1381 F	210.0F	140.9F	187.9F	10.1	36.5	13.7M
500	0.0P	0.4P	10.9P	3.66P			114.7F	116.7F	78.7F	73.7F	1.0	115.1F	152.9F	140.7F		
12:58:00	25.5K	27.4K	27.0K	2598 F	1821 F	65.7F	28.95	0.1M	1429 F	1376 F	206.5F	140.7F	188.0F	11.0	36.5	12.7M
500	0.0P	0.4P	11.4P	3.46P			114.9F	116.6F	78.3F	73.7F	1.0	115.3F	152.5F	140.6F		
13:00:00	25.5K	27.5K	26.9K	2535 F	1799 F	65.3F	28.95	0.1M	1422 F	1371 F	206.0F	140.7F	188.3F	10.4	35.8	12.6M
500	0.0P	0.4P	13.0P	3.30P			114.9F	116.8F	78.6F	73.0F	1.0	115.4F	152.2F	140.3F		
13:02:00	25.5K	27.1K	27.1K	2536 F	1788 F	65.0F	28.95	0.3M	1428 F	1375 F	201.7F	140.6F	188.5F	10.9	36.3	11.9M
500	0.0P	0.4P	13.6P	3.40P			114.9F	116.8F	78.5F	73.5F	1.0	115.3F	152.4F	140.4F		
13:04:00	24.8K	27.3K	26.9K	2531 F	1795 F	65.0F	28.95	0.2M	1423 F	1370 F	208.4F	140.6F	188.6F	11.3	36.5	11.3M
500	0.0P	0.4P	12.5P	3.38P			115.0F	117.2F	78.5F	73.9F	1.0	115.4F	152.2F	140.4F		
13:06:00	24.9K	27.3K	26.9K	2587 F	1775 F	64.9F	28.95	0.2M	1425 F	1371 F	198.2F	140.7F	188.8F	10.6	37.5	10.8M
500	0.0P	0.4P	13.9P	3.26P			115.3F	117.4F	78.6F	73.7F	1.0	115.5F	152.3F	140.3F		
13:08:00	24.9K	27.4K	27.0K	2538 F	1754 F	65.0F	28.95	0.1M	1420 F	1368 F	208.8F	140.7F	188.9F	10.3	36.8	10.5M
500	0.0P	0.4P	15.9P	3.34P			115.5F	117.7F	78.3F	73.5F	1.0	115.8F	152.3F	140.4F		
13:10:00	24.8K	27.4K	27.0K	2592 F	1761 F	65.5F	28.95	0.2M	1419 F	1368 F	207.7F	140.9F	189.1F	9.9	37.3	10.3M
500	0.0P	0.4P	16.5P	3.44P			115.8F	117.9F	78.4F	73.6F	1.0	116.0F	152.5F	140.6F		
13:12:00	24.8K	27.4K	27.0K	2515 F	1758 F	65.7F	28.95	0.2M	1414 F	1363 F	201.1F	140.8F	189.2F	9.7	37.1	9.7M
500	0.0P	0.4P	17.0P	3.32P			115.8F	117.9F	78.4F	73.7F	1.0	116.2F	152.0F	140.4F		
13:14:00	24.9K	27.5K	27.0K	2499 F	1738 F	66.2F	28.95	0.2M	1409 F	1360 F	200.4F	140.5F	189.2F	10.2	37.0	9.5M
500	0.0P	0.4P	19.3P	3.12P			116.0F	118.1F	78.5F	73.5F	1.0	116.2F	151.7F	140.0F		
13:16:00	24.9K	27.6K	27.1K	2543 F	1736 F	66.3F	28.95	0.1M	1416 F	1366 F	185.6F	140.9F	189.4F	10.2	36.7	9.0M
500	0.0P	0.4P	19.2P	3.36P			116.0F	118.3F	78.4F	73.6F	1.0	116.4F	152.0F	140.4F		
13:18:00	25.0K	27.6K	27.1K	2486 F	1729 F	66.0F	28.95	0.2M	1404 F	1353 F	202.6F	140.4F	189.5F	10.1	37.2	8.4M
500	0.0P	0.4P	20.2P	3.12P			116.1F	118.3F	78.5F	73.4F	1.0	116.4F	151.7F	140.0F		
13:20:00	24.9K	27.5K	27.1K	2551 F	1747 F	65.8F	28.95	0.0M	1418 F	1365 F	202.4F	141.1F	189.6F	9.6	37.2	7.9M
500	0.0P	0.4P	19.7P	3.50P			116.2F	118.4F	78.5F	73.3F	1.0	116.5F	152.1F	140.6F		

2 5 NRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0029																
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRN	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	D2	COMBUS	CO	CO2	HOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600	-t----------															
13:22:00	25.0K	27.5K	27.2K	2555 F	1736 F	65.7F	28.95	0.1M	1408 F	1359 F	182.1F	140.9F	189.7F	9.1	37.0	7.5M
500	0.0P	0.4P	19.9P	3.28P			116.2F	118.4F	78.0F	73.1F	1.0	116.5F	151.9F	140.3F		
13:24:00	25.0K	27.6K	27.2K	2523 F	1729 F	66.0F	28.95	0.2M	1406 F	1356 F	203.3F	140.6F	189.7F	9.7	37.2	7.2M
500	0.0P	0.4P	21.9P	3.22P			116.4F	118.6F	78.0F	73.0F	1.0	116.6F	151.8F	140.1F		
13:26:00	25.0K	27.6K	27.3K	2558 F	1726 F	67.0F	28.95	0.1M	1402 F	1355 F	202.6F	140.6F	189.8F	9.7	37.0	7.0M
500	0.0P	0.4P	22.9P	3.14P			116.5F	118.6F	77.8F	73.2F	1.0	116.7F	151.3F	140.1F		
13:28:00	25.2K	27.6K	27.3K	2464 F	1717 F	67.5F	28.95	0.1M	1400 F	1351 F	196.6F	140.5F	189.8F	10.6	37.1	6.8M
500	0.0P	0.4P	24.5P	3.02P			116.6F	118.8F	78.5F	73.2F	1.0	116.9F	151.0F	139.8F		
13:30:00	25.2K	27.7K	27.4K	2465 F	1723 F	67.2F	28.95	0.1M	1406 F	1358 F	211.3F	140.9F	189.7F	10.4	37.3	6.4M
500	0.0P	0.4P	24.8P	3.38P			116.5F	118.8F	77.8F	73.4F	1.0	116.9F	152.0F	140.3F		
13:32:00	25.1K	27.7K	27.4K	2522 F	1715 F	67.3F	28.95	0.2M	1395 F	1348 F	205.3F	140.9F	189.8F	10.1	37.0	6.2M
500	0.0P	0.4P	23.4P	3.28P			116.7F	118.9F	78.2F	73.3F	1.0	116.9F	151.4F	140.2F		
13:34:00	26.7K	27.7K	27.7K	2451 F	1714 F	67.7F	28.95	0.1M	1402 F	1351 F	173.3F	140.8F	189.9F	9.5	36.9	5.6M
500	0.0P	0.4P	24.5P	3.22P			117.1F	119.2F	78.4F	73.6F	1.0	117.2F	151.6F	140.1F		
13:36:00	26.2K	27.5K	27.7K	2603 F	1738 F	67.3F	28.95	0.1M	1420 F	1367 F	199.7F	141.6F	190.1F	9.6	37.2	5.2M
500	0.0P	0.4P	23.5P	3.04P			117.2F	119.4F	78.3F	73.1F	1.0	117.4F	152.5F	141.2F		
13:38:00	25.9K	27.6K	27.6K	2591 F	1737 F	67.6F	28.95	0.1M	1420 F	1369 F	199.4F	141.9F	190.2F	10.2	37.5	5.1M
500	0.0P	0.4P	20.8P	3.78P			117.3F	119.6F	77.9F	73.2F	1.0	117.6F	152.7F	141.4F		
13:40:00	26.1K	27.5K	27.9K	2642 F	1740 F	67.5F	28.95	0.1M	1421 F	1370 F	194.9F	142.0F	190.3F	9.6	37.2	4.7M
500	0.0P	0.4P	19.9P	3.76P			117.2F	119.4F	77.5F	73.2F	1.0	117.5F	152.6F	141.4F		
13:42:00	25.8K	27.8K	27.7K	2644 F	1745 F	67.9F	28.95	0.0M	1422 F	1372 F	202.4F	142.1F	190.5F	9.1	37.5	4.1M
500	0.0P	0.4P	19.5P	3.70P			117.5F	119.8F	78.0F	73.0F	1.0	117.7F	152.7F	141.5F		
13:44:00	26.1K	27.5K	27.8K	2594 F	1746 F	68.0F	28.95	0.1M	1414 F	1363 F	203.8F	142.0F	190.5F	8.4	37.3	4.0M
500	0.0P	0.4P	19.5P	3.74P			117.5F	119.4F	78.4F	73.3F	1.0	117.8F	152.4F	141.4F		
13:46:00	25.8K	27.9K	27.8K	2583 F	1739 F	68.6F	28.95	0.1M	1413 F	1362 F	211.0F	141.9F	190.6F	9.5	37.4	4.2M
500	0.0P	0.4P	20.5P	3.62P			117.5F	119.5F	78.1F	73.4F	1.0	117.8F	152.7F	141.3F		

2 5	MRC-MOUND		DEVELOPMENTAL WASTE PROCESSING SYSTEMS				GLASS FURNACE AND CYCLONE INCINERATOR									
0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KV AB	KV BC	KV CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	CLUG DT	MST DT	EXH DT	CLUG P	UNTR DP	AIR AMB
300																
400	----------GAS PARAMETERS CONT---------							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PM	SCRB IT	DLG RTN	VHT RTN	
600																
13:48:00	26.4K	27.5K	27.7K	2594 F	1738 F	67.9F	28.95	0.1M	1414 F	1362 F	205.4F	141.8F	190.7F	9.1	37.4	3.7M
500	0.0P	0.4P	21.2P	3.60P			117.4F	119.9F	77.6F	73.1F	1.0	117.8F	152.5F	141.3F		
13:50:00	26.3K	27.5K	27.8K	2589 F	1733 F	67.9F	28.95	0.1M	1414 F	1364 F	212.2F	141.9F	190.9F	9.9	37.5	3.3M
500	0.0P	0.4P	21.1P	3.54P			117.5F	119.8F	77.8F	73.2F	1.0	117.8F	152.5F	141.1F		
13:52:00	25.7K	27.5K	27.6K	2533 F	1729 F	67.0F	28.95	0.0M	1411 F	1362 F	195.5F	141.8F	191.0F	9.7	37.4	3.3M
500	0.0P	0.4P	20.2P	3.54P			117.5F	119.7F	77.7F	73.2F	1.0	117.8F	152.3F	141.2F		
13:54:00	26.0K	27.5K	27.9K	2579 F	1734 F	68.5F	28.95	0.1M	1406 F	1356 F	185.2F	141.8F	191.0F	9.7	37.7	2.9M
500	0.0P	0.4P	22.2P	3.48P			117.5F	120.0F	77.7F	73.0F	1.0	118.0F	152.3F	141.1F		
13:56:00	25.2K	27.6K	27.7K	2507 F	1735 F	67.5F	28.95	0.1M	1408 F	1358 F	205.3F	141.6F	191.1F	8.9	37.4	2.9M
500	0.0P	0.4P	21.7P	3.46P			117.4F	119.6F	78.1F	73.2F	1.0	117.8F	152.1F	140.9F		
13:58:00	26.3K	27.7K	27.8K	2577 F	1724 F	68.1F	28.95	0.1M	1407 F	1355 F	206.1F	141.6F	191.3F	9.4	37.6	2.6M
500	0.0P	0.4P	22.0P	3.54P			117.4F	119.9F	78.1F	73.3F	1.0	117.7F	152.2F	141.0F		
14:00:00	25.4K	27.6K	27.6K	1686 F	1619 F	68.2F	28.95	0.1M	1220 F	1199 F	183.1F	139.1F	191.3F	9.6	39.5	2.2M
500	0.0P	0.4P	22.0P	3.14P			117.6F	119.8F	77.7F	73.1F	1.0	117.8F	148.4F	138.6F		
14:02:00	25.5K	27.6K	27.9K	2366 F	1640 F	68.5F	28.95	0.2M	1362 F	1314 F	180.1F	137.2F	191.0F	10.4	37.6	1.7M
500	0.0P	0.4P	12.6P	0.28P			117.7F	120.3F	77.1F	73.2F	1.0	117.9F	145.6F	134.2F		
14:04:00	26.5K	27.7K	27.9K	2582 F	1729 F	69.5F	28.95	0.2M	1394 F	1341 F	197.4F	141.3F	191.1F	9.1	37.6	2.0M
500	0.0P	0.4P	20.3P	3.84P			117.8F	120.1F	78.2F	73.5F	1.0	118.0F	151.4F	140.4F		
14:06:00	25.5K	27.8K	28.1K	2618 F	1742 F	69.5F	28.95	0.1M	1408 F	1352 F	204.4F	141.8F	191.1F	9.2	37.5	1.2M
500	0.0P	0.4P	26.5P	4.24P			117.5F	119.8F	78.1F	73.5F	1.0	117.9F	152.3F	141.2F		
14:08:00	26.2K	27.7K	28.1K	2529 F	1718 F	68.7F	28.95	0.1M	1397 F	1345 F	202.9F	141.4F	191.2F	8.8	37.3	1.1M
500	0.0P	0.4P	22.5P	3.46P			117.4F	119.7F	78.0F	73.1F	1.0	117.8F	151.8F	140.7F		
14:10:00	25.7K	27.8K	27.8K	2514 F	1714 F	68.0F	28.95	0.1M	1395 F	1342 F	197.4F	141.0F	191.3F	9.8	37.3	1.0M
500	0.0P	0.4P	22.4P	3.28P			117.3F	119.6F	78.3F	73.2F	1.0	117.7F	151.3F	140.3F		
14:12:00	26.7K	27.5K	28.1K	2641 F	1746 F	69.6F	28.95	0.1M	1421 F	1365 F	189.7F	142.2F	191.4F	9.0	37.2	0.7M
500	0.0P	0.4P	25.8P	4.30P			117.2F	119.7F	78.3F	73.4F	1.0	117.6F	152.8F	141.6F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								/
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								/
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
600																
14:14:00	25.5K	27.8K	28.1K	2649 F	1753 F	69.1F	28.95	0.0M	1418 F	1362 F	167.0F	142.0F	191.4F	9.3	37.6	0.4M
500	0.0P	0.4P	20.6P	4.00P			117.2F	119.2F	78.1F	73.4F	1.0	117.5F	152.8F	141.5F		
14:16:00	25.9K	27.7K	27.6K	2586 F	1744 F	69.4F	28.95	0.1M	1415 F	1359 F	191.8F	142.0F	191.5F	8.7	37.7	0.1M
500	0.0P	0.4P	21.3P	3.86P			117.1F	119.3F	78.3F	73.4F	1.0	117.5F	152.8F	141.5F		
14:18:00	25.5K	27.6K	27.9K	2616 F	1748 F	69.9F	28.95	0.0M	1409 F	1358 F	194.2F	141.9F	191.5F	9.1	37.9	0.3M
500	0.0P	0.4P	20.0P	3.82P			116.8F	119.2F	78.5F	73.4F	1.0	117.4F	152.3F	141.3F		
14:20:00	26.4K	27.8K	27.8K	2597 F	1740 F	69.3F	28.95	0.1M	1407 F	1354 F	202.2F	141.6F	191.3F	9.6	37.7	0.0M
500	0.0P	0.4P	20.6P	3.66P			116.6F	119.0F	78.4F	73.4F	1.0	117.1F	152.3F	141.0F		
14:22:00	26.0K	27.6K	28.0K	2647 F	1750 F	68.0F	28.95	0.1M	1431 F	1371 F	160.9F	142.1F	191.4F	8.2	37.7	-0.1M
500	0.0P	0.4P	23.1P	3.60P			116.2F	118.5F	78.6F	73.5F	1.0	116.8F	152.6F	141.0F		
14:24:00	25.5K	27.7K	27.8K	2655 F	1791 F	68.9F	28.95	0.1M	1441 F	1382 F	157.1F	142.9F	191.5F	8.4	37.6	-0.5M
500	0.0P	0.4P	18.9P	4.72P			116.3F	118.9F	78.6F	73.5F	1.0	116.7F	154.0F	142.3F		
14:26:00	25.6K	27.8K	27.7K	2686 F	1799 F	68.4F	28.95	0.0M	1451 F	1388 F	201.5F	143.0F	191.6F	9.3	37.6	-1.4M
500	0.0P	0.4P	16.4P	4.70P			116.4F	118.4F	78.7F	73.5F	1.0	116.8F	154.0F	142.7F		
14:28:00	25.6K	27.6K	27.8K	2616 F	1790 F	68.8F	28.95	0.1M	1435 F	1374 F	210.7F	142.8F	191.8F	9.2	38.0	-0.7M
500	0.0P	0.4P	16.7P	4.38P			116.5F	118.7F	78.5F	73.6F	1.0	116.7F	153.8F	142.2F		
14:30:00	25.8K	27.5K	27.8K	2689 F	1819 F	69.1F	28.95	0.0M	1451 F	1390 F	209.1F	143.6F	191.7F	8.7	38.1	-0.8M
500	0.0P	0.4P	16.5P	5.02P			116.5F	118.8F	78.3F	73.4F	1.0	116.8F	154.6F	143.1F		
14:32:00	25.7K	27.4K	27.9K	2714 F	1831 F	69.5F	28.95	0.1M	1462 F	1399 F	162.5F	143.7F	191.8F	8.4	38.2	-1.1M
500	0.0P	0.4P	15.3P	4.98P			116.6F	118.8F	78.2F	73.5F	1.0	116.8F	154.9F	143.2F		
14:34:00	25.7K	27.4K	27.9K	2691 F	1839 F	69.4F	28.95	0.1M	1465 F	1397 F	165.2F	143.7F	191.8F	8.1	38.6	-1.2M
500	0.0P	0.4P	14.2P	5.00P			116.7F	118.8F	78.4F	73.5F	1.0	116.9F	155.0F	143.2F		
14:36:00	25.6K	27.4K	27.9K	2723 F	1836 F	69.3F	28.95	0.0M	1466 F	1400 F	197.9F	143.6F	191.9F	8.5	37.6	-1.4M
500	0.0P	0.4P	13.7P	4.86P			116.8F	118.9F	78.0F	73.4F	1.0	117.0F	154.9F	143.1F		
14:38:00	25.6K	27.3K	27.8K	2664 F	1828 F	69.6F	28.95	0.1M	1454 F	1392 F	200.1F	143.7F	192.0F	9.2	38.0	-1.6M
500	0.0P	0.4P	13.0P	4.70P			117.2F	119.2F	78.5F	73.6F	1.0	117.2F	154.9F	143.2F		

2 5	MRC-MOUND		DEVELOPMENTAL WASTE PROCESSING SYSTEMS			GLASS FURNACE AND CYCLONE INCINERATOR								
0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								
200	KV AB	KV BC	KV CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	OLUG DT	MST DT	EXH DT	OLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	OLG RTN	VNT RTN		
600																
14:40:00	25.5K	27.4K	27.8K	2680 F	1831 F	69.8F	28.95	0.0M	1455 F	1393 F	178.9F	143.7F	192.0F	0.4	38.2	-1.5M
500	0.0P	0.4P	13.7P	4.64P			117.5F	119.4F	78.6F	73.9F	1.0	117.6F	154.8F	143.1F		
14:42:00	25.6K	27.3K	27.8K	2686 F	1839 F	69.8F	28.95	0.0M	1466 F	1399 F	210.5F	144.0F	192.0F	0.0	38.1	-2.0M
500	0.0P	0.4P	13.2P	4.90P			117.8F	119.7F	78.8F	74.1F	1.0	117.9F	154.9F	143.5F		
14:44:00	25.6K	27.3K	27.8K	2586 F	1821 F	69.7F	28.95	0.1M	1455 F	1393 F	214.2F	143.6F	192.0F	0.3	38.0	-2.3M
500	0.0P	0.4P	13.0P	4.50P			118.0F	119.9F	79.2F	74.4F	1.0	118.1F	154.3F	143.1F		
14:46:00	25.6K	27.3K	27.8K	2631 F	1820 F	69.7F	28.95	0.0M	1450 F	1389 F	190.6F	143.6F	192.1F	0.5	38.0	-2.3M
500	0.0P	0.4P	13.7P	4.40P			117.9F	119.7F	79.0F	74.4F	1.0	118.3F	154.3F	143.0F		
14:48:00	25.7K	27.2K	27.7K	2711 F	1840 F	69.4F	28.95	0.0M	1464 F	1400 F	178.1F	144.1F	192.1F	0.5	38.3	-2.4M
500	0.0P	0.4P	13.6P	4.96P			118.0F	119.9F	79.0F	74.3F	1.0	118.1F	155.0F	143.6F		
14:50:00	25.6K	27.2K	27.7K	2705 F	1844 F	69.4F	28.95	0.0M	1470 F	1404 F	213.7F	144.4F	192.3F	0.2	37.7	-2.6M
500	0.0P	0.4P	13.6P	4.84P			118.3F	120.2F	79.6F	74.8F	1.0	118.4F	155.1F	143.8F		
14:52:00	25.6K	27.2K	27.8K	2703 F	1856 F	69.5F	28.95	0.1M	1469 F	1402 F	209.7F	144.4F	192.2F	0.6	38.4	-2.8M
500	0.0P	0.4P	12.4P	4.70P			118.5F	120.3F	79.4F	74.7F	1.0	118.6F	155.2F	143.7F		
14:54:00	25.6K	27.1K	27.7K	2709 F	1842 F	69.7F	28.95	0.1M	1466 F	1399 F	191.9F	144.4F	192.3F	0.3	38.6	-1.2M
500	0.0P	0.4P	12.8P	4.76P			118.5F	120.4F	79.3F	74.6F	1.0	118.7F	155.0F	143.8F		
14:56:00	25.2K	27.3K	27.7K	2734 F	1895 F	70.1F	28.95	0.1M	1483 F	1413 F	201.0F	145.4F	192.6F	9.1	38.7	-2.9M
500	0.0P	0.4P	12.4P	5.42P			118.6F	120.5F	79.5F	74.6F	1.0	118.7F	156.4F	144.9F		
14:58:00	25.2K	27.2K	27.6K	2768 F	1912 F	70.1F	28.95	0.1M	1493 F	1423 F	213.1F	145.6F	192.6F	0.3	38.6	-3.0M
500	0.0P	0.4P	13.0P	5.64P			118.5F	120.3F	79.3F	74.5F	1.0	118.7F	156.2F	145.1F		
15:00:00	25.2K	27.1K	27.5K	2725 F	1911 F	70.0F	28.95	0.1M	1502 F	1427 F	211.6F	145.8F	192.8F	0.5	38.5	-3.2M
500	0.0P	0.4P	11.5P	5.60P			118.4F	120.3F	79.4F	74.4F	1.0	118.7F	156.7F	145.3F		
15:02:00	25.0K	27.1K	27.5K	2742 F	1922 F	69.9F	28.95	0.1M	1502 F	1429 F	164.5F	145.8F	192.8F	7.5	38.4	-3.0M
500	0.0P	0.4P	11.2P	5.48P			118.4F	120.2F	79.1F	74.6F	1.0	118.6F	156.5F	145.4F		
15:04:00	25.1K	27.0K	27.5K	2748 F	1924 F	70.1F	28.95	0.1M	1497 F	1426 F	200.1F	145.7F	192.9F	8.9	38.9	-3.3M
500	0.0P	0.4P	10.5P	5.48P			118.3F	120.0F	78.8F	74.4F	1.0	118.6F	156.6F	145.2F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0029	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							--GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	UNTR DP	AIR AMB
300																
400	--GAS PARAMETERS CONT--							--LIQUID PARAMETERS---								
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	UNT RTN	
600																
15:06:00	25.0K	26.9K	27.4K	2761 F	1917 F		70.1F	28.95	0.1M	1501 F	1429 F	210.4F	145.7F	192.9F	7.8	38.7	-3.5M
500	0.0P	0.4P	11.0P	5.38P				118.1F	119.6F	79.1F	74.4F	1.0	118.5F	156.5F	145.2F		
15:08:00	25.0K	26.9K	27.4K	2737 F	1939 F		70.3F	28.95	0.1M	1504 F	1433 F	165.0F	145.7F	193.0F	7.1	38.7	-3.8M
500	0.0P	0.4P	10.8P	5.54P				118.3F	120.0F	78.9F	74.5F	1.0	118.4F	156.7F	145.2F		
15:10:00	25.0K	26.8K	27.4K	2752 F	1927 F		70.5F	28.95	0.1M	1507 F	1433 F	211.2F	145.7F	193.1F	8.1	38.4	-3.8M
500	0.0P	0.4P	10.9P	5.48P				118.5F	120.1F	79.1F	74.5F	1.0	118.6F	156.9F	145.3F		
15:12:00	24.0K	27.0K	27.0K	2752 F	1936 F		70.6F	28.95	0.1M	1501 F	1429 F	171.8F	145.8F	193.2F	7.9	38.8	-4.1M
500	0.0P	0.4P	10.3P	5.46P				118.7F	120.2F	79.2F	74.5F	1.0	118.7F	156.8F	145.3F		
15:14:00	24.0K	27.0K	27.0K	2690 F	1928 F		70.5F	28.95	0.0M	1499 F	1429 F	162.3F	145.8F	193.3F	8.1	39.7	-4.4M
500	0.0P	0.4P	10.2P	5.42P				118.7F	120.4F	79.4F	74.4F	1.0	119.0F	156.7F	145.2F		
15:16:00	24.1K	26.9K	27.0K	2751 F	1927 F		70.3F	28.95	0.1M	1503 F	1430 F	219.7F	145.9F	193.4F	7.3	39.1	-4.3M
500	0.0P	0.4P	10.1P	5.34P				118.7F	120.3F	79.2F	74.6F	1.0	119.0F	156.6F	145.2F		
15:18:00	24.1K	26.9K	27.0K	2763 F	1925 F		70.2F	28.95	0.1M	1500 F	1426 F	191.7F	145.6F	193.4F	7.6	38.8	-4.6M
500	0.0P	0.4P	10.5P	5.26P				118.5F	120.2F	79.2F	74.3F	1.0	118.8F	156.2F	145.0F		
15:20:00	24.2K	26.9K	27.0K	1619 F	1654 F		70.3F	28.95	0.1M	1291 F	1259 F	148.5F	138.5F	193.3F	8.7	37.8	-4.6M
500	0.0P	0.4P	9.5P	0.38P				118.8F	120.5F	79.2F	74.5F	1.0	118.9F	146.3F	136.6F		
15:22:00	24.4K	27.0K	27.0K	1593 F	1666 F		69.9F	28.95	0.3M	1267 F	1235 F	144.8F	136.6F	186.7F	12.3	16.4	-4.9M
500	0.0P	0.4P	10.4P	0.32P				119.0F	120.7F	79.5F	74.7F	1.0	119.1F	143.4F	133.6F		
15:24:00	25.6K	26.7K	27.4K	1623 F	1726 F		69.3F	28.95	0.2M	1270 F	1234 F	140.9F	135.2F	174.5F	10.0	11.2	-4.6M
500	0.0P	0.4P	8.1P	0.32P				118.8F	120.4F	79.1F	74.4F	1.0	119.1F	140.5F	129.9F		
15:26:00	25.8K	26.8K	27.4K	1616 F	1726 F		68.4F	28.95	0.1M	1262 F	1225 F	139.3F	134.9F	169.4F	10.1	10.9	-4.5M
500	0.0P	0.4P	7.3P	0.34P				118.6F	120.2F	78.5F	73.9F	1.0	118.9F	139.3F	129.1F		
15:28:00	25.9K	26.9K	27.4K	1602 F	1720 F		67.2F	28.95	0.1M	1253 F	1218 F	138.0F	134.7F	165.9F	10.0	10.9	-4.6M
500	0.0P	0.4P	6.9P	0.30P				118.4F	119.8F	78.3F	73.6F	1.0	118.8F	138.6F	128.6F		
15:37:25	25.4K	27.5K	27.2K	1550 F	1684 F		62.7F	28.95	0.0M	1235 F	1197 F	135.1F	133.2F	157.5F	10.0	10.9	-5.0M
500	0.0P	0.4P	4.1P	-0.18P				116.5F	118.5F	77.8F	73.4F	1.0	116.8F	136.6F	126.5F		

ZERO GAS

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 2  5    MRC-MOUND      DEVELOPMENTAL WASTE PROCESSING SYSTEMS   GLASS FURNACE AND CYCLONE INCINERATOR
0029        01      02      03      04      05      06      07      08      09      10      11      12      13      14      15      16
100       --GLASS FURNACE POWER---/-----------------------------GAS PARAMETERS-----------------------------------------------------/
200       KW AB     KW BC   KW CD    CMBR T1 CMBR T2  AMB T BAR P   AIR DRM  OFGS T1 OFGS T2 OLUG DT MST DT  EXH DT  OLUG P  VNTR DP AIR AMB
300
400       /-----------GAS PARAMETERS CONT--------/-----------------LIQUID PARAMETERS----------------------------------/
500          02     COMBUS     CO      CO2      NOX            HE INT  HE DT   RAD INT RAD DT  CSTC PH SCRB IT DLG RTN VNT RTN
600       ---------------------------------------------------------------------------------------------------------------------

15:39:04   25.6K   27.5K   27.2%  1548 F  1668 F   62.1F  20.95     0.0M  1237 F  1199 F  134.8F  132.8F  156.5F   10.0    10.9    -4.6M
500         0.0P    0.4P   104.1P   4.92P  CALIB GAS        115.9F  117.4F   77.7F   73.1F    1.0   116.3F  136.3F  126.0F
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2 5 NRC-HOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

JAN 30, 1985 Waste A

0030	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT----------							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	HOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
12:24:07	25.3K	25.1K	23.8K	2346 F	2406 F	83.7F	28.95	4.5M	932 F	926 F	62.3F	203.1F	60.1F	0.3	-0.5	53.6M
500	16.7P	0.3P	5.7P	-0.16P			65.2F	30.9F	80.8F	77.4F	1.0	65.4F	63.5F	65.1F		
12:50:00	25.2K	24.9K	23.2K	2070 F	2341 F	80.9F	28.95	3.8M	1154 F	1079 F	74.4F	162.4F	65.0F	7.4	11.5	53.7M
500	16.6P	0.4P	5.8P	-0.18P			65.2F	5.3F	81.4F	77.5F	1.0	64.8F	78.1F	66.8F		
12:52:00	25.4K	25.5K	23.5K	1960 F	2295 F	80.0F	28.95	2.2M	1231 F	1145 F	78.2F	134.3F	69.7F	7.3	11.3	53.8M
500	16.6P	0.4P	5.8P	-0.10P			65.4F	44.2F	81.9F	77.9F	1.0	65.5F	87.6F	66.5F		
12:54:00	25.2K	25.2K	23.7K	1947 F	2257 F	80.0F	28.95	1.5M	1246 F	1164 F	80.6F	127.8F	75.2F	7.2	11.0	54.3M
500	16.6P	0.4P	5.4P	-0.14P			63.6F	39.6F	81.9F	78.9F	1.0	66.2F	87.4F	66.8F		
12:56:00	25.5K	25.6K	23.5K	2105 F	2343 F	80.6F	28.95	1.2M	1298 F	1190 F	89.3F	122.9F	79.8F	7.2	11.0	53.6M
500	16.2P	0.4P	5.5P	-0.16P			65.6F	48.8F	81.9F	77.9F	1.0	65.4F	99.0F	67.3F		
12:58:00	25.6K	25.4K	23.2K	2044 F	2327 F	80.2F	28.95	0.9M	1326 F	1219 F	94.4F	115.4F	83.6F	7.2	11.0	53.3M
500	14.8P	0.4P	5.9P	2.20P			65.4F	50.3F	82.1F	78.0F	1.0	65.5F	109.9F	69.0F		
13:00:00	25.8K	25.1K	23.1K	2021 F	2312 F	80.2F	28.95	0.8M	1331 F	1220 F	97.6F	112.3F	86.2F	6.2	9.5	53.4M
500	14.3P	0.4P	6.5P	2.42P			64.5F	64.5F	81.7F	78.4F	1.0	65.4F	112.5F	70.3F		
13:02:00	26.4K	25.3K	23.0K	2007 F	2312 F	81.1F	28.95	0.8M	1325 F	1213 F	99.0F	109.3F	87.8F	4.9	7.7	54.6M
500	13.6P	0.5P	6.5P	3.26P			66.5F	59.6F	83.0F	78.0F	1.0	66.5F	113.9F	69.0F		
13:04:00	26.6K	26.0K	23.3K	2040 F	2321 F	80.5F	28.95	0.7M	1328 F	1218 F	103.7F	106.9F	89.9F	5.4	7.2	54.8M
500	12.7P	0.5P	6.6P	4.38P			66.0F	40.9F	81.8F	78.8F	1.0	66.0F	120.0F	70.0F		
13:06:00	26.8K	26.0K	23.4K	2089 F	2314 F	81.9F	28.95	0.7M	1327 F	1215 F	105.7F	105.0F	91.6F	5.2	6.4	54.7M
500	11.9P	0.5P	7.3P	5.32P			66.3F	38.6F	82.1F	78.6F	1.0	66.3F	122.1F	70.6F		
13:08:00	27.1K	26.0K	23.4K	2038 F	2310 F	82.6F	28.95	0.6M	1325 F	1218 F	106.1F	103.5F	92.7F	5.1	6.4	54.7M
500	11.8P	0.5P	7.0P	5.60P			67.0F	59.5F	82.4F	78.9F	1.0	66.8F	122.4F	71.3F		
13:10:00	27.2K	26.0K	23.5K	2052 F	2304 F	83.3F	28.95	0.6M	1322 F	1216 F	107.5F	102.5F	93.1F	5.1	6.5	54.7M
500	11.8P	0.5P	7.2P	5.54P			67.0F	29.4F	81.9F	78.7F	1.0	67.3F	120.8F	72.0F		
13:12:00	27.4K	26.0K	23.4K	1987 F	2300 F	84.2F	28.95	0.6M	1313 F	1206 F	106.6F	101.4F	94.6F	4.6	5.5	54.1M
500	11.6P	0.5P	7.1P	5.62P			68.3F	29.5F	81.6F	78.3F	1.0	68.1F	121.3F	72.4F		

2 5	NRC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0030	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
13:14:00	27.9K	26.9K	23.8K	2040 F	2296 F	84.8F	28.95	0.5M	1315 F	1206 F	107.9F	101.2F	95.4F	4.6	5.5	54.4M
500	11.3P	0.6P	7.7P	6.20P			69.0F	60.6F	82.0F	78.5F	1.0	69.7F	122.6F	73.7F		
13:16:00	28.0K	26.8K	24.0K	2077 F	2289 F	85.7F	28.95	0.5M	1317 F	1208 F	109.8F	99.7F	96.6F	4.6	5.5	54.8M
500	11.2P	0.6P	6.1P	-0.22P			69.3F	56.3F	81.9F	79.2F	1.0	69.2F	123.7F	74.6F		
13:16:33	28.0K	26.8K	23.9K	1979 F	2286 F	85.7F	28.95	0.5M	1316 F	1209 F	109.2F	99.4F	97.0F	4.7	5.5	54.5M
500	11.1P	0.6P	0.2P	0.10P	ZERO		69.2F	44.5F	82.9F	79.1F	1.0	68.8F	124.4F	74.8F		
13:17:46	28.0K	26.7K	23.2K	1989 F	2282 F	86.2F	28.95	0.5M	1318 F	1208 F	109.3F	99.0F	97.5F	4.6	5.5	54.3M
500	11.0P	0.6P	17.2P	4.96P	SPAN		67.8F	57.8F	82.2F	79.1F	1.0	70.0F	126.0F	74.8F		
13:18:00	28.0K	26.7K	23.8K	1980 F	2283 F	86.0F	28.95	0.5M	1317 F	1208 F	110.1F	98.8F	97.4F	4.7	5.8	54.3M
500	11.0P	0.6P	17.3P	5.12P			67.7F	58.5F	82.3F	79.0F	1.0	69.8F	125.4F	74.9F		
13:20:00	28.0K	26.8K	23.9K	2107 F	2278 F	86.5F	28.95	0.5M	1318 F	1208 F	110.1F	98.1F	99.0F	4.5	5.5	53.9M
500	13.2P	0.5P	2.9P	4.88P			67.9F	35.0F	82.3F	78.8F	1.0	69.6F	127.0F	74.7F		
13:22:00	28.1K	27.0K	23.7K	2034 F	2269 F	86.7F	28.95	0.4M	1319 F	1211 F	111.0F	97.2F	99.2F	4.7	5.5	54.4M
500	10.6P	0.6P	3.4P	7.72P			69.3F	36.9F	82.5F	79.2F	1.0	69.5F	128.1F	75.0F		
13:24:00	28.1K	27.1K	23.7K	2050 F	2258 F	87.0F	28.95	0.4M	1322 F	1213 F	113.4F	96.7F	99.9F	4.6	5.6	54.0M
500	10.3P	0.6P	3.7P	8.00P			69.5F	37.0F	82.2F	79.0F	1.0	69.4F	129.2F	75.4F		
13:26:00	28.0K	27.1K	23.9K	1988 F	2258 F	87.2F	28.95	0.4M	1325 F	1217 F	114.4F	96.2F	100.6F	4.3	5.1	53.8M
500	9.9P	0.7P	4.7P	8.68P			68.5F	40.5F	82.5F	78.8F	1.0	70.1F	132.2F	75.9F		
13:28:00	28.0K	27.3K	24.2K	1917 F	2250 F	87.3F	28.95	0.4M	1325 F	1216 F	114.8F	95.8F	101.1F	4.3	5.4	53.7M
500	10.5P	0.7P	5.1P	7.10P			69.5F	39.1F	82.0F	78.5F	1.0	68.9F	133.2F	75.3F		
13:30:00	27.8K	27.1K	24.0K	1937 F	2244 F	87.7F	28.95	0.4M	1321 F	1213 F	115.5F	95.6F	101.4F	4.3	5.4	53.3M
500	9.6P	0.8P	7.0P	9.16P			68.3F	38.6F	81.9F	78.6F	1.0	69.8F	132.3F	76.1F		
13:32:00	27.7K	27.2K	24.0K	1896 F	2227 F	87.8F	28.95	0.3M	1318 F	1210 F	114.2F	95.2F	101.8F	4.4	5.4	53.2M
500	9.8P	0.8P	7.5P	8.88P			68.9F	37.5F	81.6F	78.9F	1.0	69.6F	130.2F	75.4F		
13:34:00	27.8K	27.9K	24.6K	1903 F	2220 F	88.1F	28.95	0.4M	1314 F	1209 F	114.1F	95.3F	102.3F	4.3	5.2	52.6M
500	20.9P	0.5P	5.1P	0.02P			68.7F	36.8F	82.1F	78.9F	1.0	70.0F	129.1F	76.1F		

2 5	NRC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0030	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	ANB T	BAR P	AIR DRM	OFGS T1	OFGS T2	OLUG DT	MST DT	EXH DT	OLUG P	VNTR DP	AIR ANB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	OLG RTN	VHT RTN		
600																
13:36:00	27.7K	27.9K	24.6K	1900 F	2216 F	88.1F	28.95	0.3M	1312 F	1207 F	112.4F	94.6F	102.7F	4.3	5.3	52.5M
500	12.7P	0.7P	7.3P	8.82P			68.7F	64.7F	82.3F	79.5F	1.0	69.8F	128.9F	75.4F		
13:38:00	27.7K	27.9K	24.6K	1914 F	2207 F	88.2F	28.95	0.3M	1313 F	1204 F	113.4F	94.0F	103.0F	4.4	5.2	52.0M
500	12.5P	0.8P	8.6P	9.02P			68.7F	63.6F	82.6F	79.2F	1.0	69.7F	129.8F	75.5F		
13:40:00	27.7K	27.9K	24.6K	1906 F	2203 F	88.4F	28.95	0.3M	1311 F	1205 F	113.2F	93.8F	103.5F	4.2	5.2	52.3M
500	12.4P	0.8P	8.4P	9.20P			68.9F	36.5F	83.0F	79.6F	1.0	69.8F	130.0F	75.6F		
13:42:00	27.6K	27.9K	24.7K	1931 F	2194 F	88.5F	28.95	0.3M	1308 F	1205 F	112.0F	93.5F	103.8F	4.3	5.2	51.6M
500	12.5P	0.8P	9.5P	9.14P			69.1F	39.2F	83.0F	79.7F	1.0	69.9F	130.6F	75.6F		
13:44:00	27.6K	28.0K	25.1K	1946 F	2194 F	88.6F	28.95	0.3M	1308 F	1202 F	113.1F	93.1F	104.2F	4.4	5.2	51.5M
500	12.4P	0.8P	10.0P	8.60P			69.6F	44.8F	83.3F	79.9F	1.0	70.4F	130.2F	76.1F		
13:46:00	27.5K	28.0K	25.0K	1847 F	2186 F	88.9F	28.95	0.3M	1306 F	1201 F	114.3F	93.2F	104.7F	4.2	5.2	50.9M
500	12.2P	0.8P	9.9P	8.76P			69.6F	65.4F	83.0F	79.9F	1.0	70.5F	130.0F	76.3F		
13:48:00	27.5K	27.9K	25.1K	1879 F	2184 F	89.2F	28.95	0.3M	1305 F	1199 F	112.7F	92.9F	104.9F	4.2	5.2	50.7M
500	12.1P	0.8P	10.7P	8.98P			69.7F	40.1F	83.3F	79.9F	1.0	70.7F	130.1F	76.3F		
13:50:00	27.5K	27.8K	25.1K	1863 F	2179 F	89.6F	28.95	0.3M	1300 F	1197 F	112.6F	92.7F	105.0F	4.1	5.2	49.5M
500	12.2P	0.7P	11.6P	8.76P			69.9F	41.2F	83.7F	79.8F	1.0	70.8F	128.5F	76.4F		
13:52:00	27.4K	27.6K	24.9K	1837 F	2174 F	90.0F	28.95	0.3M	1296 F	1193 F	112.2F	92.4F	105.2F	4.2	5.2	49.6M
500	12.1P	0.8P	11.6P	9.38P			70.3F	43.9F	83.7F	80.2F	1.0	71.3F	128.3F	76.6F		
13:54:00	27.4K	27.7K	25.1K	1837 F	2169 F	90.5F	28.95	0.3M	1295 F	1190 F	112.2F	92.3F	105.5F	4.4	5.2	48.9M
500	12.3P	0.7P	11.9P	8.78P			70.0F	41.9F	83.6F	79.9F	1.0	71.0F	127.0F	76.7F		
13:56:00	27.4K	27.7K	25.1K	1813 F	2164 F	90.9F	28.95	0.2M	1290 F	1192 F	111.4F	92.1F	105.6F	4.1	5.2	48.5M
500	12.5P	0.7P	12.8P	8.00P			70.7F	40.5F	83.2F	80.1F	1.0	71.6F	127.8F	76.7F		
13:58:00	27.4K	27.7K	25.1K	1835 F	2158 F	91.3F	28.95	0.3M	1289 F	1189 F	111.3F	92.0F	105.8F	4.3	5.1	48.2M
500	11.7P	0.7P	13.2P	10.02P			71.0F	42.7F	83.6F	80.2F	1.0	71.9F	127.3F	76.9F		
14:00:00	27.4K	27.7K	25.1K	1840 F	2152 F	91.7F	28.95	0.3M	1290 F	1187 F	111.5F	91.8F	105.7F	4.2	5.1	48.1M
500	11.8P	0.8P	14.4P	9.92P			71.3F	44.5F	83.6F	80.3F	1.0	72.1F	126.5F	77.1F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0030	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								
200	KV AB	KV BC	KV CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
14:02:00	28.4K	28.0K	25.0K	1852 F	2144 F	91.9F	28.95	0.4M	1285 F	1183 F	111.5F	92.0F	106.4F	4.3	5.1	48.1M
500	12.0P	0.0P	14.4P	9.80P			71.5F	49.5F	83.8F	80.5F	1.0	72.6F	126.7F	77.7F		
14:04:00	27.7K	27.3K	25.1K	1814 F	2131 F	92.1F	28.95	0.3M	1285 F	1183 F	111.6F	91.4F	106.2F	4.3	5.0	47.6M
500	12.1P	0.0P	14.4P	9.50P			71.8F	39.3F	83.7F	80.0F	1.0	72.4F	126.7F	78.0F		
14:06:00	28.7K	27.5K	25.1K	1805 F	2127 F	93.0F	28.95	0.2M	1280 F	1179 F	110.9F	91.3F	106.0F	4.3	5.0	47.2M
500	12.4P	0.0P	13.4P	9.20P			72.9F	47.4F	83.6F	80.5F	1.0	73.3F	125.5F	78.0F		
14:08:00	27.7K	27.5K	25.0K	1796 F	2116 F	94.0F	28.95	0.3M	1278 F	1178 F	111.5F	91.0F	105.5F	4.2	5.0	47.3M
500	12.3P	0.0P	13.6P	9.26P			72.9F	53.0F	84.2F	80.4F	1.0	73.4F	124.7F	77.9F		
14:10:00	27.3K	27.6K	25.0K	1816 F	2108 F	93.4F	28.95	0.3M	1277 F	1177 F	112.6F	91.1F	105.4F	4.2	5.2	46.6M
500	12.3P	0.0P	16.1P	9.02P			72.6F	47.6F	84.1F	80.0F	1.0	73.6F	126.3F	78.6F		
14:12:00	27.1K	27.5K	24.9K	1804 F	2102 F	93.6F	28.95	0.3M	1278 F	1176 F	113.6F	91.3F	105.9F	4.3	5.1	46.1M
500	12.4P	0.0P	16.6P	8.72P			73.0F	55.0F	84.3F	80.6F	1.0	74.4F	127.2F	78.5F		
14:14:00	27.1K	27.5K	24.8K	1809 F	2097 F	93.9F	28.95	0.3M	1277 F	1177 F	114.1F	91.2F	105.2F	4.3	5.1	45.8M
500	12.5P	0.7P	16.6P	8.50P			72.9F	49.4F	83.7F	80.2F	1.0	74.0F	129.2F	79.2F		
14:16:00	26.8K	27.5K	24.7K	1738 F	2088 F	94.2F	28.95	0.2M	1277 F	1177 F	114.0F	91.2F	105.3F	4.1	5.1	44.7M
500	12.9P	0.6P	17.2P	7.70P			73.1F	49.6F	84.3F	80.1F	1.0	74.0F	129.8F	79.4F		
14:18:00	26.9K	27.5K	24.4K	1796 F	2084 F	93.7F	28.95	0.2M	1275 F	1180 F	114.3F	91.2F	105.4F	4.1	5.1	44.9M
500	13.5P	0.4P	17.3P	6.28P			73.3F	73.3F	83.7F	80.7F	1.0	74.5F	129.5F	80.0F		
14:20:00	27.0K	27.6K	24.8K	1790 F	2082 F	93.9F	28.95	0.2M	1273 F	1179 F	113.9F	91.1F	105.2F	4.3	5.0	44.3M
500	20.6P	0.3P	16.9P	3.02P			73.4F	52.8F	83.7F	80.2F	1.0	74.3F	130.1F	79.6F		
14:22:00	27.0K	27.6K	24.6K	1795 F	2083 F	93.6F	28.95	0.3M	1276 F	1175 F	114.0F	91.2F	104.5F	4.2	5.1	45.0M
500	21.1P	0.3P	16.3P	0.58P			73.6F	53.6F	83.9F	80.1F	1.0	74.2F	128.5F	79.6F		
14:24:00	27.2K	27.6K	24.6K	1793 F	2075 F	93.4F	28.95	0.2M	1270 F	1175 F	113.7F	91.1F	105.1F	4.2	5.0	44.0M
500	13.2P	0.6P	18.1P	9.18P			73.6F	73.4F	84.1F	80.0F	1.0	74.2F	129.3F	80.1F		
14:26:00	27.1K	27.5K	24.6K	1782 F	2073 F	93.4F	28.95	0.2M	1269 F	1173 F	114.5F	91.1F	105.1F	4.2	5.0	43.6M
500	17.6P	0.5P	18.6P	5.80P			73.7F	72.1F	84.0F	80.4F	1.0	74.5F	131.0F	79.9F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0030	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW A8	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRN	OFGS T1	OFGS T2	OLUG OT	MST OT	EXH OT	OLUG P	VNTR DP	AIR AHB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	OLG RTN	VNT RTN		
600																
14:28:00	27.8K	27.0K	24.7K	1785 F	2070 F	93.3F	28.95	0.2M	1268 F	1173 F	114.9F	91.1F	105.0F	4.2	5.0	44.0M
500	20.0P	0.4P	18.1P	3.26P			73.7F	68.7F	84.5F	80.8F	1.0	74.9F	131.1F	80.6F		
14:30:00	26.9K	27.4K	24.4K	1763 F	2071 F	93.6F	28.95	0.2M	1270 F	1171 F	114.7F	91.2F	105.1F	4.1	5.0	43.1M
500	20.4P	0.4P	18.0P	2.96P			73.9F	72.1F	84.2F	80.6F	1.0	74.5F	130.5F	80.0F		
14:32:00	26.8K	27.4K	24.1K	1759 F	2069 F	93.8F	28.95	0.2M	1266 F	1170 F	114.1F	91.3F	105.2F	4.1	5.0	43.4M
500	20.4P	0.3P	18.4P	2.56P			73.2F	48.1F	83.7F	80.3F	1.0	74.6F	130.2F	80.2F		
14:34:00	26.9K	27.4K	24.3K	1788 F	2066 F	94.0F	28.95	0.2M	1265 F	1169 F	114.0F	91.3F	105.2F	4.1	4.9	43.0M
500	20.5P	0.3P	17.8P	2.26P			74.2F	55.4F	84.0F	80.5F	1.0	74.8F	130.5F	80.2F		
14:36:00	26.9K	27.3K	24.3K	1758 F	2062 F	94.1F	28.95	0.2M	1263 F	1165 F	114.0F	91.1F	105.1F	4.0	5.0	42.3M
500	20.5P	0.4P	18.4P	2.08P			74.4F	57.3F	84.4F	80.5F	1.0	74.9F	129.4F	80.2F		
14:38:00	27.1K	27.4K	24.3K	1786 F	2058 F	94.3F	28.95	0.2M	1262 F	1164 F	113.8F	91.1F	104.9F	4.1	5.1	42.9M
500	21.3P	0.4P	18.8P	2.00P			74.5F	53.7F	84.4F	80.6F	1.0	75.1F	128.1F	80.4F		
14:40:00	27.1K	27.4K	24.2K	1845 F	2058 F	94.2F	28.95	0.2M	1261 F	1164 F	112.8F	91.0F	104.9F	4.1	4.9	42.2M
500	18.1P	0.4P	19.6P	7.26P			74.7F	53.9F	84.4F	80.6F	1.0	75.2F	127.1F	80.4F		
14:42:00	27.7K	27.4K	23.9K	1765 F	2048 F	94.4F	28.95	0.2M	1256 F	1162 F	113.0F	90.9F	104.8F	4.0	5.0	42.4M
500	14.9P	0.5P	20.6P	0.34P			74.9F	54.9F	84.2F	80.6F	1.0	75.5F	126.1F	81.1F		
14:44:00	27.1K	27.4K	23.3K	1771 F	2045 F	94.5F	28.95	0.2M	1252 F	1159 F	111.4F	91.0F	104.8F	4.3	4.9	42.0M
500	16.6P	0.6P	20.6P	7.66P			75.0F	53.8F	84.7F	80.6F	1.0	75.6F	126.1F	80.5F		
14:46:00	27.1K	27.4K	23.2K	1776 F	2042 F	94.7F	28.95	0.2M	1251 F	1157 F	110.9F	91.1F	104.8F	3.9	5.0	41.8M
500	20.4P	0.4P	20.3P	2.48P			75.3F	55.4F	84.0F	80.4F	1.0	75.8F	124.9F	80.6F		
14:48:00	26.8K	27.2K	24.0K	1748 F	2041 F	94.7F	28.95	0.1M	1251 F	1156 F	110.8F	91.3F	105.2F	4.1	4.9	41.7M
500	20.5P	0.4P	20.1P	1.98P			75.5F	54.2F	84.2F	80.5F	1.0	76.1F	125.5F	80.8F		
14:50:00	27.0K	27.1K	23.9K	1756 F	2035 F	94.8F	28.95	0.2M	1250 F	1153 F	111.5F	91.1F	105.0F	4.2	5.0	41.7M
500	15.4P	0.5P	21.3P	7.76P			75.7F	56.2F	84.0F	80.6F	1.0	76.3F	124.6F	81.0F		
14:52:00	26.9K	27.1K	23.5K	1734 F	2033 F	94.9F	28.95	0.2M	1249 F	1153 F	111.6F	91.3F	105.2F	4.0	5.1	41.5M
500	17.0P	0.6P	21.1P	6.86P			75.8F	57.1F	83.8F	80.7F	1.0	76.5F	124.7F	81.2F		

2 5 NRC-NOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0030	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	UNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	UNT RTN	
600																
14:54:00	26.9K	27.1K	23.4K	1755 F	2020 F	94.9F	28.95	0.1M	1249 F	1154 F	110.6F	91.3F	105.2F	3.9	5.0	41.6M
500	20.3P	0.4P	21.5P	4.70P			76.0F	54.3F	84.5F	80.7F	1.0	76.7F	123.6F	81.2F		
14:56:00	26.9K	27.1K	23.3K	1727 F	2015 F	94.5F	28.95	0.2M	1247 F	1155 F	110.7F	91.2F	105.2F	4.0	5.0	41.2M
500	20.6P	0.4P	21.3P	2.22P			76.1F	55.1F	84.6F	80.9F	1.0	76.8F	124.3F	81.3F		
14:58:00	26.9K	27.0K	23.2K	1744 F	2016 F	94.1F	28.95	0.1M	1250 F	1156 F	110.6F	91.4F	105.4F	4.1	5.0	41.0M
500	15.5P	0.6P	22.7P	7.24P			76.2F	73.6F	84.2F	80.7F	1.0	77.1F	123.0F	81.4F		
15:00:00	26.9K	27.0K	23.3K	1732 F	2015 F	93.5F	28.95	0.2M	1247 F	1152 F	111.5F	91.4F	105.4F	3.9	5.0	40.8M
500	16.6P	0.6P	22.8P	6.66P			76.3F	52.0F	84.0F	80.6F	1.0	77.2F	123.9F	81.6F		
15:02:00	27.0K	27.0K	23.4K	1761 F	2015 F	93.1F	28.95	0.2M	1247 F	1154 F	111.7F	91.6F	105.5F	4.3	4.6	40.2M
500	18.1P	0.6P	23.3P	5.98P			76.5F	54.4F	84.3F	80.6F	1.0	77.4F	123.6F	81.8F		
15:04:00	26.9K	26.9K	23.2K	1754 F	2015 F	93.2F	28.95	0.2M	1246 F	1150 F	112.0F	91.6F	105.6F	4.0	5.0	40.6M
500	20.1P	0.5P	24.4P	5.62P			76.8F	55.0F	84.3F	80.8F	1.0	77.6F	123.9F	81.9F		
15:06:00	26.9K	26.9K	23.1K	1754 F	2009 F	93.3F	28.95	0.1M	1245 F	1150 F	112.9F	92.0F	105.8F	3.9	5.1	40.2M
500	20.6P	0.4P	24.0P	2.06P			77.2F	72.0F	84.4F	80.4F	1.0	77.9F	125.3F	82.4F		
15:08:00	26.9K	26.8K	23.1K	1767 F	2008 F	93.7F	28.95	0.2M	1245 F	1149 F	111.9F	92.2F	106.0F	4.1	5.1	40.0M
500	20.6P	0.4P	23.1P	1.62P			77.4F	75.7F	84.5F	80.6F	1.0	78.3F	125.8F	82.8F		
15:10:00	26.9K	26.9K	23.1K	1747 F	2007 F	94.1F	28.95	0.2M	1243 F	1148 F	112.9F	92.3F	106.0F	4.0	5.0	39.6M
500	20.6P	0.4P	23.5P	1.30P			77.6F	75.2F	84.5F	80.7F	1.0	78.4F	125.9F	82.7F		
15:12:00	26.9K	26.9K	23.1K	1720 F	2005 F	94.4F	28.95	0.2M	1240 F	1147 F	112.1F	92.3F	106.0F	4.0	5.0	39.8M
500	20.6P	0.4P	23.6P	1.10P			77.9F	75.6F	84.2F	80.6F	1.0	78.6F	125.0F	83.0F		
15:14:00	27.0K	26.9K	23.2K	1718 F	2004 F	94.9F	28.95	0.2M	1237 F	1146 F	111.7F	92.5F	106.2F	4.0	5.0	39.9M
500	20.6P	0.4P	22.3P	0.86P			78.1F	57.9F	84.1F	80.5F	1.0	78.7F	125.5F	83.2F		
15:16:00	26.9K	26.9K	23.0K	1713 F	1998 F	95.2F	28.95	0.1M	1241 F	1148 F	113.7F	92.8F	106.3F	4.0	5.0	39.5M
500	19.8P	0.4P	24.1P	5.86P			78.2F	57.5F	84.5F	80.8F	1.0	78.9F	126.3F	83.6F		
15:18:00	27.0K	26.8K	23.0K	1725 F	1999 F	95.7F	28.95	0.2M	1238 F	1145 F	112.1F	93.0F	106.5F	3.9	4.9	39.4M
500	20.5P	0.4P	22.8P	0.98P			78.3F	57.7F	83.8F	80.7F	1.0	79.1F	125.8F	83.6F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0030	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR ANB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
600																
15:20:00	27.0K	26.8K	23.1K	1731 F	2001 F	96.0F	28.95	0.1M	1239 F	1144 F	112.9F	93.2F	106.7F	4.0	5.0	39.4M
500	20.5P	0.4P	23.6P	0.70P			78.5F	57.6F	84.5F	80.9F	1.0	79.3F	125.8F	83.8F		
15:22:00	27.0K	26.8K	22.9K	1721 F	2001 F	96.3F	28.95	0.2M	1232 F	1145 F	112.7F	93.3F	106.7F	4.1	4.9	39.3M
500	20.4P	0.4P	23.3P	0.60P			78.8F	58.8F	84.8F	80.8F	1.0	79.5F	126.1F	84.0F		
15:24:00	27.0K	26.8K	22.9K	1749 F	1997 F	96.6F	28.95	0.1M	1239 F	1142 F	113.1F	93.4F	106.9F	4.0	5.0	38.8M
500	20.4P	0.4P	23.6P	0.54P			78.9F	57.9F	84.3F	80.6F	1.0	79.6F	125.2F	84.2F		
15:26:00	27.0K	26.8K	22.9K	1732 F	1998 F	96.8F	28.95	0.2M	1238 F	1143 F	112.4F	93.5F	107.0F	3.8	5.0	38.6M
500	20.5P	0.4P	23.1P	0.98P			78.9F	56.9F	83.6F	81.0F	1.0	79.7F	126.1F	84.3F		
15:28:00	27.0K	26.8K	22.9K	1743 F	2000 F	96.9F	28.95	0.1M	1239 F	1142 F	113.0F	93.6F	107.2F	4.0	5.0	38.0M
500	20.5P	0.4P	22.9P	0.42P			79.2F	56.9F	85.1F	81.1F	1.0	79.9F	126.7F	84.4F		
15:30:00	27.0K	26.7K	23.0K	1749 F	1999 F	97.0F	28.95	0.1M	1236 F	1143 F	113.7F	93.8F	107.3F	3.9	4.9	38.3M
500	20.6P	0.4P	23.0P	0.42P			79.3F	58.5F	85.1F	81.4F	1.0	80.2F	126.9F	84.5F		
15:32:00	27.0K	26.7K	23.0K	1741 F	1996 F	97.2F	28.95	0.1M	1236 F	1142 F	114.1F	94.0F	107.2F	4.0	4.9	38.1M
500	20.6P	0.3P	23.5P	0.46P			79.5F	58.6F	85.2F	81.6F	1.0	80.2F	126.5F	84.8F		
15:34:00	27.0K	26.4K	23.1K	1748 F	1997 F	97.4F	28.95	0.1M	1234 F	1140 F	113.4F	94.0F	107.3F	4.0	4.9	37.2M
500	20.6P	0.3P	23.4P	0.36P			79.8F	57.3F	85.0F	81.1F	1.0	80.4F	126.5F	84.9F		
15:36:00	27.0K	26.5K	23.4K	1745 F	1995 F	97.6F	28.95	0.2M	1234 F	1142 F	114.0F	94.1F	107.3F	3.9	4.9	37.5M
500	20.7P	0.4P	23.3P	0.76P			80.1F	58.2F	85.6F	81.4F	1.0	80.8F	126.3F	85.1F		
15:38:00	27.0K	26.5K	23.2K	1729 F	1994 F	97.8F	28.95	0.2M	1235 F	1140 F	114.0F	94.3F	107.6F	3.9	5.0	37.3M
500	20.7P	0.3P	22.1P	0.32P			80.4F	57.0F	84.8F	81.1F	1.0	80.9F	126.7F	85.4F		
15:40:00	27.0K	26.6K	23.0K	1729 F	1989 F	97.8F	28.95	0.1M	1231 F	1141 F	113.7F	94.5F	107.6F	4.0	4.9	37.2M
500	20.5P	0.5P	23.5P	5.80P			80.8F	77.9F	84.8F	81.1F	1.0	81.3F	126.6F	85.7F		
15:42:00	27.0K	26.6K	23.0K	1725 F	1991 F	97.8F	28.95	0.1M	1229 F	1140 F	114.1F	94.7F	107.7F	3.9	5.0	36.9M
500	20.8P	0.4P	23.7P	4.30P			81.1F	78.7F	84.8F	80.8F	1.0	81.6F	126.5F	86.0F		
15:44:00	26.9K	26.6K	23.0K	1707 F	1988 F	97.9F	28.95	0.1M	1231 F	1139 F	114.8F	94.9F	107.8F	3.8	4.9	37.0M
500	20.7P	0.4P	23.3P	0.42P			81.5F	78.8F	84.6F	80.9F	1.0	81.9F	126.8F	86.4F		

2 5	NRC-HOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0010	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							-GAS PARAMETERS-								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR ANB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PM	SCRB IT	DLG RTN	VNT RTN		
600																
15:46:00	26.9K	26.6K	23.0K	1725 F	1987 F	98.1F	28.95	0.2M	1227 F	1138 F	113.7F	94.9F	107.9F	3.9	4.9	36.9M
500	20.7P	0.4P	22.7P	0.24P			81.8F	57.4F	84.5F	80.6F	1.0	82.2F	126.4F	86.7F		
15:48:00	26.9K	26.5K	23.0K	1745 F	1984 F	98.2F	28.95	0.2M	1227 F	1136 F	113.9F	95.4F	108.0F	4.0	4.9	36.9M
500	20.8P	0.4P	22.3P	0.56P			82.1F	58.8F	84.3F	80.6F	1.0	82.6F	126.7F	86.8F		
15:50:00	26.9K	26.5K	23.1K	1723 F	1984 F	98.3F	28.95	0.1M	1227 F	1135 F	113.4F	95.4F	108.0F	3.8	5.0	36.0M
500	20.7P	0.3P	22.9P	0.24P			82.4F	57.9F	84.2F	80.4F	1.0	82.9F	126.1F	87.1F		
15:52:00	26.9K	26.5K	23.1K	1701 F	1980 F	98.5F	28.95	0.2M	1222 F	1133 F	114.0F	95.7F	108.0F	3.9	5.0	36.3M
500	20.7P	0.3P	23.5P	0.20P			83.0F	60.3F	84.5F	80.5F	1.0	83.3F	126.2F	87.5F		
15:54:00	26.8K	26.3K	23.8K	1708 F	1976 F	97.7F	28.95	0.1M	1222 F	1134 F	113.7F	95.4F	108.1F	3.7	4.9	35.9M
500	20.7P	0.3P	22.6P	0.12P			83.2F	80.4F	84.5F	80.5F	1.0	83.7F	124.6F	87.7F		
15:56:00	27.2K	26.3K	23.9K	1688 F	1966 F	98.8F	28.95	0.2M	1224 F	1134 F	113.6F	96.4F	108.2F	3.9	4.9	36.1M
500	20.7P	0.3P	22.0P	0.12P			84.2F	79.1F	84.4F	80.3F	1.0	84.5F	125.6F	88.3F		
15:58:00	27.5K	26.5K	24.1K	1717 F	1963 F	98.6F	28.95	0.2M	1222 F	1135 F	114.1F	96.6F	108.4F	3.8	5.0	36.0M
500	20.9P	0.4P	19.3P	0.18P			84.4F	83.1F	83.8F	80.7F	1.0	84.9F	125.7F	88.9F		
16:00:00	27.2K	26.3K	23.8K	1724 F	1957 F	98.0F	28.95	0.1M	1222 F	1133 F	114.6F	96.7F	108.3F	3.9	4.9	35.7M
500	20.7P	0.3P	19.5P	0.14P			85.0F	78.5F	84.3F	81.0F	1.0	85.5F	125.1F	89.4F		
16:02:00	27.1K	26.2K	23.7K	1709 F	1962 F	97.7F	28.95	0.1M	1222 F	1133 F	115.7F	97.2F	108.4F	3.7	5.1	35.5M
500	20.6P	0.3P	20.5P	0.10P			85.8F	82.2F	84.2F	80.9F	1.0	86.1F	126.0F	90.1F		
16:04:00	27.0K	26.3K	23.3K	1705 F	1959 F	96.4F	28.95	0.2M	1223 F	1131 F	115.6F	97.4F	108.8F	3.7	5.0	35.2M
500	20.6P	0.3P	20.1P	0.06P			86.6F	84.0F	84.3F	80.8F	1.0	86.7F	125.7F	90.7F		
16:06:00	27.1K	26.1K	23.4K	1704 F	1954 F	97.3F	28.95	0.2M	1223 F	1133 F	117.1F	98.3F	108.8F	3.8	5.0	34.5M
500	20.6P	0.4P	19.7P	0.10P			87.2F	60.7F	84.7F	80.5F	1.0	87.6F	127.7F	91.0F		
16:08:00	27.2K	26.1K	23.6K	1717 F	1950 F	96.6F	28.95	0.2M	1221 F	1132 F	116.7F	98.7F	109.1F	3.7	5.1	35.1M
500	20.6P	0.4P	19.7P	0.10P			87.6F	76.2F	84.0F	80.7F	1.0	87.9F	127.7F	91.7F		
16:10:00	27.3K	26.1K	23.7K	1695 F	1950 F	96.3F	28.95	0.1M	1220 F	1132 F	115.8F	99.0F	109.0F	3.9	5.1	34.4M
500	20.6P	0.4P	19.6P	0.12P			88.0F	63.2F	84.4F	80.4F	1.0	88.3F	128.0F	92.0F		

2 5	MRC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS	GLASS FURNACE AND CYCLONE INCINERATOR												
0030	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	D2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
16:12:00	27.4K	26.1K	23.6K	1695 F	1946 F	95.0F	28.95	0.0M	1218 F	1130 F	116.9F	99.3F	109.5F	3.8	5.1	34.1M
500	20.6P	0.4P	20.3P	0.50P			88.1F	85.6F	84.4F	80.3F	1.0	88.9F	127.3F	92.2F		
16:14:00	27.3K	26.0K	23.4K	1715 F	1946 F	96.5F	28.95	0.1M	1218 F	1129 F	117.7F	99.3F	109.0F	3.6	5.0	34.1M
500	20.6P	0.4P	20.6P	0.48P			88.6F	85.2F	84.2F	80.5F	1.0	89.0F	127.6F	93.0F		
16:16:00	27.4K	25.8K	23.3K	1716 F	1944 F	94.6F	28.95	0.1M	1216 F	1129 F	116.8F	99.9F	109.2F	3.6	5.1	33.8M
500	20.6P	0.4P	20.0P	0.56P			89.0F	74.5F	84.4F	80.4F	1.0	89.0F	127.0F	93.2F		
16:18:00	27.4K	25.8K	22.8K	1697 F	1941 F	94.6F	28.95	0.1M	1212 F	1126 F	115.5F	100.2F	109.2F	3.7	5.0	34.4M
500	20.6P	0.4P	19.9P	0.56P			89.1F	71.2F	84.1F	80.5F	1.0	89.4F	125.3F	93.0F		
16:20:00	27.5K	26.0K	23.2K	1714 F	1939 F	94.8F	28.95	0.1M	1222 F	1133 F	119.7F	100.2F	109.8F	3.6	4.9	33.4M
500	20.7P	0.4P	20.6P	5.50P			89.4F	71.9F	84.6F	80.0F	1.0	89.7F	130.6F	93.8F		
16:22:00	27.4K	25.7K	22.8K	1686 F	1937 F	94.4F	28.95	0.1M	1209 F	1123 F	114.8F	100.5F	110.2F	3.7	5.0	33.3M
500	20.5P	0.4P	20.9P	3.56P			89.4F	84.1F	84.8F	80.6F	1.0	89.4F	124.0F	93.4F		
16:24:00	27.5K	25.6K	23.2K	1677 F	1935 F	94.1F	28.95	0.2M	1202 F	1119 F	112.3F	100.4F	110.0F	3.7	5.0	33.0M
500	20.5P	0.4P	20.5P	0.56P			89.7F	84.1F	83.4F	80.2F	1.0	90.0F	119.8F	93.0F		
16:26:00	27.5K	25.7K	22.9K	1682 F	1929 F	94.0F	28.95	0.2M	1199 F	1115 F	110.5F	100.3F	110.0F	3.7	5.0	33.4M
500	20.5P	0.4P	19.6P	0.40P			89.6F	61.2F	84.0F	80.2F	1.0	90.4F	117.0F	93.2F		
16:28:00	27.4K	25.8K	22.7K	1681 F	1930 F	93.9F	28.95	0.1M	1195 F	1112 F	109.5F	100.4F	110.5F	3.6	5.0	33.3M
500	20.5P	0.4P	19.5P	0.30P			90.0F	86.7F	84.2F	80.0F	1.0	90.4F	115.5F	93.0F		
16:30:00	27.4K	25.4K	22.3K	1677 F	1931 F	93.6F	28.95	0.1M	1192 F	1110 F	108.4F	100.6F	110.5F	3.7	5.0	32.7M
500	20.5P	0.4P	20.1P	0.24P			89.8F	84.3F	83.5F	79.7F	1.0	90.9F	113.9F	92.7F		
16:32:00	27.3K	25.6K	23.1K	1678 F	1928 F	93.2F	28.95	0.1M	1190 F	1107 F	107.5F	100.7F	110.6F	3.7	5.0	33.0M
500	20.5P	0.3P	19.8P	0.18P			90.3F	83.8F	83.9F	79.8F	1.0	90.9F	112.2F	92.6F		
16:34:00	27.2K	25.4K	22.4K	1681 F	1931 F	93.2F	28.95	0.2M	1186 F	1105 F	106.4F	100.6F	110.4F	3.7	5.0	33.1M
500	20.5P	0.3P	19.6P	0.18P			90.6F	68.2F	83.5F	79.6F	1.0	91.0F	110.7F	93.0F		
16:36:00	27.2K	25.4K	22.7K	1680 F	1932 F	93.1F	28.95	0.2M	1184 F	1103 F	105.7F	100.7F	110.5F	3.7	4.9	32.4M
500	20.5P	0.4P	20.5P	-0.10P			90.5F	89.4F	83.3F	79.4F	1.0	91.1F	110.1F	92.9F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

JAN 30, 1985 Waste A

0030	01	02	03	04	05	06	07	08	09	10	11	12	15	16
0100	--GLASS FURNACE POWER---							GAS PARAMETERS						
0200	KV AB	KV BC	KV CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	UNTR DP	AIR AMB
0300								LIQUID PARAMETERS								
0400	/----------GAS PARAMETERS CONT----------															
0500	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PM	SCRB IT	DLG RTN	UNT RTN	
0600																
16:37:12	27.1K	25.4K	22.7K	1686 F	1930 F	93.0F	28.95	0.0M	1183 F	1102 F	105.3F	100.6F	110.6F	3.6	4.9	32.6M
500	20.5P	0.4P	18.9P	-0.16P			90.7F	89.3F	83.3F	79.2F	1.0	90.9F	109.0F	93.0F		
16:38:00	27.1K	25.3K	23.1K	1677 F	1926 F	93.0F	28.95	0.0M	1182 F	1101 F	104.6F	100.6F	110.5F	3.7	4.9	32.4M
500	20.5P	0.4P	18.9P	-0.16P			90.6F	88.0F	83.0F	79.2F	1.0	91.0F	108.7F	92.7F		
16:39:11	27.1K	25.4K	23.0K	1684 F	1928 F	92.9F	28.95	0.1M	1182 F	1101 F	104.3F	100.6F	110.4F	3.6	4.9	31.9M
500	20.5P	0.4P	104.0P	4.98P			90.7F	86.8F	83.1F	79.2F	1.0	91.4F	108.0F	92.8F		
16:40:00	27.0K	25.4K	22.8K	1674 F	1930 F	92.7F	28.95	0.2M	1182 F	1099 F	104.0F	100.7F	110.3F	3.5	5.0	31.7M
500	20.5P	0.4P	105.0P	5.28P			90.5F	88.8F	83.0F	79.3F	1.0	91.1F	107.7F	92.6F		
16:41:44	27.0K	25.3K	23.2K	1672 F	1922 F	92.7F	28.95	0.0M	1181 F	1100 F	103.9F	100.5F	110.4F	3.7	4.9	32.2M
500	20.5P	0.4P	93.7P	4.96P			90.4F	87.9F	82.9F	79.3F	1.0	91.0F	106.9F	92.6F		
16:42:00	27.0K	25.2K	23.2K	1677 F	1923 F	92.7F	28.95	0.0M	1182 F	1100 F	103.5F	100.5F	110.3F	3.7	4.9	32.1M
500	20.5P	0.4P	93.4P	5.00P			90.5F	88.0F	83.2F	79.4F	1.0	91.0F	106.9F	92.5F		
16:44:00	26.9K	25.4K	22.9K	1773 F	1939 F	93.1F	28.95	0.1M	1043 F	1001 F	101.5F	99.9F	110.2F	0.4	7.2	31.3M
500	20.6P	0.4P	-0.3P	-0.22P			90.2F	87.6F	82.8F	79.1F	1.0	90.6F	104.7F	92.3F		
16:46:00	27.3K	25.4K	22.8K	1669 F	1917 F	92.4F	28.95	0.1M	1197 F	1105 F	102.6F	100.4F	110.6F	3.8	4.8	31.3M
500	20.6P	0.4P	-0.3P	-0.22P			90.0F	88.3F	83.1F	79.1F	1.0	90.6F	105.9F	92.1F		
16:48:00	26.8K	25.3K	22.8K	1678 F	1916 F	92.6F	28.95	0.0M	1199 F	1107 F	102.0F	100.5F	110.3F	3.8	4.9	31.9M
500	20.7P	0.4P	-0.2P	-0.22P			90.2F	81.3F	82.8F	79.1F	1.0	90.7F	105.1F	92.3F		
16:50:00	26.6K	25.3K	22.4K	1674 F	1914 F	92.4F	28.95	0.1M	1199 F	1109 F	101.8F	100.6F	110.5F	4.0	4.8	31.3M
500	20.7P	0.4P	-0.3P	-0.22P			89.9F	84.8F	82.9F	79.0F	1.0	90.7F	103.8F	92.0F		
16:52:00	26.6K	25.2K	22.9K	1682 F	1911 F	92.6F	28.95	0.1M	1199 F	1109 F	101.5F	100.6F	110.7F	3.8	4.8	31.4M
500	20.7P	0.4P	-0.3P	-0.20P			89.9F	85.7F	82.9F	79.1F	1.0	90.5F	103.7F	91.7F		
16:54:00	26.5K	25.3K	22.4K	1671 F	1911 F	92.7F	28.95	0.1M	1198 F	1110 F	101.1F	100.7F	110.5F	3.9	4.8	31.4M
500	20.7P	0.4P	-0.3P	-0.22P			89.5F	86.5F	82.9F	79.0F	1.0	90.3F	103.1F	91.4F		
16:56:00	26.4K	25.3K	22.4K	1686 F	1906 F	92.2F	28.95	0.1M	1200 F	1108 F	100.	100.7F	110.7F	3.8	4.7	31.4M
500	20.7P	0.4P	-0.3P	-0.22P			89.4F	85.7F	83.1F	78.9F		90.2F	102.4F	91.3F		

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 2  5    MRC-MOUND      DEVELOPMENTAL WASTE PROCESSING SYSTEMS   GLASS FURNACE AND CYCLONE INCINERATOR
0030        01       02       03       04       05       06       07       08       09       10       11       12       13       14       15       16
100       --GLASS FURNACE POWER---/-----------------------------GAS PARAMETERS-------------------------------------------------------------------/
200       KW AB     KW BC    KW CD    CMBR T1 CMBR T2  AMB T BAR P   AIR DRM  OFGS T1 OFGS T2 OLUG DT MST DT  EXH DT  OLUG P  VNTR DP AIR ANB
300
400       /-----------GAS PARAMETERS CONT--------/-----------------LIQUID PARAMETERS---------------------------------/
500          02     COMBUS     CO       CO2      NOX            HE INT  HE DT   RAD INT RAD DT  CSTC PH SCRB IT DLG RTN VNT RTN
600       ------------------------------------------------------------------------------------------------------------------------------------

16:57:02   26.4K    25.2K    22.9K  1674 F  1909 F    92.1F  28.95      0.0M  1202 F  1110 F  100.9F  101.1F  110.6F    3.0      4.8      30.9M
500        20.7P     0.4P    -0.4P  -0.22P                    89.1F    86.5F   82.8F   78.9F    1.0    89.8F  102.7F   91.1F
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2 5	MRC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR									
0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DEM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR ANB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	02	COMBUS	CO	CO2	NOX			HE INT	HE OT	RAD INT	RAD OT	CSTC PM	SCRB IT	DLG RTN	VNT RTN	
600																

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12:33:00	25.8K	26.0K	23.0K	2095 F	2391 F	88.2F	28.95	1.0M	1229 F	1131 F	79.4F	132.0F	82.1F	3.9	5.3	52.5M
500	19.1P	0.3P	0.2P	-0.08P			55.2F	57.0F	80.0F	78.9F	1.0	55.1F	87.2F	54.0F		
12:35:00	26.0K	26.1K	23.0K	2098 F	2386 F	88.2F	28.95	0.8M	1231 F	1135 F	79.1F	120.5F	84.9F	3.7	5.3	52.0M
500	18.8P	0.4P	0.6P	0.14P			56.6F	49.4F	81.2F	77.9F	1.0	56.8F	89.0F	58.3F		
12:37:00	25.9K	26.1K	23.3K	2092 F	2379 F	88.6F	28.95	0.7M	1234 F	1139 F	81.5F	123.9F	85.2F	3.7	5.3	53.6M
500	19.2P	0.4P	0.3P	0.12P			55.7F	54.8F	78.8F	78.0F	1.0	56.7F	91.1F	58.9F		
12:39:00	27.2K	27.7K	23.8K	2085 F	2373 F	88.8F	28.95	0.7M	1239 F	1143 F	82.8F	121.6F	88.2F	3.6	5.3	52.9M
500	19.2P	0.4P	0.1P	0.10P			57.9F	35.9F	80.3F	77.7F	1.0	57.9F	91.9F	59.6F		
12:41:00	27.3K	27.7K	23.8K	2068 F	2367 F	89.3F	28.95	0.6M	1242 F	1145 F	84.5F	118.1F	88.8F	3.8	5.3	52.4M
500	19.2P	0.4P	0.0P	0.08P			58.2F	46.7F	82.2F	78.2F	1.0	59.3F	94.8F	61.0F		
12:43:00	27.4K	27.8K	23.9K	2063 F	2357 F	89.6F	28.95	0.6M	1241 F	1148 F	82.7F	115.2F	89.2F	3.7	5.2	53.2M
500	19.4P	0.3P	0.0P	2.52P			57.8F	39.8F	79.2F	77.9F	1.0	59.2F	92.6F	60.0F		
12:45:00	27.4K	27.7K	23.9K	2055 F	2354 F	90.0F	28.95	0.6M	1235 F	1150 F	85.3F	114.1F	91.6F	3.7	5.3	54.0M
500	18.6P	0.3P	0.4P	2.98P			59.5F	51.6F	80.8F	77.7F	1.0	59.9F	94.2F	61.8F		
12:47:00	27.6K	27.7K	24.2K	2050 F	2347 F	90.4F	28.95	0.6M	1239 F	1150 F	86.9F	111.3F	92.4F	3.7	5.3	53.6M
500	18.9P	0.3P	1.2P	2.54P			59.5F	50.7F	81.9F	77.6F	1.0	59.9F	95.4F	62.0F		
12:49:00	27.6K	27.8K	24.0K	2046 F	2340 F	90.5F	28.95	0.6M	1241 F	1152 F	87.8F	109.6F	93.4F	3.8	5.3	53.8M
500	18.9P	0.2P	1.5P	2.74P			60.3F	51.0F	80.1F	77.4F	1.0	60.8F	96.6F	63.1F		
12:51:00	27.6K	27.8K	24.1K	2027 F	2335 F	90.8F	28.95	0.5M	1241 F	1151 F	88.1F	108.4F	94.4F	3.7	5.3	54.4M
500	19.1P	0.3P	1.3P	2.76P			61.0F	52.5F	80.1F	77.9F	1.0	61.5F	96.6F	63.6F		
12:53:00	27.6K	27.8K	24.3K	2021 F	2330 F	91.1F	28.95	0.5M	1241 F	1152 F	87.9F	106.9F	95.0F	3.7	5.3	54.4M
500	19.3P	0.3P	1.1P	2.66P			61.7F	53.3F	80.4F	77.8F	1.0	62.1F	95.6F	64.3F		
12:55:00	27.6K	27.8K	24.2K	2016 F	2325 F	91.4F	28.95	0.4M	1243 F	1152 F	88.4F	105.4F	95.7F	3.6	5.3	53.3M
500	19.5P	0.3P	1.3P	2.54P			62.6F	52.6F	80.3F	77.4F	1.0	62.9F	96.1F	65.0F		
12:57:00	27.6K	27.9K	24.2K	2015 F	2318 F	91.5F	28.95	0.5M	1245 F	1153 F	88.9F	104.0F	96.3F	3.6	5.2	53.9M
500	19.5P	0.3P	1.2P	2.58P			63.1F	55.2F	80.2F	77.3F	1.0	63.4F	96.9F	65.5F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR	ORN	OFGS T1	OFGS T2	SLUG DT	MST DT	EXH DT	SLUG P	VNTR DP	AIR ANB
300																	
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
12:59:00	27.5K	27.9K	24.3K	2023 F	2311 F	91.7F	28.95	0.5M	1247 F	1154 F	88.7F	103.0F	96.9F	3.5	5.3	54.4M
500	19.5P	0.3P	1.0P	2.74P			63.9F	55.8F	80.2F	77.6F	1.0	64.1F	99.9F	66.3F		
13:01:00	27.4K	27.9K	24.3K	1991 F	2304 F	91.8F	28.95	0.4M	1244 F	1152 F	90.9F	102.0F	97.0F	3.7	5.4	53.5M
500	19.6P	0.3P	1.5P	2.70P			64.1F	54.5F	80.1F	77.4F	1.0	64.4F	99.8F	66.7F		
13:03:00	27.4K	28.1K	24.4K	1987 F	2297 F	92.9F	28.95	0.3M	1243 F	1152 F	90.4F	101.3F	98.7F	3.6	5.3	53.2M
500	19.5P	0.3P	1.8P	2.88P			64.5F	53.6F	79.8F	77.3F	1.0	65.7F	99.6F	67.0F		
13:05:00	27.3K	28.0K	24.4K	1984 F	2291 F	92.1F	28.95	0.3M	1245 F	1151 F	90.8F	101.0F	97.9F	3.6	5.4	53.0M
500	19.6P	0.3P	1.9P	2.98P			65.5F	55.8F	80.1F	77.2F	1.0	65.9F	101.0F	68.1F		
13:07:00	27.3K	28.1K	24.4K	1995 F	2281 F	92.1F	28.95	0.4M	1244 F	1153 F	92.6F	100.8F	99.4F	3.6	5.5	54.3M
500	19.8P	0.4P	1.9P	2.90P			65.7F	61.5F	80.9F	77.8F	1.0	65.9F	101.0F	68.2F		
13:09:00	27.2K	28.0K	24.5K	1966 F	2276 F	92.1F	28.95	0.3M	1241 F	1151 F	91.9F	99.1F	98.7F	3.5	5.3	53.6M
500	19.9P	0.5P	2.0P	3.20P			67.1F	58.6F	81.3F	77.1F	1.0	67.2F	101.7F	69.3F		
13:11:00	27.2K	28.0K	24.6K	1955 F	2268 F	92.0F	28.95	0.4M	1238 F	1148 F	92.3F	97.8F	97.8F	3.7	5.3	53.5M
500	19.9P	0.5P	2.1P	3.06P			66.9F	54.7F	79.7F	77.4F	1.0	67.8F	103.9F	70.1F		
13:13:00	27.3K	27.8K	24.7K	1953 F	2257 F	92.3F	28.95	0.4M	1239 F	1151 F	94.7F	98.8F	100.5F	3.6	5.3	53.8M
500	19.7P	0.5P	1.6P	3.14P			67.7F	55.8F	79.2F	77.0F	1.0	68.7F	104.7F	72.0F		
13:15:00	27.7K	27.8K	24.6K	1933 F	2251 F	91.6F	28.95	0.2M	1232 F	1147 F	95.1F	97.8F	100.1F	3.6	5.5	53.3M
500	19.7P	0.5P	2.1P	3.14P			69.1F	62.5F	80.5F	77.5F	1.0	69.5F	104.5F	71.8F		
13:17:00	27.2K	27.6K	24.6K	1947 F	2243 F	91.9F	28.95	0.3M	1235 F	1148 F	93.8F	97.2F	100.0F	3.5	5.3	53.3M
500	20.2P	0.5P	2.0P	3.00P			68.3F	60.6F	80.5F	77.6F	1.0	68.5F	103.0F	71.9F		
13:19:00	26.8K	28.1K	24.9K	1948 F	2232 F	92.9F	28.95	0.4M	1232 F	1146 F	94.5F	96.3F	100.1F	3.6	5.4	52.6M
500	19.4P	0.4P	2.7P	3.36P			66.9F	60.2F	80.3F	77.6F	1.0	69.0F	101.9F	71.3F		
13:21:00	26.8K	28.0K	24.9K	1954 F	2218 F	92.8F	28.95	0.4M	1237 F	1145 F	92.5F	95.7F	100.0F	3.7	5.3	52.8M
500	19.9P	0.5P	2.5P	3.04P			68.4F	60.5F	80.3F	77.5F	1.0	68.6F	101.8F	70.9F		
13:23:00	26.7K	27.6K	24.8K	1931 F	2209 F	92.2F	28.95	0.3M	1236 F	1144 F	95.3F	95.5F	100.5F	3.6	5.3	52.3M
500	20.5P	0.5P	2.7P	2.52P			68.7F	60.6F	80.5F	77.4F	1.0	69.0F	102.6F	71.7F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
13:25:00	26.8K	27.8K	24.8K	1918 F	2198 F	93.3F	28.95	0.4M	1232 F	1144 F	94.3F	94.9F	101.0F	3.5	5.4	52.5M
500	20.2P	0.5P	2.7P	2.70P			69.1F	59.4F	79.9F	77.1F	1.0	69.2F	101.9F	71.4F		
13:27:00	26.7K	27.7K	24.7K	1926 F	2191 F	93.2F	28.95	0.3M	1234 F	1143 F	94.1F	95.4F	101.0F	3.5	5.4	51.6M
500	19.5P	0.5P	3.1P	2.82P			68.2F	59.0F	80.2F	77.3F	1.0	70.0F	104.3F	72.1F		
13:29:00	27.6K	27.0K	24.7K	1901 F	2186 F	94.7F	28.95	0.3M	1232 F	1142 F	94.6F	94.3F	101.0F	3.6	5.3	51.1M
500	19.0P	0.5P	2.5P	2.86P			69.0F	62.7F	80.3F	77.3F	1.0	69.1F	105.2F	71.9F		
13:31:00	26.7K	27.6K	24.7K	1915 F	2180 F	93.2F	28.95	0.3M	1232 F	1143 F	94.6F	94.1F	101.6F	3.5	5.4	51.4M
500	20.5P	0.6P	4.0P	2.76P			69.2F	62.1F	80.7F	77.2F	1.0	69.4F	103.4F	72.2F		
13:33:00	26.5K	27.6K	24.8K	1891 F	2174 F	93.6F	28.95	0.3M	1230 F	1141 F	94.5F	93.6F	101.3F	3.5	5.4	51.1M
500	19.4P	0.5P	3.5P	3.10P			68.8F	62.4F	80.6F	77.4F	1.0	69.7F	103.0F	72.1F		
13:35:00	26.4K	27.6K	24.8K	1886 F	2163 F	93.7F	28.95	0.3M	1231 F	1141 F	93.1F	93.2F	101.5F	3.4	5.4	50.7M
500	20.0P	0.6P	3.7P	3.08P			68.0F	62.2F	80.8F	77.5F	1.0	69.9F	102.9F	72.1F		
13:37:00	26.4K	27.6K	24.8K	1899 F	2159 F	93.6F	28.95	0.2M	1229 F	1139 F	93.2F	92.9F	101.7F	3.5	5.3	50.6M
500	20.7P	0.5P	4.2P	2.86P			68.3F	62.4F	80.5F	77.4F	1.0	69.6F	101.4F	71.7F		
13:39:00	26.4K	27.5K	24.8K	1895 F	2151 F	93.6F	28.95	0.3M	1225 F	1140 F	93.5F	92.6F	101.7F	3.6	5.3	50.2M
500	20.9P	0.5P	3.2P	1.52P			70.6F	64.8F	81.0F	78.0F	1.0	70.0F	100.6F	72.0F		
13:41:00	26.4K	27.2K	24.8K	1885 F	2144 F	93.6F	28.95	0.2M	1227 F	1137 F	93.7F	92.8F	102.0F	3.5	5.3	49.3M
500	20.8P	0.5P	3.7P	0.48P			67.8F	64.0F	81.2F	77.9F	1.0	70.0F	101.5F	72.9F		
13:43:00	26.4K	27.0K	24.7K	1889 F	2134 F	93.6F	28.95	0.3M	1223 F	1136 F	91.5F	92.4F	102.1F	3.5	5.4	49.4M
500	20.7P	0.5P	3.5P	0.22P			68.0F	64.5F	81.7F	78.1F	1.0	69.6F	98.0F	71.7F		
13:45:00	26.5K	26.9K	24.7K	1874 F	2127 F	93.6F	28.95	0.3M	1222 F	1135 F	90.7F	92.3F	102.2F	3.4	5.3	49.4M
500	20.7P	0.5P	3.3P	0.14P			67.5F	64.0F	81.4F	77.7F	1.0	69.7F	97.2F	71.8F		
13:47:00	26.6K	26.8K	24.6K	1859 F	2123 F	93.5F	28.95	0.2M	1222 F	1136 F	91.4F	92.1F	102.3F	3.6	5.4	49.2M
500	20.6P	0.5P	3.1P	0.12P			67.8F	64.1F	81.4F	78.2F	1.0	69.7F	98.9F	71.8F		
13:49:00	26.6K	26.7K	24.4K	1862 F	2116 F	92.9F	28.95	0.2M	1220 F	1134 F	93.0F	92.0F	102.5F	3.5	5.3	49.1M
500	20.6P	0.5P	3.3P	0.10P			69.6F	64.1F	81.4F	78.4F	1.0	70.1F	101.0F	72.5F		

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	KU-A8	KU-8E	KU-C0	CABR TI	CABR T2	AMB T	BAR P	AIR BRN	BFGS TI	OFGS T2	DCOG OT	AST OT	EXA OT	DCOG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS----------/								
500	02	COMBUS	CO	CO2	HOX			HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTH	VNT RTH	
600																
13:51:00	26.6K	26.5K	24.2K	1857 F	2110 F	94.0F	28.95	0.2M	1218 F	1135 F	94.4F	92.2F	102.8F	3.7	5.3	48.9M
500	20.6P	0.5P	3.9P	0.34P			69.9F	66.4F	82.4F	78.3F	1.0	69.9F	103.3F	72.8F		
13:53:00	26.5K	26.6K	23.9K	1847 F	2103 F	93.0F	28.95	0.2M	1220 F	1137 F	93.1F	91.9F	102.8F	3.3	5.4	48.5M
500	20.5P	0.5P	3.2P	0.20P			70.0F	65.4F	82.2F	78.3F	1.0	69.6F	103.2F	72.6F		
13:55:00	26.5K	26.4K	23.9K	1856 F	2097 F	93.5F	28.95	0.2M	1223 F	1136 F	94.7F	91.6F	103.2F	3.5	5.4	48.3M
500	20.4P	0.5P	2.8P	0.20P			69.0F	67.2F	81.9F	78.3F	1.0	69.7F	102.6F	72.7F		
13:57:00	26.5K	26.4K	23.8K	1826 F	2094 F	93.4F	28.95	0.1M	1222 F	1137 F	94.5F	91.4F	102.9F	3.7	5.3	47.9M
500	20.6P	0.5P	3.1P	1.78P			67.9F	66.0F	82.0F	78.0F	1.0	70.1F	104.9F	72.6F		
13:59:00	26.5K	26.3K	23.8K	1853 F	2087 F	93.2F	28.95	0.2M	1221 F	1135 F	95.0F	91.2F	103.2F	3.6	5.3	48.1M
500	19.3P	0.4P	3.9P	3.20P			70.8F	67.6F	82.3F	78.3F	1.0	70.7F	103.3F	72.4F		
14:01:00	26.5K	26.3K	23.7K	1837 F	2085 F	93.4F	28.95	0.2M	1222 F	1135 F	96.1F	91.4F	103.4F	3.5	5.3	47.5M
500	19.2P	0.5P	3.6P	3.46P			68.9F	66.7F	82.3F	78.3F	1.0	71.1F	104.5F	73.8F		
14:03:00	26.4K	26.1K	23.5K	1832 F	2079 F	93.4F	28.95	0.2M	1222 F	1136 F	94.8F	91.1F	103.3F	3.5	5.3	47.6M
500	19.3P	0.5P	3.6P	3.44P			69.7F	67.6F	81.0F	77.8F	1.0	69.6F	104.2F	72.7F		
14:05:00	26.4K	26.3K	23.4K	1845 F	2076 F	93.5F	28.95	0.2M	1221 F	1135 F	95.0F	90.8F	103.3F	3.4	5.3	47.1M
500	19.5P	0.5P	4.6P	3.60P			68.9F	68.0F	81.8F	77.6F	1.0	69.9F	104.6F	72.6F		
14:07:00	26.4K	26.2K	23.3K	1821 F	2070 F	93.5F	28.95	0.2M	1218 F	1133 F	95.0F	90.4F	103.3F	3.6	5.4	47.5M
500	20.3P	0.5P	4.3P	3.46P			68.0F	67.5F	81.5F	77.6F	1.0	70.2F	103.6F	72.7F		
14:09:00	26.4K	26.3K	23.2K	1820 F	2066 F	93.5F	28.95	0.2M	1216 F	1132 F	93.3F	90.2F	103.3F	3.5	5.4	47.2M
500	20.7P	0.5P	4.6P	3.36P			68.4F	66.8F	81.4F	77.6F	1.0	70.5F	102.1F	72.6F		
14:11:00	26.4K	26.4K	23.1K	1839 F	2059 F	93.5F	28.95	0.2M	1213 F	1131 F	92.2F	89.9F	103.4F	3.5	5.3	47.0M
500	20.7P	0.5P	4.9P	1.76P			69.7F	66.9F	81.9F	77.6F	1.0	70.7F	100.8F	72.7F		
14:13:00	26.4K	26.1K	22.8K	1826 F	2053 F	94.0F	28.95	0.1M	1213 F	1130 F	92.1F	89.8F	103.5F	3.6	5.3	46.1M
500	20.8P	0.5P	4.4P	1.66P			69.1F	67.5F	81.9F	77.8F	1.0	70.9F	101.5F	72.8F		
14:15:00	26.4K	25.9K	22.8K	1809 F	2052 F	93.4F	28.95	0.1M	1210 F	1130 F	92.4F	89.5F	103.7F	3.6	5.2	46.1M
500	19.3P	0.4P	4.1P	3.02P			69.7F	69.2F	81.6F	77.7F	1.0	69.7F	100.1F	72.6F		

	--GLASS FURNACE POWER---/							GAS PARAMETERS								
	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
	O2	COMBUS	CO	CO2	NOX			HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN	
14:17:00	26.5K	25.8K	22.8K	1778 F	2043 F	93.7F	28.95	0.2M	1210 F	1128 F	91.4F	89.6F	103.6F	3.6	5.3	46.3M
500	19.6P	0.4P	4.6P	2.68P			69.1F	68.1F	81.6F	77.6F	1.0	70.1F	101.4F	72.5F		
14:19:00	26.5K	25.8K	22.7K	1798 F	2039 F	93.8F	28.95	0.1M	1208 F	1129 F	91.4F	89.3F	103.7F	3.6	5.3	45.3M
500	19.9P	0.5P	4.5P	2.62P			70.9F	69.1F	81.5F	77.6F	1.0	70.3F	99.8F	72.5F		
14:21:00	27.0K	26.1K	23.1K	1807 F	2035 F	94.9F	28.95	0.1M	1208 F	1129 F	92.3F	89.6F	104.1F	3.5	5.4	45.5M
500	20.0P	0.5P	4.9P	2.48P			69.0F	66.9F	81.3F	78.3F	1.0	71.0F	99.4F	73.6F		
14:23:00	27.0K	25.6K	22.9K	1815 F	2034 F	93.4F	28.95	0.2M	1197 F	1120 F	91.1F	89.9F	103.8F	3.2	4.6	45.4M
500	20.3P	0.5P	5.2P	2.66P			69.5F	67.2F	82.0F	77.5F	1.0	69.5F	97.2F	72.7F		
14:25:00	26.8K	25.5K	22.8K	1808 F	2036 F	93.6F	28.95	0.2M	1194 F	1118 F	89.7F	89.7F	103.5F	3.2	4.6	44.8M
500	20.3P	0.5P	5.0P	2.64P			70.7F	67.8F	81.3F	77.7F	1.0	69.9F	94.9F	72.1F		
14:27:00	26.6K	25.3K	22.8K	1805 F	2034 F	93.9F	28.95	0.2M	1195 F	1115 F	90.2F	89.6F	103.6F	3.2	4.6	45.0M
500	20.3P	0.5P	5.2P	2.56P			69.3F	68.9F	81.6F	77.7F	1.0	71.4F	94.5F	72.9F		
14:29:00	27.5K	25.5K	23.3K	1790 F	2030 F	94.0F	28.95	0.2M	1194 F	1116 F	89.5F	90.3F	103.1F	3.1	4.7	45.3M
500	20.6P	0.5P	5.4P	2.40P			68.8F	64.8F	81.0F	77.8F	1.0	70.0F	94.7F	72.1F		
14:31:00	27.2K	25.8K	23.1K	1791 F	2027 F	93.9F	28.95	0.2M	1190 F	1112 F	89.4F	89.8F	104.5F	3.2	4.6	44.3M
500	20.7P	0.5P	5.4P	2.26P			69.2F	67.0F	81.9F	77.8F	1.0	70.4F	95.1F	72.0F		
14:33:00	27.0K	25.6K	23.0K	1789 F	2030 F	94.2F	28.95	0.2M	1189 F	1111 F	89.5F	89.6F	104.2F	3.2	4.5	45.0M
500	20.6P	0.5P	5.7P	1.32P			70.0F	68.6F	80.9F	77.4F	1.0	70.1F	93.4F	71.7F		
14:35:00	27.8K	25.1K	23.0K	1782 F	2029 F	94.0F	28.95	0.3M	1187 F	1112 F	88.5F	89.5F	104.0F	3.2	4.5	44.7M
500	20.5P	0.5P	5.4P	0.40P			69.8F	69.0F	81.2F	77.5F	1.0	71.4F	93.2F	72.5F		
14:37:00	26.6K	25.2K	23.4K	1785 F	2027 F	94.2F	28.95	0.2M	1187 F	1110 F	88.2F	89.9F	104.3F	3.2	4.5	44.4M
500	20.5P	0.5P	5.6P	0.30P			68.8F	67.0F	81.3F	77.6F	1.0	70.6F	93.1F	72.7F		
14:39:00	26.6K	25.1K	23.3K	1778 F	2026 F	94.2F	28.95	0.2M	1189 F	1109 F	89.7F	89.4F	104.2F	3.1	4.6	44.5M
500	20.4P	0.5P	5.4P	0.34P			69.4F	67.0F	80.6F	77.5F	1.0	70.8F	94.3F	72.1F		
14:41:00	26.7K	25.1K	23.3K	1776 F	2025 F	94.3F	28.95	0.2M	1189 F	1109 F	89.1F	89.4F	104.4F	3.1	4.5	43.9M
500	20.3P	0.4P	5.4P	1.64P			70.7F	67.5F	81.2F	77.8F	1.0	70.6F	94.2F	72.3F		

	--GLASS FURNACE POWER															
	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	PLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
	/----------GAS PARAMETERS CONT--------/----------LIQUID PARAMETERS----------/															
	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	QSTC PH	SCRB IT	DLG RTN	VNT RTN		
14:43:00	26.6K	25.0K	23.0K	1772 F	2024 F	94.1F	28.95	0.2M	1187 F	1109 F	90.1F	89.3F	104.3F	3.1	4.5	43.8M
500	20.8P	0.4P	5.3P	1.58P			70.9F	67.4F	81.9F	77.9F	1.0	70.1F	95.2F	72.8F		
14:45:00	26.7K	25.1K	23.3K	1771 F	2022 F	94.3F	28.95	0.3M	1190 F	1110 F	89.8F	89.2F	104.4F	3.0	4.6	43.4M
500	20.3P	0.4P	5.8P	1.50P			69.1F	67.9F	81.6F	77.8F	1.0	71.3F	94.8F	72.6F		
14:47:00	26.7K	25.1K	23.2K	1762 F	2019 F	94.4F	28.95	0.2M	1197 F	1115 F	91.4F	89.4F	104.5F	3.0	4.6	43.6M
500	19.1P	0.5P	12.7P	0.80P			69.8F	66.8F	81.8F	78.2F	1.0	70.2F	98.1F	72.7F		
14:49:00	26.7K	25.1K	23.2K	1766 F	2021 F	94.5F	28.95	0.1M	1191 F	1113 F	89.8F	89.0F	104.5F	3.1	4.5	43.4M
500	18.8P	0.5P	10.1P	2.76P			70.1F	65.7F	81.8F	77.9F	1.0	70.6F	95.8F	72.3F		
14:51:00	26.7K	25.0K	23.2K	1788 F	2019 F	94.3F	28.95	0.1M	1192 F	1112 F	91.1F	89.2F	104.5F	3.0	4.5	42.9M
500	18.8P	0.5P	0.2P	2.48P			70.1F	68.6F	81.8F	78.0F	1.0	71.0F	95.6F	72.3F		
14:53:00	26.6K	25.1K	23.1K	1794 F	2015 F	94.3F	28.95	0.2M	1193 F	1113 F	91.2F	89.6F	104.2F	3.1	4.5	42.5M
500	18.8P	0.5P	0.1P	2.48P			68.5F	66.1F	81.3F	77.5F	1.0	70.5F	97.3F	72.8F		
14:55:00	26.7K	25.1K	23.1K	1794 F	2015 F	94.2F	28.95	0.2M	1189 F	1112 F	91.5F	89.2F	104.4F	3.1	4.6	43.1M
500	18.8P	0.5P	0.2P	2.58P			68.3F	66.7F	81.4F	78.2F	1.0	70.5F	97.2F	71.9F		
14:57:00	26.7K	25.0K	23.1K	1795 F	2012 F	94.2F	28.95	0.2M	1191 F	1112 F	91.3F	89.1F	104.3F	3.2	4.6	42.5M
500	18.7P	0.5P	0.6P	2.68P			68.1F	66.2F	80.6F	77.4F	1.0	70.4F	96.2F	72.0F		
14:59:00	26.6K	25.1K	22.8K	1791 F	2011 F	94.2F	28.95	0.1M	1194 F	1112 F	91.0F	89.1F	104.8F	3.1	4.5	42.2M
500	18.5P	0.5P	0.6P	2.86P			69.4F	66.5F	81.4F	77.7F	1.0	70.5F	97.4F	72.0F		
15:01:00	26.6K	25.0K	23.0K	1788 F	2008 F	94.1F	28.95	0.1M	1193 F	1112 F	93.0F	89.0F	104.6F	3.2	4.6	42.7M
500	18.5P	0.5P	0.8P	3.02P			70.9F	68.3F	81.1F	77.6F	1.0	71.0F	99.6F	72.5F		
15:03:00	26.7K	25.0K	22.8K	1787 F	2005 F	93.6F	28.95	0.2M	1196 F	1114 F	94.1F	89.0F	104.9F	3.1	4.6	42.1M
500	18.3P	0.6P	1.3P	3.28P			67.9F	66.4F	81.0F	77.4F	1.0	70.6F	100.9F	73.6F		
15:05:00	26.6K	25.0K	23.0K	1768 F	2003 F	94.0F	28.95	0.2M	1197 F	1116 F	92.7F	88.9F	104.6F	3.1	4.5	42.7M
500	18.1P	0.6P	1.7P	3.54P			68.3F	66.3F	80.8F	77.0F	1.0	70.4F	102.4F	72.1F		
15:07:00	26.7K	25.0K	23.0K	1787 F	2001 F	93.9F	28.95	0.1M	1198 F	1115 F	95.0F	88.7F	104.5F	3.1	4.6	42.6M
500	18.0P	0.6P	2.2P	3.70P			68.2F	65.9F	80.5F	77.2F	1.0	70.5F	102.7F	72.5F		

	--GLASS FURNACE POWER---							--GAS PARAMETERS---									
	KV AB	KV BC	KV CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB	
	--GAS PARAMETERS CONT---							--LIQUID PARAMETERS---									
	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN			
15:09:00	26.8K	25.2K	22.7K	1788 F	1996 F	94.0F	28.95	0.2M	1200 F	1114 F	94.1F	88.8F	104.7F	3.2	4.6	42.5M	
500	17.9P	0.6P	2.5P	3.92P			69.6F	66.1F	80.4F	77.1F	1.0	70.8F	103.3F	72.6F			
15:11:00	27.9K	24.9K	22.8K	1779 F	1994 F	93.9F	28.95	0.0M	1199 F	1116 F	95.8F	88.8F	104.7F	3.1	4.5	42.0M	
500	17.9P	0.6P	2.7P	3.88P			70.0F	67.3F	80.6F	77.0F	1.0	70.5F	105.3F	73.0F			
15:13:00	27.8K	25.0K	22.8K	1782 F	1992 F	93.8F	28.95	0.1M	1193 F	1113 F	93.9F	89.0F	104.7F	3.0	4.5	40.8M	
500	18.3P	0.6P	3.6P	3.54P			70.7F	67.7F	81.0F	77.3F	1.0	70.1F	101.1F	72.9F			
15:15:00	26.7K	25.5K	22.9K	1784 F	1992 F	93.0F	28.95	0.2M	1196 F	1109 F	91.9F	88.6F	104.1F	2.9	4.6	41.9M	
500	18.5P	0.6P	3.1P	3.18P			70.3F	67.1F	81.0F	77.4F	1.0	69.9F	99.2F	72.7F			
15:17:00	27.6K	24.9K	22.9K	1774 F	1990 F	93.8F	28.95	0.2M	1206 F	1119 F	92.2F	89.4F	104.8F	3.3	4.4	41.3M	
500	18.6P	0.6P	4.3P	3.10P			69.0F	67.7F	81.2F	77.3F	1.0	71.3F	96.8F	72.9F			
15:19:00	26.5K	25.5K	23.0K	1774 F	1988 F	93.6F	28.95	0.1M	1209 F	1121 F	90.6F	89.6F	104.6F	3.2	4.4	41.3M	
500	18.8P	0.6P	4.4P	2.88P			69.7F	66.0F	80.3F	76.8F	1.0	70.1F	95.3F	72.4F			
15:21:00	27.5K	24.9K	23.0K	1774 F	1987 F	93.7F	28.95	0.0M	1208 F	1122 F	90.2F	89.7F	104.8F	3.3	4.4	41.1M	
500	18.9P	0.6P	4.6P	2.70P			68.6F	67.0F	81.1F	76.8F	1.0	70.8F	93.7F	72.2F			
15:23:00	26.2K	25.1K	22.9K	1781 F	1983 F	93.8F	28.95	0.1M	1206 F	1123 F	89.6F	90.0F	104.9F	3.2	4.4	40.9M	
500	19.0P	0.6P	5.1P	2.56P			69.9F	68.0F	80.7F	77.2F	1.0	69.8F	93.2F	72.0F			
15:25:00	26.2K	25.1K	23.0K	1777 F	1983 F	93.7F	28.95	0.1M	1202 F	1123 F	89.2F	90.0F	105.0F	3.1	4.4	41.1M	
500	19.1P	0.6P	4.6P	2.50P			69.3F	68.0F	80.5F	77.1F	1.0	69.9F	91.4F	72.0F			
15:27:00	26.1K	25.0K	23.1K	1775 F	1982 F	93.6F	28.95	0.1M	1205 F	1120 F	88.1F	90.0F	104.9F	3.3	4.3	41.1M	
500	19.1P	0.6P	4.9P	2.42P			68.1F	67.1F	80.5F	76.7F	1.0	70.0F	91.0F	71.9F			
15:29:00	26.0K	25.0K	23.1K	1779 F	1980 F	93.8F	28.95	0.0M	1204 F	1119 F	87.1F	90.1F	104.9F	3.3	4.4	40.8M	
500	19.2P	0.6P	5.2P	2.34P			68.4F	66.6F	80.3F	76.8F	1.0	70.6F	90.5F	71.6F			
15:31:00	26.0K	25.1K	23.1K	1783 F	1974 F	93.5F	28.95	0.1M	1201 F	1120 F	87.1F	90.1F	104.9F	3.3	4.4	41.2M	
500	19.3P	0.6P	5.3P	2.26P			69.4F	66.1F	80.1F	77.0F	1.0	70.7F	90.6F	71.7F			
15:33:00	25.9K	25.1K	23.1K	1782 F	1979 F	93.5F	28.95	0.1M	1202 F	1119 F	87.0F	90.3F	105.0F	3.2	4.3	40.8M	
500	19.3P	0.6P	5.0P	2.20P			70.8F	66.9F	79.7F	76.8F	1.0	70.4F	89.0F	71.8F			

100	GLASS FURNACE POWER															
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG OT	MST OT	EXH OT	DLUG P	VNTR DP	AIR AMB
300	GAS PARAMETERS CONT							LIQUID PARAMETERS								
400	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
500																
600																
15:35:00	25.9K	25.1K	23.1K	1781 F	1978 F	93.5F	28.95	0.1M	1201 F	1117 F	85.4F	90.3F	104.9F	3.3	4.4	41.1M
500	19.4P	0.6P	5.5P	2.18P			70.1F	67.7F	79.7F	76.5F	1.0	70.0F	88.5F	71.8F		
15:37:00	25.8K	25.1K	23.2K	1775 F	1976 F	93.5F	28.95	0.1M	1203 F	1116 F	85.4F	90.3F	105.0F	3.3	4.3	41.1M
500	19.4P	0.6P	5.8P	2.12P			68.8F	67.8F	80.4F	76.5F	1.0	69.8F	87.8F	71.7F		
15:39:00	25.8K	25.1K	23.2K	1794 F	1974 F	93.4F	28.95	0.0M	1201 F	1116 F	85.1F	90.4F	105.0F	3.3	4.4	40.5M
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1973 F	94.4F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1968 F	93.3F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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 2  5    MRC-MOUND      DEVELOPMENTAL WASTE PROCESSING SYSTEMS   GLASS FURNACE AND CYCLONE INCINERATOR
0031        01      02      03      04      05      06      07      08      09      10      11      12      13      14      15      16
 100      --GLASS FURNACE POWER---/-----------------------------GAS PARAMETERS-----------------------------------------------------/
 200      KV AB    KV BC   KV CD   CMBR T1 CMBR T2  AMB T BAR P   AIR DRM  OFGS T1 OFGS T2 DLUG DT MST DT  EXH DT  DLUG P  VNTR DP AIR AMB
 300
 400      /----------GAS PARAMETERS CONT--------/-----------------LIQUID PARAMETERS---------------------------------/
 500         02    COMBUS    CO      CO2     HDX           HE INT  HE DT   RAD INT RAD DT  CSTC PH SCRB ET DLG RTN VNT RTN
 600      ------------------------------------------------------------------------------------------------------------------
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2 5 NRC-MOUND 1

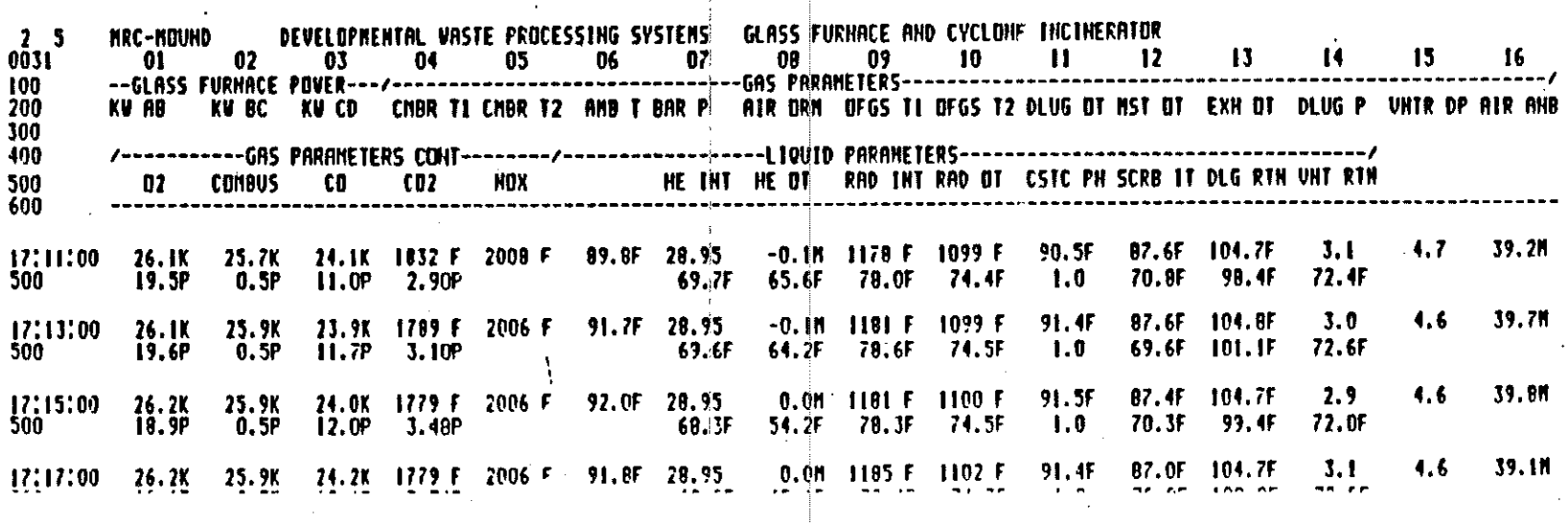
100	--GLASS FURNACE POWER---								GAS PARAMETERS									
200	KW AB	KW BC	KW CO	CMBR T1	CMBR T2	AMB T	BAR P	AIR DPM	OFGS T1	OFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB		
300																		
400	GAS PARAMETERS CONT							LIQUID PARAMETERS										
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN				
600																		
15:53:00	25.3K	25.2K	23.4K	1798 F	1960 F	93.3F	28.95	-0.1M	1200 F	1114 F	83.6F	90.4F	105.1F	3.3	4.4	39.8M		
500	20.3P	0.5P	7.0P	1.30P			68.9F	66.8F	80.0F	76.1F	1.0	71.2F	85.0F	72.3F				
15:55:00	25.3K	25.2K	23.4K	1797 F	1959 F	93.3F	28.95	0.0M	1200 F	1117 F	82.3F	90.2F	105.1F	3.2	4.4	40.0M		
500	20.2P	0.5P	6.7P	1.30P			70.0F	67.5F	80.1F	76.1F	1.0	69.8F	83.8F	71.1F				
15:57:00	25.2K	25.2K	23.4K	1806 F	1953 F	93.3F	28.95	0.0M	1201 F	1115 F	82.8F	90.1F	105.1F	3.3	4.4	40.0M		
500	20.4P	0.5P	6.7P	1.18P			69.8F	66.4F	80.0F	76.0F	1.0	70.3F	83.9F	71.5F				
15:59:00	25.1K	25.3K	23.5K	1801 F	1951 F	93.3F	28.95	0.0M	1204 F	1115 F	82.3F	90.1F	105.1F	3.4	4.4	40.5M		
500	20.3P	0.5P	7.2P	1.08P			70.1F	67.0F	79.9F	76.0F	1.0	70.3F	83.1F	71.3F				
16:01:00	25.1K	25.3K	23.5K	1804 F	1945 F	93.2F	28.95	0.0M	1201 F	1116 F	82.2F	89.9F	105.1F	3.3	4.3	40.2M		
500	20.3P	0.5P	7.2P	1.06P			68.5F	66.5F	79.6F	75.7F	1.0	70.7F	83.2F	71.4F				
16:03:00	25.1K	25.3K	23.6K	1797 F	1948 F	93.1F	28.95	-0.1M	1204 F	1115 F	81.5F	89.8F	105.0F	3.4	4.4	40.2M		
500	20.3P	0.5P	6.8P	1.00P			68.5F	65.5F	80.0F	75.7F	1.0	70.5F	83.0F	71.0F				
16:05:00	25.1K	25.3K	23.5K	1808 F	1940 F	93.1F	28.95	0.0M	1204 F	1116 F	81.5F	89.7F	105.0F	3.3	4.4	40.1M		
500	20.4P	0.5P	6.9P	0.90P			68.3F	65.6F	79.2F	75.2F	1.0	70.5F	82.4F	71.0F				
16:07:00	25.1K	25.3K	23.6K	1798 F	1935 F	93.1F	28.95	0.0M	1203 F	1115 F	81.2F	89.8F	105.1F	3.3	4.4	40.4M		
500	20.5P	0.5P	7.0P	0.86P			69.0F	67.3F	79.6F	75.7F	1.0	70.4F	82.4F	71.0F				
16:09:00	25.1K	25.3K	23.5K	1803 F	1933 F	93.0F	28.95	-0.1M	1201 F	1115 F	80.8F	89.8F	105.0F	3.3	4.4	39.7M		
500	20.5P	0.5P	6.7P	0.78P			69.8F	66.7F	79.2F	75.1F	1.0	69.9F	82.1F	71.0F				
16:11:00	25.1K	25.4K	23.5K	1798 F	1931 F	92.9F	28.95	-0.1M	1199 F	1114 F	81.5F	89.9F	105.0F	3.3	4.4	39.8M		
500	20.5P	0.5P	6.9P	0.76P			68.9F	66.4F	79.2F	75.1F	1.0	71.2F	81.9F	71.6F				
16:13:00	25.0K	25.4K	23.6K	1791 F	1923 F	93.0F	28.95	0.0M	1202 F	1115 F	80.7F	89.9F	104.9F	3.3	4.4	39.9M		
500	20.6P	0.5P	7.0P	0.66P			69.8F	66.9F	79.5F	75.2F	1.0	69.7F	82.0F	71.3F				
16:15:00	25.2K	25.4K	23.6K	1791 F	1922 F	92.9F	28.95	0.0M	1201 F	1115 F	81.4F	89.8F	105.0F	3.2	4.5	39.9M		
500	20.7P	0.5P	7.0P	0.50P			68.3F	66.6F	78.4F	75.3F	1.0	70.5F	81.7F	70.9F				
16:17:00	25.1K	25.4K	23.6K	1798 F	1919 F	92.7F	28.95	0.0M	1200 F	1115 F	80.9F	89.7F	104.9F	3.2	4.4	39.5M		
500	20.8P	0.5P	7.0P	0.34P			70.0F	67.2F	79.2F	75.2F	1.0	70.0F	81.4F	70.8F				

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								/
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DEM	OFGS T1	OFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								/
500	02	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PM	SCRB IT	DLG RTN	VNT RTN		
600																
16:19:00	25.0K	25.5K	23.6K	1808 F	1914 F	92.7F	28.95	0.0M	1200 F	1113 F	81.2F	89.7F	104.9F	3.3	4.4	39.5M
500	20.7P	0.6P	6.7P	0.18P			68.4F	66.1F	78.8F	75.0F	1.0	71.1F	81.9F	71.5F		
16:21:00	25.1K	25.5K	23.5K	1798 F	1913 F	92.5F	28.95	-0.1M	1199 F	1114 F	80.7F	89.5F	104.8F	3.3	4.4	39.4M
500	20.6P	0.6P	7.1P	0.08P			69.4F	65.6F	79.1F	74.9F	1.0	69.4F	81.6F	70.9F		
16:23:00	25.1K	25.5K	23.6K	1804 F	1912 F	92.5F	28.95	0.0M	1196 F	1112 F	81.1F	89.3F	104.8F	3.2	4.4	40.0M
500	20.6P	0.6P	7.4P	0.04P			68.3F	65.2F	78.4F	74.8F	1.0	70.5F	81.2F	71.1F		
16:25:00	25.1K	25.5K	23.6K	1814 F	1904 F	92.5F	28.95	-0.1M	1195 F	1109 F	80.7F	89.3F	104.9F	3.2	4.4	39.8M
500	20.6P	0.6P	7.5P	-0.02P			69.7F	67.0F	79.0F	74.9F	1.0	70.3F	81.3F	70.8F		
16:27:00	25.0K	25.5K	23.7K	1804 F	1903 F	92.3F	28.95	0.0M	1190 F	1110 F	80.5F	89.2F	104.7F	3.4	4.5	39.1M
500	20.5P	0.5P	7.3P	-0.06P			69.5F	66.0F	78.9F	74.9F	1.0	69.5F	81.6F	71.0F		
16:29:00	25.0K	25.6K	23.6K	1803 F	1896 F	92.3F	28.95	0.0M	1189 F	1103 F	80.6F	89.4F	104.8F	3.2	4.3	39.3M
500	20.6P	0.5P	7.1P	-0.12P			68.7F	65.0F	78.7F	75.1F	1.0	70.5F	81.3F	71.1F		
16:31:00	25.0K	25.6K	23.7K	1804 F	1898 F	92.2F	28.95	-0.1M	1185 F	1104 F	80.5F	89.5F	104.8F	3.2	4.4	39.3M
500	20.6P	0.5P	7.4P	-0.16P			70.1F	66.2F	79.0F	75.0F	1.0	70.2F	81.1F	70.7F		
16:33:00	25.0K	25.6K	23.7K	1805 F	1896 F	92.2F	28.95	0.0M	1181 F	1104 F	80.3F	89.9F	104.8F	3.2	4.5	39.0M
500	20.6P	0.5P	7.5P	-0.18P			69.7F	66.8F	78.6F	75.1F	1.0	69.6F	81.4F	71.1F		
16:35:00	25.0K	25.7K	23.7K	1810 F	1896 F	92.2F	28.95	-0.1M	1181 F	1102 F	80.7F	90.2F	104.9F	3.3	4.5	39.0M
500	20.6P	0.5P	7.6P	-0.20P			69.5F	65.2F	79.0F	75.2F	1.0	70.4F	81.3F	71.1F		
16:37:00	25.1K	25.7K	23.7K	1805 F	1896 F	92.1F	28.95	0.0M	1179 F	1101 F	80.4F	90.3F	104.9F	3.3	4.4	39.0M
500	20.6P	0.5P	7.4P	-0.20P			70.1F	67.1F	78.5F	74.8F	1.0	70.0F	80.6F	70.6F		
16:39:00	25.1K	25.7K	23.7K	1809 F	1896 F	92.1F	28.95	-0.1M	1177 F	1101 F	80.4F	90.5F	104.7F	3.2	4.3	39.3M
500	20.6P	0.5P	7.6P	-0.20P			69.4F	65.5F	77.9F	74.8F	1.0	69.4F	81.2F	70.8F		
16:41:00	25.1K	25.7K	23.8K	1879 F	1960 F	92.0F	28.95	0.0M	1004 F	987 F	77.9F	90.0F	104.5F	0.5	6.3	39.2M
500	20.6P	0.5P	7.9P	-0.22P			67.5F	63.8F	78.5F	74.6F	1.0	70.0F	78.4F	70.6F		
16:43:00	25.1K	25.7K	23.7K	1833 F	1914 F	92.3F	28.95	0.0M	1139 F	1071 F	78.4F	90.6F	104.7F	3.0	4.5	39.9M
500	20.6P	0.5P	7.8P	-0.20P			69.8F	66.0F	78.4F	75.0F	1.0	69.9F	80.0F	70.4F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
16:57:00	25.6K	25.8K	24.1K	1792 F	2010 F	91.7F	28.95	0.0M	1167 F	1092 F	86.4F	88.7F	104.7F	3.1	4.6	39.1M
500	20.1P	0.5P	9.1P	1.82P			67.5F	63.1F	78.7F	74.9F	1.0	70.0F	93.1F	71.3F		
16:59:00	25.7K	25.9K	24.1K	1781 F	2009 F	91.8F	28.95	0.0M	1170 F	1091 F	87.3F	88.5F	104.7F	3.0	4.6	39.1M
500	20.4P	0.5P	9.1P	1.92P			69.6F	64.2F	78.6F	74.8F	1.0	69.8F	93.0F	71.1F		
17:01:00	25.7K	25.8K	24.2K	1791 F	2009 F	91.8F	28.95	0.0M	1172 F	1093 F	88.0F	88.3F	104.9F	3.0	4.7	39.4M
500	20.5P	0.5P	9.6P	2.04P			69.9F	65.1F	78.7F	75.0F	1.0	70.0F	95.2F	71.8F		
17:03:00	25.7K	25.9K	24.2K	1791 F	2008 F	91.7F	28.95	-0.1M	1173 F	1095 F	89.4F	88.0F	104.8F	3.0	4.6	39.4M
500	20.6P	0.5P	10.1P	2.14P			69.2F	65.4F	78.5F	74.9F	1.0	70.0F	95.8F	71.6F		
17:05:00	25.8K	25.9K	24.2K	1818 F	2006 F	91.7F	28.95	0.0M	1173 F	1095 F	88.9F	88.0F	104.9F	3.0	4.6	40.0M
500	20.7P	0.5P	10.3P	2.16P			69.4F	65.5F	78.5F	74.9F	1.0	69.6F	96.1F	71.7F		
17:07:00	25.9K	25.9K	24.1K	1859 F	2009 F	91.8F	28.95	0.0M	1175 F	1095 F	88.6F	87.8F	104.8F	3.1	4.7	39.9M
500	20.6P	0.5P	10.3P	2.30P			68.5F	64.2F	78.4F	74.9F	1.0	70.5F	95.5F	71.9F		
17:09:00	26.0K	25.9K	24.1K	1892 F	2006 F	91.8F	28.95	0.0M	1177 F	1097 F	89.2F	87.7F	104.9F	3.1	4.6	39.6M
500	20.2P	0.4P	11.1P	2.56P			70.3F	65.8F	78.1F	75.0F	1.0	70.2F	97.1F	71.6F		



2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							GAS PARAMETERS								/
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG OT	MST OT	EXH OT	DLUG P	VNTR DP	AIR ANB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS							/	
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE OT	RAD INT	RAD OT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
17:11:00	26.1K	25.7K	24.1K	1832 F	2008 F	89.8F	28.95	-0.1M	1178 F	1099 F	90.5F	87.6F	104.7F	3.1	4.7	39.2M
500	19.5P	0.5P	11.0P	2.90P			69.7F	65.6F	78.0F	74.4F	1.0	70.8F	98.4F	72.4F		
17:13:00	26.1K	25.9K	23.9K	1789 F	2006 F	91.7F	28.95	-0.1M	1181 F	1099 F	91.4F	87.6F	104.8F	3.0	4.6	39.7M
500	19.6P	0.5P	11.7P	3.10P			69.6F	64.2F	78.6F	74.5F	1.0	69.6F	101.1F	72.6F		
17:15:00	26.2K	25.9K	24.0K	1779 F	2006 F	92.0F	28.95	0.0M	1181 F	1100 F	91.5F	87.4F	104.7F	2.9	4.6	39.8M
500	18.9P	0.5P	12.0P	3.48P			68.3F	54.2F	78.3F	74.5F	1.0	70.3F	99.4F	72.0F		
17:17:00	26.2K	25.9K	24.2K	1779 F	2006 F	91.8F	28.95	0.0M	1185 F	1102 F	91.4F	87.0F	104.7F	3.1	4.6	39.1M

17:19:00	26.2K	25.9K	24.2K	1976 F	2094 F	91.6F	28.95	0.0M	1119 F	1054 F	94.5F	86.4F	104.2F	2.9	4.9	39.5M
500	0.4P	2.0P	12.4P	3.62P			69.6F	61.0F	77.3F	74.4F	1.0	69.7F	106.7F	72.4F		
17:21:00	26.2K	25.8K	24.2K	2104 F	2145 F	91.6F	28.95	0.0M	1073 F	1023 F	93.7F	86.2F	103.6F	2.6	5.2	40.0M
500	0.5P	3.6P	259.7P	5.72P			66.9F	-72.1F	77.2F	74.3F	1.0	69.8F	103.7F	71.7F		
17:23:00	26.2K	25.8K	24.4K	2010 F	2112 F	91.5F	28.95	0.0M	1155 F	1061 F	93.9F	85.5F	103.3F	1.9	6.1	39.7M
500	14.4P	1.0P	259.6P	4.72P			68.4F	53.9F	76.8F	74.1F	1.0	69.0F	104.0F	71.4F		
17:25:00	26.2K	25.8K	24.2K	2087 F	2044 F	92.6F	28.95	0.2M	1247 F	1115 F	96.1F	85.0F	103.7F	2.6	9.2	40.0M
500	18.2P	0.7P	84.9P	0.02P			69.2F	51.7F	77.6F	74.4F	1.0	68.9F	111.6F	73.2F		
17:27:00	26.0K	25.8K	24.3K	2062 F	2031 F	93.0F	28.95	0.4M	1253 F	1140 F	96.1F	84.9F	103.9F	2.5	9.1	39.8M
500	19.0P	0.6P	32.0P	-0.16P			68.2F	61.5F	77.5F	74.4F	1.0	70.4F	111.2F	73.5F		
17:29:00	26.0K	25.8K	24.3K	1920 F	1987 F	93.2F	28.95	0.4M	1255 F	1156 F	96.8F	85.2F	103.3F	2.4	9.2	39.7M
500	20.1P	0.6P	29.1P	1.54P			69.5F	-0.2F	78.2F	74.5F	1.0	69.5F	111.5F	74.2F		
17:31:00	26.0K	25.8K	24.2K	1900 F	1982 F	93.1F	28.95	0.5M	1254 F	1156 F	95.1F	84.6F	105.3F	2.6	9.1	39.2M
500	20.0P	0.6P	25.7P	1.50P			68.2F	63.3F	78.2F	74.5F	1.0	70.2F	109.5F	73.7F		
17:33:00	25.9K	25.8K	24.2K	1875 F	1960 F	93.1F	28.95	0.5M	1254 F	1150 F	93.5F	84.5F	103.3F	2.4	9.3	39.6M
500	20.5P	0.5P	22.3P	0.86P			67.8F	63.7F	78.7F	74.9F	1.0	70.0F	106.8F	73.3F		
17:35:00	26.0K	25.8K	24.3K	1851 F	1950 F	93.2F	28.95	0.5M	1252 F	1150 F	92.7F	84.3F	105.4F	2.7	9.1	39.3M
500	20.3P	0.5P	18.9P	1.38P			68.7F	63.7F	78.7F	74.7F	1.0	70.4F	103.8F	73.3F		

2 5	NRC-HOUND		DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DPM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS								
500	O2	COMBUS	CO	CO2	NOX			HE INT	HE OT	RAD INT	RAD OT	CSTC PM	SCRB IT	DLG RTN	VNT RTN	
600																
17:37:00	25.9K	25.8K	24.4K	1868 F	1954 F	93.1F	28.95	0.6M	1245 F	1153 F	93.6F	84.3F	105.2F	2.7	9.0	39.9M
500	20.4P	0.5P	18.0P	1.54P			70.0F	62.5F	78.3F	74.7F	1.0	70.4F	106.5F	73.4F		
17:39:00	25.9K	25.8K	24.3K	1834 F	1944 F	93.1F	28.95	0.5M	1245 F	1154 F	93.6F	83.9F	105.0F	2.7	9.1	40.1M
500	20.4P	0.5P	17.4P	1.28P			70.6F	64.5F	78.6F	74.6F	1.0	70.1F	105.9F	73.6F		
17:41:00	25.9K	25.8K	24.3K	1817 F	1933 F	93.1F	28.95	0.6M	1245 F	1154 F	92.4F	84.0F	105.0F	2.8	9.2	39.3M
500	20.4P	0.5P	16.1P	0.96P			69.3F	66.4F	79.0F	74.9F	1.0	69.8F	106.1F	73.5F		
17:43:00	25.8K	25.9K	24.3K	1818 F	1915 F	93.2F	28.95	0.5M	1246 F	1154 F	92.6F	84.1F	105.1F	2.6	9.2	39.7M
500	22.1P	0.4P	15.2P	0.92P			69.2F	64.5F	79.2F	75.1F	1.0	70.1F	105.5F	73.5F		

17:45:00	25.8K	25.9K	24.3K	1809 F	1913 F	93.1F	28.95	0.5M	1242 F	1153 F	92.6F	84.1F	104.8F	2.7	9.1	39.4M
500	20.4P	0.4P	15.6P	0.82P			68.3F	65.1F	79.1F	74.8F	1.0	70.5F	105.2F	73.4F		
17:47:00	[illegible]	[illegible]	[illegible]	[illegible]	1904 F	93.3F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.1	39.0M
17:49:00	[illegible]	[illegible]	[illegible]	[illegible]	1907 F	93.2F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.2	39.1M
500	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

2 5	MRC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	GAS PARAMETERS CONT							LIQUID PARAMETERS								
500	02	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
17:51:00	25.7K	25.9K	24.3K	1780 F	1894 F	93.2F	28.95	0.5M	1238 F	1150 F	92.0F	84.0F	104.9F	2.8	9.3	39.7M
500	20.3P	0.5P	14.9P	0.74P			69.7F	48.4F	78.9F	74.9F	1.0	69.9F	104.7F	73.5F		
17:53:00	25.6K	25.9K	24.2K	1782 F	1889 F	93.2F	28.95	0.4M	1239 F	1149 F	92.7F	84.1F	104.9F	2.7	9.1	39.2M
500	20.3P	0.4P	14.6P	0.72P			68.1F	65.6F	78.5F	74.5F	1.0	70.1F	105.1F	73.4F		
17:55:00	25.6K	25.9K	24.3K	1771 F	1887 F	93.2F	28.95	0.4M	1239 F	1149 F	91.7F	83.9F	105.0F	2.5	9.3	39.2M
500	20.3P	0.4P	14.3P	0.64P			68.3F	65.3F	78.8F	74.5F	1.0	70.5F	105.0F	73.4F		
17:57:00	25.6K	26.0K	24.1K	1774 F	1882 F	93.2F	28.93	0.5M	1239 F	1149 F	91.5F	84.0F	104.9F	2.6	9.2	39.5M
500	20.3P	0.4P	13.9P	0.64P			70.1F	65.1F	78.6F	74.6F	1.0	70.8F	104.9F	73.5F		
17:59:00	25.5K	26.0K	24.2K	1761 F	1879 F	93.1F	28.95	0.3M	1235 F	1147 F	91.0F	83.9F	104.8F	2.8	9.2	39.5M
500	20.3P	0.4P	13.9P	0.48P			70.9F	66.3F	78.3F	74.2F	1.0	70.3F	104.3F	73.5F		
18:01:00	25.5K	26.0K	24.1K	1771 F	1873 F	93.2F	28.95	0.4M	1233 F	1148 F	91.5F	84.1F	105.0F	2.7	9.2	39.3M
500	20.3P	0.4P	13.9P	0.52P			70.0F	67.5F	78.6F	74.1F	1.0	70.1F	104.1F	73.4F		
18:03:00	25.5K	26.0K	24.2K	1764 F	1875 F	93.2F	28.95	0.3M	1234 F	1146 F	92.1F	84.0F	104.9F	2.7	9.2	38.7M
500	20.3P	0.4P	14.0P	0.54P			68.4F	67.1F	77.9F	73.7F	1.0	70.1F	103.9F	73.5F		
18:05:00	25.5K	26.1K	24.1K	1757 F	1873 F	93.3F	28.95	0.4M	1234 F	1145 F	92.6F	84.0F	105.0F	2.7	9.3	38.9M
500	20.3P	0.4P	13.9P	0.58P			68.5F	66.0F	76.8F	73.4F	1.0	70.7F	105.6F	73.6F		
18:07:00	25.5K	26.0K	24.1K	1763 F	1875 F	93.3F	28.95	0.3M	1233 F	1145 F	94.1F	84.2F	105.0F	2.7	9.3	38.5M
500	20.3P	0.4P	13.4P	0.64P			69.9F	66.1F	77.2F	73.0F	1.0	71.0F	106.8F	73.8F		
18:09:00	25.6K	26.1K	24.0K	1756 F	1868 F	93.2F	28.95	0.3M	1234 F	1144 F	93.3F	84.1F	104.8F	2.7	9.2	38.5M
500	20.3P	0.4P	13.8P	0.62P			71.2F	66.9F	77.5F	73.2F	1.0	70.8F	106.5F	74.0F		
18:11:00	25.5K	26.1K	24.0K	1761 F	1871 F	93.2F	28.95	0.3M	1233 F	1144 F	93.8F	84.1F	104.8F	2.8	9.3	39.1M
500	20.3P	0.4P	14.0P	0.62P			70.1F	63.1F	77.4F	73.2F	1.0	70.2F	107.4F	74.2F		
18:13:00	25.5K	26.1K	24.1K	1796 F	1861 F	93.2F	28.95	0.2M	1234 F	1144 F	95.0F	84.2F	104.9F	2.7	9.3	38.7M
500	20.3P	0.4P	13.9P	0.74P			68.7F	65.2F	77.2F	72.9F	1.0	70.1F	108.2F	74.2F		
18:15:00	25.5K	26.1K	24.1K	1806 F	1866 F	93.2F	28.95	0.2M	1235 F	1146 F	96.3F	84.1F	104.8F	2.7	9.3	38.2M
500	20.3P	0.4P	14.0P	0.92P			68.2F	59.9F	76.3F	72.3F	1.0	70.5F	110.5F	74.2F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							GAS PARAMETERS								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							LIQUID PARAMETERS-----								
500	02	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
18:17:00	25.5K	26.2K	24.1K	1810 F	1865 F	93.1F	28.95	0.1M	1237 F	1147 F	96.8F	84.2F	104.7F	2.7	9.4	38.3M
500	20.3P	0.4P	13.9P	0.82P			70.0F	58.6F	76.4F	72.1F	1.0	70.9F	110.7F	74.2F		
18:19:00	25.6K	26.2K	24.2K	1782 F	1867 F	93.2F	28.95	0.2M	1238 F	1147 F	97.2F	84.3F	104.8F	2.7	9.4	38.8M
500	20.3P	0.4P	13.8P	0.78P			71.2F	64.9F	76.7F	72.3F	1.0	70.8F	111.5F	74.7F		
18:21:00	25.6K	26.2K	24.2K	1818 F	1865 F	93.1F	28.95	0.2M	1238 F	1148 F	97.0F	84.3F	104.8F	2.7	9.3	38.8M
500	20.3P	0.4P	13.9P	0.58P			70.0F	57.9F	76.3F	72.0F	1.0	70.3F	110.4F	74.7F		
18:23:00	25.6K	26.2K	24.2K	1800 F	1864 F	93.1F	28.95	0.2M	1239 F	1148 F	97.8F	84.3F	105.0F	2.7	9.3	38.3M
500	20.2P	0.4P	13.5P	0.52P			68.3F	64.9F	75.9F	71.9F	1.0	70.3F	110.7F	74.6F		
18:25:00	25.7K	26.2K	24.3K	1800 F	1859 F	93.1F	28.95	0.2M	1238 F	1147 F	96.6F	84.3F	105.1F	2.7	9.4	38.3M
500	20.2P	0.4P	13.9P	0.24P			68.4F	58.9F	76.1F	71.9F	1.0	70.7F	111.2F	74.4F		
18:27:00	25.7K	26.2K	24.3K	1811 F	1861 F	93.1F	28.95	0.2M	1238 F	1148 F	97.4F	84.3F	105.2F	2.6	9.4	38.4M
500	20.2P	0.4P	13.7P	0.12P			70.4F	64.5F	75.6F	71.8F	1.0	71.0F	111.6F	74.6F		
18:29:00	25.8K	26.2K	24.3K	1786 F	1859 F	93.0F	28.95	0.2M	1239 F	1148 F	96.9F	84.3F	105.3F	2.6	9.5	38.2M
500	20.2P	0.4P	14.1P	0.14P			71.2F	64.4F	75.8F	72.0F	1.0	70.6F	111.9F	74.8F		
18:31:00	25.8K	26.2K	24.3K	1765 F	1859 F	93.0F	28.95	0.2M	1242 F	1150 F	99.6F	84.4F	105.4F	2.6	9.4	37.9M
500	20.2P	0.4P	13.9P	0.10P			69.8F	67.5F	76.3F	71.9F	1.0	70.4F	115.2F	75.0F		
18:33:00	25.8K	26.2K	24.3K	1807 F	1865 F	93.1F	28.95	0.2M	1241 F	1150 F	100.1F	84.5F	105.5F	2.6	9.3	38.3M
500	20.5P	0.4P	15.2P	2.84P			68.3F	63.0F	76.0F	71.6F	1.0	70.5F	114.3F	75.2F		
18:35:00	25.8K	26.2K	24.4K	1763 F	1857 F	93.1F	28.95	0.2M	1239 F	1150 F	98.8F	84.6F	105.7F	2.5	9.4	37.8M
500	20.5P	0.4P	15.4P	2.70P			69.2F	39.4F	75.9F	71.6F	1.0	71.1F	114.7F	75.1F		
18:37:00	25.8K	26.2K	24.3K	1790 F	1851 F	93.1F	28.95	0.2M	1238 F	1149 F	99.5F	84.6F	105.7F	2.7	9.4	37.7M
500	20.5P	0.4P	16.3P	2.24P			70.9F	39.5F	75.8F	71.4F	1.0	71.2F	114.0F	75.1F		
18:39:00	25.8K	26.2K	24.4K	1781 F	1846 F	93.0F	28.95	0.2M	1238 F	1148 F	98.6F	84.7F	105.9F	2.7	9.4	38.1M
500	20.4P	0.4P	16.1P	2.00P			71.2F	64.0F	75.5F	71.3F	1.0	70.8F	114.2F	75.4F		
18:41:00	25.8K	26.2K	24.4K	1809 F	1844 F	93.0F	28.95	0.2M	1236 F	1148 F	98.6F	84.7F	105.9F	2.6	9.4	37.8M
500	20.4P	0.4P	16.6P	1.94P			69.4F	50.4F	75.3F	71.3F	1.0	70.5F	113.9F	75.3F		

2 5 MRC-MOUND DEVELOPMENTAL WASTE PROCESSING SYSTEMS GLASS FURNACE AND CYCLONE INCINERATOR

0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---/							-GAS PARAMETERS-								
200	KV AB	KV BC	KV CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	OFGS T1	OFGS T2	PLUG DT	MST DT	EXH DT	PLUG P	VNTR DP	AIR ANB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PH	SCRB IT	DLG RTN	VNT RTN		
600																
18:43:00	25.8K	26.2K	24.4K	1748 F	1839 F	93.0F	28.95	0.2M	1234 F	1148 F	98.1F	84.7F	106.0F	2.7	9.4	37.8M
500	20.4P	0.4P	16.6P	1.76P			68.4F	65.0F	75.3F	71.1F	1.0	70.6F	111.9F	75.1F		
18:45:00	25.8K	26.2K	24.5K	1775 F	1834 F	93.0F	28.95	0.2M	1234 F	1147 F	95.6F	84.6F	106.2F	2.6	9.4	38.2M
500	20.4P	0.4P	16.3P	1.14P			69.1F	65.7F	75.7F	71.4F	1.0	71.2F	109.1F	74.6F		
18:47:00	25.8K	26.2K	24.5K	1721 F	1831 F	93.0F	28.95	0.2M	1231 F	1145 F	93.6F	84.3F	106.3F	2.6	9.4	37.7M
500	20.3P	0.4P	16.2P	0.78P			70.8F	66.9F	75.7F	71.4F	1.0	71.3F	106.5F	74.4F		
18:49:00	25.9K	26.2K	24.5K	1714 F	1824 F	92.9F	28.95	0.2M	1228 F	1145 F	92.7F	84.2F	106.3F	2.6	9.4	37.6M
500	20.3P	0.4P	15.9P	0.56P			71.6F	68.2F	75.9F	71.6F	1.0	71.0F	104.9F	74.3F		
18:51:00	25.9K	26.2K	24.5K	1714 F	1821 F	92.9F	28.95	0.2M	1234 F	1151 F	91.8F	84.0F	106.3F	2.7	9.3	37.6M
500	20.3P	0.4P	16.0P	0.48P			69.9F	68.1F	75.4F	71.3F	1.0	70.6F	103.5F	74.1F		
18:53:00	25.8K	26.2K	24.6K	1710 F	1821 F	92.9F	28.95	0.1M	1233 F	1156 F	92.0F	84.2F	106.6F	2.7	9.3	37.4M
500	20.3P	0.4P	15.8P	0.34P			68.5F	67.9F	75.0F	71.5F	1.0	70.9F	102.4F	74.0F		
18:55:00	25.8K	26.2K	24.6K	1699 F	1808 F	92.8F	28.95	0.1M	1233 F	1154 F	90.9F	84.2F	106.6F	2.7	9.3	37.6M
500	20.2P	0.4P	16.0P	0.22P			68.7F	67.5F	75.7F	71.1F	1.0	71.2F	101.7F	73.7F		
18:57:00	25.8K	26.2K	24.5K	1712 F	1805 F	92.8F	28.95	0.1M	1232 F	1154 F	90.4F	84.2F	106.7F	2.7	9.4	37.8M
500	20.2P	0.4P	16.0P	0.00P			70.8F	67.8F	75.7F	71.4F	1.0	71.4F	100.6F	73.7F		
18:59:00	25.8K	26.2K	24.5K	1683 F	1803 F	92.7F	28.95	0.0M	1232 F	1154 F	89.7F	84.0F	106.6F	2.7	9.3	37.5M
500	20.2P	0.4P	15.9P	-0.02P			71.6F	69.1F	75.3F	71.1F	1.0	71.1F	100.4F	73.8F		
19:01:00	25.7K	26.3K	24.5K	1668 F	1798 F	92.7F	28.95	0.1M	1229 F	1153 F	89.7F	84.1F	106.7F	2.7	9.3	37.1M
500	20.2P	0.4P	15.8P	-0.04P			70.3F	70.0F	75.2F	70.9F	1.0	70.7F	99.7F	73.9F		
19:03:00	25.7K	26.3K	24.5K	1686 F	1802 F	92.7F	28.95	0.1M	1227 F	1153 F	89.3F	84.1F	106.6F	2.7	9.3	37.1M
500	20.2P	0.4P	16.2P	-0.06P			68.6F	68.5F	75.6F	70.9F	1.0	71.0F	100.1F	73.7F		
19:05:00	25.7K	26.3K	24.5K	1675 F	1795 F	92.7F	28.95	0.1M	1227 F	1152 F	89.2F	84.1F	106.7F	2.7	9.3	37.4M
500	20.2P	0.4P	16.2P	-0.06P			69.3F	67.8F	75.3F	70.8F	1.0	71.3F	99.3F	73.5F		
19:07:00	25.6K	26.3K	24.5K	1683 F	1795 F	92.6F	28.95	0.1M	1225 F	1151 F	89.1F	84.0F	106.6F	2.7	9.4	37.5M
500	20.2P	0.4P	16.0P	-0.06P			71.1F	68.3F	74.8F	70.5F	1.0	71.5F	99.1F	73.5F		

2 5	MRC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR								
0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							-GAS PARAMETERS-								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR ORM	OFGS T1	OFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AHB
300																
400	/----------GAS PARAMETERS CONT--------/							-LIQUID PARAMETERS-								
500	02	COMBUS	CO	CO2	NOX			HE INT	HE OT	RAD INT	RAD OT	CSIC PH	SCRB LT	DLG BIN	VNT BIN	
600																
19:09:00	25.6K	26.4K	24.5K	1677 F	1801 F	92.3F	28.95	0.1M	1225 F	1148 F	90.9F	84.1F	106.7F	2.6	9.3	37.0M
500	20.2P	0.4P	15.8P	-0.02P			71.4F	69.5F	75.1F	70.5F	1.0	71.0F	101.8F	73.9F		
19:11:00	25.6K	26.4K	24.6K	1672 F	1792 F	92.3F	28.95	0.1M	1225 F	1148 F	90.3F	84.2F	106.7F	2.7	9.3	37.1M
500	20.2P	0.4P	16.4P	-0.08P			69.2F	69.2F	74.9F	70.5F	1.0	70.6F	101.9F	73.8F		
19:13:00	25.6K	26.4K	24.6K	1674 F	1807 F	92.2F	28.95	0.2M	1228 F	1150 F	93.1F	84.2F	106.8F	2.8	9.3	36.9M
500	20.2P	0.4P	16.2P	-0.04P			68.6F	68.5F	74.8F	70.2F	1.0	70.9F	105.1F	74.0F		
19:15:00	25.6K	26.4K	24.6K	1663 F	1790 F	92.1F	28.95	0.0M	1227 F	1151 F	89.7F	84.3F	106.8F	2.8	9.4	36.5M
500	-6.3P	-1.3P	2.4P	-0.50P			69.9F	67.9F	74.5F	69.9F	1.0	71.4F	101.1F	73.5F		
19:17:00	25.6K	26.4K	24.7K	1668 F	1780 F	92.0F	28.95	0.0M	1224 F	1150 F	88.3F	84.4F	106.7F	2.6	9.3	37.1M
500	-6.3P	-1.3P	2.4P	-0.46P			71.4F	68.2F	74.5F	70.2F	1.0	71.1F	99.3F	73.4F		
19:19:00	25.5K	26.4K	24.7K	1663 F	1775 F	91.9F	28.95	0.0M	1222 F	1148 F	88.4F	84.5F	106.9F	2.7	9.4	37.0M
500	-6.3P	-1.3P	2.5P	-0.44P			70.7F	69.2F	74.4F	70.3F	1.0	70.7F	98.6F	73.5F		
19:21:00	25.6K	26.5K	24.7K	1663 F	1777 F	91.7F	28.95	0.0M	1221 F	1148 F	88.0F	84.6F	106.8F	2.6	9.3	36.5M
500	-6.3P	-1.3P	2.4P	-0.44P			68.6F	68.6F	74.1F	69.7F	1.0	70.5F	97.9F	73.3F		
19:23:00	25.5K	26.5K	24.8K	1659 F	1772 F	91.7F	28.95	0.0M	1220 F	1147 F	87.3F	84.6F	106.9F	2.7	9.4	36.6M
500	-6.3P	-1.3P	2.4P	-0.42P			68.7F	67.4F	74.4F	69.8F	1.0	71.2F	97.6F	73.1F		
19:25:00	25.5K	26.5K	24.7K	1660 F	1766 F	91.7F	28.95	0.0M	1218 F	1147 F	86.4F	84.7F	107.0F	2.7	9.3	37.1M
500	-6.3P	-1.3P	2.4P	-0.42P			70.4F	67.6F	74.0F	69.5F	1.0	71.3F	96.0F	73.0F		
19:27:00	25.6K	26.5K	24.8K	1651 F	1770 F	91.6F	28.95	-0.1M	1215 F	1146 F	86.5F	84.6F	107.0F	2.6	9.3	36.7M
500	-6.3P	-1.3P	2.4P	-0.40P			71.5F	69.2F	74.2F	69.6F	1.0	71.0F	96.6F	73.2F		
19:29:00	25.6K	26.6K	24.7K	1661 F	1775 F	91.6F	28.95	0.0M	1215 F	1145 F	86.5F	84.7F	107.1F	2.7	9.3	36.1M
500	-6.3P	-1.3P	2.4P	-0.40P			70.0F	70.3F	74.3F	69.7F	1.0	70.6F	96.0F	73.2F		
19:31:00	25.6K	26.5K	24.8K	1658 F	1765 F	91.5F	28.95	-0.1M	1215 F	1144 F	86.3F	84.7F	107.1F	2.7	9.4	36.1M
500	-6.3P	-1.3P	2.4P	-0.42P			68.5F	69.3F	74.0F	69.6F	1.0	70.8F	95.9F	72.9F		
19:33:00	25.6K	26.5K	24.8K	1660 F	1763 F	91.6F	28.95	0.0M	1214 F	1142 F	86.3F	84.8F	107.1F	2.7	9.3	36.6M
500	-6.3P	-1.3P	2.4P	-0.40P			69.2F	65.4F	74.2F	69.6F	1.0	71.3F	96.1F	72.9F		

2 5	ARC-MOUND	DEVELOPMENTAL WASTE PROCESSING SYSTEMS					GLASS FURNACE AND CYCLONE INCINERATOR							
0031	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
100	--GLASS FURNACE POWER---							--GAS PARAMETERS--								
200	KW AB	KW BC	KW CD	CMBR T1	CMBR T2	AMB T	BAR P	AIR DRM	DFGS T1	DFGS T2	DLUG DT	MST DT	EXH DT	DLUG P	VNTR DP	AIR AMB
300																
400	/----------GAS PARAMETERS CONT--------/							--LIQUID PARAMETERS--								
500	O2	COMBUS	CO	CO2	NOX		HE INT	HE DT	RAD INT	RAD DT	CSTC PN	SCRB IT	DLG RTN	VNT RTN		
600																
19:35:00	25.6K	26.5K	24.9K	1649 F	1766 F	91.6F	28.95	0.0M	1212 F	1143 F	86.8F	84.8F	107.2F	2.7	9.4	36.5M
500	-6.3P	-1.3P	2.4P	-0.40P			71.2F	67.5F	73.8F	69.4F	1.0	71.3F	95.8F	72.9F		
19:37:00	25.7K	26.6K	24.9K	1644 F	1756 F	91.6F	28.95	-0.1M	1213 F	1142 F	86.3F	84.9F	107.2F	2.7	9.3	36.5M
500	-6.3P	-1.3P	2.4P	-0.40P			71.4F	63.3F	73.6F	69.2F	1.0	70.8F	95.9F	73.1F		
19:39:00	25.6K	26.6K	24.9K	1657 F	1755 F	91.7F	28.95	0.0M	1211 F	1141 F	86.1F	85.0F	107.4F	2.6	9.4	36.2M
500	-6.3P	-1.3P	2.4P	-0.40P			69.4F	69.6F	73.7F	69.2F	1.0	70.6F	96.0F	73.1F		
19:41:00	25.6K	26.6K	24.9K	1650 F	1755 F	91.7F	28.95	-0.1M	1211 F	1140 F	85.6F	85.1F	107.4F	2.7	9.3	36.1M
500	-6.3P	-1.3P	2.4P	-0.38P			68.4F	68.2F	73.8F	69.2F	1.0	70.9F	95.6F	72.8F		
19:43:00	25.6K	26.6K	24.9K	1653 F	1754 F	91.7F	28.95	0.0M	1208 F	1140 F	85.7F	85.0F	107.4F	2.6	9.4	36.4M
500	-6.3P	-1.3P	2.4P	-0.40P			69.8F	56.1F	73.8F	69.2F	1.0	71.2F	95.4F	72.7F		
19:45:00	25.5K	26.6K	25.0K	1649 F	1753 F	91.8F	28.95	0.0M	1208 F	1138 F	85.6F	85.2F	107.5F	2.6	9.3	36.5M
500	-6.3P	-1.3P	2.4P	-0.38P			71.3F	66.5F	73.6F	69.0F	1.0	71.2F	95.3F	72.9F		
19:47:00	25.5K	26.6K	24.9K	1656 F	1756 F	91.8F	28.95	-0.1M	1206 F	1138 F	85.9F	85.3F	107.7F	2.7	9.3	36.2M
500	-6.3P	-1.3P	2.4P	-0.40P			70.9F	69.2F	73.7F	69.2F	1.0	70.5F	95.3F	73.0F		
19:49:00	25.5K	26.6K	24.9K	1640 F	1750 F	91.9F	28.95	-0.1M	1205 F	1138 F	85.2F	85.3F	107.8F	2.6	9.3	36.4M
500	-6.3P	-1.3P	2.4P	-0.38P			69.4F	68.9F	73.7F	69.2F	1.0	70.3F	94.0F	72.9F		
19:51:00	25.6K	26.7K	24.9K	1646 F	1754 F	91.9F	28.95	-0.1M	1203 F	1137 F	85.2F	85.2F	107.9F	2.7	9.4	36:2M
500	-6.3P	-1.3P	2.4P	-0.38P			68.3F	67.8F	73.4F	68.9F	1.0	70.7F	94.1F	72.6F		
19:53:00	25.6K	26.7K	24.9K	1653 F	1745 F	92.0F	28.95	0.0M	1203 F	1136 F	84.9F	85.3F	107.9F	2.6	9.4	36.3M
500	-6.3P	-1.3P	2.4P	-0.40P			69.2F	67.8F	73.6F	69.1F	1.0	71.2F	94.4F	72.6F		
19:55:00	25.6K	26.7K	25.0K	1651 F	1750 F	92.1F	28.95	0.0M	1202 F	1135 F	85.9F	85.4F	108.1F	2.7	9.3	36.2M
500	-6.3P	-1.3P	2.5P	-0.36P			70.6F	67.6F	73.4F	68.9F	1.0	71.2F	94.3F	72.8F		
19:57:00	25.6K	26.7K	25.1K	1645 F	1747 F	92.1F	28.95	0.0M	1199 F	1135 F	85.0F	85.4F	108.1F	2.6	9.4	35.9M
500	-6.3P	-1.3P	2.5P	-0.36P			71.2F	68.7F	73.5F	69.0F	1.0	70.9F	94.3F	72.9F		
19:59:00	25.6K	26.8K	25.1K	1747 F	1830 F	92.1F	28.95	0.1M	1122 F	1059 F	82.6F	86.8F	106.7F	0.3	0.3	35.9M
500	-6.3P	-1.3P	2.5P	-0.36P			71.0F	67.0F	72.7F	68.6F	1.0	70.2F	82.4F	71.5F		

Testing Conducted in
June 1987

MLM-3577

Joule-Heated Glass Furnace Processing of a Highly Aqueous Hazardous Waste Stream

Larry M. Klingler and Perry L. Abellera

March 17, 1989

MOUND

operated by

EG&G MOUND APPLIED TECHNOLOGIES

P.O. Box 3000, Miamisburg, Ohio 45343-0987

for the

U. S. DEPARTMENT OF ENERGY

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Joule-Heated Glass Furnace Processing of a Highly Aqueous Hazardous Waste Stream

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MOUND

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Abstract

A hazardous waste stream, covered by the Resource Conservation and Recovery Act (RCRA), generated as a by-product of explosives fabrication processes, was treated by means of a joule-heated glass furnace in a series of test burns at Mound.

The burns were designed to determine the furnace's capability to meet the Environmental Protection Agency's hazardous waste incineration standards while processing a highly aqueous, low BTU waste. A second goal of the experiments was to determine the energy cost of this onsite processing. The current procedure for handling the waste, shipping it offsite to a disposal contractor, is expensive and carries long-term environmental law liability concerns.

Four test burns were made, with wastewater content varied between 44 and 100%. Despite mechanical and operational problems (since corrected), the tests yielded destruction and removal efficiency factors greater than the required 99.99% for all runs, and greater than 99.999% for all but two samples.

Energy costs proved to be of minor significance. Projected operational labor costs, however, eliminate much of the economic incentive for glass melter treatment of this waste stream at the present time.

Introduction

The management of hazardous, toxic, and "mixed" (hazardous organics and radioactivity) wastes has become a serious problem for companies throughout the United States. Environmental law enacted over the past seven years has resulted not only in escalating costs for the complicated handling, storage, and treatment processes required, but also in greatly increased concerns for corporate and personal liability, because responsibility for the waste continues as long as the waste or a listed by-product exists.

As a generator of hazardous wastes, Mound has been affected by these changes. Currently, Mound is able to package most of its nonradioactive hazardous wastes for shipment offsite to private firms for treatment. Mixed wastes, however, are being stored indefinitely onsite because there is presently no disposal option for them. High disposal costs -- projected to rise steeply in the future -- the mixed waste problem, and especially the long-term waste responsibility, have generated interest in onsite treatment for at least some of these wastes by methods such as recycling and incineration.

An incineration device, the joule-heated glass melter, has been in use for several years at Mound. Operated primarily for experimental purposes, the glass melter was procured originally for a project sponsored by the Department of Energy (DOE) to evaluate its potential as a treatment option for nuclear power plant waste. It was discovered while performing this work that much better combustion was occurring in the furnace than had been anticipated. Later tests with Monsanto Company waste compositions indicated that the furnace was capable of providing waste destruction efficiencies exceeding environmental law requirements even with difficult to burn, low BTU waste feeds.

This evaluation has been designed to provide further data on hazardous waste treatment by means of the glass melter by:

1. Confirming earlier destruction efficiency results;

2. Determining whether the melter could adequately and economically be used to process one of Mound's major hazardous waste streams;

3. Determining furnace conditions that lead to glass furnace processing failure in terms of organic destruction.

4. Using this waste stream, which is high in water content, to further define glass melter operating parameters for acceptable hazardous waste combustion. The criterion for "acceptable thermal destruction" has been defined by the Environmental Protection Agency

(EPA) to mean that a disposal process must destroy or remove hazardous constituents of a waste on a continuing basis at an efficiency of at least 99.99%;

The waste stream selected for this study is produced as a by-product of an explosives fabrication process. This waste consists primarily of water, acetone, and ethanol, with smaller amounts of other hydrocarbons and chlorohydrocarbons. Trace quantities of explosives may also be present. The waste falls under the RCRA's "hazardous" designation because of its organic constituents. It must therefore be handled and disposed of in accordance with RCRA laws. Current disposal practice consists of packaging the liquid in 55-gal drums, which are picked up by a contractor for transportation to a treatment facility at a current cost of $150-$200 per drum. Ten to 20 drums per month are being generated.

Mound's responsibility for this waste continues through transportation and disposal. In addition, Mound incurs continuing liability in using offsite disposal because, under Superfund law, a waste generator is responsible for cleanup of any disposal site it has ever used in the event of hazardous waste releases at that site.

Study Description

This study consisted of four burns (each approximately eight hours in duration) of simulated waste. Each burn differed in relative quantities of acetone, ethanol, and water. The compositions chosen represent a high, a low, and two midpoints of those which could be expected in normal process waste. All waste compositions were relatively high in water content, varying from a low of 44% to nearly 100%. A known quantity of an RCRA-listed hazardous waste, methylene chloride, was spiked into each feed batch. Methylene chloride, a normal contaminant of the waste under study, is quite high on "difficult to incinerate" lists.

Because of the high water content of the waste, its heat value is very low. Almost all of the heat required for raising the temperature of the feed and combustion air, vaporizing the organics, evaporating the water and

raising the resulting steam to chamber temperature, and destroying the organic molecules must come from heat supplied from the bed of molten glass. The molten glass is in turn maintained at a high temperature by an electrical powering system.

One of the objectives of this study was to determine the energy efficiency of this process by monitoring power input and feed rate data. Unfortunately, furnace problems hindered this effort. For reasons not ascertained at the time, the glass melter had been operating well below its power specifications for many months. Just before the start of these experiments, modifications were made that were intended to correct the problems. They were not successful.

Maximum electrical current supply to the melter for these runs was 25% below what the power system should have been capable of providing, and at least 10% below the minimum required to properly handle this waste. On several occasions, furnace power was interrupted completely by circuit breaker trips. When electrical deficiencies were finally uncovered and corrected, it was discovered that a significant part of the electricity supplied to the power system and recorded as input was actually being dissipated in the power system rather than being transmitted to the glass. In addition to providing higher than actual power readings, the furnace problems limited the quantities of waste (especially of the very aqueous types) that could be fed to the furnace.

Equipment

Incinerator

The combustion device is a 150 kW joule-heated glass melter purchased from Penberthy, Electromelt, Inc. Molten glass is initially formed in the furnace by heating component chemicals or recycled glass frit to approximately 1400°F with a propane burner. Once glass reaches the molten state it will conduct electricity. The burner is then turned off, and heat for maintaining or increasing the glass temperature is generated from the resistance of the glass to the electrical current passing through it.

Power is supplied to the melter by means of three pairs of iron electrodes protruding horizontally into the bed of molten glass. (See Figure 1.) Power is controlled by three independent silicon-controlled rectifier units. The melter chamber holds approximately one ton of glass. The surface area of the glass is approximately 17 ft^2, and the bed depth can vary from approximately 9 to 12 in.

Waste for these experiments was introduced to the melter through a port in the top of the chamber. The waste is fed in as a stream and drops primarily as liquid to the glass bed from where it evaporates. Waste feed atomization, a process which has traditionally caused problems in waste incinerator operation, is not necessary. The molten glass covering the

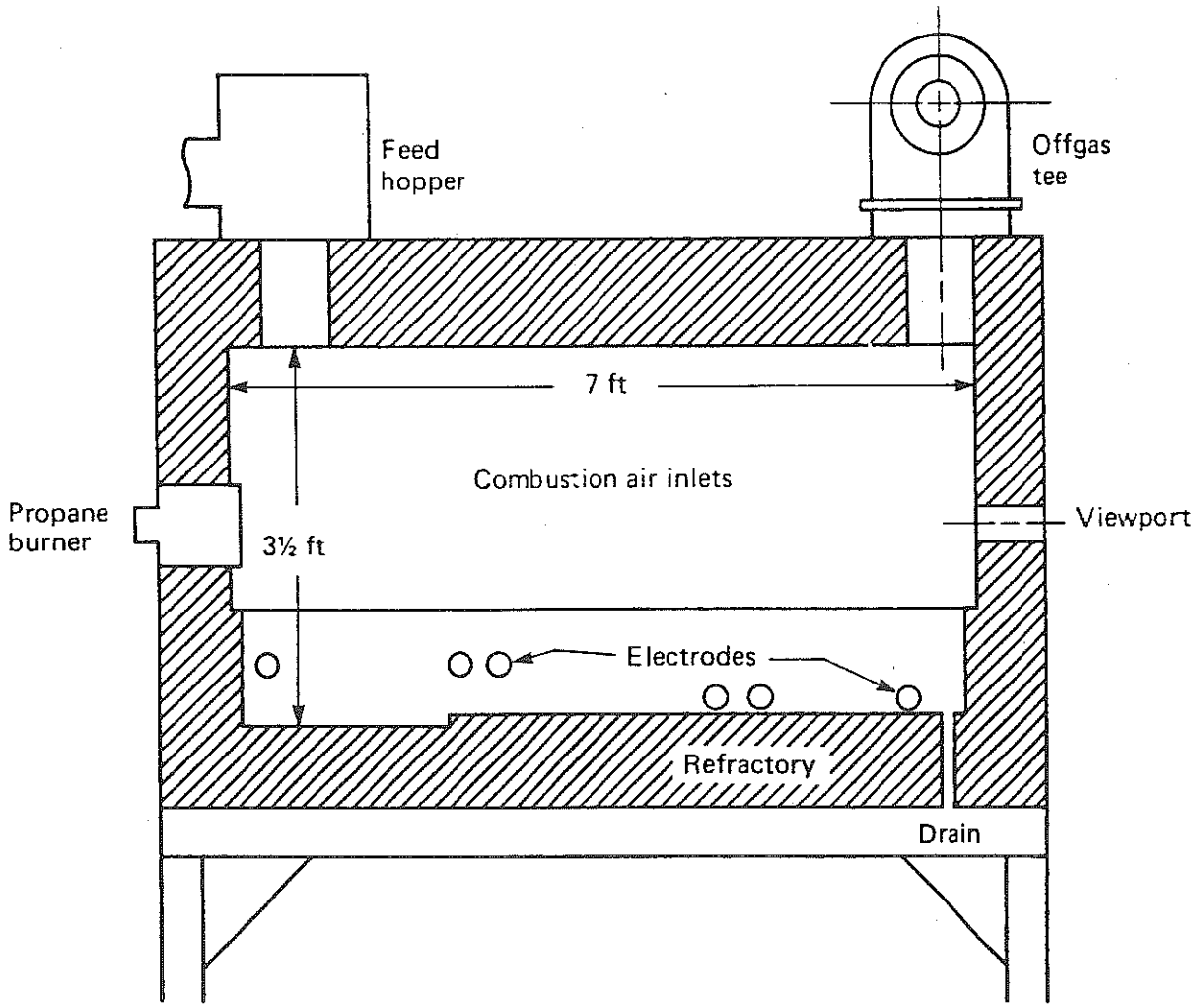


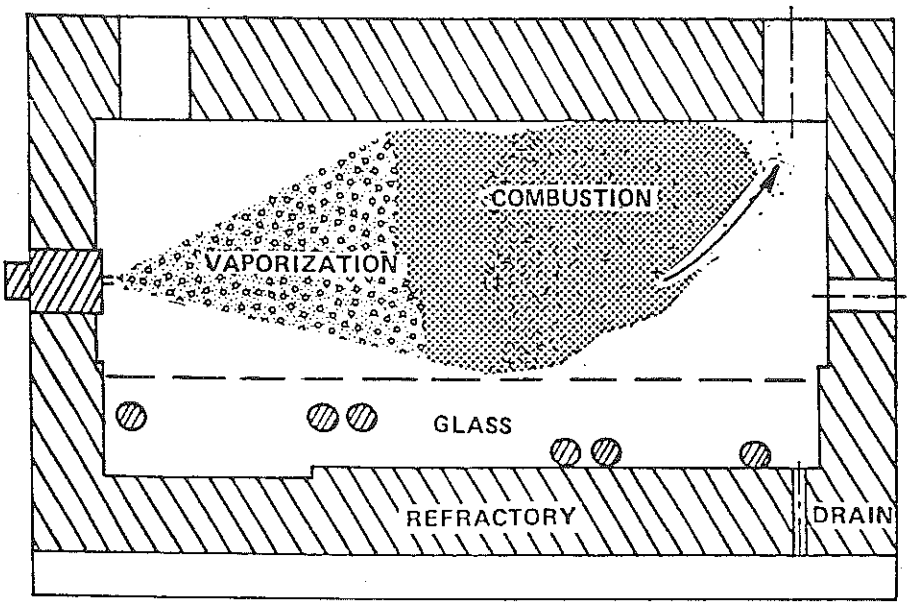
Figure 1 - Schematic of joule-heated glass furnace.

chamber floor protects the refractory from direct impingement by cool liquid and also provides the energy for vaporizing the waste which puddles on it. Since waste liquid evaporation takes place at the relatively nonturbulent feed end of the furnace chamber, the full volume of the chamber is available for combustion of organic vapors. (See Figure 2.) The waste atomization process, if required, would not only sharply circumscribe feed characteristics, but, because it inevitably projects droplets downstream and into the gas stream, might well result in inadequate waste destruction. Operating properly, atomizers typically project 100-500 μm droplets. The penetration of one 300-μm droplet through the system for every 10 million droplets of 30-μm mean diameter can result in failure to meet waste destruction efficiency standards [1].

Provisions for glass additions and removal are available, but would rarely be needed for this feed because of its low ash content. Exhaust fans located downstream of an offgas conditioning system pull combustion by-product gases and water to the offgas system by way of a top port at the chamber end opposite the feed port.

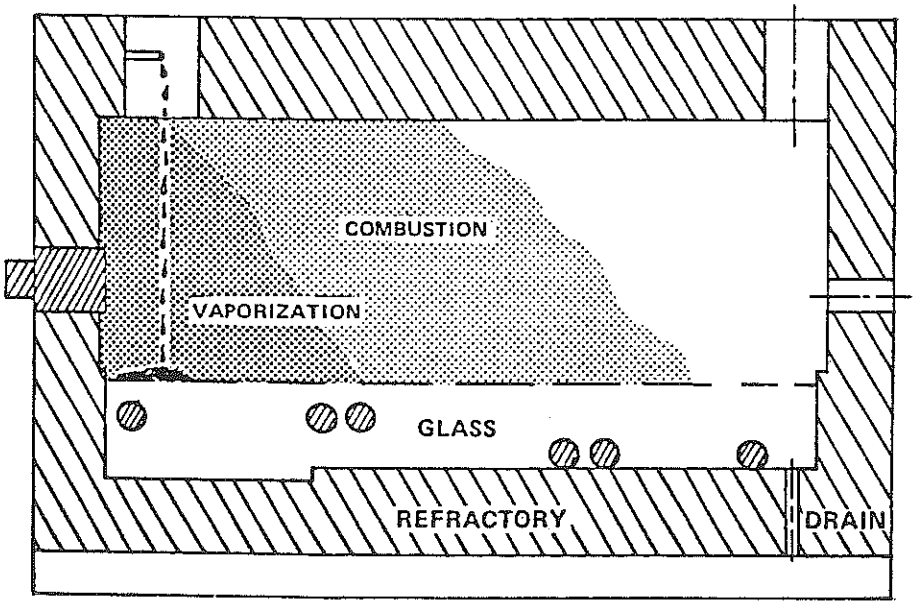
Offgas System

The offgas system used to treat the melter exhaust is a wet system which uses a sodium hydroxide solution to cool and clean gases. (See Figure 3.) A spray tank and venturi scrubber combine to cool gases to less than 180°F, remove nearly all particulate matter, and neutralize acid gases generated in the combustion process. The ventilation system was not adequately designed at the time of these experiments to provide the very low combustion air volume needed and still maintain proper differential pressure across the venturi scrubber. As a result, the scrubber was operated considerably below its design pressure drop for these experiments. It would be expected, therefore, that particulate and acid gas removal efficiencies would be negatively effected.



FEED ATOMIZATION

UNEVEN PARTICLE SIZE DISTRIBUTION, POTENTIAL FOR AGGLOMERATION, COOLING EFFECT OF DROPLET SURFACE EVAPORATION, AND SHORTENED PATH TO EXIT CAN RESULT IN ORGANIC LIQUID EXITING THE CHAMBER.



STREAM WASTE FEED

DISTILLATION OF FEED IS SURFACE PHENOMENON OCCURRING PRIMARILY ON GLASS SURFACE. LITTLE CHANCE FOR AIR STREAM TO CARRY LIQUID FROM THE CHAMBER.

Figure 2 - Feed alternatives.

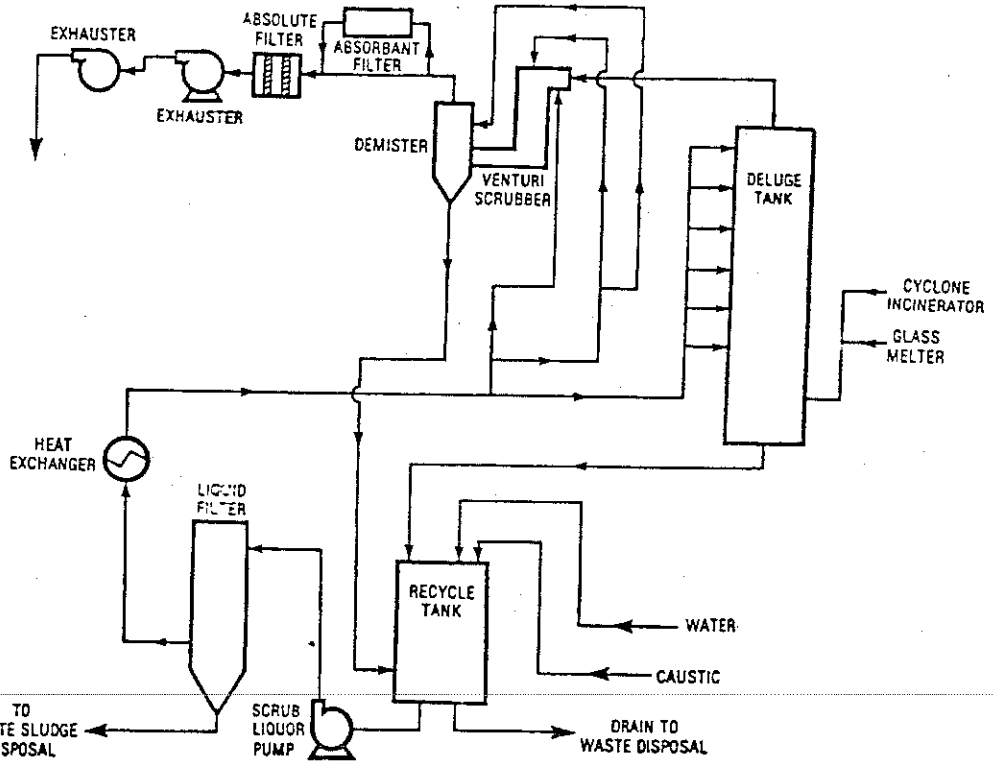


Figure 3 - Wet offgas system.

Monitoring and Analysis

The most critical analysis for this study -- that of hazardous component destruction and removal efficiency (DRE) determination -- was performed by an outside contractor, PEI Associates, of Cincinnati, a nationally recognized environmental pollution monitoring and analysis company. PEI measured incinerator stack emissions of methylene chloride, the principal organic hazardous component (POHC), by means of a volatile organic sampling train (VOST). The function of the train (see Figure 4) is to capture organic molecules from a representative sample of flue gas by means of a tenax resin trap. The trap is then desorbed to a gas chromatograph/mass spectrometer for qualitative and quantitative analysis of the captured organics.

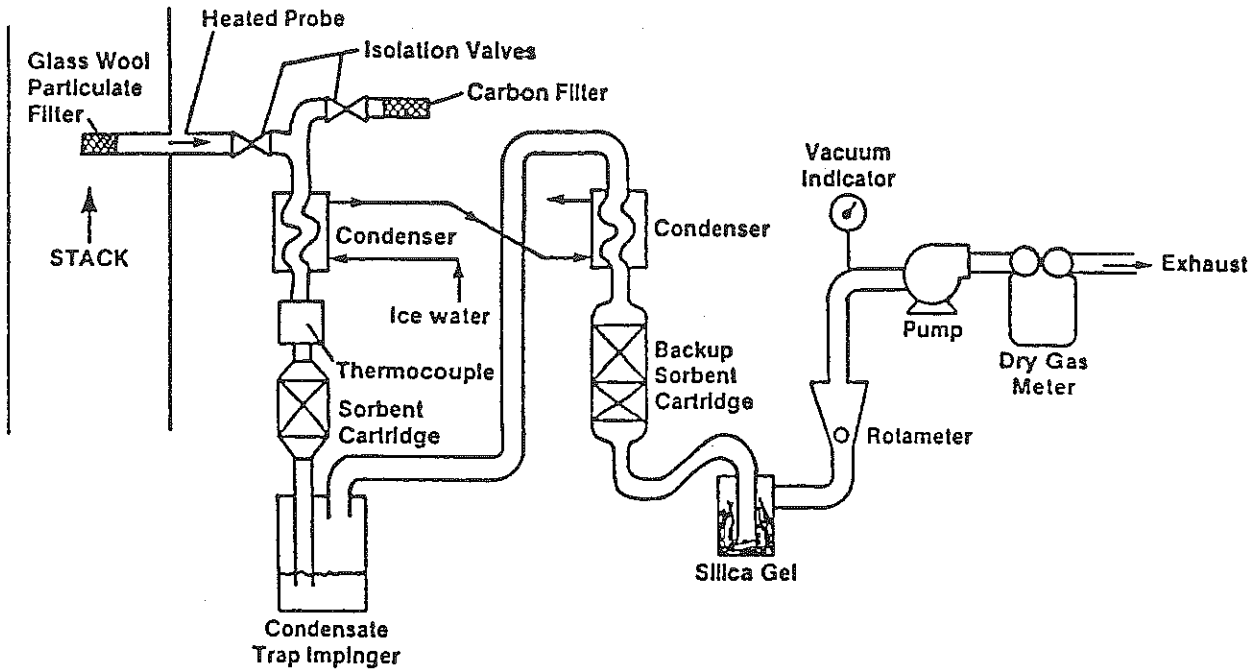


Figure 4 - Schematic of volatile organic sampling train (VOST).

Particulate matter, stack moisture, and chloride emissions were monitored using an EPA method 5 train. This equipment (see Figure 5) is designed to isokinetically collect a representative sample of flue gas for analysis of contaminants. Materials that are particulate at elevated temperatures are collected quantitatively on an inline filter. Other contaminants, including water, are collected in cooled impingers. Hydrochloric acid is collected quantitatively by changing the standard impinger solution to a sodium hydroxide solution.

NO_x, CO, and CO_2 were monitored with continuous emission monitors.

Other system parameters were monitored continuously and recorded every 5 min using applicable sensors and a Kaye Instrument data logger.

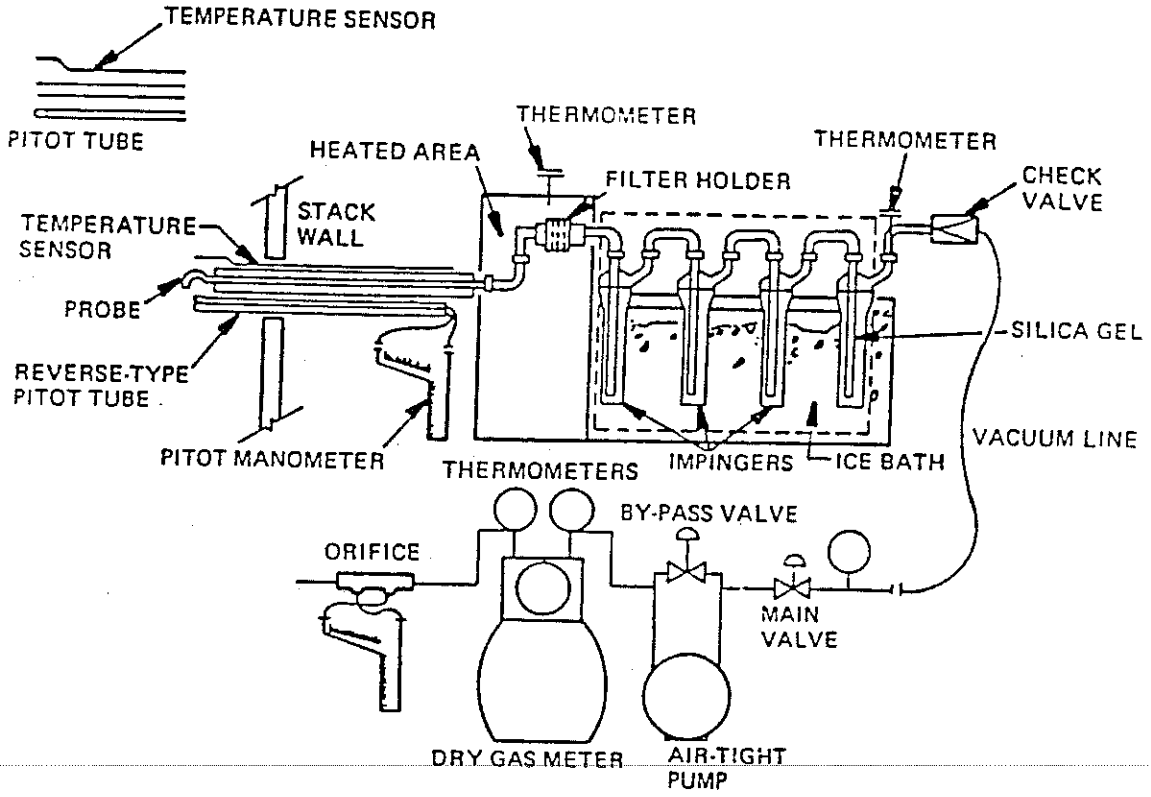


Figure 5 - Diagram of EPA method 5 sampling train.

Experiments

Waste Preparation and Feed

Specially prepared drum batches of acetone, ethanol, and water were opened just prior to burning and spiked with 1500 mL of methylene chloride, which is miscible in all the feed types in the concentrations used. The waste was then mixed thoroughly by recirculation and pumped to a closed feed tank. Feed to the furnace was accomplished by pumping the waste through a flow meter, a shut-off valve, a check valve, and into a nozzle with several large holes, from where it dropped onto the glass. Mixing was continued throughout the run by recirculating part of the feed back to the feed tank. Feed rate to the furnace was set using the flow meter, and rates were checked periodically by measuring differential volumes in the feed tank.

Furnace Preparation

Electrical power was maintained as high as the problem-plagued control system would permit throughout all runs, and through evening hours between runs as well.

Run Parameters

Waste compositions were varied for each of the four runs. Table 1 provides the waste mix for each day's processing:

Waste feed rates were changed periodically during each run to explore as wide a range of conditions as possible and, on occasion, because conditions mandated changes. Feed rates, the period of time the rate was operative, and the total feed in gallons fed in that time period are shown in Tables 2-5 and graphically as a function of chamber temperature and DREs in Figures 6-9.

Table 1 - WASTE COMPOSITIONS

Waste Component	Run 1 (waste C)	Run 2 (waste B)	Run 3 (waste D)	Run 4 (waste A)
Acetone	11.0%	3.7%	16.5%	0
Ethanol	23.9%	12.9%	38.6%	0
Water	64.4%	82.7%	44.1%	99.27%
Methylene Chloride	0.73%	0.73%	0.73%	0.73%

Table 2 - RUN 1 WASTE FEED DATA

Run Time	Feed Rate (gal/hr)	Time at Rate (min)	Total Feed (gal)
08:25-09:40	3.39	75	4.24
09:40-12:23	7.15	163	19.42
12:23-13:40	7.30	77	9.37
13:40-15:56	9.87	136	22.38
15:56-18:23	4.61	147	11.29
			66.70

Table 3 - RUN 2 WASTE FEED DATA

Run Time	Feed Rate (gal/hr)	Time at Rate (min)	Total Feed (gal)
08:25-11:39	8.95	134	19.99
11:39-13:14	8.79	95	13.92
13:14-14:26	OFF[a]	---	-----
14:26-16:50	6.16	144	14.78
			48.69

[a]The glass melter circuit breaker tripped at approximately 11:17. Dropping temperatures and rising CO resulted in feed shut-off from 13:14 to 14:26.

Table 4 - RUN 3 WASTE FEED DATA

Run Time	Feed Rate (gal/hr)	Time at Rate (min)	Total Feed (gal)
10:00-10:20	3.82	20	1.27
10:20-11:22	7.91	62	8.17
11:22-13:27	8.42	125	17.54
13:27-15:31	11.47	124	23.70
15:31-16:41	12.67	70	14.78
			65.46

Table 5 - RUN 4 WASTE FEED DATA

Run Time	Feed Rate (gal/hr)	Time at Rate (min)	Total Feed (gal)
08:06-09:50	2.26	104	3.92
09:50-10:50	2.72	60	2.72
10:50-11:50	3.81	60	3.81
11:50-12:53	OFF[a]	---	----
12:53-13:53	6.41	60	6.41
13:53-17:00	7.61	187	23.72
			40.58

[a]The circuit breaker tripped at 10:58 on this run. Waste feed and fans were shut down for approximately 1 hr to allow glass to regain heat. Power was turned quite high for afternoon burning with no additional problem until just after run completion.

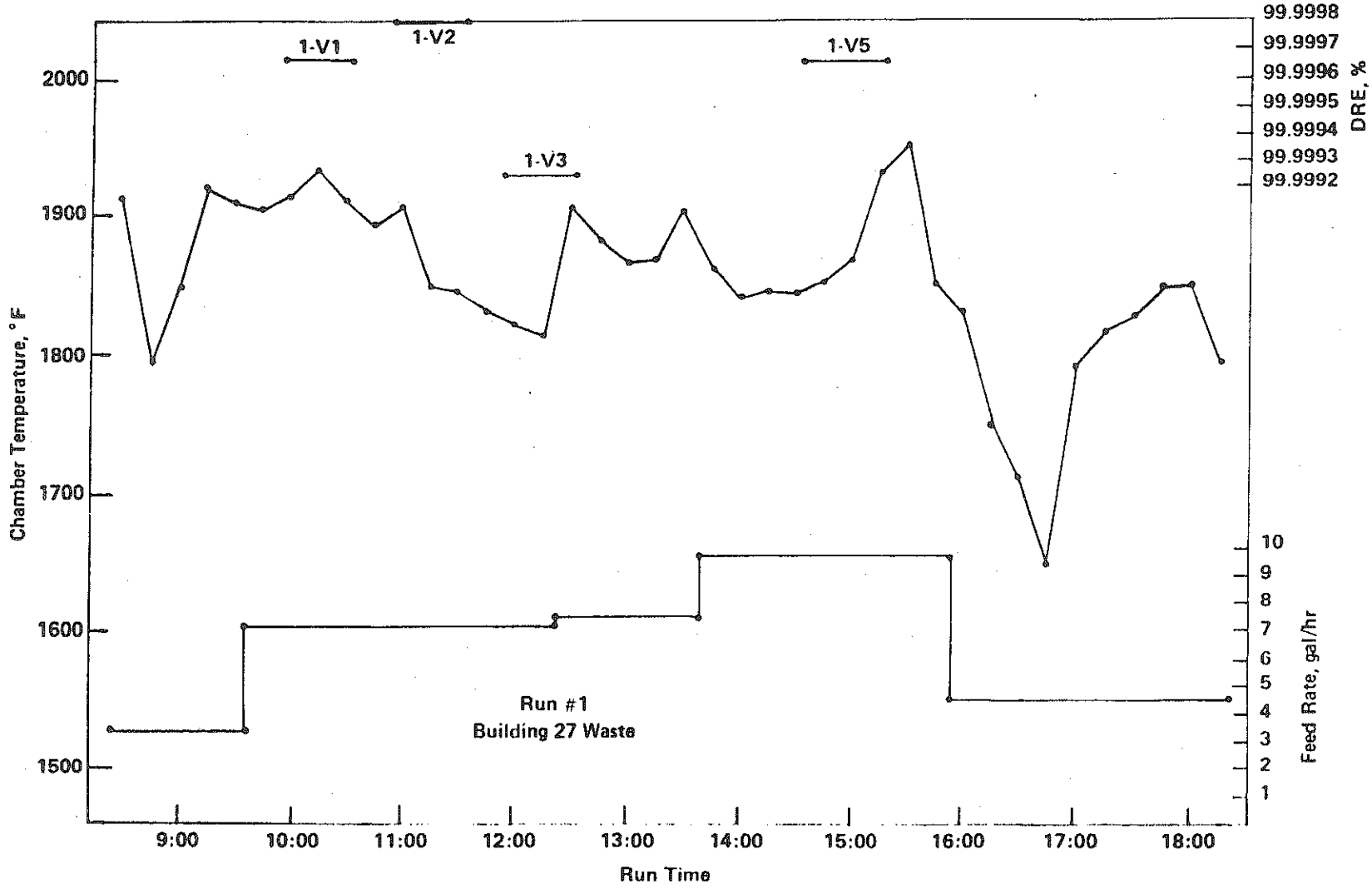


Figure 6 - Feed rate, temperature, and destruction removal efficiency (DRE) as a function of time. (Run No. 1)

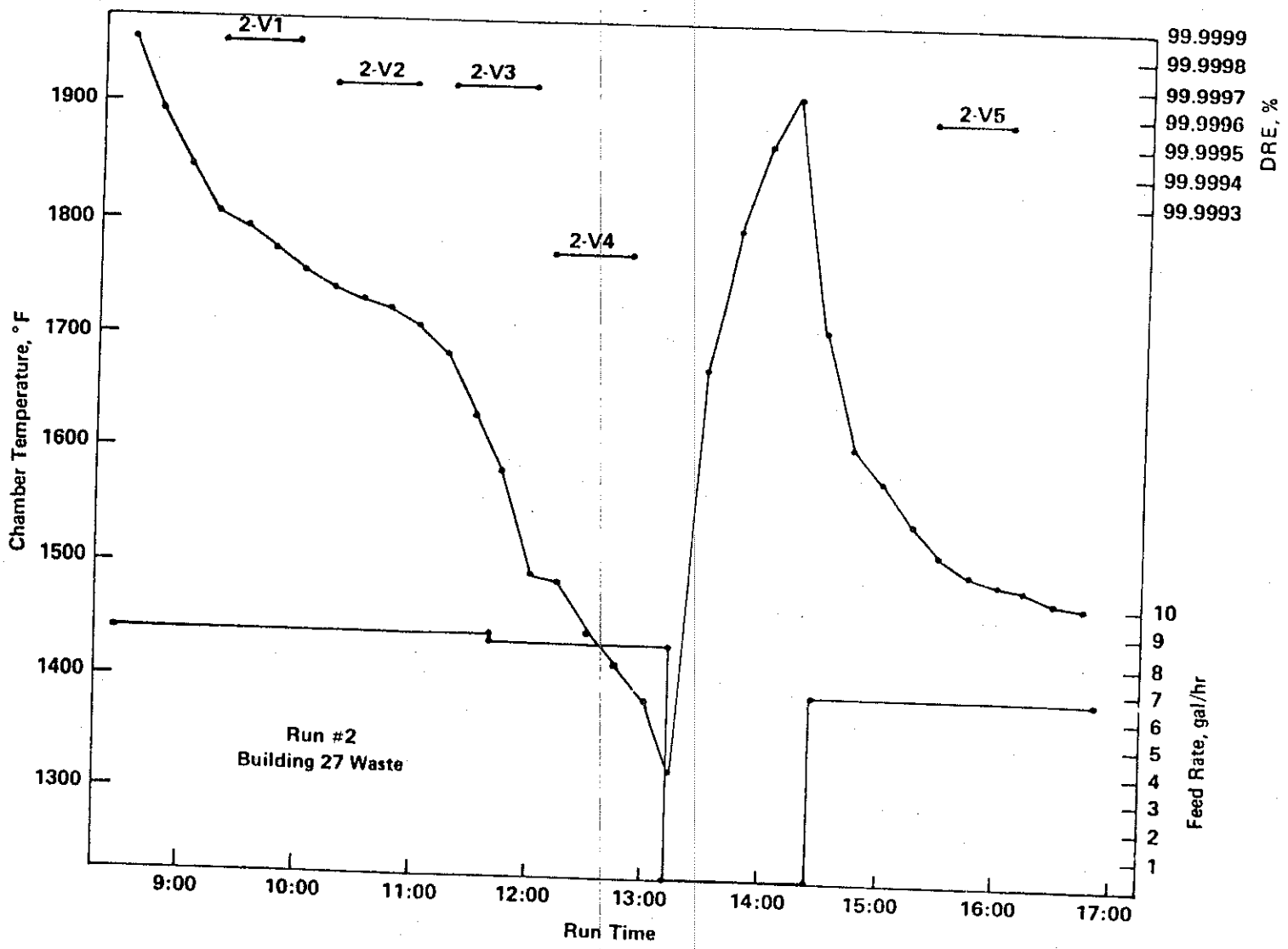


Figure 7 - Feed rate, temperature, and destruction removal efficiency (DRE) as a function of time. (Run No. 2)

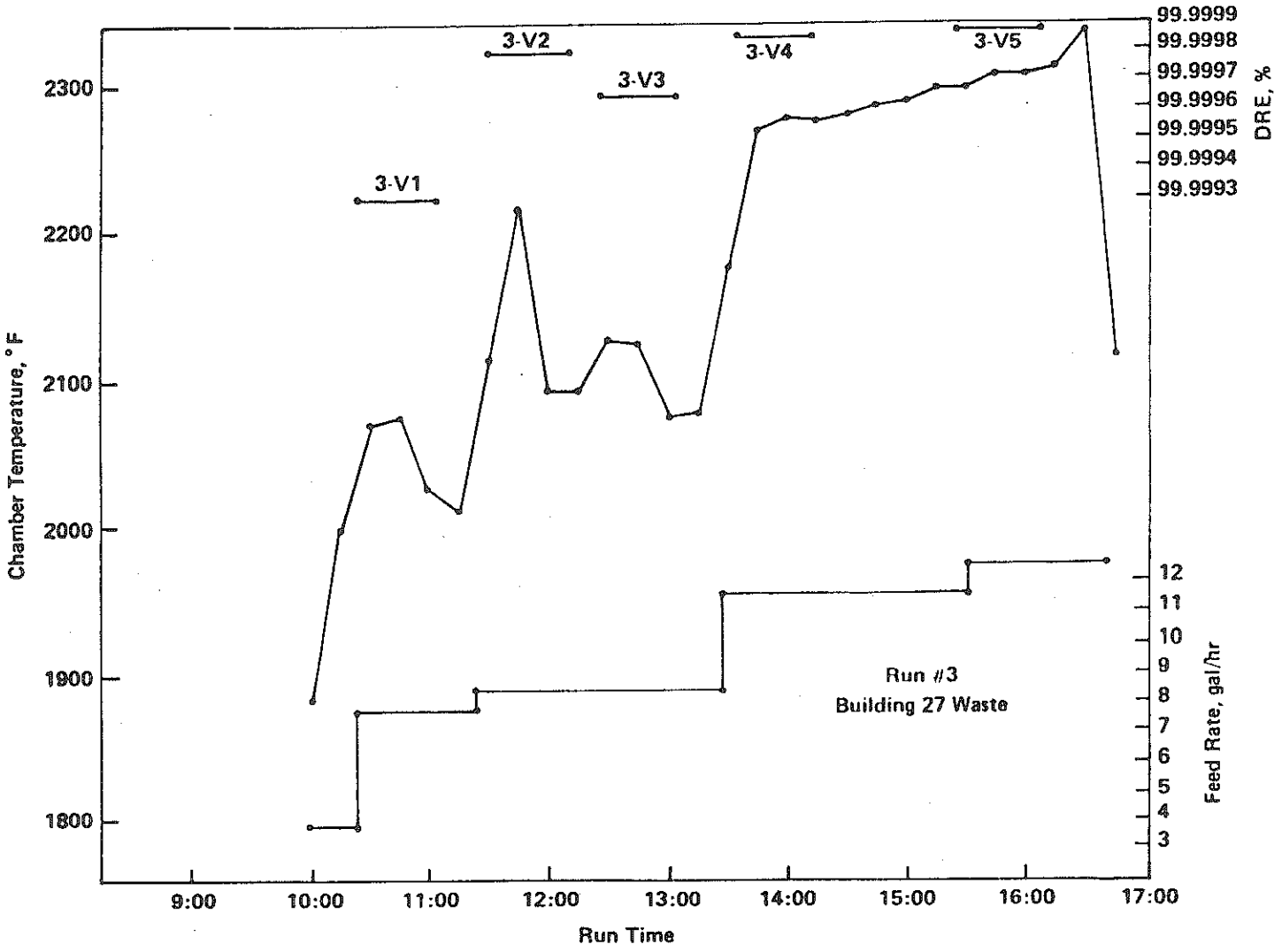


Figure 8 - Feed rate, temperature, and destruction removal efficiency (DRE) as a function of time. (Run No. 3)

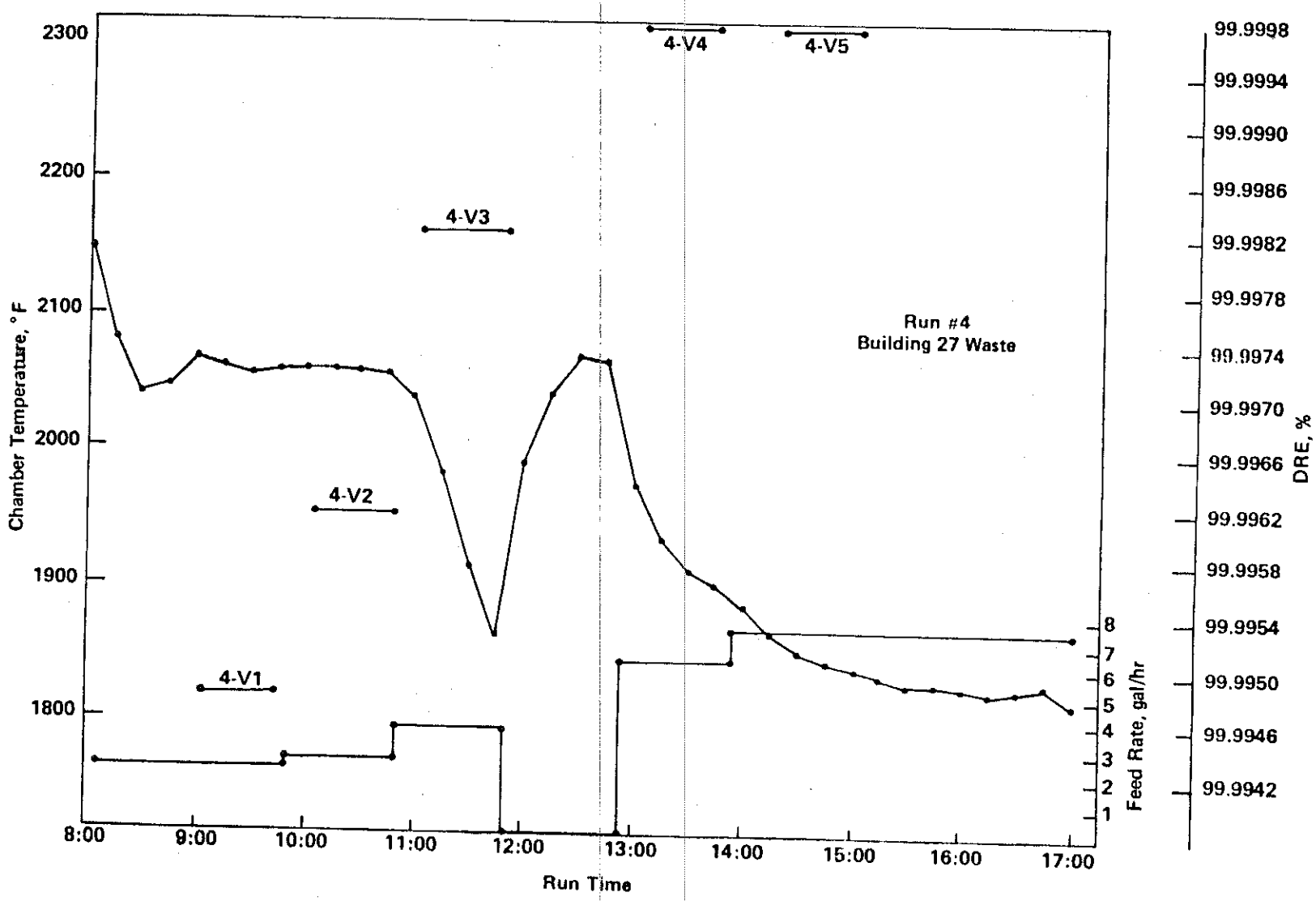


Figure 9 - Feed rate, temperature, and destruction removal efficiency (DRE) as a function of time. (Run No. 4)

Results

Destruction and Removal Efficiencies

DREs for principal organic hazardous constituents (POHCs) are calculated by means of the formula:

$$DRE = [(W_{in} - W_{out}) / W_{in})] (100)$$

where W(in) is equal to the waste flow rate times the POHC concentration and W(out) is equal to the emission gas flow rate times its POHC concentration. For these experiments, the POHC concentration in the feed remained constant for all runs at 9.726 g/L of feed. Since feed flow rates and exhaust gas flow rates were varied throughout the runs, the values used in these calculations represent the rates in use during the 40-min time span of each VOST run. In most cases conditions had been held constant well in advance of the start of the VOST run. Tables 6-9 list the DREs for runs 1-4 and include also the data collected to arrive at the DREs.

Stack Particulate

Particulate matter in the stack exiting the offgas system was measured by an EPA Method 5 train of standard configuration but using 1 N sodium hydroxide as the impinger solution. Method 5 sampling was conducted once on the first day of waste burning, and in the morning and afternoon of the next three days. The sampling was coordinated generally with one of the VOST sampling periods. From the sampling conducted during Run 1, offgas particle concentration was determined to be:

0.0164 grains/dry standard cubic feet (DSCF)

RCRA regulations require that measured particle concentrations be corrected for the amount of oxygen in the stack gas according to the formula:

$$P(corrected) = P(measured) [14/(21 - Y)]$$

Table 6 - RUN 1-MeCl DESTRUCTION AND REMOVAL EFFICIENCY DATA

VOST Sample	Feed Volume (L/40 min)	Total MeCl In (microgram)	Gas Out (CF/40 min)	MeCl Out[a] (microgram/CF)	Total MeCl Out (microgram)	DRE %
1-V1	18.047	175525120	9182	0.0600	550.92	99.99968
1-V2	18.047	175525120	8719	0.0224	195.31	99.99989
1-V3	18.142	176449090	8655	0.1526	1320.75	99.99925
1-V4	24.914	242313560	8452	------	------	--------
1-V5	24.914	242313560	8249	0.0994	819.95	99.99966

[a]PEI reported results. According to PEI, a tenax trap was broken on sample 1-V4, making analysis meaningless.

Table 7 - RUN 2-MeCl DESTRUCTION AND REMOVAL EFFICIENCY DATA

VOST Sample	Feed Volume (L/40 min)	Total MeCl In (microgram)	Gas Out (CF/40 min)	MeCl Out[a] (microgram/CF)	Total MeCl Out (microgram)	DRE %
2-V1	22.574	219554720	8316	0.0442	367.57	99.99983
2-V2	22.574	219554720	7885	0.0892	703.34	99.99968
2-V3	22.384	217706780	7780	0.0807	627.85	99.99968
2-V4	22.172	215644870	7602	0.2523	1917.98	99.99911
2-V5	15.542	151161490	6082	0.1034	628.88	99.99958

[a]PEI reported results.

Table 8 - RUN 3-MeCl DESTRUCTION AND REMOVAL EFFICIENCY DATA

VOST Sample	Feed Volume (L/40 min)	Total MeCl In (microgram)	Gas Out (CF/40 min)	MeCl Out[a] (microgram/CF)	Total MeCl Out (microgram)	DRE %
3-V1	19.967	194199040	9699	0.1362	1321.00	99.99932
3-V2	21.236	206541330	8734	0.0439	383.42	99.99980
3-V3	21.236	206541330	8048	0.0864	695.35	99.99966
3-V4	28.928	281353720	7159	0.0515	368.69	99.99986
3-V5	31.972	310959670	8020	0.0476	381.75	99.99987

[a]PEI reported results.

Table 9 - RUN 4-MeCl DESTRUCTION AND REMOVAL EFFICIENCY DATA

VOST Sample	Feed Volume (L/40 min)	Total MeCl In (microgram)	Gas Out (CF/40 min)	MeCl Out[a] (microgram/CF)	Total MeCl Out (microgram)	DRE %
4-V1	05.696	055399296	8283	0.3455	2861.78	99.99480
4-V2	06.856	066681456	8017	0.3200	2565.44	99.99615
4-V3	09.600	093369600	7770	0.2093	1626.26	99.99826
4-V4	16.184	157405580	7480	0.0428	0320.14	99.99979
4-V5	19.199	186729470	6953	0.0753	0523.56	99.99972

[a]PEI reported results.

where Y is the concentration of oxygen in the stack gas. Using this correction, the corrected particle concentration becomes:

0.13-9 grains/DSCF

Table 10 summarizes particle collection data for each of the four runs.

Chloride

Stack chloride concentration was measured by means of the Method 5 train by replacing the standard water impinger solution with a weak solution of sodium hydroxide. Chloride captured by the impinger solution was measured by ion chromatography. Chloride was generated in the melter during these runs by breakdown of the methylene chloride in the feed. The quantity of chloride presumed to enter the offgas system during the time period of Method 5 runs is given in Table 11. Stack gas concentrations were calculated from analyses of the Method 5 samples. Then scrub system removal factors were determined by comparing concentrations of chloride going into the offgas system against those coming out in the scrubbed gases. These results are also given in Table 11.

Table 10 - STACK PARTICLE DATA

Method 5 Sample	Measured Concentration (grains/DSCF)	Corrected Concentration (grains/DSCF)
1A	0.01638	0.1349
2A	0.01036	0.1450
2B	0.02427	0.4854
3A	0.01995	0.1470
3B	0.03558	0.0940
4A	0.01826	infinite
4B	0.01951	infinite

Table 11 - CHLORIDE GENERATION AND REMOVAL DATA

Sample	MeCl Burned (grams)	Cl Generated (grams)	Cl per Sample (grams)	Stack Cl (grams)	Removal Eff (%)
1A	169.71	142.76	0.0002313	0.128	99.91
2A	325.82	272.16	0.0003298	0.179	99.93
2B	226.75	189.40	0.0001104	0.059	99.97
3A	309.81	258.78	0.0002068	0.117	99.95
3B	466.46	389.63	0.0002852	0.152	99.96
4A	109.35	91.34	0.0000379	0.022	99.98
4B	280.10	233.96	0.0000737	0.042	99.98

Continuous Emission Monitor Data

CO_2, CO, and NO_x monitors were used to continually analyze the glass furnace flue gas. Concentration levels were recorded every 5 min. Periodically during the runs, monitors were calibrated with zero and span gas. Summary statements regarding the data collected for individual runs are given below:

Run 1:

High amounts of excess air, resulting from the low fuel content of this waste composition, caused CO_2, CO, and NO_x values to near the baseline to be significant for most of this run.

Run 2:

NO_x values remained at or near zero for the entire run. CO_2 concentrations varied from 0 to 1.2%. CO values were generally at or near zero, but rose steeply on occasion. CO concentration is graphed as a function of time in Figure 6.

Run 3:

NO_x, CO, and CO_2 values remained relatively constant throughout the run, rising slightly with each increase in feed rate. CO varied from zero

to 23 ppm. CO_2 increased progessively from zero to a high of 10%. NO_x reached a high of just 17 ppm.

Run 4:

Except for one short blurp, NO_x, CO, and CO_2 values remained close to zero for the entire run, reflecting the high excess air of the run. The blurp came just after the extraction system was washed with acetone and likely represents vapors from residual acetone in the filter.

Discussion

Destruction and Removal Efficiencies

A part of the purpose of these experiments was to find lower limit conditions for glass melter operation in hazardous waste burning by testing. From the standpoint of the VOST samples, failure was never reached, even when furnace chamber temperatures dropped to extremely low levels. DRE results (see Table 12 for summary) on all samples taken were well above the RCRA standard of 4 nines and, except for two samples, exceeded 5 nines.

The graphs in Figures 7-10 show an overlay of chamber temperature, feed rate, and DREs for all four runs. Relationships are not obvious. For example, in the first two VOST samples of Run 4, in which DREs were a factor of 10 below all other samples, furnace chamber temperatures were relatively high and the waste feed rate was low. Later in the run when chamber temperatures were much lower and the amounts of water and methylene chloride going into the furnace were higher, DREs were extremely high.

Table 12 - DRE RESULTS FOR BUILDING 27 WASTE PROCESSING

Sample	Run 1 64+% H2O	Run 2 82+% H2O	Run 3 44+% H2O	Run 4 99+% H2O
1	99.99968	99.99983	99.99932	99.99480
2	99.99989	99.99968	99.99980	99.99615
3	99.99925	99.99968	99.99966	99.99826
4	--------	99.99911	99.99986	99.99979
5	99.99966	99.99958	99.99987	99.99972

Methylene chloride is not often chosen as a POHC because it tends to be everywhere and often contaminates equipment and traps. Trip and lab blanks are used as a quality control mechanism to determine contamination potential. PEI reported an average blank value of 0.46 ± 0.28 ng/L. These blank data were ignored in calculating DRE results, although corrections based on the data would have improved reported results. The presence of methylene chloride on the blanks does indicate that traps, sampling equipment, and analytical equipment are subject to contamination. This could be a plausible explanation for two sample results that do not appear consistent with the rest of the data.

Continuous Emission Monitor Results

The one indication of approaching failure in terms of hazardous waste destruction during these experiments came during Run 2 (see Figure 10). Furnace chamber temperatures dropped momentarily to their lowest point (near 1300°F). At the same time, the continuous carbon monoxide analyzer recorded a small, but real, peak of CO. Smaller, but measurable quantities of CO showed up again later in the run as temperatures dropped into the low 1500s. Although oxidative combustion reaction stoichiometry demands some CO production, CO is an indicator of the degree of incomplete combustion. As such, at high levels it may predict failing POHC destruction efficiency. The connection has not proved to be very reliable, however, so it is not surprising that DREs remained high as CO became measurable, especially with the very low quantities of CO present.

Stack Particulate

Table 10 summarizes stack particulate concentration data. Actual particulate catches were extremely small for all runs, as would be expected for this feed material. The filters in the Method 5 train samples showed virtually no evidence of particle loading, with specks of duct rust and sampling equipment joint grease appearing to contribute most of the measured weights. After application of the stack gas oxygen content correction factor, however, all particle loadings exceeded the RCRA mandated 0.08 grains/DSCF.

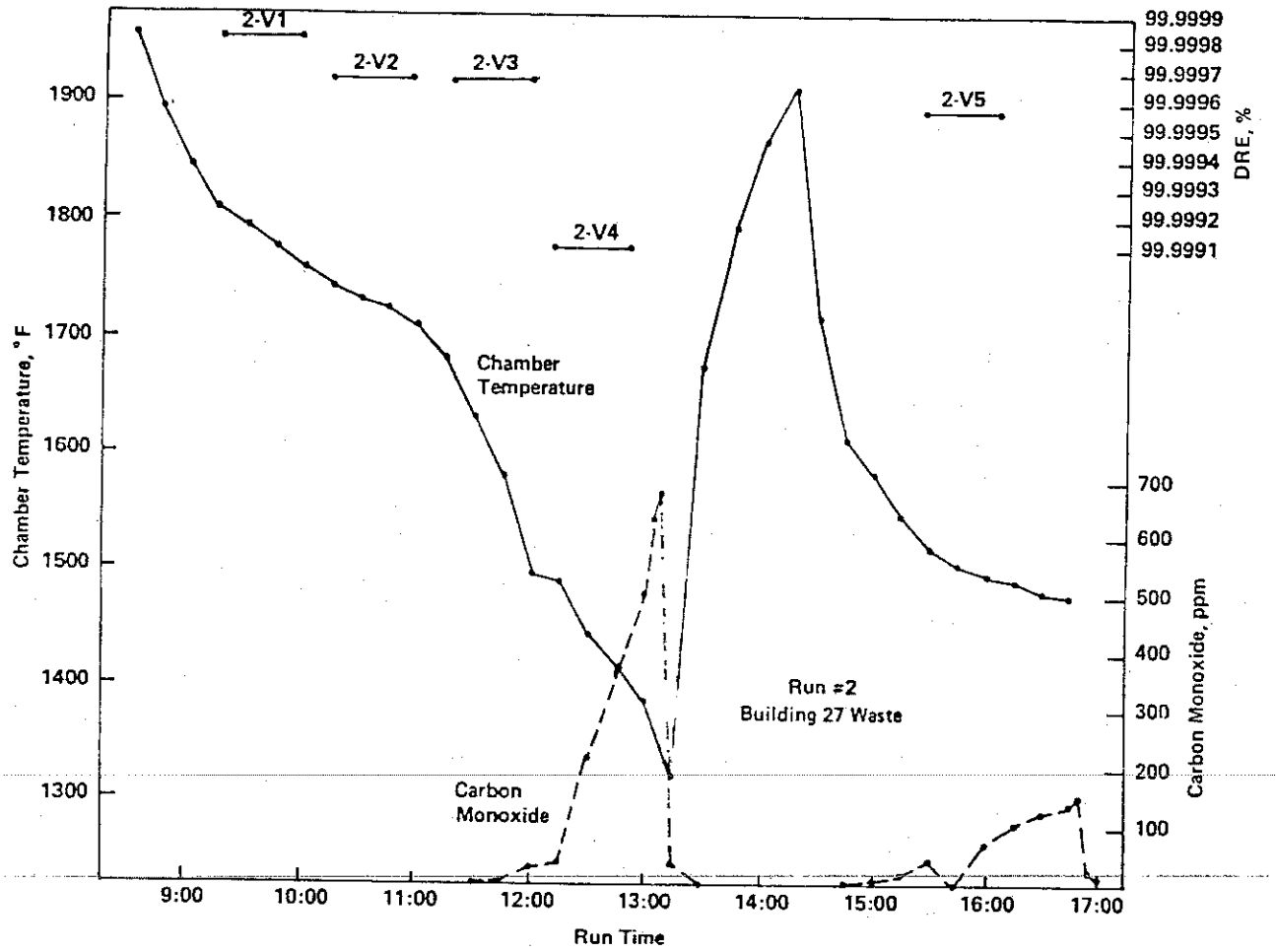


Figure 10 - Carbon monoxide as a function of temperature.

The high corrected values are attributable to the high excess oxygen in the stack gas. As Y (measured stack oxygen concentration) in the correction formula

$$P(\text{corrected}) = P(\text{measured}) \, [14/(21 - Y)]$$

approaches 21% of atmospheric air, P(corrected) can quickly become very large. The correction factor was put into the RCRA incinerator regulations to ensure that operators did not add air downstream of an incinerator as a means of diluting stack effluents in order to meet standards. For a standard incinerator, even when burning low BTU waste, this is no problem. As waste heat content goes down, auxiliary burners fired by fossil fuel must be employed to maintain chamber temperatures. The CO_2 by-product of

the combustion of this fuel becomes a significant percentage of the offgas composition, and oxygen is, of course, maintained as low as practical for economic reasons.

The glass furnace, on the other hand, uses no auxiliary fossil fuel in operation, and its flue gas contains only waste degradation products, steam, and excess air. Because of excessive system inleakage and an inability to adequately control fan speed, the amount of excess air used in these experiments is much higher than economically desirable. However, air flow in excess of that required for combustion is essential to remove waste by-products from the chamber and to maintain negative pressures in the system. For most of the waste burned in these runs, waste by-products other than water provided very little dilution to the excess air, making Y very near to atmospheric air oxygen, the correction factor denominator very small, and P(corrected) unrealistically large.

Chloride

RCRA regulations require that an incinerator producing more than four pounds of HCl per hour have an offgas treatment system that removes at least 99% of the generated Cl. Table 11 details chloride generation and removal information for the melter and offgas scrub system. The removal efficiency results show that the offgas system easily met the RCRA regulations for chloride removal during these runs.

Process Energy Costs

The focus of this section will be limited to the energy cost of processing the selected waste compositions in the glass furnace.

Table 13 summarizes data collected. Values are for the actual waste burning period. They do not take into account any energy required to maintain glass temperatures, should the furnace be used for less than around-the-clock operation. Costs other than those provided are expected to be of the same magnitude regardless of the incineration device selected, and as such are the subject of another study.

Table 13 - GLASS FURNACE WASTE PROCESSING ENERGY COSTS

Test Run	1	2	3	4
Feed Type	C	B	D	A
Water %	64+	83+	44+	99+
Total Feed (gal)	66.70	48.69	65.46	40.58
Duration of Run (min)	9:58	8:25	6:41	8:54
Power Use (kWH)				
Melter	897	814	335	904
Offgas system	400	337	267	356
TOTAL	1297	1151	602	1260
Cost($)[a]	51.88	46.04	24.08	50.40
Energy Cost/gal	0.78	0.95	0.37	1.24

[a]Based on Mound's current cost for electricity: $0.04/kWH

As discussed earlier, two factors had a negative effect on energy use in these experimental burns. The first factor was the difficulty experienced with the power system. A significant portion of the energy reported as powering the system was actually dissipated as heat in the transformers. The second factor was the inability to control air flow. Much more air was brought into the furnace and heated to chamber temperature -- at a large energy expense -- than was required for oxidation of the organic waste. Repairs to the electrical system and modification of the gas control system have since been made. Table 14 provides an energy balance and projections of furnace electrical requirements for processing the various waste types based on current energy use and controlled oxygen levels.

To simplify calculations, run conditions have been set as follows:

Feed rate - 5 gal/hr
Chamber temperature - Maintained at 1800°F
Excess air - 100%, or total air flow of two times that required to burn the organic part of the waste

Table 14 - ENERGY BALANCE PROJECTIONS FOR BUILDING 27 WASTES

Waste Type	Heat Removal from Furnace (BTU/hr)			Heat Supply (BTU/hr)	Electrical Requirement	
	Flue Gas (100% xs air)	Cooling Water	Skin Loss	Waste Combustion	(BTU/hr)[a]	(kW)[b]
Waste C Run No. 1 (64+% water)	152,338	147,436	20,973	136,834	183,913	53.9
Waste B Run No. 2 (83+% water)	120,301	147,436	20,973	65,198	223,512	65.5
Waste D Run No. 3 (44+% water)	194,873	147,436	20,973	215,555	147,727	43.3
Waste A Run No. 4 (99+% water)	80,309	147,436	20,973	925	247,813	72.6
Furnace Idle (No air flow)		147,436	20,973		168,409	49.3

[a]It should be noted that the furnace refractory has passed its projected life by several years and is probably permitting significantly more heat loss to the cooling water and room than earlier in its life.

[b]Power supply will have to be somewhat higher than the values listed, since losses (approximately 7%) will occur in the transformers.

The system for which energy balance data was collected is shown in Figure 11.

Table 15 provides a projection of the cost of processing the Building 27 waste stream if the waste contains 91% water (an average calculated from reported analyses) and optimal air supply is provided (100% excess). Per year projections are based on a two-shift operation, five-day week, with allowances made for holidays. No allowances are made for maintenance shutdowns. A feed rate of 10 gal/hr -- well within the capabilities of the existing furnace if operating properly -- is assumed.

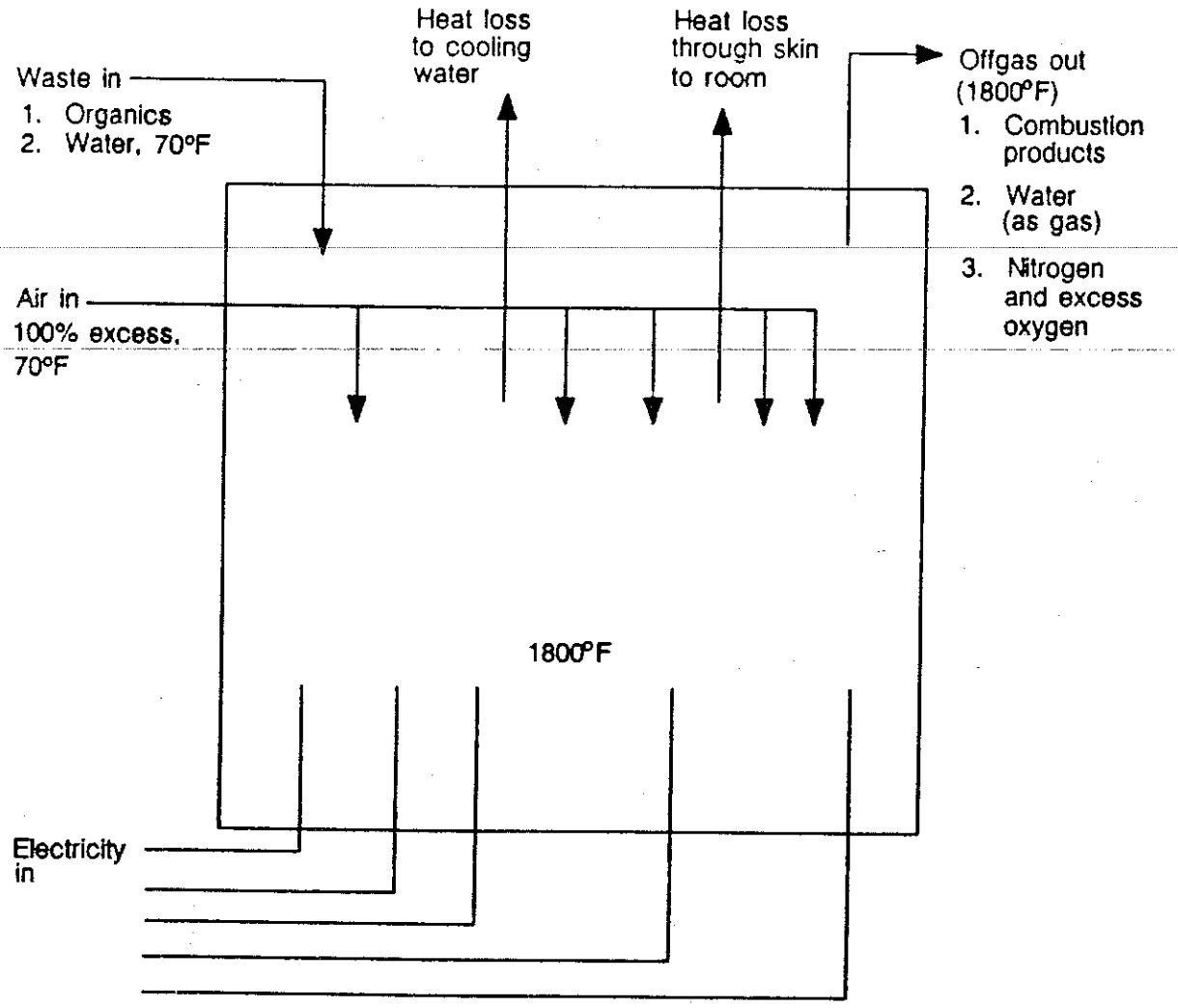


Figure 11 - Glass furnace energy transfers.

Table 15 - COST PROJECTIONS FOR ACTUAL WASTE PROCESSING

Feed Composition:	Acetone	4.13%
	Ethanol	4.14%
	Methylene Chloride	0.73%
	Water	91.00%
Feed Rate	10 gal/hr	

Energy Balance (per hour basis)

Energy Out -	Offgas	198,509 BTU
	- Skin	20,973 BTU
	- Cooling H20	147,436 BTU
Energy In -	Combustion	67,389 BTU
Required -	Electrical	299,529 BTU

Electrical Energy Required (kW):

	Per Hour	Per Year
- While Processing		
- Melter	87.79	348,351
- Offgas	41.70	165,466
- While Idle	(49.30)	236,246
- TOTAL	129.49	750,063
Total Waste Feed (gal)	10	39,680
Energy Cost per Gallon Waste (kW)	12.95	18.90
Cost per Gallon Waste	$0.518	$0.756

Conclusions

Waste Processing Capabilities

The glass melter has been demonstrated in these experiments to effectively destroy "difficult to incinerate" organics at efficiencies exceeding hazardous waste incinerator standards, even when the waste form has extremely low heat value.

Despite reportable particle loadings that exceed standards, actual particulate catch and chloride removal efficiencies demonstrate that the offgas system is adequately cleaning the incinerator flue gas. High efficiency particulate absorption (HEPA) filtration, which takes place downstream of the sampling points, virtually eliminates particle emissions. HEPA filter efficiency is rated at 99.97% for the most difficult particles to capture -- 0.3 micron.) Planned system changes will result in improved gas throughput control, improved scrubbing, and, in most cases, reportable particulate concentrations well within standard limits.

Suitability of Process for Aqueous Solvent Wastes

The glass furnace appears to be technically well suited for processing the waste under study. Waste feeding presents no apparent problems. The furnace has been shown capable of destroying the organic portion of the waste at the required efficiency regardless of the waste water content. Demonstrated feed rates are more than adequate to handle the quantities of waste being generated.

The major obstacle to using the glass melter for this work would appear to be the lack of any economic justification. The data collected (with the furnace working improperly) indicate that the system could process waste as now generated at a rate of 70-80 gal per 8-hr shift. Disposal of this quantity of material offsite is presently costing $190-$290. The energy cost of processing it in the glass melter should be less than $60. The other significant cost factor, however, that of labor to operate the system, would probably eliminate much of the economic advantage.

Table 16 uses data provided earlier, relative to energy costs for glass melter processing of waste, to outline a comparison of that disposal method versus continuation of the present practice of offsite shipment for disposal. Present generation rates are assumed. The projected 240 drums of waste produced annually would require a two-thirds year campaign if burning was limited to a five-day-per-week, single-shift operation. It is assumed that the furnace would be shut down for the remainder of the year. Incineration by means of the glass melter is considered to be a one-man

Table 16 - ANNUAL OPERATING COST ANALYSIS

	Current Practice		Glass Melter Treatment	
Offsite disposal	240 drums at $200 ea	$48,000		[a]
Electric		----	1,320 op hrs (129.5 kWH) 4,512 idle hrs (49.3 kWH)	$6,840 $8,900
Labor		----	one man-year[b]	$40,000
Other		[c]		[c]
TOTALS		$48,000		$55,800

[a]Assumed to be negligible.

[b]Annual generation actually requires two-thirds manyear ($27,000) operator effort.

[c]Assumed to be similar for both cases.

operation. For estimating purposes, operator labor costs are set at $40,000 per year.

Factors yet to be considered and balanced for a complete evaluation include:

1. Capital and maintenance costs of onsite equipment.

2. The consideration of rising offsite disposal costs compared to rising electrical costs.

3. The cost of compliance permits and onsite liability concerns compared to sharing liability with second parties offsite.

Reference

1. Mulholland, J. A., "The Role of Droplet Combustion in Hazardous Waste Incineration," *Land Disposal, Remedial Action. Incineration and Treatment of Hazardous Waste - Proceedings of the Twelfth Annual Research Symposium*, U.S. EPA/600/9/86/022, August 1986.

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APPENDIX C

REGULARLY TREATED WASTE TYPES AT THE U.S. DEPARTMENT OF ENERGY MOUND PLANT

Table C-1

Waste Types to be Treated at the EG&G Facility

Waste Name (EG&G No.)	EPA ID No.	Physical State	Btu/lb	Sp. Wt. (lb/gal)	Components	% Range	Analytical Method SW 846 No.	Hc (Kcal/g)
Hazardous Wastes								
Solvent 28 (MTO 27)	D001 F002 F003	Clear Liquid	5,470	6-11	Methylene Chloride Isopropanol Acetone Ethanol Methanol Diacetone Alcohol	20-40 20-90 5-20 0-5 0-5 0-5	8010, 8240	1.70
B-Solvent (MTO 29)	D001 F002 F003 F005	Clear Liquid	5,400-10,200	6-13	Methanol Ethanol Isopropanol Trichloroethylene Water Acetone Methylene Chloride 1,1,1-Trichloroethane Toluene Trichlorotrifluoroethane Hexane Heptane	0-40 0-40 0-40 0-40 5-20 0-20 0-15 0-40 0-40 0-40 0-10 0-10	8010, 8240 8010, 8240 8020, 8240	1.74 1.70 1.99 10.14
E-Solvent	D001 F001 F002	Clear Liquid	3,500-6,065	8.06	Isopropanol Trichlorofluoroethane Methylene Chloride Water Ethanol	0-45 0-45 10-30 20-80 0-10	8010, 8240	1.70
DS-Solvent (MTO 28)	D001 F001 F002 F005	Liquid	7,000	7-9	Isopropanol 1,1,1-Trichloroethane Trichlorotrifluoroethane Trichloroethylene Acetone Toluene Ethanol 1,4-Dioxane	0-50 0-40 0-20 0-20 0-20 0-30 0-75 0-10	8010, 8240 8010, 8240 8020, 8240 8015, 8240	1.99 1.74 10.14

Table C-1
(continued)

Waste Name (EG&G No.)	EPA ID No.	Physical State	Btu/lb	Sp. Wt. (lb/gal)	Components	% Range	Analytical Method SW 846 No.	Hc (Kcal/g)
Waste Acetone (MTO 19)	D001 F003	Clear liquid	11,600	6-7	Acetone	75-100		
					Water	0-10		
					Methyl Ethyl Ketone	0-10	8015, 8240	
					Ethanol	0-10		
					Cyclohexanone	0-5		
Waste Alcohol (MTO 30)	D001 F003	Clear liquid	8,100	5-10	Methanol	5-50		
					Ethanol	5-50		
					Isopropanol	5-50		
					Water	0-40		
					Cyclohexanone	0-5		
I-Solvent (MTO 107)	D001 F001 F002	Clear liquid	9,884	7-10	1,1,1-Trichloroethane	0-70	8010, 8240	1.99
					Trichlorotrifluoroethane	0-70		
					Methylene Chloride	0-60	8010, 8240	1.70
					Isopropanol	0-35		
Blankrola Solvent (M 48)	D001 F001	Reddish-brown liquid	16,820	7-9	Petroleum Naphtha	75-80		
					Tetrachloroethylene	0-35	8010, 8240	1.19
Carbon Disulfide (MTO 18)	F005	Yellow liquid		10.8	Carbon Disulfide	100	8015, 8240	
Trichloroethane (MTO 26)	F002	Liquid		10-12	1,1,1-Trichloroethane	70-100	8010, 8240	1.99
					Water	0-30		
Tetrachloroethane (MTO 61)	F001	Liquid		10-15	Tetrachloroethane	90-100	8010, 8240	
					Water	0-10		
Organic Solvent (MTO 86)	D001 F001 F002	Liquid	3,680	8-9	Methylene Chloride	0-20	8010, 8240	1.70
					Mineral Spirits, Oil	10-20		
					1,1,1-Trichloroethane	0-10	8010, 8240	1.99
					Tetrachloroethane	0-5	8010, 8240	
					Water	0-60		
Organic Solvent (MTO 109)	D001 F002	Liquid (two-phase)	6,690	7-9	Isopropanol	0-50		
					1,1,1-Trichloroethane	0-10	8010, 8240	
					1,1,2-Trichloroethane	0-10	8010, 8240	
					Water	0-60		

Table C-1
(continued)

Waste Name (EG&G No.)	EPA ID No.	Physical State	Btu/lb	Sp. Wt. (lb/gal)	Components	% Range	Analytical Method SW 846 No.	Hc (Kcal/g)
Trichloroethylene (MTO 33)	F002	Liquid		12-13	Trichloroethylene	70-100	8010, 8240	1.74
					Water	0-30		
Paint Waste (M-93)	D001	Liquid	8,000-	5-10	Acetone	0-20		
	F001	(Multiphase)	12,000		Toluene	0-20	8020, 8024	10.14
	F002				Ethanol	0-15		
	F003				1,1,1-Trichloroethane	0-10	8010, 8240	1.99
	F005				Tetrachloroethylene	0-10	8010, 8240	1.19
					Chlorobenzene	0-10	8020, 8024	6.60
					Mineral Spirits	0-20		
					Water	0-40		
					Methyl Isobutyl Ketone	0-20		
					Isopropanol	0-10		
					Heptane	0-10		
					Xylene	0-5	8020, 8240	
Trichlorotri-fluoroethane (MTO 60)	F002	Liquid		10-15	Trichlorotrifluoroethane	60-100		
					Water	0-40		
27 Solvent (M 134)	D001	Liquid	1,000-	6-11	Acetone	0-100		
	F002		6,000		Ethanol	0-100		
	F003				Acetonitrile	0-100	8030, 8240	7.37
	F005				Tetrahydrofuran	0-100		
					Methylene Chloride	0-50	8010, 8240	1.70
					Dimethylsulfoxide	0-25		
					Toluene	0-15	8020, 8024	10.14
					Diacetone alcohol	0-5		
					Butylrolacetone	0-5		
					Water	0-100		
Wastewater Coolant	F002	Liquid	9,000-		Hydrocarbon Oil	50-98		
			18,000		Trichlorotrifluoroethane	2-15		
					Water	0-48		
Radioactive Mixed Wastes								
Scintillation Vials-Type 1 (M 136)	D001	Gel or Clear Liquid			Pseudocumene Solvents	20-60		
					Surfactants	0-50		
					Water	0-60		

Table C-1
(continued)

Waste Name (EG&G No.)	EPA ID No.	Physical State	Btu/lb	Sp. Wt. (lb/gal)	Components	% Range	Analytical Method SW 846 No.	Hc (Kcal/g)
Scintillation Vials-Type 2 (M 137)	D001 F003	Gel or Clear Liquid			Xylene Water Alkylpolyethoxyethanol Arylhydrocarbons	25-70 0-60 0-30 0-30	8020, 8240	
Scintillation Vials-Type 3 (M 138)	D001	Gel or Clear Liquid			1,4-Dioxane Naphthalene Water 2,5-Diphenyloxazole	40-95 2-15 0-60 0-1	8100, 8250	9.62
Waste Oils (in drums)		Liquids (1 or more phases)	1,000-20,000	7-11	Oils Water Other Organics (see Table A-2)	0-100 0-99 0-20		
Mixed Waste Solvents (in drums)	D001 F001 F002 F003 F005	Liquids (1 or more phases)	1,000-16,000	6-12	Water Solvents (see Table A-2)	0-100 0-100		

Table C-2

RCRA Appendix VIII Components That Could Be Present in Waste Feed Streams

Compound	Heat of Combustion (Kcal/g)
Trichloromonofluoromethane	0.11
Carbon Tetrachloride	0.24
Chloroform	0.75
Tetrachloroethylene	1.19
Tetrachloroethane	1.39
Methylene Chloride	1.70
Trichloroethylene	1.74
Trichloroethane	1.99
Trichlorophenol	2.23
Dichloroethylene	2.70
Dichloroethane	3.00
Carbon Disulfide	3.24
Maleic Anhydride	3.39
Trichlorobenzene	3.40
Dichlorobenzene	4.57
Nitrophenol	4.88
Nitropropane	5.37
Nitrobenzene	5.50
1,4-Dioxane	6.41
Chlorobenzene	6.60
Benzyl Chloride	7.00
Acetonitrile	7.37
Phenol	7.68
Acrylonitrile	7.93
Methyl Ethyl Ketone	8.07
Cresols	8.18
Pyridine	8.32
Isobutyl Alcohol	8.62
Naphthalene	9.62
Benzene	10.03
Toluene	10.14
Xylene	10.27

Table C-3

RCRA Appendix VIII Metals That Could Be Present in Waste Feed Streams

Antimony	Mercury
Arsenic	Nickel
Barium	Osmium
Beryllium	Selenium
Cadmium	Silver
Chromium	Thallium
Copper	Vanadium
Lead	Zinc

Table C-4

Radionuclides That Could be Present in Waste Feed Streams

Americium-241	Plutonium-241
Cobalt-60	Thorium-228
Cesium-137	Thorium-230
Hydrogen-3	Thorium-232
Plutonium-238	Uranium-235
Plutonium-239	Uranium-238
Plutonium-240	

APPENDIX D

DETERMINATION OF METALS REGULATIONS

(Tabs and Tables referenced in this Appendix are from "Guidance on Metals and Hydrogen Chloride Controls for Hazardous Waste Incinerators", Draft Final Report, September 1988.)

Tab A

Data Gathering: Terrain Analysis, and Applicability of Screening Tables

Step 1 - Site Data are provided on Table 4.4 The site location is shown in the U.S. Geological Survey 7.5 minute Topographic map (Figure D-1).

Step 2 - The terrain rise within 5 km is greater than 17.3 m (effective stack height). Therefore terrain is considered complex.

Step 3 - Site is assumed to be in an urban setting, which is more restrictive.

Step 4 - Applicability of screening

Facility is not located in a narrow valley <1 km wide.

Stack height is less than 20 meters (65.6 ft).

Ratio of the nearest tall building height to the stack height (74 ft/48 ft) = 1.54, distance from the stack to the building divided by building height is (1,063 ft/74 ft) = 14.3, and distance from stack to the building divided by maximum projected width (1063 ft/183 ft) = 5.8, therefore, there are no down wash problems.

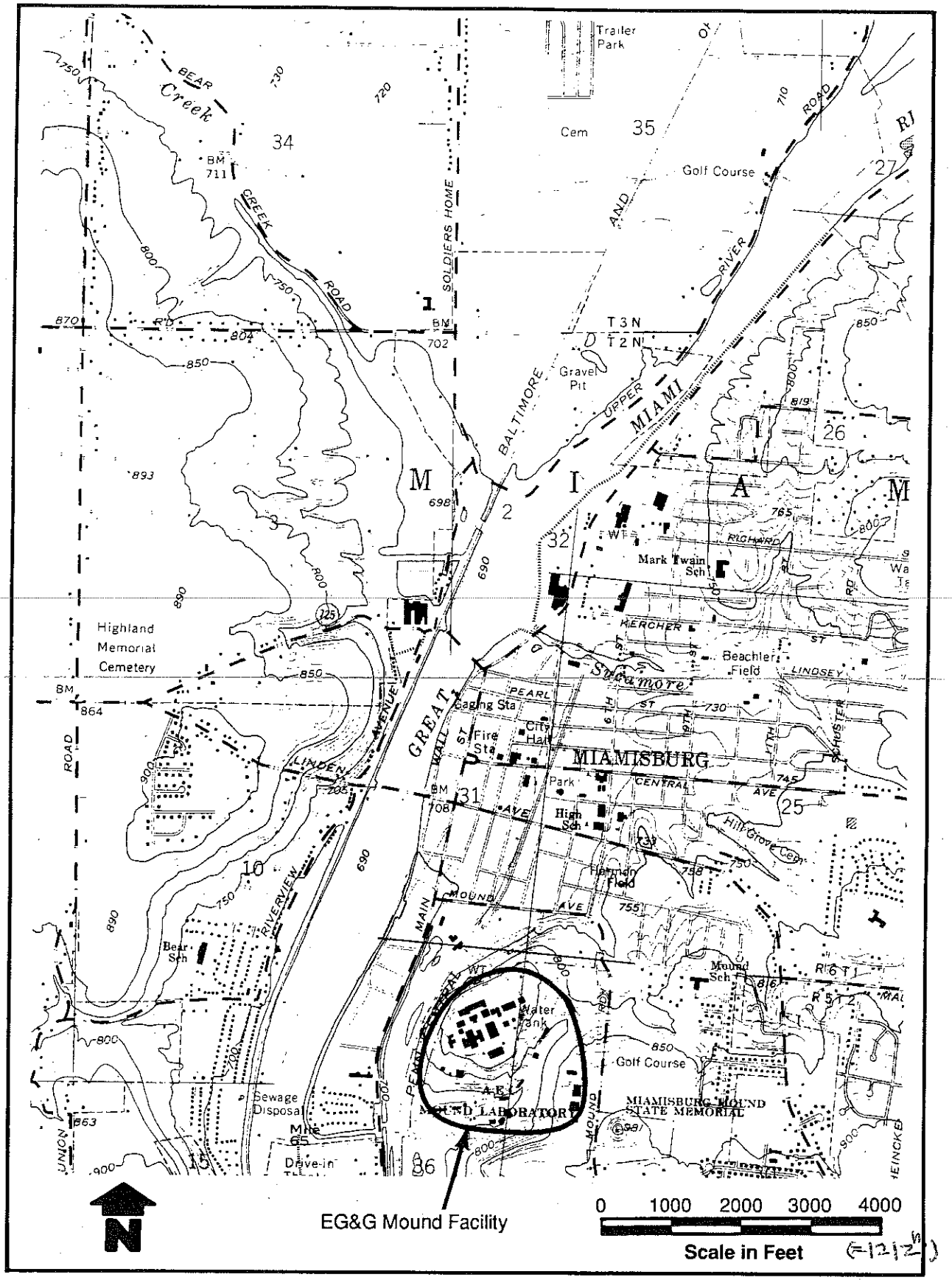


FIGURE D-1 PORTION OF THE 7 1/2 MINUTE TOPOGRAPHIC QUADRANGLE

Tab B

Determine Feed Rates or Emission Limits (Tier I and Tier II)

Step 1 - Only one hazardous waste incinerator on-site.

Step 2 - a. Determine plume rise value from Table B-1.

Flow Rate 14,000 acfm $\frac{(m)^3}{(3.281\ ft)^3}$ = 396 m^3/min.
= 6.6 m^3/sec.

Temperature (70°F) = 20°C

20°C + 273 = 293°K

From Table B-1, plume rise = 3 m

b. Effective Stack Ht = (47 ft/3.281) + 3 m
= 17.3 m

c. Terrain Rise within 5 km = 179 ft

179 ft/3.281 = 54.6 m

Terrain Adjust Stack Ht = 17.3-54.6 m
= -37.4

Since this is a negative number, Terrain Adjusted Effective Stack Height of 4 m is assumed.

Step 3a - Determine TIER I Limitations
(Based on 70 lb/hr feed rate)

Noncarcinogens - Table B-3 Metals (Complex Terrain)

Antimony	0.03	lb/hr	=	429 ppm
Barium	5.0	lb/hr	=	71,429 ppm
Lead	0.009	lb/hr	=	129 ppm
Mercury	0.2	lb/hr	=	2,857 ppm
Silver	0.3	lb/hr	=	4,286 ppm
Thallium	0.03	lb/hr	=	429 ppm

Table B-10 HCl

Chlorine	.26 lb/hr	=	0.37%

Carcinogens - Table B-5 Metals (Complex Terrain)

Arsenic	0.0002	lb/hr	2.9 ppm
Cadmium	0.0006	lb/hr	8.6 ppm
Chromium	0.00009	lb/hr	1.3 ppm
Beryllium	0.004	lb/hr	57.1 ppm

Step 3b - Determine TIER II Stack Limitations for all metals exceeding 1,000 ppm

Noncarcinogens - Table B-7 Metals (Complex Terrain)

Antimony	0.004 gm/sec	=	0.032 lb/hr
Lead	0.001 gm/sec	=	0.008 lb/hr
Thallium	0.004 gm/sec	=	0.032 lb/hr

Table B-11 HCl Emissions

HCl = 0.033 gm/sec = 0.26 lb/hr

Carcinogens - Table B-9 Metals (Complex Terrain)

Arsenic	0.00003 gm/sec	=	0.0002 lb/hr
Cadmium	0.00007 gm/sec	=	0.00056 lb/hr
Chromium	0.00001 gm/sec	=	0.00008 lb/hr
Beryllium	0.0005 gm/sec	=	0.0004 lb/hr

Using conservative collection efficiencies for high ΔP scrubber = 60 in wg

Arsenic Removal	97%
Cadmium Removal	97%
Chromium Removal	98%
Beryllium Removal	98%

Using the estimated removal efficiencies

Arsenic (0.0002 lb/hr) $\left(\frac{1}{1-.97}\right)$ = 0.0067 lb/hr = 95 ppm

Cadmium (0.00056 lb/hr) $\left(\frac{1}{1-.97}\right)$ = 0.0187 lb/hr = 266 ppm

Chromium (0.00008 lb/hr) $\left(\frac{1}{1-.98}\right)$ = 0.004 lb/hr = 57 ppm

Beryllium (0.0004 lb/hr) $\left(\frac{1}{1-.98}\right)$ = 0.02 lb/hr = 285 ppm

Since multiple carcinogens will be divided by all 4

Arsenic	=(0.0067 lb/hr)	(1/4)	= 0.0017 lb/hr	=	24 ppm
Cadmium	=(0.0187 lb/hr)	(1/4)	= 0.0047 lb/hr	=	67 ppm
Chromium	=(0.004 lb/hr)	(1/4)	= 0.001 lb/hr	=	14 ppm
Beryllium	=(0.02 lb/hr)	(1/4)	= 0.005 lb/hr	=	71 ppm

Appendix E

Analytical Methods for Liquid, Sludge, and Solid Samples

- Method 5030
- SW 846 Method 8240
- ASTM Method D129
- EPA Method 325.2
- ASTM Method D240
- ASTM Method D2216-80
- EPA Method 209.0
- SW 846 EPA Methods 3010/3020
- SW 846 EPA Method 3050
- SW 846 EPA Method 6010
- SW 846 EPA Method 7000 Series
- SW 846 EPA Method 1310
- EPA Method 209C
- EPA Method 423
- EPA Method 300.0

PURGE AND TRAP

SW 846 METHOD 5030

0173L

PURGE-AND-TRAP

1.0 SCOPE AND APPLICATION

1.1 This method describes sample preparation and extraction for the analysis of volatile organics by a purge-and-trap procedure. The gas chromatographic determinative steps are found in Methods 8010, 8015, 8020, and 8030. Although applicable to Method 8240, the purge-and-trap procedure is already incorporated into Method 8240.

1.2 Method 5030 can be used for most volatile organic compounds that have boiling points below 200°C (vapor pressure is approximately equal to mm Hg @ 25°C) and are insoluble or slightly soluble in water. Volatile water-soluble compounds can be included in this analytical technique; however, quantitation limits (by GC or GC/MS) are approximately ten times higher because of poor purging efficiency. The method is also limited to compounds that elute as sharp peaks from a GC column packed with graphitized carbon lightly coated with a carbowax. Such compounds include low-molecular-weight halogenated hydrocarbons, aromatics, ketones, nitriles, acetates, acrylates, ethers, and sulfides.

1.3 Water samples can be analyzed directly for volatile organic compounds by purge-and-trap extraction and gas chromatography. Higher concentrations of these analytes in water can be determined by direct injection of the sample into the chromatographic system.

1.4 This method also describes the preparation of water-miscible liquids, solids, wastes, and soil/sediments for analysis by the purge-and-trap procedure.

2.0 SUMMARY OF METHOD

2.1 The purge-and-trap process: An inert gas is bubbled through the solution at ambient temperature, and the volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile components are adsorbed. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the components onto a gas chromatographic column.

2.2 If the above sample introduction techniques are not applicable, a portion of the sample is dispersed in methanol to dissolve the volatile organic constituents. A portion of the methanolic solution is combined with water in a specially designed purging chamber. It is then analyzed by purge-and-trap GC following the normal water method.

3.0 INTERFERENCES

3.1 Impurities in the purge gas and from organic compounds out-gassing from the plumbing ahead of the trap account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory reagent blanks. The use of non-TFE plastic coating, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

3.2 Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) through the septum seal of the sample vial during shipment and storage. A field reagent blank prepared from reagent water and carried through sampling and handling protocols serves as a check on such contamination.

3.3 Contamination by carryover can occur whenever high-level and low-level samples are analyzed sequentially. Whenever an unusually concentrated sample is analyzed, it should be followed by an analysis of reagent water to check for cross-contamination. The trap and other parts of the system are subject to contamination; therefore, frequent bake-out and purging of the entire system may be required.

3.4 The laboratory where volatile analysis is performed should be completely free of solvents.

4.0 APPARATUS AND MATERIALS

4.1 Microsyringes: 10-uL, 25-uL, 100-uL, 250-uL, 500-uL, and 1,000 uL. These syringes should be equipped with a 20-gauge (0.006-in I.D.) needle having a length sufficient to extend from the sample inlet to within 1 cm of the glass frit in the purging device. The needle length will depend upon the dimensions of the purging device employed.

4.2 Syringe valve: Two-way, with Luer ends (three each), if applicable to the purging device.

4.3 Syringe: 5-mL, gas-tight with shutoff valve.

4.4 Balance: Analytical, capable of accurately weighing 0.0001 g, and a top-loading balance capable of weighing 0.1 g.

4.5 Glass scintillation vials: 20-mL, with screw-caps and Teflon liners or glass culture tubes with a screw-cap and Teflon liner.

4.6 Volumetric flasks: 10-mL and 100-mL, class A with ground-glass stoppers.

4.7 Vials: 2-mL, for GC autosampler.

4.8 Spatula: Stainless steel.

4.9 Disposable pipets: Pasteur.

4.10 Purge-and-trap device: The purge-and-trap device consists of three separate pieces of equipment: the sample purger, the trap, and the desorber. Several complete devices are commercially available.

4.10.1 The recommended purging chamber is designed to accept 5-mL samples with a water column at least 3 cm deep. The gaseous headspace between the water column and the trap must have a total volume of less than 15 mL. The purge gas must pass through the water column as finely divided bubbles with a diameter of less than 3-mm at the origin. The purge gas must be introduced no more than 5 mm from the base of the water column. The sample purger, illustrated in Figure 1, meets these design criteria. Alternate sample purge devices may be used, provided equivalent performance is demonstrated.

4.10,2 The trap must be at least 25 cm long and have an inside diameter of at least 0.105 in. Starting from the inlet, the trap must contain the following amounts of adsorbents: 1/3 of 2,6-diphenylene oxide polymer, 1/3 of silica gel, and 1/3 of coconut charcoal. It is recommended that 1.0 cm of methyl silicone-coated packing be inserted at the inlet to extend the life of the trap (see Figures 2 and 3). If it is not necessary to analyze for dichlorodifluoromethane or other fluorocarbons of similar volatility, the charcoal can be eliminated and the polymer increased to fill 2/3 of the trap. If only compounds boiling above 35°C are to be analyzed, both the silica gel and charcoal can be eliminated and the polymer increased to fill the entire trap. Before initial use, the trap should be conditioned overnight at 180°C by backflushing with an inert gas flow of at least 20 mL/min. Vent the trap effluent to the hood, not to the analytical column. Prior to daily use, the trap should be conditioned for 10 min at 180°C with backflushing. The trap may be vented to the analytical column during daily conditioning; however, the column must be run through the temperature program prior to analysis of samples.

4.10.3 The desorber should be capable of rapidly heating the trap to 180°C for desorption. The polymer section of the trap should not be heated higher than 180°C, and the remaining sections should not exceed 220°C during bake-out mode. The desorber design illustrated in Figures 2 and 3 meet these criteria.

4.10.4 The purge-and-trap device may be assembled as a separate unit or may be coupled to a gas chromatograph, as shown in Figures 4 and 5.

4.10.5 Trap Packing Materials

4.10.5.1 2,6-Diphenylene oxide polymer: 60/80 mesh, chromatographic grade (Tenax GC or equivalent).

4.10.5.2 Methyl silicone packing: OV-1 (3%) on Chromosorb-W, 60/80 mesh or equivalent.

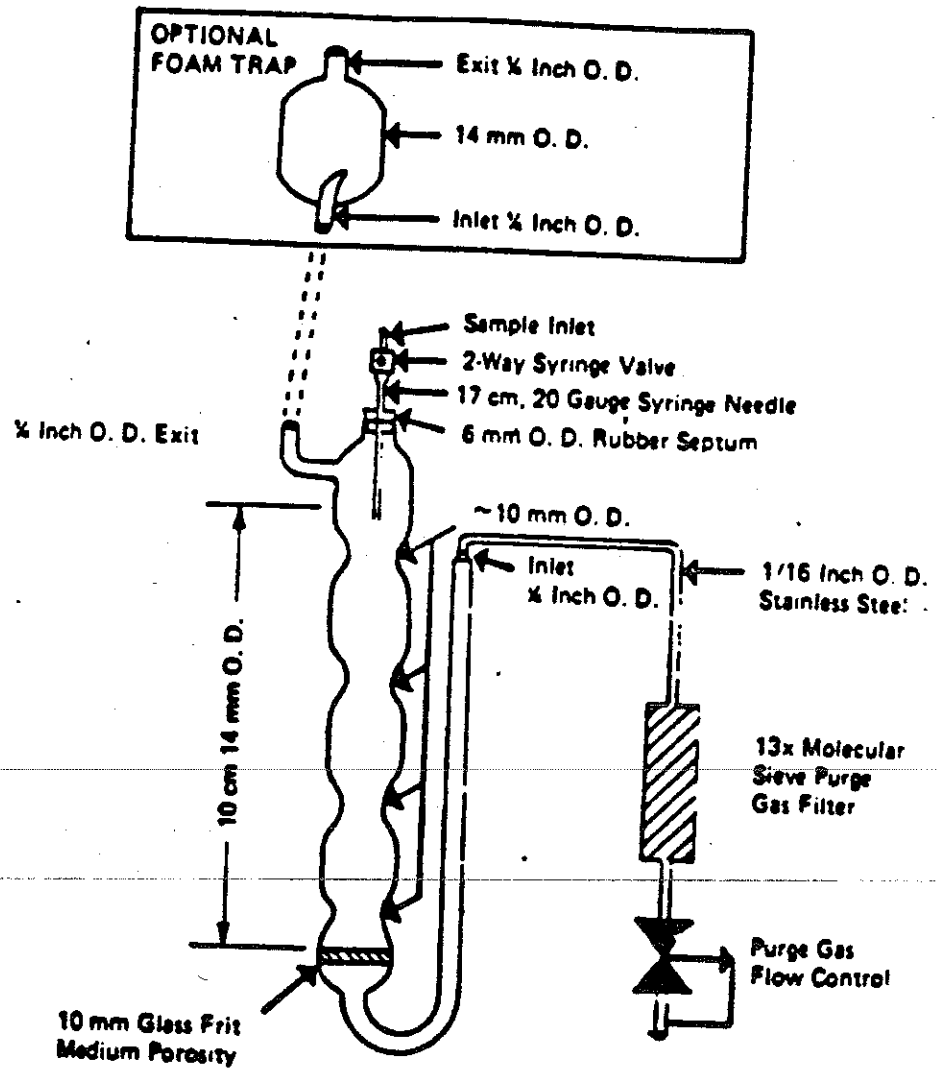


Figure 1. Purging chamber.

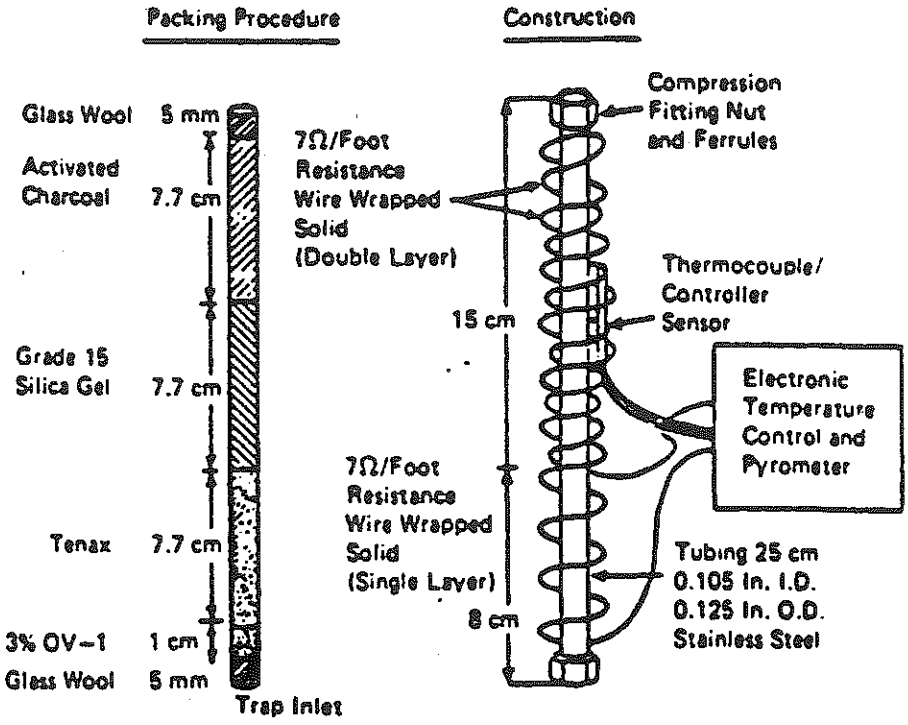


Figure 2. Trap packings and construction for Method 8010.

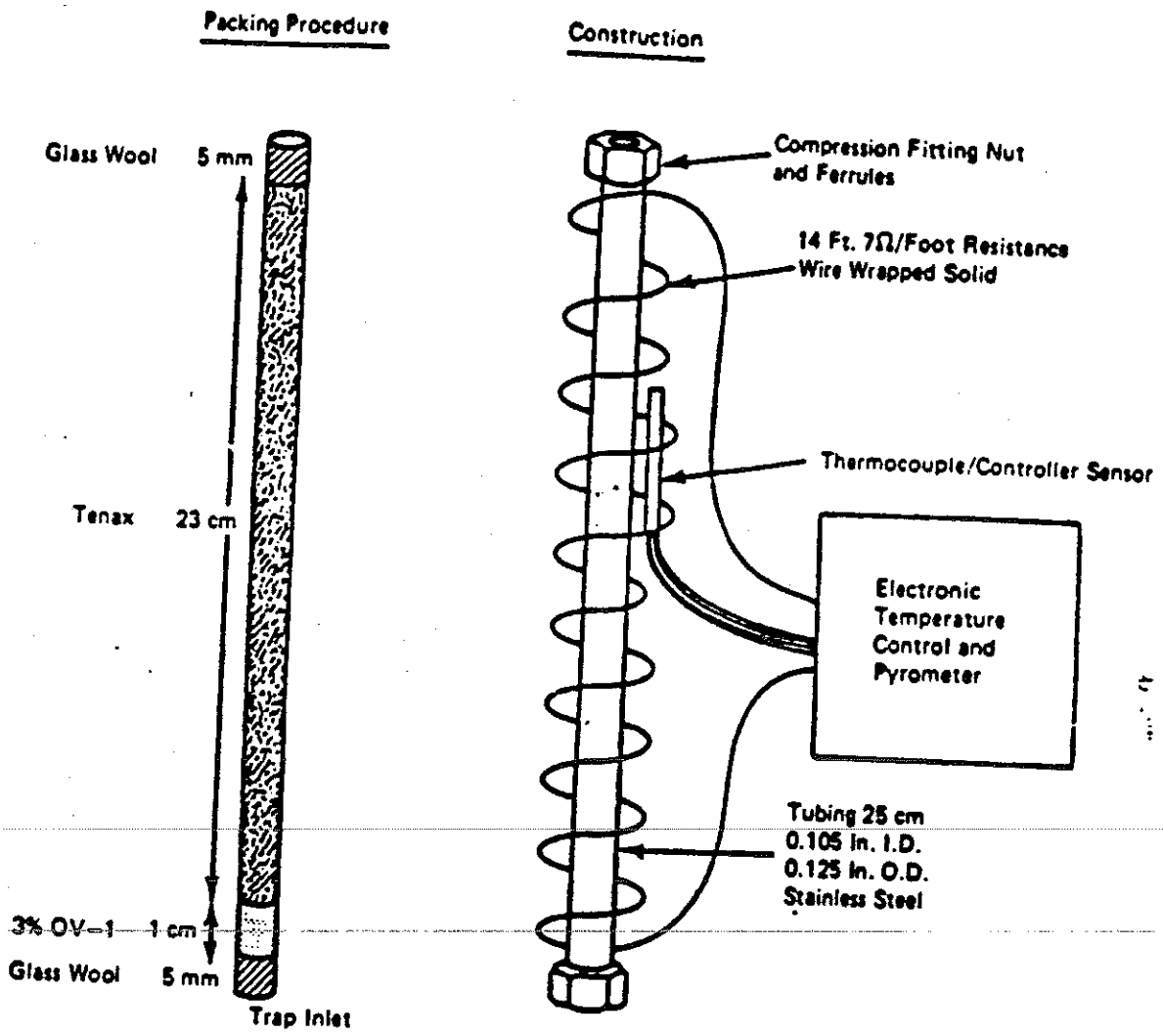


Figure 3. Trap packing and construction for Methods 8020 and 8030.

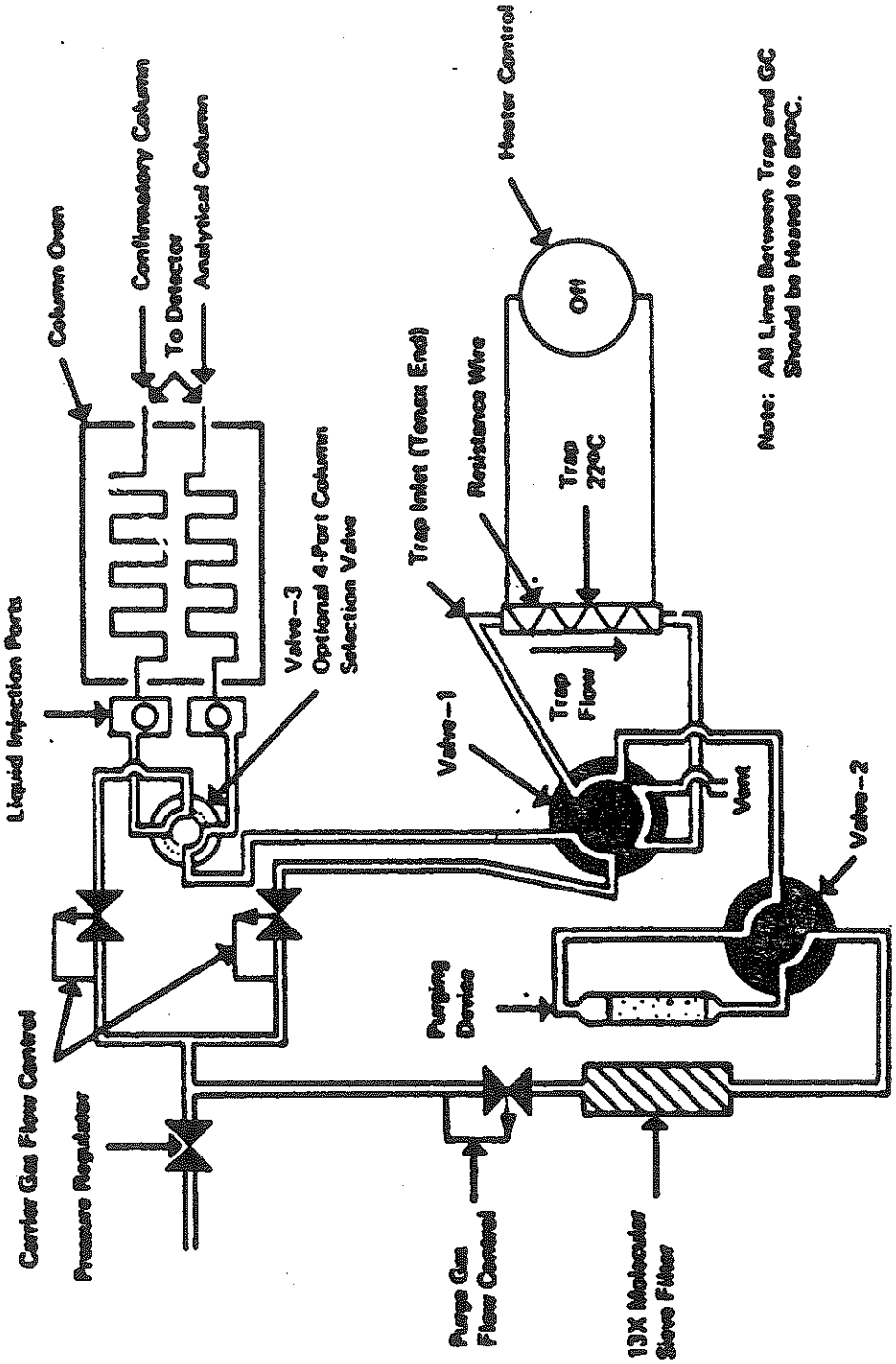


Figure 4. Purge-and-trap system, purge-sorb mode, for Methods 8010, 8020, and 8030.

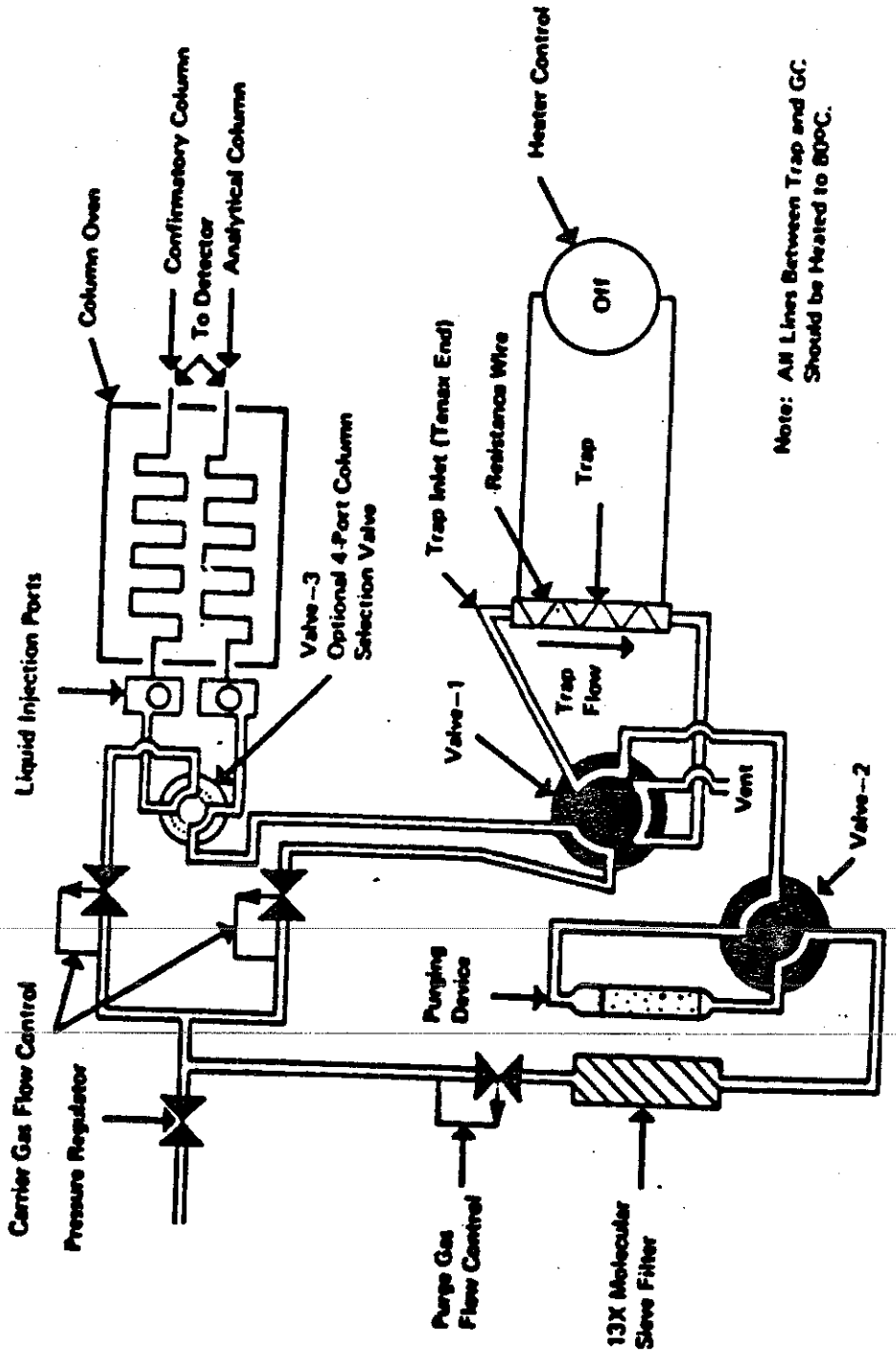


Figure 5. Purge-and-trap system, desorb mode, for Methods 8010, 8020, and 8030.

4.10.5.3 Silica gel: 35/60 mesh, Davison, grade 15 or equivalent.

4.10.5.4 Coconut charcoal: Prepare from Barnebey Cheney, CA-580-26 lot #M-2649, by crushing through 26 mesh screen.

4.11 Heater or heated oil bath: Should be capable of maintaining the purging chamber to within 1°C over a temperature range from ambient to 100°C.

5.0 REAGENTS

5.1 Reagent water: Reagent water is defined as water in which an interferent is not observed at the method detection limit of the compounds of interest.

5.1.1 Reagent water may be generated by passing trap water through a carbon filter bed containing about 500 g of activated carbon (Calgon Corp., Filtrasorb-300 or equivalent).

5.1.2 A water purification system (Millipore Super-Q or equivalent) may be used to generate reagent water.

5.1.3 Reagent water may also be prepared by boiling water for 15 min. Subsequently, while maintaining the water temperature at 90°C, bubble a contaminant-free inert gas through the water for 1 hr. While still hot, transfer the water to a narrow-mouth screw-cap bottle and seal with a Teflon-lined septum and cap.

5.2 Methanol: Pesticide quality or equivalent. Store away from other solvents.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Refer to the introductory material to this chapter, Organic Analytes, Section 4.1.

7.0 PROCEDURE

7.1 Initial calibration: Prior to using this introduction technique for any GC method, the system must be calibrated. General calibration procedures are discussed in Method 8000, Section 7.4, while the specific determinative methods and Method 3500 give details on preparation of standards.

7.1.1 Assemble a purge-and-trap device that meets the specification in Section 4.10. Condition the trap overnight at 180°C in the purge mode with an inert gas flow of at least 20 mL/min. Prior to use, condition the trap daily for 10 min while backflushing at 180°C with the column at 220°C.

7.1.2 Connect the purge-and-trap device to a gas chromatograph.

7.1.3 Prepare the final solutions containing the required concentrations of calibration standards, including surrogate standards, directly in the purging device. Add 5.0 mL of reagent water to the purging device. The reagent water is added to the purging device using a 5-mL glass syringe fitted with a 15-cm 20-gauge needle. The needle is inserted through the sample inlet shown in Figure 1. The internal diameter of the 14-gauge needle that forms the sample inlet will permit insertion of the 20-gauge needle. Next, using a 10-uL or 25-uL microsyringe equipped with a long needle (Paragraph 4.1), take a volume of the secondary dilution solution containing appropriate concentrations of the calibration standards. Add the aliquot of calibration solution directly to the reagent water in the purging device by inserting the needle through the sample inlet. When discharging the contents of the microsyringe, be sure that the end of the syringe needle is well beneath the surface of the reagent water. Similarly, add 10 uL of the internal standard solution. Close the 2-way syringe valve at the sample inlet.

7.1.4 Carry out the purge-and-trap analysis procedure using the specific conditions given in Table 1.

7.1.5 Calculate response factors or calibration factors for each analyte of interest using the procedure described in Method 8000, Section 7.4.

7.1.6 The average RF must be calculated for each compound. A system performance check should be made before this calibration curve is used. If the purge-and-trap procedure is used with Method 8010, the following five compounds are checked for a minimum average response factor: chloromethane; 1,1-dichloroethane; bromoform; 1,1,2,2-tetrachloroethane; and chlorobenzene. The minimum acceptable average RF for these compounds should be 0.300 (0.250 for bromoform). These compounds typically have RFs of 0.4-0.6 and are used to check compound instability and check for degradation caused by contaminated lines or active sites in the system. Examples of these occurrences are:

7.1.6.1 Chloromethane: This compound is the most likely compound to be lost if the purge flow is too fast.

7.1.6.2 Bromoform: This compound is one of the compounds most likely to be purged very poorly if the purge flow is too slow. Cold spots and/or active sites in the transfer lines may adversely affect response.

7.1.6.3 Tetrachloroethane and 1,1-dichloroethane: These compounds are degraded by contaminated transfer lines in purge-and-trap systems and/or active sites in trapping materials.

7.2 On-going calibration: Refer to Method 8000, Sections 7.4.2.3 and 7.4.3.4 for details on continuing calibration.

TABLE 1. PURGE-AND-TRAP OPERATING PARAMETERS

	Analysis Method			
	8010	8015	8020	8030
Purge gas	Nitrogen or Helium	Nitrogen or Helium	Nitrogen or Helium	Nitrogen or Helium
Purge gas flow rate (mL/min)	40	20	40	20
Purge time (min)	11.0 ± 0.1	15.0 ± 0.1	12.0 ± 0.1	15.0 ± 0.1
Purge temperature (°C)	Ambient	85 ± 2	Ambient	85 ± 2
Desorb temperature (°C)	180	180	180	180
Backflush inert gas flow (mL/min)	20-60	20-60	20-60	20-60
Desorb time (min)	4	1.5	4	1.5

7.3 Sample preparation:

7.3.1 Water samples:

7.3.1.1 Screening of the sample prior to purge-and-trap analysis will provide guidance on whether sample dilution is necessary and will prevent contamination of the purge-and-trap system. Two screening techniques that can be utilized are: the use of an automated headspace sampler (modified Method 3810), interfaced to a gas chromatograph (GC), equipped with a photo ionization detector (PID), in series with an electrolytic conductivity detector (ECD); and extraction of the sample with hexadecane (Method 3820) and analysis of the extract on a GC with a FID and/or an ECD.

7.3.1.2 All samples and standard solutions must be allowed to warm to ambient temperature before analysis.

7.3.1.3 Assemble the purge-and-trap device. The operating conditions for the GC are given in Section 7.0 of the specific determinative method to be employed.

7.3.1.4 Daily GC calibration criteria must be met (Method 8000, Section 7.4) before analyzing samples.

7.3.1.5 Adjust the purge gas flow rate (nitrogen or helium) to that shown in Table 1, on the purge-and-trap device. Optimize the flow rate to provide the best response for chloromethane and bromoform, if these compounds are analytes. Excessive flow rate reduces chloromethane response, whereas insufficient flow reduces bromoform response.

7.3.1.6 Remove the plunger from a 5-mL syringe and attach a closed syringe valve. Open the sample or standard bottle, which has been allowed to come to ambient temperature, and carefully pour the sample into the syringe barrel to just short of overflowing. Replace the syringe plunger and compress the sample. Open the syringe valve and vent any residual air while adjusting the sample volume to 5.0 mL. This process of taking an aliquot destroys the validity of the liquid sample for future analysis; therefore, if there is only one VOA vial, the analyst should fill a second syringe at this time to protect against possible loss of sample integrity. This second sample is maintained only until such time when the analyst has determined that the first sample has been analyzed properly. Filling one 20-mL syringe would allow the use of only one syringe. If a second analysis is needed from a syringe, it must be analyzed within 24 hr. Care must be taken to prevent air from leaking into the syringe.

7.3.1.7 The following procedure is appropriate for diluting purgeable samples. All steps must be performed without delays until the diluted sample is in a gas-tight syringe.

7.3.1.7.1 Dilutions may be made in volumetric flasks (10-mL to 100-mL). Select the volumetric flask that will allow for the necessary dilution. Intermediate dilutions may be necessary for extremely large dilutions.

7.3.1.7.2 Calculate the approximate volume of reagent water to be added to the volumetric flask selected and add slightly less than this quantity of reagent water to the flask.

7.3.1.7.3 Inject the proper aliquot of samples from the syringe prepared in Paragraph 7.3.1.5 into the flask. Aliquots of less than 1-mL are not recommended. Dilute the sample to the mark with reagent water. Cap the flask, invert, and shake three times. Repeat the above procedure for additional dilutions.

7.3.1.7.4 Fill a 5-mL syringe with the diluted sample as in Paragraph 7.3.1.5.

7.3.1.8 Add 10.0 uL of surrogate spiking solution (found in each determinative method, Section 5.0) and, if applicable, 10 uL of internal standard spiking solution through the valve bore of the syringe; then close the valve. The surrogate and internal standards may be mixed and added as a single spiking solution. Matrix spiking solutions, if indicated, should be added (10 uL) to the sample at this time.

7.3.1.9 Attach the syringe-syringe valve assembly to the syringe valve on the purging device. Open the syringe valves and inject the sample into the purging chamber.

7.3.1.10 Close both valves and purge the sample for the time and at the temperature specified in Table 1.

7.3.1.11 At the conclusion of the purge time, attach the trap to the chromatograph, adjust the device to the desorb mode, and begin the gas chromatographic temperature program and GC data acquisition. Concurrently, introduce the trapped materials to the gas chromatographic column by rapidly heating the trap to 180°C while backflushing the trap with inert gas between 20 and 60 mL/min for the time specified in Table 1.

7.3.1.12 While the trap is being desorbed into the gas chromatograph, empty the purging chamber. Wash the chamber with a minimum of two 5-mL flushes of reagent water (or methanol followed by reagent water) to avoid carryover of pollutant compounds into subsequent analyses.

7.3.1.13 After desorbing the sample, recondition the trap by returning the purge-and-trap device to the purge mode. Wait 15 sec; then close the syringe valve on the purging device to begin gas flow

through the trap. The trap temperature should be maintained at 180°C for Methods 8010 and 8020, and 210°C for Methods 8015 and 8030. Trap temperatures up to 220°C may be employed; however, the higher temperature will shorten the useful life of the trap. After approximately 7 min, turn off the trap heater and open the syringe valve to stop the gas flow through the trap. When cool, the trap is ready for the next sample.

7.3.1.14 If the initial analysis of a sample or a dilution of the sample has a concentration of analytes that exceeds the initial calibration range, the sample must be reanalyzed at a higher dilution. When a sample is analyzed that has saturated response from a compound, this analysis must be followed by a blank reagent water analysis. If the blank analysis is not free of interferences, the system must be decontaminated. Sample analysis may not resume until a blank can be analyzed that is free of interferences.

7.3.1.15 All dilutions should keep the response of the major constituents (previously saturated peaks) in the upper half of the linear range of the curve. Proceed to Method 8000 and the specific determinative method for details on calculating analyte response.

7.3.2 Water-miscible liquids:

7.3.2.1 Water-miscible liquids are analyzed as water samples after first diluting them at least 50-fold with reagent water.

7.3.2.2 Initial and serial dilutions can be prepared by pipetting 2 mL of the sample to a 100-mL volumetric flask and diluting to volume with reagent water. Transfer immediately to a 5-mL gas-tight syringe.

7.3.2.3 Alternatively, prepare dilutions directly in a 5-mL syringe filled with reagent water by adding at least 20 uL, but not more than 100-uL of liquid sample. The sample is ready for addition of surrogate and, if applicable, internal and matrix spiking standards.

7.3.3 Sediment/soil and waste samples: It is highly recommended that all samples of this type be screened prior to the purge-and-trap GC analysis. These samples may contain percent quantities of purgeable organics that will contaminate the purge-and-trap system, and require extensive cleanup and instrument downtime. See Paragraph 7.3.1.1 for recommended screening techniques. Use the screening data to determine whether to use the low-level method (0.005-1 mg/kg) or the high-level method (>1 mg/kg).

7.3.3.1 Low-level method: This is designed for samples containing individual purgeable compounds of <1 mg/kg. It is limited to sediment/soil samples and waste that is of a similar consistency (granular and porous). The low-level method is based on

purging a heated sediment/soil sample mixed with reagent water containing the surrogate and, if applicable, internal and matrix spiking standards. Analyze all reagent blanks and standards under the same conditions as the samples.

7.3.3.1.1 Use a 5-g sample if the expected concentration is <0.1 mg/kg or a 1-g sample for expected concentrations between 0.1 and 1 mg/kg.

7.3.3.1.2 The GC system should be set up as in Section 7.0 of the specific determinative method. This should be done prior to the preparation of the sample to avoid loss of volatiles from standards and samples. A heated purge calibration curve must be prepared and used for the quantitation of all samples analyzed with the low-level method. Follow the initial and daily calibration instructions, except for the addition of a 40°C purge temperature for Methods 8010 and 8020.

7.3.3.1.3 Remove the plunger from a 5-mL Luerlock type syringe equipped with a syringe valve and fill until overflowing with reagent water. Replace the plunger and compress the water to vent trapped air. Adjust the volume to 5.0 mL. Add 10 uL each of surrogate spiking solution and internal standard solution to the syringe through the valve. (Surrogate spiking solution and internal standard solution may be mixed together.) Matrix spiking solutions, if indicated, should be added (10 uL) to the sample at this time.

7.3.3.1.4 The sample (for volatile organics) consists of the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula. Weigh the amount determined in Paragraph 7.3.3.1.1 into a tared purge device. Note and record the actual weight to the nearest 0.1 g.

7.3.3.1.5 In certain cases, sample results are desired based on a dry-weight basis. When such data is desired, a portion of sample for moisture determination should be weighed out at the same time as the portion used for analytical determination. Immediately after weighing the sample for extraction, weigh 5-10 g of the sample into a tared crucible. Determine the percent moisture by drying overnight at 105°C. Allow to cool in a desiccator before weighing:

$$\frac{\text{g of sample} - \text{g of dry sample}}{\text{g of sample}} \times 100 = \% \text{ moisture}$$

7.3.3.1.6 Add the spiked reagent water to the purge device, which contains the weighed amount of sample, and connect the device to the purge-and-trap system.

NOTE: Prior to the attachment of the purge device, steps 7.3.3.1.4 and 7.3.3.1.6 must be performed rapidly and without interruption to avoid loss of volatile organics. These steps must be performed in a laboratory free of solvent fumes.

7.3.3.1.7 Heat the sample to 40°C ± 1°C (Methods 8010 and 8020) or to 85°C ± 2°C (Methods 8015 and 8030) and purge the sample for the time shown in Table 1.

7.3.3.1.8 Proceed with the analysis as outlined in Paragraphs 7.3.1.11-7.3.1.15. Use 5 mL of the same reagent water as in the reagent blank. If saturated peaks occurred or would occur if a 1-g sample were analyzed, the high-level method must be followed.

7.3.3.2 High-level method: The method is based on extracting the sediment/soil with methanol. A waste sample is either extracted or diluted, depending on its solubility in methanol. An aliquot of the extract is added to reagent water containing surrogate and, if applicable, internal and matrix spiking standards. This is purged at the temperatures indicated in Table 1. All samples with an expected concentration of >1.0 mg/kg should be analyzed by this method.

7.3.3.2.1 The sample (for volatile organics) consists of the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula. For sediment/soil and waste that are insoluble in methanol, weigh 4 g (wet weight) of sample into a tared 20-mL vial. Use a top-loading balance. Note and record the actual weight to 0.1 gram and determine the percent moisture of the sample using the procedure in Paragraph 7.3.3.1.5. For waste that is soluble in methanol, weigh 1 g (wet weight) into a tared scintillation vial or culture tube or a 10-mL volumetric flask. (If a vial or tube is used, it must be calibrated prior to use. Pipet 10.0 mL of methanol into the vial and mark the bottom of the meniscus. Discard this solvent.)

7.3.3.2.2 Quickly add 9.0 mL of methanol; then add 1.0 mL of the surrogate spiking solution to the vial. Cap and shake for 2 min.

NOTE: Steps 7.3.3.2.1 and 7.3.3.2.2 must be performed rapidly and without interruption to avoid loss of volatile organics. These steps must be performed in a laboratory free from solvent fumes.

7.3.3.2.3 Pipet approximately 1 mL of the extract to a GC vial for storage, using a disposable pipet. The remainder may be disposed of. Transfer approximately 1 mL of reagent methanol to a separate GC vial for use as the method blank for each set of samples. These extracts may be stored at 4°C in the dark, prior to analysis.

7.3.3.2.4 The GC system should be set up as in Section 7.0 of the specific determinative method. This should be done prior to the addition of the methanol extract to reagent water.

7.3.3.2.5 Table 2 can be used to determine the volume of methanol extract to add to the 5 mL of reagent water for analysis. If a screening procedure was followed, use the estimated concentration to determine the appropriate volume. Otherwise, estimate the concentration range of the sample from the low-level analysis to determine the appropriate volume. If the sample was submitted as a high-level sample, start with 100 uL. All dilutions must keep the response of the major constituents (previously saturated peaks) in the upper half of the linear range of the curve.

7.3.3.2.6 Remove the plunger from a 5.0-mL Luerlock type syringe equipped with a syringe valve and fill until overflowing with reagent water. Replace the plunger and compress the water to vent trapped air. Adjust the volume to 4.9 mL. Pull the plunger back to 5.0 mL to allow volume for the addition of the sample extract and of standards. Add 10 uL of internal standard solution. Also add the volume of methanol extract determined in Paragraph 7.3.3.2.5 and a volume of methanol solvent to total 100 uL (excluding methanol in standards).

7.3.3.2.7 Attach the syringe-syringe valve assembly to the syringe valve on the purging device. Open the syringe valve and inject the water/methanol sample into the purging chamber.

7.3.3.2.8 Proceed with the analysis as outlined in the specific determinative method. Analyze all reagent blanks on the same instrument as that used for the samples. The standards and blanks should also contain 100 uL of methanol to simulate the sample conditions.

7.3.3.2.9 For a matrix spike in the high-level sediment/soil samples, add 8.0 mL of methanol, 1.0 mL of surrogate spike solution and 1.0 mL of matrix spike solution. Add a 100-uL aliquot of this extract to 5 mL of water for purging (as per Paragraph 7.3.3.2.6).

TABLE 2. QUANTITY OF METHANOL EXTRACT REQUIRED FOR ANALYSIS OF HIGH-LEVEL SOILS/SEDIMENTS

Approximate Concentration Range	Volume of Methanol Extract[a]
500-10,000 ug/kg	100 uL
1,000-20,000 ug/kg	50 uL
5,000-100,000 ug/kg	10 uL
25,000-500,000 ug/kg	100 uL of 1/50 dilution [b]

Calculate appropriate dilution factor for concentrations exceeding this table.

[a]The volume of methanol added to 5 mL of water being purged should be kept constant. Therefore, add to the 5-mL syringe whatever volume of methanol is necessary to maintain a volume of 100 uL added to the syringe.

[b]Dilute an aliquot of the methanol extract and then take 100 uL for analysis.

7.4 Sample analysis:

7.4.1 The samples prepared by this method may be analyzed by Methods 8010, 8015, 8020, 8030, and 8240. Refer to these methods for appropriate analysis conditions.

8.0 QUALITY CONTROL

8.1 Refer to Chapter One for specific quality control procedures and Method 3500 for sample preparation procedures.

8.2 Before processing any samples, the analyst should demonstrate through the analysis of a reagent water method blank that all glassware and reagents are interference free. Each time a set of samples is extracted, or there is a change in reagents, a method blank should be processed as a safe-guard against chronic laboratory contamination. The blank samples should be carried through all stages of the sample preparation and measurement.

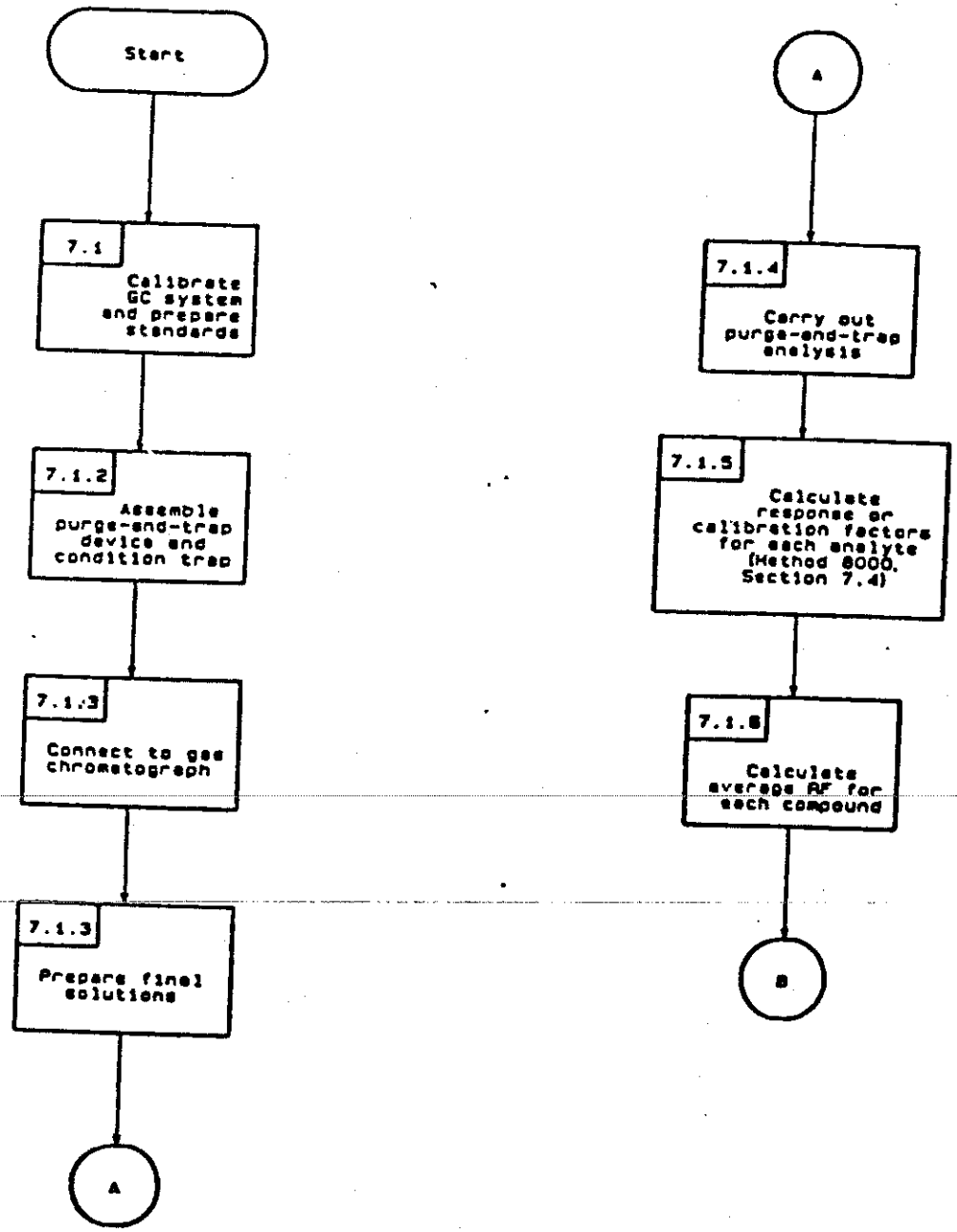
8.3 Standard quality assurance practices should be used with this method. Field replicates should be collected to validate the precision of the sampling technique. Laboratory replicates should be analyzed to validate the precision of the analysis. Fortified samples should be carried through all stages of sample preparation and measurement; they should be analyzed to validate the sensitivity and accuracy of the analysis. If the fortified samples do not indicate sufficient sensitivity to detect <1 ug/g of the analytes in the sample, then the sensitivity of the instrument should be increased, or the sample should be subjected to additional cleanup.

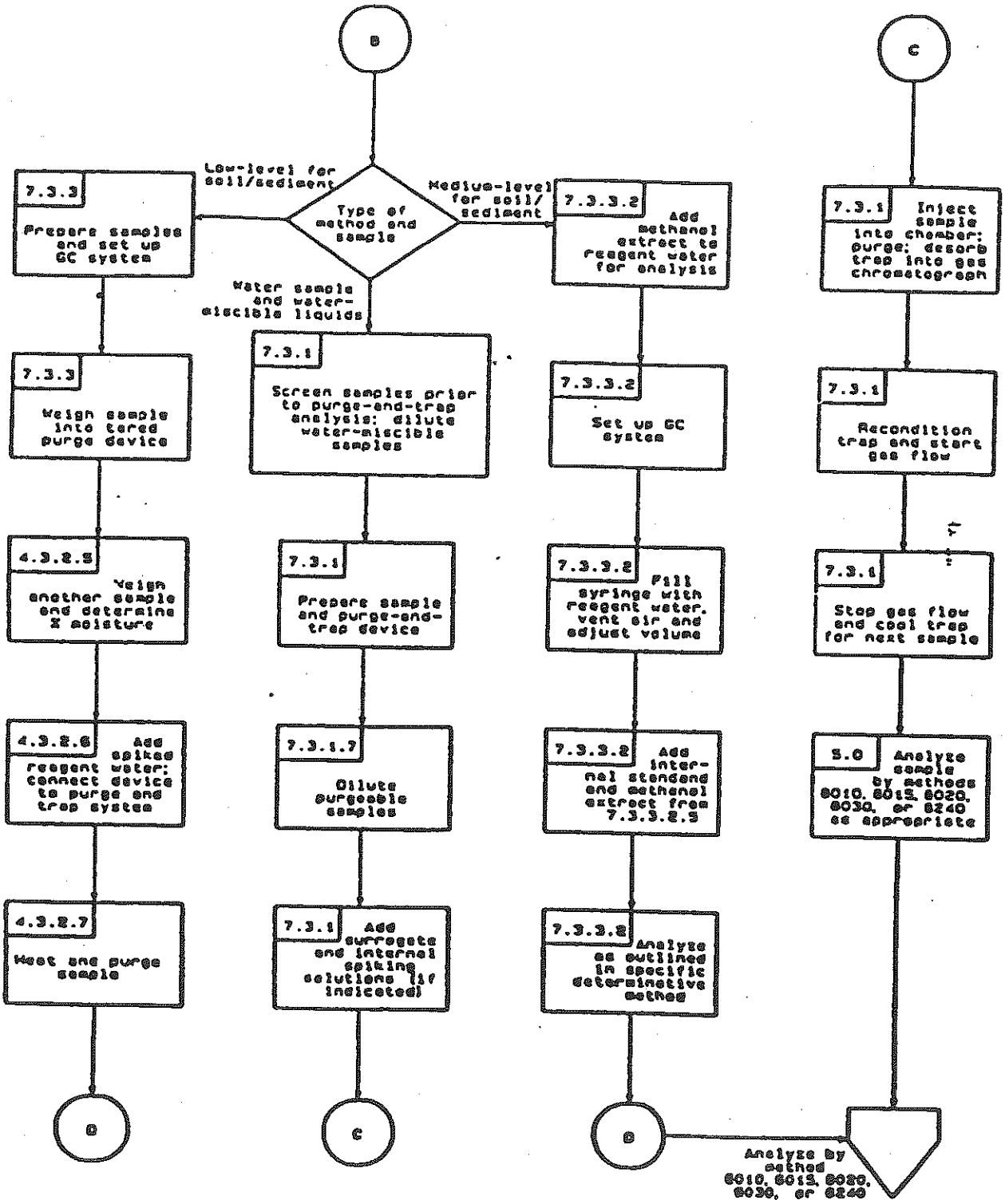
9.0 METHOD PERFORMANCE

9.1 Refer to the determinative methods for performance data.

10.0 REFERENCES

1. U.S. EPA 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule," October 26, 1984.


Start
7.1
Calibrate GC system and prepare standards
7.1.2
Assemble purge-and-trap device and condition trap
7.1.3
Connect to gas chromatograph
7.1.3
Prepare final solutions
A
A
7.1.4
Carry out purge-and-trap analysis
7.1.5
Calculate response or calibration factors for each analyte (Method 8000, Section 7.4)
7.1.6
Calculate average RF for each compound
B


B
C
Type of method and sample
Low-level for soil/sediment
Medium-level for soil/sediment
Water sample and water-miscible liquids
7.3.3 Prepare samples and set up GC system
7.3.3.2 Add methanol extract to reagent water for analysis
7.3.1 Inject sample into chamber; purge; desorb trap into gas chromatograph
7.3.3 Weigh sample into tared purge device
7.3.1 Screen samples prior to purge-and-trap analysis; dilute water-miscible samples
7.3.3.2 Set up GC system
7.3.1 Recondition trap and start gas flow
4.3.2.5 Weigh another sample and determine % moisture
7.3.1 Prepare sample and purge-and-trap device
7.3.3.2 Fill syringe with reagent water, vent air and adjust volume
7.3.1 Stop gas flow and cool trap for next sample
4.3.2.6 Add spikes reagent water; connect device to purge and trap system
7.3.1.7 Dilute purgeable samples
7.3.3.2 Add internal standard and methanol extract from 7.3.3.2.3
5.0 Analyze sample by methods 8010, 8015, 8020, 8030, or 8240 as appropriate
4.3.2.7 Heat and purge sample
7.3.1 Add surrogate and internal spiking solutions (if indicated)
7.3.3.2 Analyze as outlined in specific determinative method
D
C
D
Analyze by method 8010, 8015, 8020, 8030, or 8240

VOLATILES BY GC/MS

SW 846 METHOD 8240

WESTON SOP OP21-16-8240

0173L

ORGANIC ANALYSIS PROTOCOL
GC/MS ANALYSIS OF VOLATILE ORGANICS
(AQUEOUS)

1.0 PURPOSE

1.1 This method is applicable for determination of various purgeable organics in water and wastewater. The parameters listed in Table 1 may be determined by this method.

2.0 REFERENCES

SW846 Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Method 8240.

40CFR136, appendix A, Methods for Organic Chemical Analysts of Municipal and Industrial Wastewater, Method 624-Purgeables.

3.0 PRINCIPLE

3.1 An inert gas is bubbled through a 5 mL sample contained in a specifically designed purging chamber at ambient temperature. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed, the sorbent column is heated and back flushed with the inert gas to desorb the purgeables onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate purgeables which are then detected with a mass spectrometer.

4.0 INTERFERENCES

4.1 Impurities in the purge gas and organic compounds outgassing from plumbing head of the trap account for the majority of the contamination problems. The analytical system must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. Method blanks are run by charging the purging device with organic-free water and

analyzing it in a normal manner. The use of non-TFE plastic tubing, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

4.2 Samples can be contaminated by diffusion of volatile organics through the septum seal into the sample during shipment and storage. A field blank prepared form organic-free water and carried through the sampling and handling can serve as a check of such contamination.

4.3 Cross contamination can occur whenever high levels and low level samples are sequentially analyzed. To reduce the likelihood of this, the purging device and sample syringe should be rinsed out twice between samples with organic-free water. Whenever an unusually concentrated sample is encountered, it should be followed by analysis of organic-free water to check for cross contamination. For samples containing large amounts of water soluable materials, suspended solids, high boiling compounds or high levels of aromatics, it may be necessary to replace the filled sample vessel with a clean, dry vessel before the bake cycle on the purge and trap device.

5.0 APPARATUS AND MATERIALS

5.1 Sample Containers

5.1.1 Vials with cap - 40 mL capacity screw cap (Pierce No. 13075 or equivalent). Detergent wash and dry at 105°C for one (1) hour before use.

5.1.2 Septum - Teflon-faced silicone (Pierce No. 12722 or equivalent). Detergent wash, rinse with tap and distilled water, and dry at 105°C for one (1) hour before use.

5.2 Purge and Trap device - the purge and trap equipment consist of three (3) separate pieces of apparatus: The purging device, trap, and desorber. Several complete devices are available commercially. This laboratory utilizes Tekmar purge and trap devices.

5.3 Gas Chromatograph/Mass Spectrometer - This laboratory uses both Finnigan MAT (Models 1050 and 5100) and Hewlett Packard (Model HP-5970 MSD) mass spectrometers.

All systems are equipped with glass jet separators. The HP GC/MS systems are controlled by a HP-1000 computer system using the Aquarius software. The Finnigans are equipped with Superincas Software.

5.3.1 Column 1 - 6 ft. long by 2 mm ID glass column packed with 1% SP-1000 on Carbopack B (60/80 mesh).

5.3.2 Column 2 - 30 meter by 053 mem ID DB-24 megabore capillary column. (J & W Scientific)

5.4 Syringes - 5 mL glass hypodermic with Luer-Lock tip.

5.5 Micro syringes - 1.0, 10, 50, 100, 250, and 500 uL.

5.6 Trap Materials

5.6.1 Tenex GC 60/80 mesh.

5.6.2 Coconut charcoal.

5.6.3 Silica gel.

5.7 Activated Carbon - Filtersorb-200 (Calgon Corp.) or equivalent.

5.8 Organic-Free Water.

5.8.1 A Sybron/Barnstead organic pure water purification system is used in this laboratory.

6.0 **PREPARATION OF SOLUTION AND STANDARDS**

6.1 Tuning Standard. Prepare a stock solution of 4-bromofluorobenzene (BFB) at 1000 ng/uL by dissolving 10 mg in 10 mL methanol. This stock solution must be prepared every three (3) months and stored at 4°C or less. Every week a fresh working standard will be prepared by the addition of 50 uL of stock solution to 1 mL of Methanol. The working solution will be stored at 4°C or less while not in use.

6.2 Internal Standards. a 1000 ug/mL stock solution is purchased from Supelco or prepared separately containing the following compounds:

Bromochloromethane
1,4-Difluorobenzene
Chlorobenzene-d_5

6.2.1 Using the Supleco cocktail containing all three compounds @ 1000 ug/mL, transfer 500 uL to a 10 mL volumetric flask containing about eight (8) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three internal standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the internal standards at the required 50 ug/L level.

6.2.2 The internal standard solution can be prepared separately from neat compounds by dissolving 10 ng of each compound, accurately weighed to 0.1 ng, in 10 mL methanol to produce three separate stock solutions @ 1000 ug/mL. These stock solutions must be prepared every three (3) months at a minimum, and be stored at 4°C or less. Transfer 500 uL of each of the three stock solutions to a 10 mL volumetric flask containing about eight (8) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three internal standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the internal standards at the required 50 ug/L level.

6.3 Surrogate Standards. a stock solution is purchased from Supelco or prepared separately containing the following compounds:

1,2-Dichloroethane-d_4
Toluene-d_8
4-Bromofluorobenzene

6.3.1 Using the Supleco cocktail containing all three compounds @ 250 ug/mL, transfer 1000 uL to a 5 mL volumetric flask containing about three (3) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three surrogate standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the surrogate standards at the required 50 ug/L level.

6.3.2 The surrogate standard solution can be prepared separately from neat compounds by dissolving 10 ng of each compound, accurately weighed to 0.1 ng, in 10 mL methanol to produce three separate stock solutions @ 1000 ug/mL. These stock solutions must be prepared every three (3) months at a minimum, and be stored at 4°C or less. Transfer 500 uL of each of the three stock solutions to a 10 mL volumetric flask containing about eight (8) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three surrogate standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the surrogate standards at the required 50 ug/L level.

6.4 Matrix Spike Standard. A stock solution is purchased from Supelco or prepared separately containing the following compounds.

1,1-Dichloroethene
Trichloroethene
Benzene
Toluene
Chlorobenzene

6.4.1 Using the Supelco cocktail containing all five (5) compounds @ 250 ug/mL, transfer 1000 uL to a 5mL

volumetric flask containing about three (3) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the five (5) matrix spike compounds at 50 ug/mL. This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

6.4.2 The spiking standard solution can be prepared separately from neat compounds by dissolving 10 ng of each compound, accurately weighed to 0.1 ng, in 10 mL methanol to produce five separate stock solutions @ 1000 ug/mL. These stock solutions must be prepared every three (3) months at a minimum, and be stored at 4°C or less. Transfer 500 uL of each of the five stock solutions to a 10 mL volumetric flask containing about three (3) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the five spiking compounds @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the matrix spike standards at the required 50 ug/L level.

6.5 Calibration Standards. The calibration standards are prepared form "cocktail" mixtures purchased from Supelco. all standards are referenced to EPA repository standards when available. The standards are prepared to a concentration of 50 ug/mL. The standards will contain each compound of interest including the surrogates. all standards will be stored at 4°C or less. This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy.

7.0 **CALIBRATION**

7.1 Daily Tune. Each GC/MS system must be hardware tuned to meet criteria listed in Table 2 for a 50 ng injection of BFB. No sample analyses can begin until all these criteria have been met. This criteria must be demonstrated each day. BFB has to be injected to meet this criterion. Post-acquisition manipulation of

criteria is not acceptable. The tune must be documented with a bar graph plot and a mass listing and are stored in the daily calibration folder.

7.2 Initial Calibration Data. A five point curve is made by analyzing the calibration standards by using 2 uL, 5 uL, 10 uL, 15 uL, and 20 uL of the calibration standard resulting in standard analysis at 20, 50, 100, 150, and 200 ppb. The response factors (RF) for each compound including surrogates are recorded on Form VI and the average response factor and the percent relative standard deviation (%RSD) are calculated and recorded.

7.2.1 The following requirements must be met before the 5-point calibration curve is valid.

7.2.1.1 Each of the five System Performance Check Performance Compounds (SPCC) must have an average relative response factor greater than 0.300 (0.250 for bromoform). These compounds are:

Chloromethane
1,1-Dicholorethane
1,1,2,2-Tetrachloroethane
Chlorobenzene

7.2.1.2 Each of the six Calibration Check Compounds (CCC) must have a percent relative standard deviation (%RSD) of 30% or less. These compounds are:

1,1-Dichloroethene
Chloroform
1,2-Dichloropropane
Toluene
Ethylbenzene
Vinyl Chloride

7.2.2 The Form VI and respective chromatograms/quant reports will be filed with the respective daily tune, bar graph and mass listing.

7.3 Daily Calibration Data. A check of the calibration curve must be performed every 12 hours. The calibration standard is analyzed at 50 ng/mL and the response factor (RF) is calculated. The resulting RF is compared to the average RF from the 5-point and the percent difference (%D) is computed and recorded on

Form VII. The maximum %D for the CCC compounds is 25%. The minimum RF for the SPCC compounds is 0.300 (0.250 for bromoform). If these criteria on the daily calibration cannot be met, the initial 5-point calibration cannot be met, the initial 5-point calibration curve must be repeated.

7.3.1 The Form VII and respective chromatogram/quant report will be filed with the respective daily tune, bar graph, and mass listings.

7.4 Internal Standards Data. The internal standard areas and retention times in all samples must be evaluated immediately after or during acquisition. If the retention time for any internal standard changes by more than 30 seconds from the test daily calibration standard, the chromatographic system must be inspected for malfunctions, and corrections made as required. The extracted ion current profile (EICP) of the internal standards must be monitored and evaluated for each standard. If the EICP area for any internal standard changes by more than factor of two (-50% to +100%), the mass spectrometeric system must be inspected for malfunction and corrections made as appropriate.

8.0 **ANALYSIS**

8.1 Method blanks. A method blank analysis must be analyzed once every twelve hours for each matrix after the respective matrix calibration standard(s). The method blank must contain no greater than five times (5X) the detection limits of common laboratory solvents (methylene chloride, acetone, toluene, and 2-butanone) and less than the detection limit of any other single target compound. If a laboratory method blank exceeds criteria, the analytical system is considered out of control. The source of the contamination is investigated and appropriate corrective measures must be taken and documented before further sample analysis proceeds.

8.2 Surrogate spikes. Surrogate determinations are performed on all samples and blank. All samples and blanks are fortified with surrogate spiking compounds in order to monitor preparation and analysis of samples. Surrogate recovery data is required for samples, method blanks, matrix spikes, matrix spike

duplicates, and all sample re-analysis that substantiate a matrix effect.

8.3 Matrix spike, matrix spike duplicate. A matrix spike and matrix spike duplicate must be performed at least once per 12-hour shift or every twenty (20) samples. Samples requiring optional dilutions and chosen as the matrix spike and matrix spike duplicate samples, must be analyzed at the same dilution as the original unspiked sample.

8.4 Sample analysis. Remove the plunger from a 5 mL syringe and attach a closed syringe valve. Open the sample bottle and carefully pour the sample into the syringe barrel to just short of overflowing. Replace the syringe plunger and compress the sample. Open the syringe valve and vent any residual air while adjusting the sample volume to 5.0 mL.

8.4.1 Add 5.0 uL of the surrogate spiking solution and 5.0 uL of the internal standard spiking solution through the valve bore of the syringe, then close the valve. The addition of 5 uL of the surrogate spiking solution is equivalent to a concentration of 50 ug/L of each surrogate standard.

9.0 **QUALITATIVE ANALYSIS**

9.1 Target Compounds. The compounds of interest shall be identified by an analyst competent in the interpretation of mass spectra by comparison of the sample mass spectrum to the mass spectrum of a standard of the suspected compound. Two criteria must be satisfied to verify the identification.

9.1.1 Relative Retention Time. The sample component's relative retention time (RRT) must compare with $\pm$ 0.06 RRT units of the RRT of the standard component. For reference, the standard must be run on the same day as the sample. The RRT should be assigned by using extracted ion current profiles for ions unique to the component of interest.

9.1.2 Spectra. (1) All ions present in the standard mass spectra at a relative intensity greater than 10% (most abundant ion in the spectrum equal 100%) must be present in the sample spectrum. (2) The relative

intensities of ions specified in (1) must agree within plus or minus 20% between the standard and sample spectra. (3) Ions greater than 10% in the sample spectrum but not present in the standard spectrum must be considered and accounted for by the analyst making the comparison. The verification process should favor false negatives.

9.2 Tentative Identification. Substances of greatest apparent concentration not listed as a target compound may require tentative identification when required by the customer. These will be tentatively identified via a library search of the EPA/NIH spectra base. Computer generated library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Guidelines for making tentative identification are:

9.2.1 The relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.

9.2.2 The relative intensities of the major ions should agree ± 20%.

9.2.3 Molecular ions present in reference spectrum should be present in the sample spectrum.

9.2.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

If, in the opinion of the mass spectral specialist, no valid tentative identification can be made, the compound should be reported as unknown. The mass spectral specialist should give additional classification of the unknown compounds, if possible (i.e., unknown phthalate, unknown hydrocarbon, unknown acid type, unknown chlorinated compound). If probable molecular weight can be distinguished, include them.

10.0 **QUANTITATION**

10.1 All target compounds identified shall be quantified by the internal standard method. The internal standard method used shall be the one nearest the retention time

to that of a given analyte. The EICP area of characteristic ions of analytes are used.

10.2 If the analysis results in samples containing compounds greater than the linear range of the 5-point curve, a dilution is made and the sample is re-analyzed. Only the compound above the detection limit of the re-analyzed diluted sample will be reported, unless the client made prior arrangements for reporting of both sets of data.

10.3 The relative response factor (RRF) from the daily calibration standard analysis is used to calculate the concentration in the sample. If the sample is analyzed after the initial 5-point calibration, then the relative response factor from the 50 ug/L standard is used. Secondary ions may be used if interferences are present. The area of a secondary ion cannot be substituted for the area of a primary ion unless a relative response factor is calculated using the secondary ion.

10.3.1 The concentration of the analytes in the standards have been based upon a sample of 5 mL. The dilution factor used when a 5 mL sample is analyzed in 1.0. If a dilution is made, then the dilution factor is raised accordingly (i.e., if a 1:10 dilution is analyzed, then 500 uL of sample is added to 4.5 mL uL deionized water and the factor used to quantitate the results would be 10).

10.4 An estimated concentration for tentatively identified compounds will be made by the internal standard method. For quantitation, the nearest internal standard free of interferences shall be used.

10.5 Calculate surrogate standard recoveries on all samples, blanks and spikes. If any surrogates fall outside the limits, the sample, blank, or spike must be re-analyzed. If the re-analysis reveals similar recoveries, then both analyses are reported and documented as a matrix effect with that particular sample.

For complicated matrices, it may be necessary to also evaluate the internal standard areas along with the surrogate recoveries to determine matrix effects. For

example, two of three surrogates may be outside QC limits on initial analysis and all internal standard (IS) areas compliant. However, on reanalysis the surrogates may all be in, but the IS areas maybe outside the limits. This has been a problem in the past with clay-like matrices. In three instances adequate description of sample appearance should appear in the analysis log to help document QC discrepancy.

11.0 **SAFETY**

11.1 The toxicity or carciongenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard. A reference file of material data handling sheets (MSDS) is available to all personnel through the laboratory Health and Safety Officer, who maintains the MSDS repository. Any of these documents may be copied for the employees personal file, on request.

11.2 The following reagents covered by this method have been tentatively classified as known or suspected carcinogens:

Benzene
Carbon tetrachloride
Chloroform
1,4-Dichlorobenzene
Vinyl chloride

12.0 **PROJECT SPECIFIC QC: NJDEP**

12.1 A method blank for volatile analysis must contain less than or equal to three times (3X) the Contract Required Quantitation Limit (CRQL from Exhibit C) of methylene chloride, acetone, toluene, and 2-butanone.

12.2 For all other TCL compounds not listed above, the method blank must contain less than or equal to the Contract Required Quantitation Limit of any single TCL analyte.

12.3 CLP data packages must include positive and negative spectra for all analytes present on the quantitation report at or above 0.500 ug/L.

INSTRUMENT ID ____

GC/KE VOLATILE ANALYSIS LOG

(year)

WESTON

ANALYSIS DATE TIME	FILE NAME	RFW NUMBER TYPE L XXX XXX	CLIENT / SAMPLE ID	SPARG NO.	PREPARATION SAMPLE WT/VOL	PREPARATION INJ. VOL. (uL)	INST DIL.	ANALYSIS STATUS %S	ANALYSIS STATUS LIST	ANALYSIS STATUS DEL	COMMENTS	SECTORS	TAPE NO.	ANAL INIT

RFW 21-21-004/B-10/88

Reviewed By (date/initials) _____

Page 01

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ORGANIC ANALYSIS PROTOCOL
GC/MS ANALYSIS OF VOLATILE ORGANICS
(Low Level Soil)

1.0 PURPOSE

1.1 This method is applicable for determination of various purgeable organics in soil and sediment. The parameters listed in Table 1 may be determined by this method.

2.0 REFERENCES

SW846 Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Method 8240.

40CFR136, appendix A, Methods for Organic Chemical Analysts of Municipal and Industrial Wastewater, Method 624-Purgeables.

3.0 PRINCIPLE

3.1 An inert gas is bubbled through a 5 g sample mixed with 5 uL water contained in a specifically designed purging chamber at elevated temperature. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed, the sorbent column is heated and back flushed with the inert gas to desorb the purgeables onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate purgeables which are then detected with a mass spectrometer.

4.0 INTERFERENCES

4.1 Impurities in the purge gas and organic compounds outgassing from plumbing head of the trap account for the majority of the contamination problems. The analytical system must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. Method blanks are run by charging the purging device with organic-free water and

analyzing it in a normal manner. The use of non-TFE plastic tubing, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

4.2 Samples can be contaminated by diffusion of volatile organics through the septum seal into the sample during shipment and storage. A field blank prepared form organic-free water and carried through the sampling and handling can serve as a check of such contamination.

4.3 Cross contamination can occur whenever high levels and low level samples are sequentially analyzed. To reduce the likelihood of this, the purging device and sample syringe should be rinsed out twice between samples with organic-free water. Whenever an unusually concentrated sample is encountered, it should be followed by analysis of organic-free water to check for cross contamination. For samples containing large amounts of water soluable materials, suspended solids, high boiling compounds or high levels of aromatics, it may be necessary to replace the filled sample vessel with a clean, dry vessel before the bake cycle on the purge and trap device.

5.0 **APPARATUS AND MATERIALS**

5.1 Sample Containers

5.1.1 Vials with cap - 40 mL capacity screw cap (Pierce No. 13075 or equivalent). Detergent wash and dry at 105°C for one (1) hour before use.

5.1.2 Septum - Teflon-faced silicone (Pierce No. 12722 or equivalent). Detergent wash, rinse with tap and distilled water, and dry at 105°C for one (1) hour before use.

5.2 Purge and Trap device - the purge and trap equipment consist of three (3) separate pieces of apparatus: The purging device, trap, and desorber. Several complete devices are available commercially. This laboratory utilizes Tekmar purge and trap devices.

5.3 Gas Chromatograph/Mass Spectrometer - This laboratory uses both Finnigan MAT (Models 1050 and 5100) and Hewlett Packard (Model HP-5970 MSD) mass spectrometers. All systems are equipped with glass jet separators. The HP GC/MS systems are controlled by a HP-1000 computer system using the Aquarius software. The Finnigans are equipped with Superincos Software.

5.3.1 Column 1 - 6 ft. long by 2 mm ID glass column packed with 1% SP-1000 on Carbopack B (60/80 mesh).

5.3.2 Column 2 - 30 meter by 053 mm ID DB-24 megabore capillary column. (J & W Scientific)

5.4 Syringes - 5 mL glass hypodermic with Luer-Lock tip.

5.5 Micro syringes - 1.0, 10, 50, 100, 250, and 500 uL.

5.6 Trap Materials

5.6.1 Tenex GC 60/80 mesh.

5.6.2 Coconut charcoal.

5.6.3 Silica gel.

5.7 Activated Carbon - Filtersorb-200 (Calgon Corp.) or equivalent.

5.8 Organic-Free Water.

6.0 **PREPARATION OF SOLUTION AND STANDARDS**

6.1 Tuning Standard. Prepare a stock solution of 4-bromofluorobenzene (BFB) at 1000 ng/uL by dissolving 10 mg in 10 mL methanol. This stock solution must be prepared every three (3) months and stored at 4°C or less. Every week a fresh working standard will be prepared by the addition of 50 uL of stock solution to 1 mL of Methanol. The working solution will be stored at 4°C or less while not in use.

6.2 Internal Standards. a 1000 ug/mL stock solution is purchased from Supelco or prepared separately containing the following compounds:

Bromochloromethane
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Chlorobenzene-d_5

6.2.1 Using the Supleco cocktail containing all three compounds @ 1000 ug/mL, transfer 500 uL to a 10 mL volumetric flask containing about eight (8) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three internal standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the internal standards at the required 50 ug/L level.

6.2.2 The internal standard solution can be prepared separately from neat compounds by dissolving 10 ng of each compound, accurately weighed to 0.1 ng, in 10 mL methanol to produce three separate stock solutions @ 1000 ug/mL. These stock solutions must be prepared every three (3) months at a minimum, and be stored at 4°C or less. Transfer 500 uL of each of the three stock solutions to a 10 mL volumetric flask containing about eight (8) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three internal standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

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Toluene-d_8
4-Bromofluorobenzene

6.3.1 Using the Supleco cocktail containing all three compounds @ 250 ug/mL, transfer 1000 uL to a 5 mL volumetric flask containing about three (3) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three surrogate standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

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6.4 Matrix Spike Standard. A stock solution is purchased from Supelco or prepared separately containing the following compounds.

1,1-Dichloroethene
Trichloroethene
Benzene
Toluene
Chlorobenzene

6.4.1 Using the Supelco cocktail containing all five (5) compounds @ 250 ug/mL, transfer 1000 uL to a 5mL volumetric flask containing about three (3) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the five (5) matrix spike compounds at 50 ug/mL. This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

6.4.2 The spiking standard solution can be prepared separately from neat compounds by dissolving 10 ng of each compound, accurately weighed to 0.1 ng, in 10 mL methanol to produce five separate stock solutions @ 1000 ug/mL. These stock solutions must be prepared every three (3) months at a minimum, and be stored at 4°C or less. Transfer 500 uL of each of the five stock solutions to a 10 mL volumetric flask containing about three (3) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the five spiking compounds. @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the matrix spike standards at the required 50 ug/L level.

6.5 Calibration Standards. The calibration standards are prepared form "cocktail" mixtures purchased from Supelco. all standards are referenced to EPA repository standards when available. The standards are prepared to a concentration of 50 ug/mL. The standards will contain each compound of interest including the surrogates. all standards will be stored at 4°C or less. This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy.

7.0 **CALIBRATION**

7.1 Daily Tune. Each GC/MS system must be hardware tuned to meet criteria listed in Table 2 for a 50 ng injection of BFB. No sample analyses can begin until all these criteria have been met. This criteria must

be demonstrated each day. BFB has to be injected to meet this criterion. Post-acquisition manipulation of criteria is not acceptable. The tune must be documented with a bar graph plot and a mass listing and are stored in the daily calibration folder.

7.2 Initial Calibration Data. A five point curve is made by analyzing the calibration standards by using 2 uL, 5 uL, 10 uL, 15 uL, and 20 uL of the calibration standard resulting in standard analysis at 20, 50, 100, 150, and 200 ppb. The response factors (RF) for each compound including surrogates are recorded on Form VI and the average response factor and the percent relative standard deviation (%RSD) are calculated and recorded.

7.2.1 The following requirements must be met before the 5-point calibration curve is valid.

7.2.1.1 Each of the five System Performance Check Performance Compounds (SPCC) must have an average relative response factor greater than 0.300 (0.250 for bromoform). These compounds are:

Chloromethane
1,1-Dicholorethane
1,1,2,2-Tetrachloroethane
Chlorobenzene

7.2.1.2 Each of the six Calibration Check Compounds (CCC) must have a percent relative standard deviation (%RSD) of 30% or less. These compounds are:

1,1-Dichloroethene
Chloroform
1,2-Dichloropropane
Toluene
Ethylbenzene
Vinyl Chloride

7.2.2 The Form VI and respective chromatograms/quant reports will be filed with the respective daily tune, bar graph and mass listing.

7.3 Daily Calibration Data. A check of the calibration curve must be performed every 12 hours. The calibration standard is analyzed at 50 ng/mL and the response factor (RF) is calculated. The resulting RF

is compared to the average RF from the 5-point and the percent difference (%D) is computed and recorded on Form VII. The maximum %D for the CCC compounds is 25%. The minimum RF for the SPCC compounds is 0.300 (0.250 for bromoform). If these criteria on the daily calibration cannot be met, the initial 5-point calibration cannot be met, the initial 5-point calibration curve must be repeated.

7.3.1 The Form VII and respective chromatogram/quant report will be filed with the respective daily tune, bar graph, and mass listings.

7.4 Internal Standards Data. The internal standard areas and retention times in all samples must be evaluated immediately after or during acquisition. If the retention time for any internal standard changes by more than 30 seconds from the test daily calibration standard, the chromatographic system must be inspected for malfunctions, and corrections made as required. The extracted ion current profile (EICP) of the internal standards must be monitored and evaluated for each standard. If the EICP area for any internal standard changes by more than factor of two (-50% to +100%), the mass spectrometeric system must be inspected for malfunction and corrections made as appropriate.

8.0 **ANALYSIS**

8.1 Method blanks. A method blank analysis must be analyzed once every twelve hours for each matrix after the respective matrix calibration standard(s). The method blank must contain no greater than five times (5X) the detection limits of common laboratory solvents (methylene chloride, acetone, toluene, and 2-butanone) and less than the detection limit of any other single target compound. If a laboratory method blank exceeds criteria, the analytical system is considered out of control. The source of the contamination is investigated and appropriate corrective measures must be taken and documented before further sample analysis proceeds.

8.2 Surrogate spikes. Surrogate determinations are performed on all samples and blank. All samples and blanks are fortified with surrogate spiking compounds in order to monitor preparation and analysis of samples. Surrogate recovery data is required for samples, method blanks, matrix spikes, matrix spike duplicates, and all sample re-analysis that substantiate a matrix effect.

8.3 Matrix spike, matrix spike duplicate. A matrix spike and matrix spike duplicate must be performed at least once per 12-hour shift or every twenty (20) samples. Samples requiring optional dilutions and chosen as the matrix spike and matrix spike duplicate samples, must be analyzed at the same dilution as the original unspiked sample.

8.4 Sample Analysis: To prepare the reagent water containing the surrogates and internal standards, remove the plunger from a 5 mL "Luerlock" type syringe and fill until overflowing with reagent water. Replace the plunger and compress the water to vent trapped air. Adjust the volume 5.0 mL. Add 10 uL each of the surrogate spiking solution and the internal standard solution to the syringe through the valve. (Surrogate spiking solution and internal standard solution may be mixed together). The addition of 10 uL of the surrogate spiking solution to 5 g of soil/sediment is equivalent to 50 ug/kg of each surrogate standard.

8.4.1 The sample (for volatile organics) consists of the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula. Weigh 5 g into a tared purge device. Use a top loading balance. Note and record the actual weight to the nearest 0.1 g.

8.4.2 Add the spiked reagent water to the purge device and connect the device to the purge and trap system. Note: Prior to the attachment of the purge device, steps VII.C.3.a. and b. must be performed rapidly to avoid loss of volatile organics. These steps must be performed in a laboratory free of solvent fumes.

8.5 After desorbing the sample for four minutes, recondition the trap by baking the trap at 180°C for 4 minutes. When cool, the trap is ready for the next sample.

8.6 If the initial analysis of a sample or a dilution of a sample has concentrations of compounds that exceed the initial calibration range, the sample must be reanalyzed at a higher dilution. Secondary ion quantitation is only allowed when there are sample interferences with the primary ion. If secondary ion quantitation is used, document the reasons in the Case Narrative. If peaks are saturated from the analysis of a 5 g sample, a smaller sample size must be analyzed to prevent saturation. However, the smallest sample size permitted is 1 g. If smaller than 1 g sample size is needed to prevent saturation, the medium level method must be used. If the blank analysis is not free of interference, the system must be decontaminated. Sample analysis may not resume until a blank can be analyzed that is free of interferences.

9.0 **QUALITATIVE ANALYSIS**

9.1 Target Compounds. The compounds of interest shall be identified by an analyst competent in the interpretation of mass spectra by comparison of the sample mass spectrum to the mass spectrum of a standard of the suspected compound. Two criteria must be satisfied to verify the identification.

9.1.1 Relative Retention Time. The sample component's relative retention time (RRT) must compare with ± 0.06 RRT units of the RRT of the standard component. For reference, the standard must be run on the same day as the sample. The RRT should be assigned by using extracted ion current profiles for ions unique to the component of interest.

9.1.2 Spectra. (1) All ions present in the standard mass spectra at a relative intensity greater than 10% (most abundant ion in the spectrum equal 100%) must be present in the sample spectrum. (2) The relative intensities of ions specified in (1) must agree within plus or minus 20% between the standard and sample spectra. (3) Ions greater than 10% in the sample spectrum but not present in the standard spectrum must

be considered and accounted for by the analyst making the comparison. The verification process should favor false negatives.

9.2 Tentative Identification. Substances of greatest apparent concentration not listed as a target compound may require tentative identification when required by the customer. These will be tentatively identified via a library search of the EPA/NIH spectra base. Computer generated library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Guidelines for making tentative identification are:

9.2.1 The relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.

9.2.2 The relative intensities of the major ions should agree ± 20%.

9.2.3 Molecular ions present in reference spectrum should be present in the sample spectrum.

9.2.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

If, in the opinion of the mass spectral specialist, no valid tentative identification can be made, the compound should be reported as unknown. The mass spectral specialist should give additional classification of the unknown compounds, if possible (i.e., unknown phthalate, unknown hydrocarbon, unknown acid type, unknown chlorinated compound). If probable molecular weight can be distinguished, include them.

10.0 **QUANTITATION**

10.1 All target compounds identified shall be quantified by the internal standard method. The internal standard method used shall be the one nearest the retention time to that of a given analyte. The EICP area of characteristic ions of analytes are used.

10.2 If the analysis results in samples containing compounds greater than the linear range of the 5-point curve, a dilution is made and the sample is re-analyzed. Only the compound above the detection limit of the re-analyzed diluted sample will be reported, unless the client made prior arrangements for reporting of both sets of data.

10.3 The relative response factor (RRF) from the daily calibration standard analysis is used to calculate the concentration in the sample. If the sample is analyzed after the initial 5-point calibration, then the relative response factor from the 50 ug/L standard is used. Secondary ions may be used if interferences are present. The area of a secondary ion cannot be substituted for the area of a primary ion unless a relative response factor is calculated using the secondary ion.

10.3.1 The concentration of the analytes in the standards have been based upon a sample of 5 mL. The dilution factor used when a 5 mL sample is analyzed in 1.0. If a dilution is made, then the dilution factor is raised accordingly (i.e., if a 1:10 dilution is analyzed, then 500 uL of sample is added to 4.5 mL uL deionized water and the factor used to quantitate the results would be 10).

10.4 An estimated concentration for tentatively identified compounds will be made by the internal standard method. For quantitation, the nearest internal standard free of interferences shall be used.

10.5 Calculate surrogate standard recoveries on all samples, blanks and spikes. If any surrogates fall outside the limits, the sample, blank, or spike must be re-analyzed. If the re-analysis reveals similar recoveries, then both analyses are reported and documented as a matrix effect with that particular sample.

For complicated matrices, it may be necessary to also evaluate the internal standard areas along with the surrogate recoveries to determine matrix effects. For example, two of three surrogates may be outside QC limits on initial analysis and all internal standard

(IS) areas compliant. However, on reanalysis the surrogates may all be in, but the IS areas maybe outside the limits. This has been a problem in the past with clay-like matrices. In three instances adequate description of sample appearance should appear in the analysis log to help document QC discrepancy.

11.0 **SAFETY**

11.1 The toxicity or carciongenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard. A reference file of material data handling sheets (MSDS) is available to all personnel through the laboratory Health and Safety Officer, who maintains the MSDS repository. Any of these documents may be copied for the employees personal file, on request.

11.2 The following reagents covered by this method have been tentatively classified as known or suspected carcinogens:

Benzene
Carbon tetrachloride
Chloroform
1,4-Dichlorobenzene
Vinyl chloride

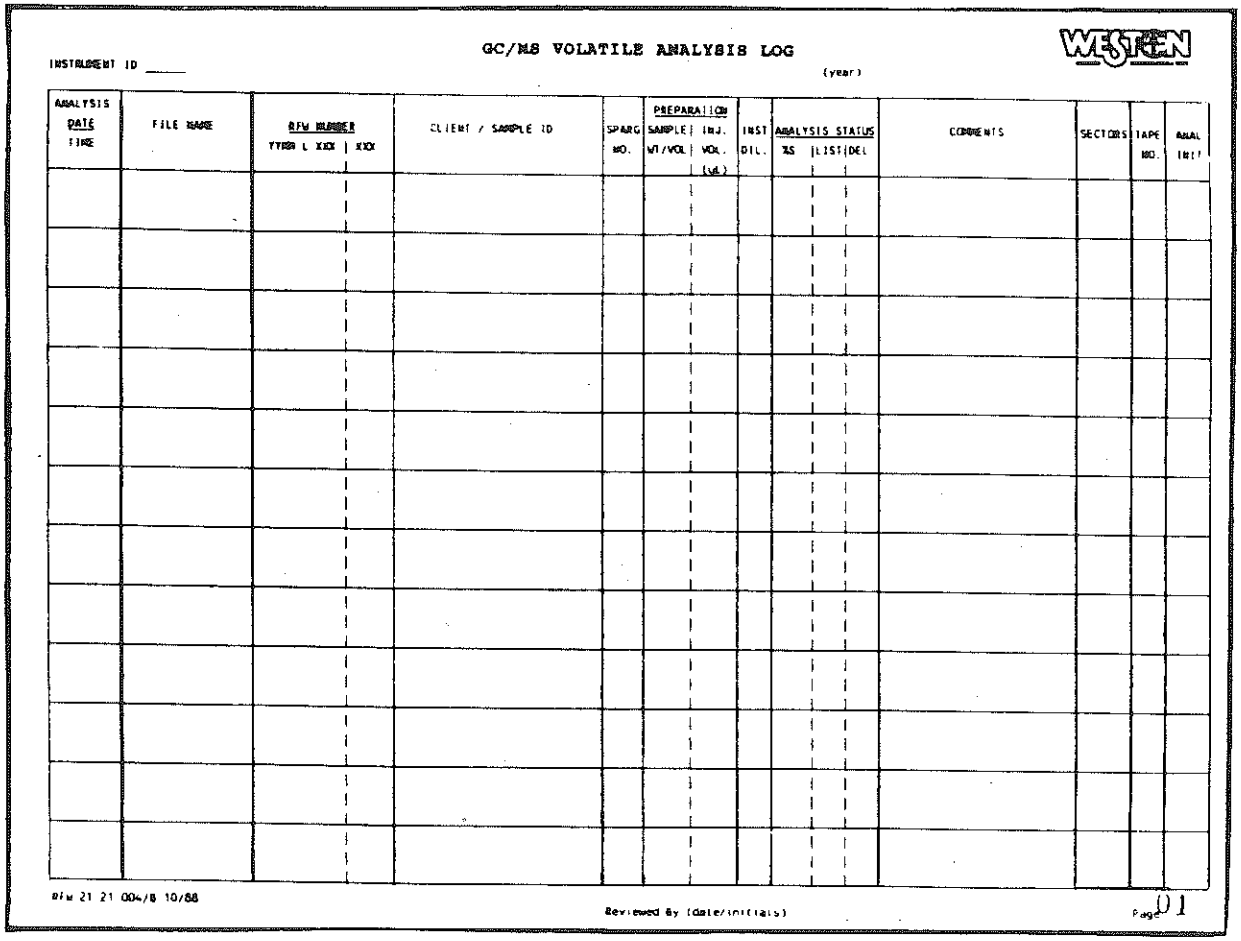
12.0 **PROJECT SPECIFIC QC: NJDEP**

12.1 A method blank for volatile analysis must contain less than or equal to three times (3X) the Contract Required Quantitation Limit (CRQL from Exhibit C) of methylene chloride, acetone, toluene, and 2-butanone.

12.2 For all other TCL compounds not listed above, the method blank must contain less than or equal to the Contract Required Quantitation Limit of any single TCL analyte.

12.3 CLP data packages must include positive and negative spectra for all analytes present on the quantitation report at or above 0.500 ug/L.

dvn\sop\op2116\8240.1



GC/MS VOLATILE ANALYSIS LOG

INSTRUMENT ID ____ (year)

ANALYSIS DATE TIME	FILE NAME	RFW NUMBER YYBR L XXX	XXX	CLIENT / SAMPLE ID	SPARG NO.	PREPARATION SAMPLE WT/VOL	PREPARATION INJ. VOL. (uL)	INST DIL.	ANALYSIS STATUS %S	ANALYSIS STATUS LIST	ANALYSIS STATUS DEL	COMMENTS	SECTORS	TAPE NO.	ANAL INIT

RFW 21 21 004/8 10/88

Reviewed By (date/initials)

Page 01

ORGANIC ANALYSIS PROTOCOL
GC/MS ANALYSIS OF VOLATILE ORGANICS
(Medium Level Soils)

1.0 **PURPOSE**

1.1 This method is applicable for determination of various purgeable organics in soil and sediment. The parameters listed in Table 1 may be determined by this method.

2.0 **REFERENCES**

SW846 Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Method 8240.

40CFR136, appendix A, Methods for Organic Chemical Analysts of Municipal and Industrial Wastewater, Method 624-Purgeables.

3.0 **PRINCIPLE**

3.1 The medium level soil method is based on extracting the soil/ sediment sample with methanol. An aliquot of the methanol extract is added to reagent water containing the surrogates and internal standards.

3.2 An inert gas is bubbled through the 5 uL reagent water with the aliquot of methanol extract contained in a specifically designed purging chamber at ambient temperature. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed, the sorbent column is heated and back flushed with the inert gas to desorb the purgeables onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate purgeables which are then detected with a mass spectrometer.

4.0 **INTERFERENCES**

4.1 Impurities in the purge gas and organic compounds outgassing from plumbing head of the trap account for

the majority of the contamination problems. The analytical system must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. Method blanks are run by charging the purging device with organic-free water and analyzing it in a normal manner. The use of non-TFE plastic tubing, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

4.2 Samples can be contaminated by diffusion of volatile organics through the septum seal into the sample during shipment and storage. A field blank prepared form organic-free water and carried through the sampling and handling can serve as a check of such contamination.

4.3 Cross contamination can occur whenever high levels and low level samples are sequentially analyzed. To reduce the likelihood of this, the purging device and sample syringe should be rinsed out twice between samples with organic-free water. Whenever an unusually concentrated sample is encountered, it should be followed by analysis of organic-free water to check for cross contamination. For samples containing large amounts of water soluable materials, suspended solids, high boiling compounds or high levels of aromatics, it may be necessary to replace the filled sample vessel with a clean, dry vessel before the bake cycle on the purge and trap device.

5.0 **APPARATUS AND MATERIALS**

5.1 Sample Containers

5.1.1 Vials with cap - 40 mL capacity screw cap (Pierce No. 13075 or equivalent). Detergent wash and dry at 105°C for one (1) hour before use.

5.1.2 Septum - Teflon-faced silicone (Pierce No. 12722 or equivalent). Detergent wash, rinse with tap and distilled water, and dry at 105°C for one (1) hour before use.

5.2 Purge and Trap device - the purge and trap equipment consist of three (3) separate pieces of apparatus: The purging device, trap, and desorber. Several complete

devices are available commercially. This laboratory utilizes Tekmar purge and trap devices.

5.3 Gas Chromatograph/Mass Spectrometer - This laboratory uses both Finnigan MAT (Models 1050 and 5100) and Hewlett Packard (Model HP-5970 MSD) mass spectrometers. All systems are equipped with glass jet separators. The HP GC/MS systems are controlled by a HP-1000 computer system using the Aquarius software. The Finnigans are equipped with Superincas Software.

5.3.1 Column 1 - 6 ft. long by 2 mm ID glass column packed with 1% SP-1000 on Carbopack B (60/80 mesh).

5.3.2 Column 2 - 30 meter by 053 mem ID DB-24 megabore capillary column. (J & W Scientific)

5.4 Syringes - 5 mL glass hypodermic with Luer-Lock tip.

5.5 Micro syringes - 1.0, 10, 50, 100, 250, and 500 uL.

5.6 Trap Materials

5.6.1 Tenex GC 60/80 mesh.

5.6.2 Coconut charcoal.

5.6.3 Silica gel.

5.7 Activated Carbon - Filtersorb-200 (Calgon Corp.) or equivalent.

5.8 Organic-Free Water.

5.9 Purge and trap grade methanol.

6.0 **PREPARATION OF SOLUTION AND STANDARDS**

6.1 Tuning Standard. Prepare a stock solution of 4-bromofluorobenzene (BFB) at 1000 ng/uL by dissolving 10 mg in 10 mL methanol. This stock solution must be prepared every three (3) months and stored at 4°C or less. Every week a fresh working standard will be prepared by the addition of 50 uL of stock solution to 1 mL of Methanol. The working solution will be stored at 4°C or less while not in use.

6.2 Internal Standards. a 1000 ug/mL stock solution is purchased from Supelco or prepared separately containing the following compounds:

Bromochloromethane
1,4-Difluorobenzene
Chlorobenzene-d_5

6.2.1 Using the Supleco cocktail containing all three compounds @ 1000 ug/mL, transfer 500 uL to a 10 mL volumetric flask containing about eight (8) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three internal standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the internal standards at the required 50 ug/L level.

6.2.2 The internal standard solution can be prepared separately from neat compounds by dissolving 10 ng of each compound, accurately weighed to 0.1 ng, in 10 mL methanol to produce three separate stock solutions @ 1000 ug/mL. These stock solutions must be prepared every three (3) months at a minimum, and be stored at 4°C or less. Transfer 500 uL of each of the three stock solutions to a 10 mL volumetric flask containing about eight (8) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three internal standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the internal standards at the required 50 ug/L level.

6.3 Surrogate Standards. a stock solution is purchased from Supelco or prepared separately containing the following compounds:

1,2-Dichloroethane-d_4
Toluene-d_8
4-Bromofluorobenzene

6.3.1 Using the Supleco cocktail containing all three compounds @ 250 ug/mL, transfer 1000 uL to a 5 mL volumetric flask containing about three (3) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three surrogate standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the surrogate standards at the required 50 ug/L level.

6.3.2 The surrogate standard solution can be prepared separately from neat compounds by dissolving 10 ng of each compound, accurately weighed to 0.1 ng, in 10 mL methanol to produce three separate stock solutions @ 1000 ug/mL. These stock solutions must be prepared every three (3) months at a minimum, and be stored at 4°C or less. Transfer 500 uL of each of the three stock solutions to a 10 mL volumetric flask containing about eight (8) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the three surrogate standards @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the surrogate standards at the required 50 ug/L level.

6.4 Matrix Spike Standard. A stock solution is purchased from Supelco or prepared separately containing the following compounds.

1,1-Dichloroethene
Trichloroethene
Benzene

Toluene
Chlorobenzene

6.4.1 Using the Supelco cocktail containing all five (5) compounds @ 250 ug/mL, transfer 1000 uL to a 5mL volumetric flask containing about three (3) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the five (5) matrix spike compounds at 50 ug/mL. This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

6.4.2 The spiking standard solution can be prepared separately from neat compounds by dissolving 10 ng of each compound, accurately weighed to 0.1 ng, in 10 mL methanol to produce five separate stock solutions @ 1000 ug/mL. These stock solutions must be prepared every three (3) months at a minimum, and be stored at 4°C or less. Transfer 500 uL of each of the five stock solutions to a 10 mL volumetric flask containing about three (3) mL of methanol. Dilute to volume with methanol. Mix thoroughly by inverting several times. Separate into 1 mL vials for storage. The resulting solution will contain the five spiking compounds. @ 50 ug/mL This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy. Store at 4°C or less.

For analysis, five (5) uL is added to 5 mL water to give the matrix spike standards at the required 50 ug/L level.

6.5 Calibration Standards. The calibration standards are prepared form "cocktail" mixtures purchased from Supelco. all standards are referenced to EPA repository standards when available. The standards are prepared to a concentration of 50 ug/mL. The standards will contain each compound of interest including the surrogates. all standards will be stored at 4°C or less. This working solution is good for 3 months, however, we are preparing it weekly to insure accuracy.

7.0 **CALIBRATION**

7.1 Daily Tune. Each GC/MS system must be hardware tuned to meet criteria listed in Table 2 for a 50 ng injection of BFB. No sample analyses can begin until all these criteria have been met. This criteria must be demonstrated each day. BFB has to be injected to meet this criterion. Post-acquisition manipulation of criteria is not acceptable. The tune must be documented with a bar graph plot and a mass listing and are stored in the daily calibration folder.

7.2 Initial Calibration Data. A five point curve is made by analyzing the calibration standards by using 2 uL, 5 uL, 10 uL, 15 uL, and 20 uL of the calibration standard resulting in standard analysis at 20, 50, 100, 150, and 200 ppb. The response factors (RF) for each compound including surrogates are recorded on Form VI and the average response factor and the percent relative standard deviation (%RSD) are calculated and recorded.

7.2.1 The following requirements must be met before the 5-point calibration curve is valid.

7.2.1.1 Each of the five System Performance Check Performance Compounds (SPCC) must have an average relative response factor greater than 0.300 (0.250 for bromoform). These compounds are:

Chloromethane
1,1-Dicholorethane
1,1,2,2-Tetrachloroethane
Chlorobenzene

7.2.1.2 Each of the six Calibration Check Compounds (CCC) must have a percent relative standard deviation (%RSD) of 30% or less. These compounds are:

1,1-Dichloroethene
Chloroform
1,2-Dichloropropane
Toluene
Ethylbenzene
Vinyl Chloride

7.2.2 The Form VI and respective chromatograms/quant reports will be filed with the respective daily tune, bar graph and mass listing.

7.3 Daily Calibration Data. A check of the calibration curve must be performed every 12 hours. The calibration standard is analyzed at 50 ng/mL and the response factor (RF) is calculated. The resulting RF is compared to the average RF from the 5-point and the percent difference (%D) is computed and recorded on Form VII. The maximum %D for the CCC compounds is 25%. The minimum RF for the SPCC compounds is 0.300 (0.250 for bromoform). If these criteria on the daily calibration cannot be met, the initial 5-point calibration cannot be met, the initial 5-point calibration curve must be repeated.

7.3.1 The Form VII and respective chromatogram/quant report will be filed with the respective daily tune, bar graph, and mass listings.

7.4 Internal Standards Data. The internal standard areas and retention times in all samples must be evaluated immediately after or during acquisition. If the retention time for any internal standard changes by more than 30 seconds from the test daily calibration standard, the chromatographic system must be inspected for malfunctions, and corrections made as required. The extracted ion current profile (EICP) of the internal standards must be monitored and evaluated for each standard. If the EICP area for any internal standard changes by more than factor of two (-50% to +100%), the mass spectrometeric system must be inspected for malfunction and corrections made as appropriate.

8.0 **ANALYSIS**

8.1 Method blanks. A method blank analysis must be analyzed once every twelve hours for each matrix after the respective matrix calibration standard(s). The method blank is prepared by extracting 4 g of clean soil with methanol. And 100 uL aliquot of methanol is then analyzed. The method blank must contain no greater than five times (5X) the detection limits of common laboratory solvents (methylene chloride, acetone, toluene, and 2-butanone) and less than the detection limit of any other single target compound. If a laboratory method blank exceeds criteria, the analytical system is considered out of control. The source of the contamination is investigated and

appropriate corrective measures must be taken and documented before further sample analysis proceeds.

8.2 Surrogate spikes. Surrogate determinations are performed on all samples and blank. All samples and blanks are fortified with surrogate spiking compounds in order to monitor preparation and analysis of samples. Surrogate recovery data is required for samples, method blanks, matrix spikes, matrix spike duplicates, and all sample re-analysis that substantiate a matrix effect.

8.3 Matrix spike, matrix spike duplicate. A matrix spike and matrix spike duplicate must be performed at least once per 12-hour shift or every twenty (20) samples. Samples requiring optional dilutions and chosen as the matrix spike and matrix spike duplicate samples, must be analyzed at the same dilution as the original unspiked sample.

8.4 The sample (for volatiled organics) consits of the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula. Weigh 4 g (wet weight) into tared 15 mL vial. Use a top loading balance. Note and record the actual weight to the nearest 0.1 g.

8.4.1 Quickly add 9.0 mL of methanol, then 1.0 mL of the surrogate spiking solution to the vial. Cap and shake for 2 minutes. these steps must be performed rapidly to avoid loss of volatale organics. These steps must be performed in a laboratory free of solvent fumes.

8.4.2 Using a disposable pipette, transfer approsimately 1 mL of extract into a GC vial for storage. The remainder may be disposed of. Transfer approximately 1 mL of the reagent methanol to a GC vial for use as the method blank for each case or set of 20 samples, whichever is more frequent. These extracts may be stored in the dark at 4°C (±2°C) prior to analysis.

The addition of a 100 uL aliquot of each of these extracts will give a concentration equivalent to 6,200 ug/kg of each surrogate standard.

8.4.3 The following table can be used to determine the volume of methanol extract to add to the 5 mL of reagent water for analysis. Otherwise, estimate the concentration range of the sample from the low level analysis to determine the appropriate volume. If the sample was submitted as a medium level sample, start with 100 uL.

All dilutions must keep the response of the major constituents (previously saturated peaks) in the upper half of linear range of the curve.

Estimated Concentration Range[1]	Take this Volume of Methanol Extract[2]
ug/kg	uL
500 - 10,000	100
1000 - 20,000	50
5000 - 100,000	50
25,000 - 500,000	100 of 1/50 dilution[3]

9.0 **QUALITATIVE ANALYSIS**

9.1 Target Compounds. The compounds of interest shall be identified by an analyst competent in the interpretation of mass spectra by comparison of the sample mass spectrum to the mass spectrum of a standard of the suspected compound. Two criteria must be satisfied to verify the identification.

9.1.1 Relative Retention Time. The sample component's relative retention time (RRT) must compare with ± 0.06 RRT units of the RRT of the standard component. For reference, the standard must be run on the same day as the sample. The RRT should be assigned by using extracted ion current profiles for ions unique to the component of interest.

9.1.2 Spectra. (1) All ions present in the standard mass spectra at a relative intensity greater than 10% (most abundant ion in the spectrum equal 100%) must be present in the sample spectrum. (2) The relative intensities of ions specified in (1) must agree within plus or minus 20% between the standard and sample spectra. (3) Ions greater than 10% in the sample spectrum but not present in the standard spectrum must

be considered and accounted for by the analyst making the comparison. The verification process should favor false negatives.

9.2 Tentative Identification. Substances of greatest apparent concentration not listed as a target compound may require tentative identification when required by the customer. These will be tentatively identified via a library search of the EPA/NIH spectra base. Computer generated library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Guidelines for making tentative identification are:

9.2.1 The relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.

9.2.2 The relative intensities of the major ions should agree ± 20%.

9.2.3 Molecular ions present in reference spectrum should be present in the sample spectrum.

9.2.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

If, in the opinion of the mass spectral specialist, no valid tentative identification can be made, the compound should be reported as unknown. The mass spectral specialist should give additional classification of the unknown compounds, if possible (i.e., unknown phthalate, unknown hydrocarbon, unknown acid type, unknown chlorinated compound). If probable molecular weight can be distinguished, include them.

10.0 **QUANTITATION**

10.1 All target compounds identified shall be quantified by the internal standard method. The internal standard method used shall be the one nearest the retention time to that of a given analyte. The EICP area of characteristic ions of analytes are used.

10.2 If the analysis results in samples containing compounds greater than the linear range of the 5-point curve, a dilution is made and the sample is re-analyzed. Only the compound above the detection limit of the re-analyzed diluted sample will be reported, unless the client made prior arrangements for reporting of both sets of data.

10.3 The relative response factor (RRF) from the daily calibration standard analysis is used to calculate the concentration in the sample. If the sample is analyzed after the initial 5-point calibration, then the relative response factor from the 50 ug/L standard is used. Secondary ions may be used if interferences are present. The area of a secondary ion cannot be substituted for the area of a primary ion unless a relative response factor is calculated using the secondary ion.

10.3.1 The concentration of the analytes in the standards have been based upon a sample of 5 mL. The dilution factor used when a 5 mL sample is analyzed in 1.0. If a dilution is made, then the dilution factor is raised accordingly (i.e., if a 1:10 dilution is analyzed, then 500 uL of sample is added to 4.5 mL uL deionized water and the factor used to quantitate the results would be 10).

10.4 An estimated concentration for tentatively identified compounds will be made by the internal standard method. For quantitation, the nearest internal standard free of interferences shall be used.

10.5 Calculate surrogate standard recoveries on all samples, blanks and spikes. If any surrogates fall outside the limits, the sample, blank, or spike must be re-analyzed. If the re-analysis reveals similar recoveries, then both analyses are reported and documented as a matrix effect with that particular sample.

For complicated matrices, it may be necessary to also evaluate the internal standard areas along with the surrogate recoveries to determine matrix effects. For example, two of three surrogates may be outside QC limits on initial analysis and all internal standard (IS) areas compliant. However, on reanalysis the

surrogates may all be in, but the IS areas maybe outside the limits. This has been a problem in the past with clay-like matrices. In three instances adequate description of sample appearance should appear in the analysis log to help document QC discrepancy.

11.0 **SAFETY**

11.1 The toxicity or carciongenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard. A reference file of material data handling sheets (MSDS) is available to all personnel through the laboratory Health and Safety Officer, who maintains the MSDS repository. Any of these documents may be copied for the employees personal file, on request.

11.2 The following reagents covered by this method have been tentatively classified as known or suspected carcinogens:

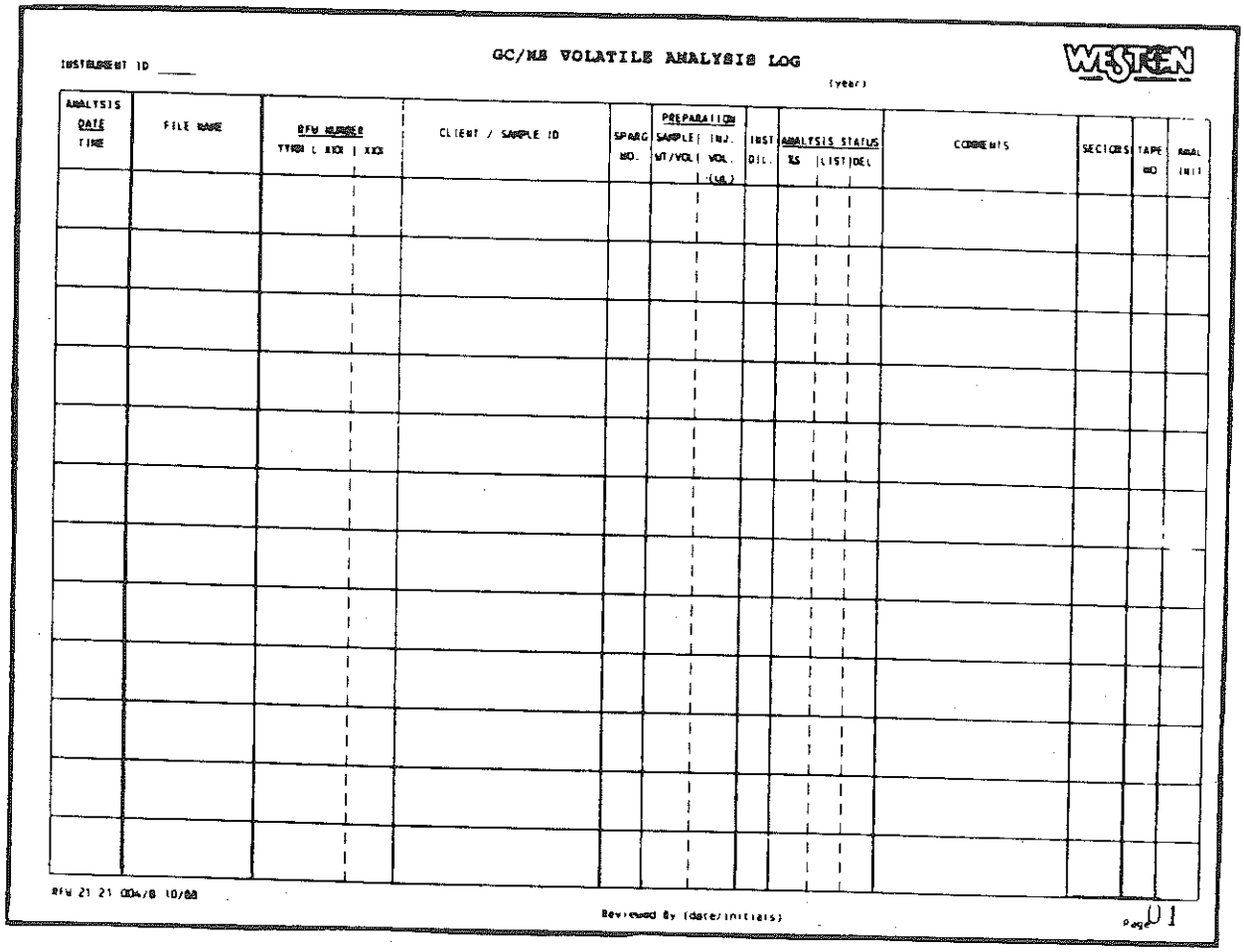
Benzene
Carbon tetrachloride
Chloroform
1,4-Dichlorobenzene
Vinyl chloride

12.0 **PROJECT SPECIFIC QC: NJDEP**

12.1 A method blank for volatile analysis must contain less than or equal to three times (3X) the Contract Required Quantitation Limit (CRQL from Exhibit C) of methylene chloride, acetone, toluene, and 2-butanone.

12.2 For all other TCL compounds not listed above, the method blank must contain less than or equal to the Contract Required Quantitation Limit of any single TCL analyte.

12.3 CLP data packages must include positive and negative spectra for all analytes present on the quantitation report at or above 0.500 ug/L.



INSTRUMENT ID ____

GC/MS VOLATILE ANALYSIS LOG

WESTERN

(Year)

ANALYSIS DATE TIME	FILE NAME	RFW NUMBER YYMM C XXX | XXX	CLIENT / SAMPLE ID	SPARG NO.	PREPARATION SAMPLE WT/VOL	PREPARATION INJ. VOL. (uL)	INST DIL.	ANALYSIS STATUS TS | LIST | DEL	COMMENTS	SECTORS	TAPE NO	AQUAL UNIT

RFW 21 21 004/8 10/88

Reviewed By (date/initials)

Page 01

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SULFUR CONTENT

ASTM METHOD D129

0173L

Designation: D 129 – 64 (Reapproved 1978)[ε1]

An American National Standard
British Standard 4454

Designation: 61/65 (75)

Standard Test Method for SULFUR IN PETROLEUM PRODUCTS (GENERAL BOMB METHOD)[1]

This standard is issued under the fixed designation D 129; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval. This is also a standard of the Institute of Petroleum issued under the fixed designation IP 61. The final number indicates the year of last revision.

This method was adopted as a joint ASTM-IP standard in 1964.

This method has been adopted for use by government agencies to replace Method 5202 of Federal Test Method Standard No. 791b.

[ε1] NOTE—Editorial changes were made throughout in July 1981.

Attention is called to Section 2.2 on Safety and to the specific precautionary directions incorporated in the method.

1. Scope

1.1 This test method covers the determination of sulfur in petroleum products, including lubricating oils containing additives, additive concentrates, and lubricating greases, that cannot be burned completely in a wick lamp. The method is applicable to any petroleum product sufficiently low in volatility that it can be weighed accurately in an open sample boat and containing at least 0.1 % sulfur.

NOTE 1—This method is not applicable to samples containing elements that give residues, other than barium sulfate, which are insoluble in dilute hydrochloric acid and would interfere in the precipitation step. These interfering elements include iron, aluminum, calcium, silicon, and lead which are sometimes present in greases, lube oil additives, or additive oils. Other acid insoluble materials that interfere are silica, molybdenum disulfide, asbestos, mica, etc. The method is not applicable to used oils containing wear metals, and lead or silicates from contamination. Samples that are excluded can be analyzed by ASTM Test Method D 1552, Test for Sulfur in Petroleum Products (High-Temperature Method).[2]

2. Summary of Method

2.1 The sample is oxidized by combustion in a bomb containing oxygen under pressure. The sulfur, as sulfate in the bomb washings, is determined gravimetrically as barium sulfate.

2.2 Safety—*Strict adherence to all of the provisions prescribed hereafter ensures against explosive rupture of the bomb, or a blow-out, provided the bomb is of proper design and construction and in good mechanical condition. It is desirable, however, that the bomb be enclosed in a shield of steel plate at least 13 mm thick, or equivalent protection be provided against unforseeable contingencies.*

3. Apparatus and Materials

3.1 *Bomb*,[3,4] having a capacity of not less than 300 mL, so constructed that it will not leak during the test and that quantitative recovery of the liquids from the bomb may be achieved readily. The inner surface of the bomb may be made of stainless steel or any other material that will not be affected by the combustion process or products. Materials used in

[1] This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants.

Current edition effective Aug. 31, 1964. Originally issued 1922. In 1949, revised incorporating former D 894. Replaces D 129 – 62.

In the IP, this method is under the jurisdiction of the Standardization Committee.

[2] *Annual Book of ASTM Standards*, Vol 05.01.

[3] Criteria for judging the acceptability of new and used oxygen combustion bombs are described in ASTM Recommended Practice E 144, for Safe Use of Oxygen Combustion Bombs, *Annual Book of ASTM Standards*, Part 44.

[4] A bomb conforming to the test specifications in IP Standard IP 12 is suitable.

the bomb assembly, such as the head gasket and lead-wire insulation, shall be resistant to heat and chemical action, and shall not undergo any reaction that will affect the sulfur content of the liquid in the bomb.

3.2 *Sample Cup,* platinum, 24 mm in outside diameter at the bottom, 27 mm in outside diameter at the top, 12 mm in height outside, and weighing 10 to 11 g.

3.3 *Firing Wire,* platinum, approximately No. 26 B & S gage, 27 SWG, or equivalent.

Caution—*The switch in the ignition circuit shall be of a type which remains open, except when held in closed position by the operator.*

3.4 *Ignition Circuit,* capable of supplying sufficient current to ignite the cotton wicking or nylon thread without melting the wire. The current shall be drawn from a step-down transformer or from a suitable battery.

3.5 *Cotton Wicking or Nylon Sewing Thread,* white.

4. Reagents and Materials

4.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[5] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

4.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean distilled water or water of equal purity.

4.3 *Barium Chloride Solution (85 g/litre)*—Dissolve 100 g of barium chloride dihydrate ($BaCl_2 \cdot 2H_2O$) in distilled water and dilute to 1 liter.

4.4 *Bromine Water (saturated).*

4.5 *Hydrochloric Acid (sp gr 1.19)*—Concentrated hydrochloric acid (HCl).

4.6 *Oxygen,* free of combustible material and sulfur compounds, available at a pressure of 40 atm (41 kgf/cm^2).

4.7 *Sodium Carbonate Solution (50 g/litre)*—Dissolve 135 g of sodium carbonate decahydrate ($Na_2CO_3 \cdot 10H_2O$) or its equivalent weight in distilled water and dilute to 1 litre.

4.8 *White Oil, USP, or Liquid Paraffin,* BP, *or equivalent.*

5. Procedure

5.1 *Preparation of Bomb and Sample*—Cut a piece of firing wire 100 mm in length. Coil the middle section (about 20 mm) and attach the free ends to the terminals. Arrange the coil so that it will be above and to one side of the sample cup. Insert between two loops of the coil a wisp of cotton or nylon thread of such length that one end will extend into the sample cup. Place about 5 mL of Na_2CO_3 solution in the bomb (Note 2) and rotate the bomb in such a manner that the interior surface is moistened by the solution. Introduce into the sample cup the quantities of sample and white oil (Notes 3 and 4) specified in the following table, weighing the sample to the nearest 0.2 mg (when white oil is used, stir the mixture with a short length of quartz rod and allow the rod to remain in the sample cup during the combustion).

NOTE 2—After repeated use of the bomb for sulfur determinations, a film may be noticed on the inner surface. This dullness should be removed by periodic polishing of the bomb. A satisfactory method for doing this is to rotate the bomb in a lathe at about 300 rpm and polish the inside surface with emery polishing papers Grit No. ⅜, or equivalent paper,[6] coated with a light machine oil to prevent cutting, and then with a paste of grit-free chromic oxide[3] and water. This procedure will remove all but very deep pits and put a high polish on the surface. Before the bomb is used it should be washed with soap and water to remove oil or paste left from the polishing operation.

Caution—*Do not use more than 1.0 g total of sample and white oil or other low sulfur combustible material or more than 0.8 g if the IP 12 bomb is used.*

Sulfur Content percent	Weight of Sample, g	Weight of White Oil, g
5 or under	0.6 to 0.8	0.0
Over 5	0.3 to 0.4	0.3 to 0.4

NOTE 3—Use of sample weights containing over 20 mg of chlorine may cause corrosion of the bomb. To avoid this, it is recommended that for samples containing over 2 % chlorine, the sample weight be based on the chlorine content as given in the following table:

[5] "Reagent Chemicals, American Chemical Society Specifications," Am. Chemical Soc., Washington, D.C. For suggestions on the testing of reagents not listed by the American Chemical Society, see "Reagent Chemicals and Standards," by Joseph Rosin, D. Van Nostrand Co., Inc., New York, N. Y., and the "United States Pharmacopeia."

[6] Emery Polishing Paper Grit No. ⅜ may be purchased from the Behr-Manning Co., Troy, N. Y. Chromic oxide may be purchased from J. T. Baker & Co., Phillipsburg, N. J.

Chlorine Content percent	Weight of Sample, g	Weight of White Oil, g
2 to 5	0.4	0.4
Over 5 to 10	0.2	0.6
Over 10 to 20	0.1	0.7
Over 20 to 50	0.05	0.7

NOTE 4—If the sample is not readily miscible with white oil, some other low sulfur combustible diluent may be substituted. However, the combined weight of sample and nonvolatile diluent shall not exceed 1.0 g or more than 0.8 g if the IP 12 bomb is used.

5.2 *Addition of Oxygen*—Place the sample cup in position and arrange the cotton wisp or nylon thread so that the end dips into the sample. Assemble the bomb and tighten the cover securely. **Caution**—*Do not add oxygen or ignite the sample if the bomb has been jarred, dropped, or tilted.* Admit oxygen slowly (to avoid blowing the oil from the cup) until a pressure is reached as indicated in the following table:

Capacity of Bomb, ml	Minimum Gage Pressure,[a] atm kgf/cm²	Maximum Gage Pressure,[a] atm kgf/cm²
300 to 350	38 (39)	40 (41)
350 to 400	35 (36)	37 (38)
400 to 450	30 (31)	32 (33)
450 to 500	27 (28)	29 (30)

[a] The minimum pressures are specified to provide sufficient oxygen for complete combustion and the *maximum pressures represent a safety requirement.*

5.3 *Combustion*—Immerse the bomb in a cold distilled-water bath. Connect the terminals to the open electrical circuit. Close the circuit to ignite the sample. **Caution**—*Do not go near the bomb until at least 20 s after firing.* Remove the bomb from the bath after immersion for at least 10 min. Release the pressure at a slow, uniform rate such that the operation requires not less than 1 min. Open the bomb and examine the contents. If traces of unburned oil or sooty deposits are found, discard the determination and thoroughly clean the bomb before again putting it in use (Note 2).

5.4 *Collection of Sulfur Solution*—Rinse the interior of the bomb, the oil cup, and the inner surface of the bomb cover with a fine jet of distilled water, and collect the washings in a 600-mL beaker having a mark to indicate 75 mL. Remove any precipitate in the bomb by means of a rubber policeman. Wash the base of the terminals until the washings are neutral to a suitable indicator. Add 10 mL of saturated bromine water to the washings in the beaker. (The volume of the washings is normally in excess of 300 mL.) Place the sample cup in a 50-mL beaker. Add 5 mL of saturated bromine water, 2 mL of HCl, and enough distilled water just to cover the cup. Heat the contents of the beaker to just below its boiling point for 3 or 4 min and add to the beaker containing the bomb washings. Wash the sample cup and the 50-mL beaker thoroughly with distilled water. Remove any precipitate in the cup by means of a rubber policeman. Add the washings from the cup and the 50-mL beaker, and the precipitate, if any, to the bomb washings in the 600-mL beaker. Do not filter any of the washings, since filtering would remove any sulfur present as insoluble material.

5.5 *Determination of Sulfur*—Evaporate the combined washings to 200 mL on a hot plate or other source of heat. Adjust the heat to maintain slow boiling of the solution and add 10 mL of a $BaCl_2$ solution, either in a fine stream or dropwise. Stir the solution during the addition and for 2 min thereafter. Cover the beaker with a fluted watch glass and continue boiling slowly until the solution has evaporated to a volume approximately 75 mL as indicated by a mark on the beaker. Remove the beaker from the hot plate (or other source of heat) and allow it to cool for 1 hr before filtering. Filter the supernatant liquid through an ashless, quantitative filter paper (Note 5). Wash the precipitate with water, first by decantation and then on the filter, until free from chloride. Transfer the paper and precipitate to a weighed crucible and dry (Note 6) at a low heat until the moisture has evaporated. Char the paper completely without igniting it, and finally ignite at a bright red heat until the residue is white in color. After ignition is complete, allow the crucible to cool at room temperature, and weigh.

NOTE 5—A weighed porcelain filter crucible (Selas type) of 5 to 9-μm porosity may be used in place of the filter paper. In this case the precipitate is washed free of chloride and then dried to constant weight at 500 ± 25°C.

NOTE 6—A satisfactory means of drying, charring, and igniting the paper and precipitate is to place the crucible containing the wet filter paper in a cold electric muffle furnace and to turn on the current. Drying, charring, and ignition usually will occur at the desired rate.

5.6 *Blank*—Make a blank determination whenever new reagents, white oil, or other low-sulfur combustible material are used. When running a blank on white oil, use 0.3 to 0.4 g and follow the normal procedure.

6. Calculation

6.1 Calculate the sulfur content of the sample as follows:

$$\text{Sulfur, weight percent} = (P - B)13.73/W$$

where:

P = grams of $BaSO_4$ obtained from sample,
B = grams of $BaSO_4$ obtained from blank, and
W = grams of sample used.

7. Report

7.1 Report the results of the test to the nearest 0.01 %.

8. Precision

8.1 The precision of this test is not known to have been obtained in accordance with currently accepted guidelines (for example in Committee D-2 Research Report RR: D02-1007, "Manual on Determining Precision Data for ASTM Methods on Petroleum Products and Lubricants").

8.1.1 *Repeatability*—The difference between two test results, obtained by the same operator with the same apparatus under constant operating conditions on identical test material, would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in twenty:

8.1.2 *Reproducibility*—The difference between two single and independent results obtained by different operators working in different laboratories on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in twenty:

Sulfur, weight percent	Repeatability	Reproducibility
0.1 to 0.5	0.04	0.05
0.5 to 1.0	0.06	0.09
1.0 to 1.5	0.08	0.15
1.5 to 2.0	0.12	0.25
2.0 to 5.0	0.18	0.27

NOTE 7—The precision shown in the above table does not apply to samples containing over 2 % chlorine because an added restriction on the amount of sample which can be ignited is imposed.

NOTE 8—This method has been cooperatively tested only in the range of 0.1 to 5.0 % sulfur.

NOTE 9—The following information on the precision of this method has been developed by the Institute of Petroleum (London):

(*a*) Results of duplicate tests should not differ by more than the following amounts:

Repeatability	Reproducibility
$0.016\,x + 0.06$	$0.037\,x + 0.13$

where x is the mean of duplicate test results.

(*b*) These precision values were obtained in 1960 by statistical examination of interlaboratory test results.[7] No limits have been established for additive concentrates.

[7] IP Standards for Petroleum and Its Products, Part I, Appendix E.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, Pa. 19103.

CHLORIDE BY AUTOMATED FERRICYANIDE

EPA METHOD 325.2

WESTON SOP OP21-15-0325.2

0173L

INORGANIC ANALYSIS PROTOCOL
CHLORIDE AUTOMATED FERRICYANIDE

1.0 PURPOSE

The determination of chloride in water and wastes.

2.0 REFERENCE

2.1 40CFR136 - Guidelines Establishing Test Procedures for the Analysis of Priority Pollutants, Revised as of 1 July 1988.

2.2 ALPCHEM Rapid Flow Analyzer Operator's Manual.

2.3 Standard Methods for the Examination of Water and Wastes, 16th Edition, 1985, Method 407D.

2.4 EPA-600/4-79-020, Methods for Chemical Analysis of Water and Wastes, March 1983, Method 325.2

3.0 PRINCIPLE

Thiocyanate is displaced from mercuric thiocyanate by the chloride ion. The liberated thiocyanate reacts with ferric ion to form the colored complexes $[Fe(SCN)]^{++}$. The amount of complex formed, is directly proportional to the concentration of chloride complex and is measured at 480 nm.

4.0 INTERFERENCES

There are no significant interferences. Filter turbid samples before analysis.

5.0 METHOD DETECTION LIMIT

5 mg/L

6.0 OPTIMUM CONCENTRATION RANGE

5 mg/L to 100 mg/L, range can be extended through dilution.

7.0 REAGENTS

7.1 Stock Ferric Nitrate: Dissolve 202 g of ferric nitrate $Fe(NO_3)_3 \cdot 9H_2O$ in approximately 500 mL of deionized water contained in a 1 L volumetric flask. Add 31.5 mL of nitric acid. Dilute to the mark with deionized water and mix well.

7.2 Stock Mercuric Thiocyanate: Use purchased reagent 0.42% in methanol. If unavailable, dissolve 4.17 g of mercuric thiocyanate in about 500 mL of methanol in a 1 L volumetric flask. Dilute to the mark with methanol and mix well.

CAUTION: Mercuric thiocyanate is a poison. Do not breath dust, wash thoroughly after handling. Methanol is flammable. Ingestion may be fatal or cause blindness. Avoid prolonged breathing vapor. Use both materials only with adequate ventilation.

7.3 Chloride Color Reagent: Add 150 mL of stock ferric nitrate and 150 mL of stock mercuric thiocyanate to approximately 500 mL of deionized water in a 1 L volumetric flask. Dilute to the mark with deionized water and mix well. Filter through a Whatman 41 filter paper or 0.45 um Millipore filtering system.

7.4 Nitric Acid Solution: Add 15.8 mL of concentrated HNO_3 to 800 mL of deionized water in a 1 L volumetric flask. Dilute to the mark with deionized water. Add 1 mL of Brij-35, 30% solution and mix well.

7.5 Diluent: Add 1 mL of Brij-35, 30% solution to 1 L of deionized water and mix well.

8.0 **STANDARDS**

8.1 Calibration Standards

8.1.1 Stock Standard (10,000 ppm) Dissolve 16.4866 g of dry sodium chloride in approximately 900mL of deionized water contained in a 1 L volumetric flask. Dilute the solution to the mark with deionized water and mix it well.

8.1.2 Intermediate standard (1000 ppm) Add 100 mL of stock standard to about 500 mL of deionized water in a 1 L

volumetric flask and dilute to the mark with deionized water, and mix well.

8.1.3 Working Calibration Standards: To a series of 100 mL volumetric flasks add the indicated aliquots of the stock calibration standard. Dilute to the mark with deionized water, and mix well.

Volume of 1000 ppm Intermediate Stock Standard (mL)	Concentration (mg/L)
0	0
0.1	1
0.5	5
1.0	10
2.5	25
5.0	50
10.0	100

8.2 Calibration Verification Stock Solution (10,000 ppm) Dissolve 21.02 g of dried potassium chloride in approximately 900 mL deionized water contained in a 1 L volumetric flask. Dilute to the mark with deionized water and mix well. Make an intermediate 1000 ppm and dilute it per 8.1.2.

8.2.1 Calibration Verification Standard - CCV (25 ppm) Add 2.5 mL of intermediate 1000 ppm solution to a 100 mL volumetric flask. Dilute to the mark with deionized water, and mix well.

9.0 **INSTRUMENT PARAMETERS**

Alpkem Rapid Flow Analyzer 300

10.0 **PRESERVATION**

None; collected in plastic or glass containers.

11.0 **HOLDING TIME**

28 days

12.0 **PROCEDURE**

12.1 Instrument: Turn on the system with the switch located on the main function box behind the instrument. Warm up time is ten minutes.

12.2 Autosampler:

12.2.1 Switch on the peck cycle button, located in the rear right side of the sampler.

12.2.2 Set the wash time to 20 and the sample time to 25.

12.2.3 Set stop count to the required number, correspondent to the number of samples to be analyzed.

12.2.4 Push reset to store the above information in the sampler memory. Push the reset button again, if the stop count is increased and restart.

12.2.5 Load sample tray in the following order:

Cup #	ID	Cup #	ID
1	STD 100	18	Blk
2	STD 100	19	Blk
3	Blk	20	% STD 10 ICV
4	Blk	21	% STD 10 ICV
5	Blk	22	Blk ICB
6	STD 100	23	Blk ICB
7	STD 100	24	Sample #1
8	STD 50	|	|
9	STD 50	V	V
10	STD 25	33	Sample #10
11	STD 25	34	% STD CCV 10 mg/L
12	STD 10	35	Blk CCB
13	STD 10	Repeat pattern of cup 24-> 35 always end run with a CCV followed by a CCB.	
14	STD 5		
15	STD 5		
16	STD 1		
17	STD 1		

12.3 Analytical Cartridge Module

12.3.1 Gently place the 200 - 1 mg/L chloride cartridge in the second lot of the module.

12.3.2 Insure that the tubing is installed as diagramed in Alpchem method number A303-5090-04.

12.3.3 Connect a 12 mm flowcell to the cartridge.

12.3.4 The dialyzer must be fitted with a type "C" membrane, following the directions for membrane replacement on page 13 through 15 of the Alpchem manual.

12.4 Micro Pump

12.4.1 Fasten pump tubes from cartridge on the closest section of platen.

12.4.2 Close and secure all four platens to set the pump in motion.

12.4.3 All lines should be immersed in deionized water, with the exception of the Brij solution line which should draw Brij treated water.

12.4.4 Six solenoid valves, located in a row at the rear of the pump, control air injection. Two valves are required for this cartridge. The air output nipples are in the center of each valve. The corresponding inlet nipple is beside the center output nipple. Refer to method diagram to place this tubing. Air should be injected into the cartridge at the bottom of the downstroke of the platen. The timing of air injection is controlled by the small screws beside each valve and the main screw control to the right. Further explanation of a proper flow pattern can be found on pages 3 through 7 of the Alpchem Manual.

12.5 Photometer: Use the center photometer for this analysis.

12.5.1 Secure 480 nm filters, mirror side facing the photometer, into the sample and reference channel filterholders, using the set screws.

12.5.2 Install a 12 mm flowcell into the flowcell holder.

12.5.3 Gently slide the flowcell holder along the holder guide to meet the filter holder. Secure this with its set screw. Avoid bending the fiber optic cable attached to the flowcell holder. Tubing from the cartridge should be attached before installation as diagramed in the manual.

12.5.4 Set the lamp to 4S.

12.5.5 Set the standard calibration to about 4.40. This may need to be adjusted to achieve 95% scale peak height for the 100 mg/L standard.

12.5.6 Turn the bubble gate switch on and set the gate delay as instructed in the RFA manual on pages 10 through 16.

12.5.7 Set the function switch to the reference position. Adjust the coarse and fine gain so that the LCD reads 5.00 ± .02.

12.5.8 Set the function switch to the sample position. Adjust the coarse and fine gain so that the LCD reads 5.00 ± 0.02 volts.

12.5.9 Set the function switch to the absorbance position. The LCD voltage should read 0 ± 0.02. If the voltage shows excessive deviation or fluctuation the bubble gate may need adjustment. Refer to the RFA manual pages 10 through 16.

12.5.10 After a good baseline is established on deionized water, immerse the labelled lines in the corresponding reagent containers as diagramed in the manual. The system is equilibrated when the absorbance increases sharply.

12.5.11 Readjust the LCD voltage back to 5.00 volts on the reference and sample channels as previously described.

12.5.12 The function switch must be in the absorbance position for the analysis.

12.6 Recorder

12.6.1 Attach DC cable #2 from the recorder output on the photometer to the recorder. The side showing tow wires should face front. Use the center control panel for the second pen.

12.6.2 Set the VAR/CAL switch to VAR.

12.6.3 Set the CAL dial to 10 volts.

12.6.4 Set the baseline with the zero knob < 0 >.

12.6.5 Set the chart paper to full scale with the VAR knob.

12.6.6 Set chart paper speed to 1 cm/min.

12.6.7 Put the chart drive in the forward position to run.

12.6.8 Put the pen down.

13.0 **QUALITY CONTROL**

Calibration curves must be composed of a minimum of a blank and 5 standards. Linear calibration curves must have a minimum correlation coefficient of 0.996, which must be reported with the raw data.

Calibration curve must be verified with a mid-range check standard prepared independently from the calibration curve standards. The check standard must not vary more than fifteen (15%) percent from the true value.

Calibration verification will be performed with a calibration blank and check standard after every ten samples and at the end of the analysis. The check standard must not vary more than fifteen (15) percent from the true value.

Dilute samples if they are more concentrated than the highest standard or if they fall on the plateau of a calibration curve.

A minimum of one preparation blank must be analyzed per sample batch to determine if contamination has occurred. For this parameter, the calibration check blank and preparation blank are equivalent.

Duplicate laboratory control samples (LCS) will be included with each sample batch of 20 samples. The analyzed result must not vary more than 15% from the true value. For this parameter, the LCS and the calibration check standard are equivalent.

Matrix spike and duplicate samples must be analyzed as requested by the client.

14.0 **CALCULATION**

Use the first order equation y = ms + b to perform a linear regression analysis of standard concentration versus instrument response.

15.0 **METHOD PERFORMANCE**

Laboratory control charts will be maintained for laboratory control standards. Accuracy and precision will be based on the laboratory control standard.

16.0 **ANALYSIS RATE**

One analyst can set up and run a calibration curve in 1 hour, sample analysis is conducted at approximate rate of 100 samples per day.

17.0 **SAFETY**

Fully fastened lab coat and safety glasses must be worn.

All damaged or broken glassware should be discarded immediately.

Immediately clean up any materials spilled on floor, in hoods or on bench tops.

dvn\sop\op2115\0325.2

WESTON

CHLORIDE

ANALYST______________ BATCH ____________ CAL-STD:FISHER NaCl
DATE_________________ WRKSHT____________ ICV/CCV:EM KCl
ALPKEM RFA-300 CORR.COEF__________
EPA METHOD 325.2 COLORIMETRIC AUTOMATED FERRICYANIDE ANALYSIS

STD/RFW#	Cl mg/L	DIL	%SOL	g/mL	Cl mg/kg	COMMENTS

UNLESS OTHERWISE NOTED:
ALL ICV/CCV = 25.0 mg/L
ALL MATRIX SPIKES = 10.0 mg/L

VERIFIED______________
DATE__________________

RFW21-21-016/0-12/89

HEAT OF COMBUSTION BY BOMB CALORIMETER (BTU)

ASTM METHOD D240

WESTON SOP 15-009

0173L

Date: 09/08/89
Revision No.: 2
Revised by: GLR
Approved by:

1. TITLE: Heat of Combustion by Bomb Colorimeter (BTU)
Ref: ASTM D240
SOP #15-009

Container, preservation, and holding times may vary and is dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include container and preservation requirements for compliance with the safe Drinking Water Act (SDWA) and The Clean Water Act (CWA).

REGULATION	HOLDING TIME	REFERENCE
CWA	28 Days	CFR 40 pt. 136.3
SDWA	28 Days	EPA-570/9-82-002

2. SUMMARY:

Heat of combustion is determined by burning a specific amount of a sample in an oxygen bomb colorimeter. Without losing any of the sample or its combustion products, the burning process converts any solid or liquid combustible sample into soluble form ready for analysis. All hydrocarbons are oxidized to carbon dioxide and water during the reaction, while sulfur compounds are converted into oxides and absorbed in a small volume of water in the bottom of the bomb. Any mineral constituents remain as ash while other inorganic elements such as arsenic, boron and any halogens are recovered in the bomb washings. The heat of combustion is computed from the change of temperature before and after ignition, with proper allowances or thermochemical and heat transfer corrections.

INTERFERENCES:

None

DETECTION LIMIT:

500 BTU/lb

3. INSTRUMENTATION and EQUIPMENT/APPARATUS:

Parr Adiabatic Colorimeter
Parr 1901 Oxygen Bomb apparatus
Analytical balance
Oxygen tank
Sample bomb cups

4. PREVENTATIVE MAINTENANCE:

4.1 Check the seal on the oxygen bomb periodically for cracks and wear. Replace if necessary to prevent oxygen leakage.

4.2 The water bath before ignition should range from 22 C to 27 C to prevent the temperature from going out of range on the thermometer.

4.3 The analytical balance should be leveled and zeroed before weighing samples.

4.4 Sample cups should be soaked in nitric acid, scrubbed and dried at 105 C before using.

5. REAGENTS:

5.1 Methyl Red Indicator: Dissolve 100 mg methyl red in 100 ml ethyl alcohol.

Life of Reagent: one year
Storage Requirements: none

5.2 0.0725N NaOH Solution: In a 1000 ml volumetric, dissolve 2.9 g NaOH in 800 ml DI water. Place in water bath on a stir plate. Mix well. Bring to volume with DI water.

Life of Reagent: one year
Storage Requirements: none

5.3 Ethylene glycol - purchased from CMS

5.4 Benzoic acid - purchased from CMS

6. PROCEDURE:

6.1 SAMPLE SIZE:

Approximately 1 gram of sample is used. If ethylene glycol or benzoic acid is used, approximately 0.5 grams of sample is used with approximately 0.5 grams of ethylene glycol or benzoic acid. (Ethylene glycol is added to a solid sample which will not burn by itself. Benzoic acid is added to a liquid sample which does not burn.

6.2 Standardization:

A benzoic acid tablet (0.9 g - 1.25 g) is analyzed twice. The average value obtained from these two runs is a constant, W. The W value is re-analyzed after every 10 samples, not to exceed 13 for each bomb in the following procedure.

6.3 Analytical Sequence:

Quality Controls	Frequency	Control Limit
Preparation Blank (PB)	1 in 20 samples	control chart
Lab Control Stand.(LCS)	1 in 20 samples	control chart
Lab Control Stand. Dup.	1 in 20 samples	control chart
Matrix Duplicate	1 in 20 samples	control chart

6.4 Preparation of Quality Controls:

6.4.1. Preparation Blank (PB) - bomb one benzoic acid tablet of about 1.0 g and use washings for procedural check in % Sulfur analysis.

6.4.2. Lab Control Standard (LCS) and LCS Duplicate - Bomb one benzoic acid tablet of about one gram.

6.5 Procedure:

6.5.1. Weigh out approximately 1.0 g of sample (making the necessary allowances when ethylene glycol or benzoic acid is used) on an analytical balance.

6.5.2. Add a small amount of DI water to the bomb, and seal the bomb shut.

6.5.3. Purge the bomb with oxygen to 30 atmospheres. DO NOT OVERCHARGE THE BOMB! If by accident the oxygen introduced into the bomb should exceed 40 atmospheres, do not proceed to combustion. An explosion could occur with possible violent rupture to the bomb. Release the air pressure and proceed in the usual manner.

6.5.4. Use the same amount (0.5 g) of DI water in the colorimeter vessel for each test. To do so, empty the entire water reservoir into the colorimeter for each analysis.

6.5.5. Assemble the colorimeter in the jacket, making sure the stirrer is revolving.

6.5.6. Allow the temperature to equilibrate, and record the initial temperature.

6.5.7. When both thermometers are the same (0.01), push the ignite button and watch for the temperature to rise.

6.5.8. After six minutes of from firing, begin reading the temperature every minute.

6.5.9. When the temperature is the same for three

consecutive minutes, record the final temperature. (If the temperature does not rise, sample will have to be re-analyzed.)

6.5.10. Remove the bomb and release the pressure at a uniform rate in a fume hood.

6.5.11. Examine the interior of the bomb to confirm that combustion was complete (small amounts of ash may be present).

6.5.12. Measure the unburned firing wire, subtract from the original length and record as residual wire (calories).

6.5.13. Wash the interior of the bomb with DI water.

6.5.14. Collect the washings into a graduated cylinder.

6.5.15. Bring up to a volume of 250 ml or 500 ml, depending on the number of analysis to be performed on the sample.

6.5.16. Titrate 50 ml of the washings with 0.0725N NaOH, using methyl red indicator.

7. CALCULATIONS:

7.1 Standard Value of Bomb (W):

$$W = \frac{Hm + e}{t}$$

Where: e = residual wirw in calories
H = heat of combustion of benzoic acid in cal/gram
m = mass of benzoic acid used
t = temperature rise

7.2 BTU/lb:

$$BTU/lb = \frac{[\ t(W) - NaOH(d) - E.G.\ or\ B.A. - Res.wire - X]}{Sample\ Weight\ (g)}$$

Where: t = change in temperature,
W = Standard Bomb Value,
NaOH = mls 0.0725 N NaOH titrated,
d = dilution factor (if final volume is 250 ml, then d = 5; if final volume is 500 ml, then d = 10),
E.G. (ethylene glycol) = (4425 cal/g)(gms E.G.)
B.A. (benzoic acid) = (6318 cal/g)(gms of B.A.)

Res.wire = amount of burned wire in calories
X = % Sulfur, if % Sulfur is >0.1% then:
X = (%S) (14) (sample wt. in gm)

7.3 LCS and LCS Dup % Recovery (%R):

$$\%R = \frac{\text{observed concentration}}{\text{actual concentration}} \times 100$$

7.4 Matrix Dup. and LCSD Relative Percent Difference (RPD):

$$RPD = \frac{\text{difference}}{\text{mean}} \times 100$$

8. QUALITY CONTROL:

At least one method blank and at least two Lab Control Standards (LCS) will be included in each laboratory lot of 20 samples. Regardless of the matrix being processed, the LCS and method blanks will be in an aqueous media.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

The LCS will be examined to determine both precision and accuracy.

Accuracy will be measured by the percent recovery (%R) of the LCS. The recovery must be in range, as determined by statistical analysis, in order to be considered acceptable. Additionally, %R will be plotted on control charts to monitor method accuracy.

Precision will be measured by the reproducibility of both LCSs and will be calculated as Relative Percent Difference (RPD). Results must agree within statistical control limits in order to be considered acceptable.

9. CORRECTIVE ACTIONS:

9.1 Listed below are steps to be taken when an out of control situation occurs. The analyst MUST:

9.1.1. demonstrate that all of the problems creating the out of control situation were addressed,
9.1.2. document the problem and the action that was taken to correct the problem on a corrective action report form,
9.1.3. document on a corrective action report that an in control situation has been achieved, and
9.1.4. receive approval (signature) of the unit leader, QA personnel, or the laboratory manager prior to the release of any analytical data associated with the problem.

9.2 Listed below are some suggested courses of actions that may be taken to correct out of control situations that may occur with this procedure:

9.2.1. Laboratory Control Standards (LCS):
- If the LCS is low;
- determine the source of error within the sample preparation and repeat the set, WRITE A CAR.
- If the LCS is high;
- check for source of contamination,
- correct for contamination and repeat set, WRITE A CAR.

9.2.2. Laboratory Control Standard Duplicate (LCSD):
- The LCS duplicate must meet all control limits as LCS in addition to limits set for precision (same corrective action as LCS).

9.2.3. Preparation Blank (PB):
- reanalyze PB to verify that it is beyond detection limit;
- check and correct for any source of contamination,
- repeat sample set,
- in the extreme case where all samples in the set are at least ten times greater than the PB, reanalysis will not be required, WRITE A CAR.

9.2.4. Matrix Duplicate:
- the sample must be reprocessed and reanalyzed;
- if the reanalysis is still out of control, then the sample set will be ticked with a "N";
- regardless of the outcome of the reanalysis, a CAR will be written and approved.

10. HEALTH and SAFETY:

As always, general laboratory safety practices should always be followed. Waste samples should be handled with care due to the uncertainty of the properties and contents involved. Refer to the specific MSDS for the hazardous properties of any chemical or reagent involved in this procedure.

Many samples for BTU are hazardous. Therefore extra caution should be used when handling the samples. Wear safety glasses, gloves and a lab coat if desired.

Release the oxygen from the bomb under a fume hood.

ASTM METHOD 2216-80

0173L

Designation: D 2216 – 80

An American National Standard

Standard Method for
LABORATORY DETERMINATION OF WATER (MOISTURE) CONTENT OF SOIL, ROCK, AND SOIL-AGGREGATE MIXTURES[1]

This standard is issued under the fixed designation D 2216; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This method covers the laboratory determination of the water (moisture) content of soil, rock, and soil-aggregate mixtures by weight. For simplicity, the word "material" hereinafter refers to either soil, rock, or soil-aggregate mixtures, whichever is most applicable.

1.2 The water content of a material is defined as the ratio, expressed as a percentage, of the mass of "pore" or "free" water in a given mass of material to the mass of the solid material particles.

1.3 This method does not give true representative results for: materials containing significant amounts of halloysite, montmorillonite, or gypsum minerals; highly organic soils; or, materials in which the pore water contains dissolved solids (such as salt in the case of marine deposits). For a material of the previously mentioned types, a modified method of testing or data calculation may be established to give results consistent with the purpose of the test.

2. Summary of Method

2.1 The practical application in determining the water content of a material is to determine the mass of water removed by drying the moist material (test specimen) to a constant mass in a drying oven controlled at 110 ± 5°C and to use this value as the mass of water in the test specimen. The mass of material remaining after oven-drying is used as the mass of the solid particles.

3. Significance and Use

3.1 For many soil types, the water content is one of the most significant index properties used in establishing a correlation between soil behavior and an index property.

3.2 The water content of a soil is used in almost every equation expressing the phase relationships of air, water, and solids in a given volume of material.

3.3 In fine-grained (cohesive) soils, the consistency of a given soil type depends on its water content. The water content of a soil, along with its liquid and plastic limit, is used to express its relative consistency or liquidity index.

3.4 The term "water" as used in geotechnical engineering, is typically assumed to be "pore" or "free" water and not that which is hydrated to the mineral surfaces. Therefore, the water content of materials containing significant amounts of hydrated water at in-situ temperatures or less than 110°C can be misleading.

3.5 The term "solid particles" as used in geotechnical engineering, is typically assumed to mean naturally occurring mineral particles that are not readily soluble in water. Therefore, the water content of materials containing extraneous matter (such as cement, etc), water-soluble matter (such as salt) and highly organic

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[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity and Density Characteristics of Soils.

Current edition approved May 30, 1980. Published July 1980. Originally published as D 2216 – 63 T. Last previous edition D 2216 – 71.

matter typically require special treatment or a qualified definition of water content.

4. Apparatus

4.1 *Drying Oven*, thermostatically-controlled, preferably of the forced-draft type, and maintaining a uniform temperature of 110 ± 5°C thrpughout the drying chamber.

4.2 *Balances*, having a precision (repeatability) of ±0.01 g for specimens having a mass of 200 g or less, ±0.1 g for specimens having a mass of between 200 and 1000 g, or ± 1 g for specimens having a mass greater than 1000 g.

4.3 *Specimen Containers*—Suitable containers made of material resistant to corrosion and a change in mass upon repeated heating, cooling, and cleaning. Containers with close-fitting lids shall be used for testing specimens having a mass of less than about 200 g; while for specimens having a mass greater than about 200 g, containers without lids may be used (Note 1). One container is needed for each water content determination.

NOTE 1—The purpose of close-fitting lids is to prevent loss of moisture from specimens before initial weighing and to prevent absorption of moisture from the atmosphere following drying and before final weighing.

4.4 *Desiccator*—A desiccator of suitable size (a convenient size is 200 to 250-mm diameter) containing a hydrous silica gel. This equipment is only recommended for use when containers having close-fitting lids are not used. See 7.4.1.

5. Samples

5.1 Keep the samples that are stored prior to testing in noncorrodible airtight containers at a temperature between approximately 3 and 30°C and in an area that prevents direct contact with sunlight.

5.2 The water content determination should be done as soon as practicable after sampling, especially if potentially corrodible containers (such as steel thin-walled tubes, paint cans, etc.) or sample bags are used.

6. Test Specimen

6.1 For water contents being determined in conjunction with another ASTM method, the method of specimen selection specified in that method controls.

6.2 The manner in which the test specimen is selected and its required mass is basically dependent on the purpose (application) of the test, type of material being tested, and the type of sample (specimen from another test, bag, tube, split-barrel, etc.). In all cases, however, a representative portion of the total sample shall be selected. If a layered soil or more than one soil type is encountered, select an average portion or individual portions or both, and note which portion(s) was tested in the report of the results.

6.2.1 For bulk samples, select the test specimen from the material after it has been thoroughly mixed. The mass of moist material selected shall be in accordance with the following table:

Sieve Retaining More Than About 10 % of Sample	Recommended Minimum Mass of Moist Specimen, g
2.0 mm (No. 10) sieve	100 to 200
4.75 mm (No. 4) sieve	300 to 500
19 mm	500 to 1000
38 mm	1500 to 3000
76 mm	5000 to 10 000

6.2.2 For small (jar) samples, select a representative portion in accordance with the following procedure:

6.2.2.1 For cohesionless soils, thoroughly mix the material, then select a test specimen having a mass of moist material in accordance with the table in 6.2.1. See Note 2.

6.2.2.2 For cohesive soils, remove about 3 mm of material from the exposed periphery of the sample and slice it in half (to check if the material is layered) prior to selecting the test specimen. If the soil is layered see 6.2. The mass of moist material selected should not be less than 25 g or should be in accordance with the table in 6.2.1 if coarse-grained particles are noted. (Note 2).

6.3 Using a test specimen smaller than the minimum mass indicated previously requires discretion, though it may be adequate for the purpose of the test. A specimen having a mass less than the previously indicated value shall be noted in the report of the results.

NOTE 2—In many cases, when working with a small sample containing a relatively large coarse-grained particle, it is appropriate not to include this particle in the test specimen. If this occurs, it should be noted in the report of the results.

7. Procedure

7.1 Select representative test specimens in accordance with Section 6.

7.2 Place the moist specimen in a clean, dry container of known mass (Note 3), set the lid securely in position, and determine the mass of the container and moist material using an appropriate balance (4.2). Record these values.

7.3 Remove the lid and place the container with moist material in a drying oven maintained at 110 ± 5°C and dry to a constant mass (Notes 4, 5, and 6).

NOTE 3—To assist in the oven-drying of large test specimens, they should be placed in containers having a large surface area (such as pans) and the material broken up into smaller aggregations.

NOTE 4—The time required to obtain constant mass will vary depending on the type of material, size of specimen, oven type and capacity, and other factors. The influence of these factors generally can be established by good judgment, and experience with the materials being tested and the apparatus being used. In most cases, drying a test specimen over night (about 16 h) is sufficient. In cases where there is doubt concerning the adequacy of drying, drying should be continued until the mass after two successive periods (greater than ½ h) of drying indicate an insignificant change (less than about 0.1 %). Specimens of sand may often be dried to constant mass in a period of about 4 h, when a forced-draft oven is used.

NOTE 5—Oven-drying at 110 ± 5°C does not always result in water content values related to the intended use or the basic definition especially for materials containing gypsum or other minerals having significant amounts of hydrated water or for soil containing a significant amount of organic material. In many cases, and depending on the intended use for these types of materials, it might be more applicable to maintain the drying oven at 60 ± 5°C or use a vacuum desiccator at a vacuum of approximately 133 Pa (10 mm Hg) and at a temperature ranging between 23 and 60°C for drying. If either of these drying methods are used, it should be noted in the report of the results.

NOTE 6—Since some dry materials may absorb moisture from moist specimens, dried specimens should be removed before placing moist specimens in the oven. However, this requirement is not applicable if the previously dried specimens will remain in the drying oven for an additional time period of about 16 h.

7.4 After the material has dried to constant mass remove the container from the oven and replace the lid. Allow the material and container to cool to room temperature or until the container can be handled comfortably with bare hands and the operation of the balance will not be affected by convection currents. Determine the mass of the container and oven-dried material using the same balance as used in 7.2. Record this value.

7.4.1 If the container does not have a lid, weigh the container and material right after their temperatures are such that the operation of the balance will not be affected by convection currents or after cooling in a desiccator.

NOTE 7—Cooling in a desiccator is recommended since it prevents absorption of moisture from the atmosphere during cooling.

8. Calculation

8.1 Calculate the water content of the material as follows:

$$w = [(W_1 - W_2)/(W_2 - W_c)] \times 100 = \frac{W_w}{W_s} \times 100$$

where:

w = water content, %,
W_1 = mass of container and moist specimen, g,
W_2 = mass of container and oven-dried specimen, g,
W_c = mass of container, g,
W_w = mass of water, g, and
W_s = mass of solid particles, g.

9. Report

9.1 The report (data sheet) shall include the following:

9.1.1 Identification of the sample (material) being tested, by boring number, sample number, test number, etc.

9.1.2 Water content of the specimen to the nearest 0.1 % or 1 %, depending on the purpose of the test.

9.1.3 Indication of test specimen having a mass less than the minimum indicated in Section 6.

9.1.4 Indication of test specimen containing more than one soil type (layered, etc).

9.1.5 Indication of the method of drying if different from oven-drying at 110 ± 5°C.

9.1.6 Indication of any material (size and amount) excluded from the test specimen.

10. Precision and Accuracy

10.1 Requirements for the precision and accuracy of this test method have not yet been developed.

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, Pa. 19103.

PERCENT MOISTURE, PERCENT ASH

EPA METHOD 209.0

WESTON SOP OP21-15-0160.6

0173L

INORGANIC ANALYSIS PROTOCOL
% SOLIDS, % MOISTURE % ASH, AND % VOLATILE SOLID DETERMINATION PROCEDURES

1.0 **PURPOSE**

1.1 To determine the percent moisture and solid composition of waste materials.

1.2 To determine the % ash or fixed solid and volatile solid composition of waste materials.

2.0 **REFERENCES**

2.1 Laboratory Determination of Water Content of Soil, Rock and Soil Aggregate Mixture, ASTM 02216-80. 04.08

2.2 Methods of Soil Analysis, Water Content Part 1, 21-2.2

2.3 Standard Methods for the Examination of Water, and Wastewate 16th Edition, 1985. Method 209.0., Fixed and Volatile Solic Ignited at 550°C.

3.0 **PRINCIPLE**

3.1 Percent Solids and % moisture determinations are made by drying a moist material to a constant mass in a drying oven. The masses of the sample before and after the drying procedure are used in calculating the percent of moisture and solid content of the original sample.

3.2 Percent Ash and % Volatile Solids are determined by igniting an already dried sample in a 550°C oven. The mass that is left after ignition is the ash (or fixed solid) component, the mass that is lost is the volatile solid component.

4.0 **INTERFERENCES**

Non-representative particulates should be excluded from the sample if it is determined that their inclusion is not desired in the final result (ie. large rocks).

5.0 **METHOD DETECTION LIMIT**

0.10%

6.0 **OPTIMUM CONCENTRATION RANGE**

0.10-100%

7.0 **REAGENTS**

None

8.0 **STANDARDS**

None

9.0 **INSTRUMENTAL PARAMETERS**

Any balance that can read 0.01 gram.

10.0 **PRESERVATION**

None

11.0 **HOLDING TIME**

None

12.0 **PROCEDURE**

12.1 Before starting, be sure that the balance has been checked with at least two Class P standard weights. These can be found in a desiccator in the balance room. Document the weights in the balance log book found by each one of the balances. Ensure that the weights are at least ± 0.01g of there true value. If there is a problem, please contact your supervisor.

12.2 For % solids and % moisture determinations, weigh and record the weight of an empty aluminum pan to the nearest 0.01g. This is the tared weight.

12.3 Add 5-10g of sample to the tared aluminum pan. Weigh and record the weight to the nearest 0.01g.

12.4 Place sample and pan in drying oven set at 105°C. Dry the sample overnight (12-24 hours) but no longer than 24 hours. Note: Wear heat resistant gloves when handling hot containers. If the sample is dried less than 12 hours it must be documented that a constant weight was attained (see 12.5). If the drying time exceeds 12 hours proceed to section 12.6.

12.5 Constant weight determination:

12.5.1 Desiccate the sample for one hour, weigh and record to the nearest 0.01g. Place the sample back into the oven for at least one hour, desiccate re-weigh and record. Repeat process until constant weight is achieved.

12.5.2 Constant weight is achieved when the loss of weight is no greater than 0.01g between each weighing.

12.6 Place the dried sample in a desiccator for at least one hour. Take the sample out of the desiccator and immediately weigh and record weight to the nearest 0.01g.

12.7 The calculation for % solids is as follows:

$$\% \text{ solids} = \frac{\text{Pan and dry sample wt.-pan wt.}}{\text{Pan and wet sample wt.-pan wt.}} \times 100$$

The calculation for % moisture is as follows:

% Moisture = 100% - % solids result

12.8 Percent ash and % Volatile Solid determinations can be made using the dry sample obtained from the % solids or % moisture determination. Instead of using an aluminum pan a ceramic evaporating dish must be used.

12.8.1 Prepare the evaporating dish by drying it in a furnace at 550 ± 50°C for at least 20 minutes. Note: Wear heat resistant gloves when handling hot containers. Remove dish from furnace and let it cool partially in the air until most of the heat has been dissipated. Desiccate the dish for at least one hour, and proceed with % solids determination using the dish instead of the pans (12.2 to 12.7).

12.8.2 After the sample is dry, weigh and record the weight. Insert the dried sample in a furnace that is already warmed up to 550± 50°C. Ignite the sample for at least 20 minutes. Remove and desiccate as before (see 12.8.1). Weigh and record final weight of ashed sample.

12.8.3 Calculate % ash using this formula:

$$\frac{\text{wt. of residue and dish after ignition-wt. of dish}}{\text{wt. of residue and dish before ignition-wt. of dish}} \times 100 = \% \text{ Ash}$$

12.8.4 Calculate % volatile solids using this formula.

100% - % ash results = % Volatile Solids

12.9 It is important to include the following information in the book when doing % solids, % moisture, % volatile solid and % determinations:

12.9.1 Temperature and time in and out of the oven, or furnace.

12.9.2 Date analysis was started and completed.

12.9.3 ID of balance (the same balance must be used for all weighings).

12.9.4 Analysts signature for all entries.

13.0 **QUALITY CONTROL**

13.1 Analyze a minimum of one duplicate with every batch or every 20 samples.

13.2 Check the balance with at least 2 known standard weights each day.

15.0 **METHOD PERFORMANCE**

N/A

16.0 **ANALYSES RATE**

Samples can be weighed out at a rate of one every two minutes. The samples then have to be put in an oven for at least 12 hours, dessicated for one hour and weighed back at an approximate rate of one per minute.

17.0 **SAFETY**

Fully fastened lab coat, safety glasses and latex gloves must be worn.

Balances and ovens must be cleaned after use. Immediately clean up any materials spilled on floor, in hoods, or on bench tops.

All damaged or broken glassware should be discarded immediately.

% SOL/% MST/% ASH DATA

WESTON

Log Book #_____

DATE/INIT.	TEMP TIME IN	TEMP TIME OUT	RFW #	CONTAINER WT	INITIAL WT (Sample & Container)	INITIAL WT SAMPLE	FINAL WT (Sample & Container)	FINAL WT SAMPLE	RESULT

Balance ID:_____
Reviewed by:_____
Date:_____

RFW21-21-016/M-12/89

dvn\SOP\OP2115\0160.6

METALS PROTOCOL

SW 846 3010/3020

WESTON SOP'S OP21-15-3020.1
OP21-15-0200.2
OP21-15-0200.7

0173L

INORGANIC ANALYSIS PROTOCOL
METALS DIGESTION: AQUEOUS SAMPLES BY ICP/AA FLAME

1.0 PURPOSE

1.1 This method describes a technique for the preparation of aqueous samples for the determination of trace elements in solution by ICP or AA Flame.

2.0 SCOPE AND APPLICATION

2.1 This method describes an acceptable sample preparation procedure for "total" element analysis; the procedure is a total recoverable acid solublilization procedure. Note: the ICP/flame AA digest is used for the determination of Sb by GFAA.

3.0 PRESERVATION AND HOLDING TIME

3.1 For the determination of total or total recoverable elements, the sample is acidified with (1+1) HNO_3 to pH 2 or less as soon as possible, preferably at the time of collection.

3.2 The holding time is 180 days.

4.0 INTERFERENCES

4.1 For the determination of trace elements, contamination and loss are of prime concern. Dust in the laboratory environment, impurities in reagents, and impurities on laboratory apparatus are all sources of potential contamination. The collection and treatment of the sample requires particular attention to laboratory glassware, which should be thoroughly washed with detergent and tap water; rinsed with (1+1) nitric acid, tap water, (1+1) hydrochloric acid, tap water, and finally deionized, distilled water in that order. (Refer to OP 21-20-014).

5.0 APPARATUS

5.1 150 mL Griffen beakers, watch glasses, graduated cylinders, hot plate, funnels, filter paper (Whatman 42), thermometer (0-200°C).

6.0 REAGENTS

6.1 Hydrochloric acid conc. (sp gr 1.19).

6.2 Nitric acid conc. (sp gr 1.41).

6.3 Hydrogen peroxide (30%).

6.4 Deionized water, ASTM Type II from Milli-Q system (Q-water).

6.5 2% HNO_3 (V/V), 2 mL conc HNO_3 per 100 mL Q-water.

6.6 Laboratory control stock solutions. Refer to OP 21-15-3000.4.

6.7 Mixed calibration standard solutions. Refer to OP 21-15-3000.4.

7.0 PROCEDURE

7.1 ICP/Flame AA Digestion

7.1.1 Shake sample vigorously to achieve homogeneity.

7.1.2 Using universal litmus paper, check pH. Note if greater than pH 2 in the digestion notebook and complete/distribute a sample discrepancy report.

7.1.3 Pour 100 mL of sample into graduated cylinder then transfer into a 250 mL pyrex beaker.

7.1.4 Add 2 mL 1:1 HNO_3; add 10 mL 1:1 HCl.

7.1.5 Cover with a watch glass and heat until volume is less than 50 mL (Do not boil, do not reduce to less than 25 mL).

7.1.6 Cool sample, filter through Whatman 42 paper into a graduated cylinder, dilute to 100 mL with deionized water. Sample is now ready for analysis. Document sample appearance, and preparation information in digestion notebook.

7.2 **GFAA Digestion**

7.2.1 Shake sample vigorously to achieve homogeneity.

7.2.2 Using universal litmus paper, check pH. Note if greater than pH 2.

7.2.3 Pour 100 mL of sample into graduated cylinder, then transfer into a 250 mL pyrex beaker.

7.2.4 Add 1 mL 1:1 HNO_3; add 2 mL 30% H_2O_2.

7.2.5 Cover with a watch glass and heat until volume is less than 50 mL (do not boil, do not reduce to less than 25 mL).

7.2.6 Cool sample, filter through Whatman 42 paper into a graduated cylinder, dilute to 100 mL with deionized water. Sample is now ready for analysis. Document sample appearance and preparation information in the digestion notebook.

8.0 QUALITY CONTROL

8.1 Method Blank

8.1.1 A minimum of one method blank, consisting of deionized water must be processed through each sample preparation procedure for each batch of samples digested or each group of 20 samples, whichever is more frequent.

8.2 Laboratory Control Sample

8.2.1 Duplicate laboratory control samples must be processed through each sample preparation procedure for each batch of samples digested or each group of 20 samples, whichever is more frequent.

8.3 Matrix Spike Samples are analyzed as requested by the client.

8.4 Duplicate Samples are analyzed as requested by the client.

9.0 METHOD PERFORMANCE

9.1 Laboratory control charts are maintained for laboratory control standards. Accuracy and precision is based on the laboratory control standards.

10.0 REFERENCE

10.1 SOW 788, Revision 2/89.

11.0 SAFETY

Fully fastened labcoat, safety glasses and latex gloves should be worn. All damaged or broken glass should be discarded immediately. All chemical containers should be clean and properly labeled. Immediately cleanup any materials spilled on the floor, in hoods, or on bench tops.

SW 846 METHOD 3050

OP21-15-3050.1

INORGANIC ANALYSIS PROTOCOL
METALS DIGESTION: SOIL SAMPLES

1.0 PURPOSE

1.1 This method describes a technique for the preparation of soils/sediments for the determination of trace elements in solution by ICP or AA.

2.0 SCOPE AND APPLICATION

2.1 This method describes an acceptable sample preparation procedure for "total" element analysis. The procedure is a nitric acid digestion.

2.2 The preparation procedures for GFAA and ICP digests differ slightly in the final steps. HCl is used as the final acid for flame AA and ICP preparations. The ICP digest is also used for the determination of Sb by GFAA.

3.0 PRESERVATION AND HOLDING TIME

3.1 Soil/sediment (non aqueous) samples must be refrigerated at 4°C (±20°) from receipt until analysis.

3.2 Holding times have not been established by the U.S. EPA for soil samples. However, the aqueous sample holding time of 180 days is used as a guideline.

4.0 INTERFERENCES

4.1 For the determination of trace elements, contamination and loss are of prime concern. Dust in the laboratory environment, impurities in reagents, and impurities on laboratory apparatus are all sources of potential contamination. The collection and treatment of the sample requires particular attention to laboratory glassware, which should be thoroughly washed with detergent and tap water; rinsed with (1+1) nitric acid, tap water, (1+1) hydrochloric acid, tap water, and finally deionized, distilled water in that order. (See OP 21-20-014).

5.0 APPARATUS

5.1 150 mL Griffen beakers, watch glasses, graduated cylinders, hot plate, funnels, filter paper (Whatman 42), thermometer (0°-200° C).

6.0 REAGENTS

6.1 Hydrochloric acid conc. (sp gr 1.19).

6.2 Nitric acid conc. (sp gr 1.41).

6.3 Hydrogen peroxide (30%).

6.4 Deionized water, ASTM Type II from Milli-Q System (Q-water).

6.5 2% HNO_3 (v/v), 2 mL conc. HNO_3 per 100 mL Q-water.

6.6 Laboratory control stock solutions. Refer to OP 21-15-3000.2 .

6.7 Mixed calibration standard solutions. Refer to OP 21-15-3000.2.

7.0 PROCEDURE

7.1 Mix sample thoroughly.

7.2 Weigh 1.0 to 1.5 grams of sample into pyrex beaker. Record weight to the nearest 0.01g.

7.3 Add 10 mL 1:1 HNO_3, mix the slurry, cover with a watchglass and heat the sample to 95°C. Reflux for 10 minutes. Do not boil.

7.4 Allow to cool and add 5 mL concentrated HNO_3. Replace the watch glass and reflux for 30 minutes. Do not boil, do not reduce to less than 5 mL.

7.5 Allow to cool. Add 2 mL of Q-water and 3 mL H_2O_2 (30%). Warm until reaction stops.

7.6 Continue to add 1 mL aliquots of H_2O_2 until the effervescence is minimal or until the sample appearance is unchanged. Do Not add more than a total of 10 mL H_2O_2.

7.7 If sample is being prepared for furnace (AA) analysis, reduce sample volume to approximately 2 mL, add 10 mL of Q-water and warm.

7.8 If sample is being prepared for ICP analysis. Add 10 mL of Q-water, and 5 mL 1:1 HCL and heat for an additional 10 minutes.

7.9 Cool samples and filter through Whatman No. 42 filter paper. Rinse digestion beaker with several aliquots of 2% HNO_3. Pour rinsates through filter paper. Dilute sample to 200 mL sample volume with acidified water (2% HNO_3 v/v) to maintain constant acid strength. Sample is now ready for analysis.

7.10 Document all preparation steps as per OP 21-15-3000.3.

8.0 QUALITY CONTROL

8.1 Method Blank

8.1.1 A minimum of one method blank, consisting of deionized water must be processed through each sample preparation procedure for each batch of samples digested or each group of 20 samples, whichever is more frequent.

8.2 Laboratory Control Sample

8.2.1 Duplicate laboratory control samples must be processed through each sample preparation procedure for each batch of samples digested or each group of 20 samples, whichever is more frequent.

8.3 Matrix Spike Samples are analyzed as requested by the client.

8.4 Duplicate Samples are analyzed as requested by the client.

9.0 METHOD PERFORMANCE

9.1 Laboratory control charts are maintained for laboratory control standards. Accuracy and precision is based on the laboratory control standards.

10.0 REFERENCE

10.1 SOW (788), Revision 2/89.

11.0 SAFETY

Fully fastened labcoat, safety glasses and latex gloves must be worn. All chemical containers should be clean and properly labeled. Immediately cleanup any materials spilled on the floor, in hoods or on bench tops.

A face shield must be worn when using auto-pipettors which contain concentrated acids. Both hydrochloric acid and nitric acid are corrosive.

METALS BY ICP

SW 846 METHOD 6010

WESTON SOP OP21-15-0200.7

0173L

INORGANIC ANALYSIS PROTOCOL
METALS BY ICP

1.0 PURPOSE

Determination of elements by Inductively Coupled Plasma Atomic Emission Spectrophotometry in aqueous media.

2.0 REFERENCE

2.1 EPA-600/4-79-020, Methods for Chemical Analysis of Water and Wastes, March 1979, Method 200.7.

2.2 U.S. EPA CLP SOW 788, Method 200.7 CLP-M.

3.0 PRINCIPLE

The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio-frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of th line are monitored by photomultiplier tubes.

4.0 INTERFERENCES

Several types of interference effects may contribute to the inaccuracies in the determination of trace elements.

4.1 Spectral Interferences

Spectral Interferences can be corrected for via computer application of interelement correction factors and/or background correction.

4.2 Physical Interferences

Generally, physical interferences are considered to be effects associated with the sample nebulization and transport processes. These interferences can be reduced by dilution of the sample and/or utilization of standard addition techniques. Samples with high dissolved solids content often exhibit inaccuracies attributable to this type of interference.

4.3 Chemical Interferences

Chemical Interferences are characterized by molecular compound formation and ionization effects. Matrix matching and standard addition procedures can compensate for this interference.

5.0 **METHOD DETECTION LIMIT**

Refer to Table I.

6.0 **OPTIMUM CONCENTRATION RANGE**

Refer to Table I for linear range information.

7.0 **REAGENTS**

7.1 Nitric Acid, conc.

7.2 Nitric Acid, (1+1): Add 500 mL conc. HNO_3 to 400 mL deionized water and dilute to 1 liter. Hydrochloric Acid (1+1): Add 500 ml conc. HCl to 400 mL deionized water and dilute to 1 liter.

7.3 Deionized water, ASTM Type II reagent grade.

8.0 **STANDARDS**

Custom-made standards: Inorganic Ventures (Refer to Table I.)

8.1 **Calibration Standards**

RFWCAL 1, 2, 3, 4A, 4B. Add 1 mL of stock, 1 mL 1+1 HNO_3, 2.5 ml 1+1 HCl to 50 mL deionized water and dilute to 100 mL.

8.2 **Continuing Calibration Verification Standards**

RFWICV 1, 2, 3, 4A, 4B. Add 1 mL of stock, 1 mL 1+1 HNO_3, 25 mL 1+1 HCl to 50 mL deionized water and dilute to 100 mL.

8.3 **CRI (low concentration verification standard)**

Add 2 mL of each calibration standard (RFWCAL), 1 mL 1+1 HNO_3, 2.5 mL HCl to 50 mL of deionized water and dilute to 100 mL.

8.4 **Interferent Check Standard A**

Check-2. Add 10 mL of stock check-2, 1 mL 1+1 HNO_3, 2.5 mL HCl, to 50 mL deionized water and dilute to 100 mL.

8.5 **Interferent Check Standard B**

Check-1,2. Add 10 mL of stock check-2, 1 mL check-1, 1 mL 1+1 HNO_3, 2.5 mL 1+1 HCl to 50 mL deionized water and dilute to 100 mL.

8.6 **Calibration Blank**

Add 15 mL 1+1 HNO_3, 5 mL 1+1 HCl to 100 mL of deionized water and dilute to 200 mL.

9.0 **INSTRUMENT PARAMETERS**

Refer to Table II for wavelengths.

10.0 **PROCEDURE**

Refer to ICP Operation SOP (OP# 21-15-6000.1) for specific procedural information.

11.0 **QUALITY CONTROL**

Table II illustrates the required QC, control criteria and proper corrective actions.

11.1 Calibration must be performed daily with a blank and a high standard. (Multiple level standards are analyzed quarterly. Refer to 11.9.)

11.2 Calibration must be verified with a mid-range check standard (ICV) prepared independently from the calibration standard. The ICV must not vary more than 10% form the true value.

11.3 Calibration verification will be performed with a calibration blank (CCB) and check standard (CCV) after every 10 samples and at the end of the analysis. The CCV must not vary more than 10% from the true value.

11.4 A low level calibration verification standard (CRI) must be analyzed at the beginning and end of the analytical run to document the linearity of response at the detection limit. the standard should be at a level of 2 times the CRDL.

11.5 An interference check standard (ICS) must be analyzed at the beginning and end of the analytical run to document the accuracy of the interelement corrections.

11.6 Dilute samples if they exceed the quarterly determined linear range.

11.7 Preparation quality control samples (ie. method blanks, laboratory control standards, matrix spikes and duplicates) must accompany any sample batches processed through digestion or preparation procedures as described in the Quality Assurance Project Plan.

11.8 Specific, additional QC requirements may be necessary for individual clients. Refer to the appropriate source for this information (eg. SOW 788 for USEPA CLP).

11.9 Refer to OP# 21-15-005.1 for a description of quarterly QC procedures (ie. IDL, IEC and Linear Range determinations and quarterly 5 pt. calibrations).

12.0 CALCULATION

All calculations are performed directly by the instrument data system. The laboratory information system (LIMS) converts al instrument concentrations to the appropriate reporting units.

13.0 METHOD PERFORMANCE

Laboratory control charts will be maintained for blanks and laboratory control standards. Accuracy and precision will be based on the laboratory control standards.

14.0 ANALYSIS RATE

Instrument set-up and calibration can occur in 1 hour. Sample: are subsequently analyzed at a rate of 15-20 samples per hour.

15.0 SAFETY

Safety glasses must be worn when handling standards or samples.

Table I. Calibration Standards and CRI for ICP Metals

ICV/LCS Solution

ELEMENT	STD. ID.	STOCK CONCENTRATION UG/L	FINAL CONCENTRATION (UG/L)
Aluminum	RFW ICV-2	1000	10,000
Antimony	RRW ICV-3	300	3,000
Arsenic	RFW ICV-4A	1000	10,000
Barium	RFW ICV-2	1000	10,000
Beryllium	RFW ICV-1	25	250
Cadmium	RFW ICV-1	25	250
Calcium	RFW CLP-1	2500	25000
Chromium	RFW ICV-1	50	500
Cobalt	RFW ICV-1	250	2500
Copper	RFW ICV-1	125	1250
Iron	RFW ICV-1	500	5000
Lead	RFW ICV-1	250	2500
Magnesium	RFW CLP-1	2500	25000
Manganese	RFW ICV-1	75	750
Nickel	RFW ICV-1	200	2000
Potassium	RFW CLP-1	2500	25000
Selenium	RFW ICV-4A	1000	10000
Silver	RFW ICV-1	50	500
Sodium	RFW CLP-1	25000	25000
Thallium	RFW ICV-4A	1000	10000
Vanadium	RFW ICV-1	250	2500
Zinc	RFW ICV-1	100	1000
Strontium	RFW ICV-4A	500	5000
Molybedium	RFW ICV-4B	500	5000
Silicon	RFW ICV-4B	500	5000
Titanium	RFW ICV-4B	500	5000
Tin	RFW ICV-4B	500	5000
Boron	RFW ICV-4A	500	5000

Table I. Calibration Standards and CRI for ICP Metals (con't)

RFWCAL1

ELEMENT	STOCK CONCENTRATION UG/ML	FINAL CONCENTRATION (UG/L)	CRI (UG/L)
Beryllium	50	500	10
Cadmium	50	500	10
Chromium	100	1000	20
Cobalt	500	5000	100
Copper	250	2500	50
Iron	1000	10,000	NR
Lead	500	5000	100
Manganese	150	1500	30
Nickel	400	4000	80
Silver	100	1000	20
Vanadium	500	5000	100
Zinc	200	2000	40

RFWCAL2

ELEMENT	STOCK CONCENTRATION UG/ML	FINAL CONCENTRATION (UG/L)	CRI (UG/L)
Sodium	5000	50,000	NR
Potssium	5000	50,000	NR
Calcium	5000	50,000	NR
Magnesium	5000	50,000	NR
Aluminum	1000	10,000	NR
Barium	1000	10,000	NR

RFWCAL3

ELEMENT	STOCK CONCENTRATION UG/ML	FINAL CONCENTRATION (UG/L)	CRI (UG/L)
Antimony	600	6000	120

Table I. Calibration Standards and CRI for ICP Metals (con't)

RFWCAL4A,B

ELEMENT	STOCK CONCENTRATION UG/ML	FINAL CONCENTRATION (UG/L)	CRI (UG/L)
A Arsenic	2000	20,000	400
A Selenium	2000	20,000	400
A Thallium	2000	20,000	400
A Strontium	1000	10,000	-
B Molybedium	1000	10,000	-
B Silicon	1000	10,000	-
B Titanium	1000	10,000	-
B Tin	1000	10,000	-
A Boron	1000	10,000	-

Table II. Wave Length Instrument Detection Limits (MDL) Standard Laboratory Reporting Limits (LRL), and Limits Range

ELEMENT	WAVE LENGTH (nm)	APPROXIMATE IDL(ug/L)	REPORTING LIMIT (ug/L)	OPTIMUM CONC. RANGE ug/L
Aluminum	308.215	30	200	200 --> 100,000
Barium	455.403	3	200	200 --> 200,000
Beryllium	313.042	0.1	5	5.0 --> 2,500
Cadmium	226.502	2	5	5.0 --> 2,500
Chromium	267.716	3	10	5.0 --> 2,500
Cobalt	228.626	3	50	10 --> 5,000
Copper	324.754	2	25	25 --> 25,000
Iron	259.940	11	100	100 --> 200,000
Manganese	257.610	0.6	15	15 --> 7,500
Nickel	231.604	5	40	40 --> 20,000
Silver	318.068	5	10	10 --> 10,000
Vanadium	292.402	4	50	50 --> 10,000
Zinc	213.856	1	20	20 --> 10,000
Calcium	317.933	34	5000	500 --> 500,000
Sodium	588.995	18	500	500 --> 500,000
Potassium	766.491	421	5000	500 --> 500,000
Magnesium	279.079	26	5000	500 --> 500,000
Arsenic	193.696	28	120	100 --> 40,000
Selenium	196.026	75	300	100 --> 40,000
Lead	220.353	16	100	100 --> 25,000
Thallium	190.864	41	160	100 --> 20,000
Titanium	334.941	50	100	50 --> 20,000
Strontium	407.771	50	100	50 --> 20,000
Boron	249.773	50	100	50 --> 20,000
Molybdenum	202.030	50	100	50 --> 20,000
Antimony	206.833	35	60	60 --> 40,000
Silicon(SiO_2)	251.612	50	100	50 --> 20,000
Tin	189.900	50	100	50 --> 20,000
Lithium	670.784	50	100	50 --> 40,000
Uranium	367.007	1000	1000	1000 --> 10,000
Scandium	361.384	50	100	50 --> 5,000

Table III. Quality Control Limits and Corrective Actions

QC SAMPLE	IDENTIFICATION	FREQUENCY	CONTROL LIMITS	ACTION TO TAKE IF OUT-OF-CONTROL
MB	Method Blank	5% 1 Per 20 samples digested	< CRDL	Notify Section Management; Redigest
LCS	Laboratory Control Standard	5% 1 Per 20 samples digested	80%-120% Ex: Sb,Ag	Notify Section Management; Redigest
ICV	Initial Calibration Verification Std	Once Immediately after ICV	< CRDL	Recalibrate
ICB	Initial Calibration Blank	Once Immediately After Calibration	90-110%	Recalibrate
CCV	Continuing Calibration Verifiction Std	10% After Every CCV	< CRDL	Recalibrate; Rerun Previous 10 Samples
CCB	Continuing Calibration Blank	10% After Every 10 Samples	90-110%	Recalibrate; Rerun Previous 10 Samples
CRI	Low Concentration Check Standard	Analyze Twice 1-After Calibration 2-At End of Run	None	None
ICS	Interference Check Standard	Analyze Twice 1-After calibration 2- At End of Run	80%-120%	Recalibrate
S. Dil.	Serial Dilution	5% 1 Per 20 Sample Received (Matrix)	90%-110%	None

Table III. Quality Control Limits and Corrective Actions

QC SAMPLE	IDENTIFICATION	FREQUENCY	CONTROL LIMITS	ACTION TO TAKE IF OUT-OF-CONTROL
S	Spike Sample	5% 1 Per 20 samples received	75%-125%	PMS at 2 X CRDL or 2X SR whichever is greater
R	Replicate Sample	5% 1 Per 20 samples received	*	None
PMS	Post Matrix Spike	Analyze when Spike is Out-Of-Control	--	None

*SR>5X CRDL = 20% RPD
SR<5X CRDL = ±CRDL

SR = Sample Result

METALS BY GFAA

SW 846 METHOD 7000 SERIES

WESTON SOP OP21-15-0200.2

0173L

INORGANIC ANALYSIS PROTOCOL

METALS BY GRAPHIC FURNACE ATOMIC ABSORPTION

1.0 PURPOSE

1.1 This method is applicable to the determination of the following metals; As, Ag, Cd, Cr, Pb, Sb, Se, Tl, BE and Cu in solution.

2.0 REFERENCE

2.1 USEPA 600/4-79-020, Methods for the Chemical Analysis of Water and Waste Water, March 1979. Refer to the Table I for EPA method references.

2.2 Beaty, Richard D. 1978. Concepts, Instrumentation, and Techniques in Atomic Absorption Spectroscopy

2.3 EPA CLP SOW 787

3.0 PRINCIPLE

3.1 A representative sample aliquot is evaporated to dryness, charred and atomized utilizing a graphite furnace. During the atomization cycle elements are converted to their ground state. As radiation of a specific wavelength is passed through the vapor containing the ground state atoms, the intensity of light transmission is monitored. Absorption of light occurs at discrete wavelengths characteristic to the element. The amount of light energy absorbed is directly proportional to analyte concentration.

4.0 INTERFERENCES

4.1 Spectral and nonspectral interferences may occur during analyses.

4.2 Most spectral interferences can be eliminated by applying background correction with a deuterium arc lamp or a Zeeman system.

4.3 Nonspectral interferences can be compensated through the use of matrix modifiers, L'vov platforms, and pyrolytically coated tubes.

5.0 METHOD DETECTION LIMIT

5.1 Refer to Table I.

6.0 OPTIMUM CONCENTRATION RANGE

6.1 Refer to Table I.

7.0 **REAGENTS**

7.1 Matrix Modifier (0.5% $NiNO_3$): Dissolve 0.5 g $NiNO_3$ in 900 mL of dionized water, add 1 mL of concentrated reagent grade HNO_3 and dilute to volume with deionized water.

7.2 Dilutions are made using a 2% HNO_3 solution in order to insure matrix matching.

8.0 **STANDARDS**

8.1 Intermediate and working standards are prepared fresh daily.

8.2 Refer to the standards preparation log book located in the metals lab for calibration standards preparation.

8.3 Calibration curve concentrations will vary depending upon the element; refer to Table II.

9.0 **PROCEDURE**

9.1 Calibration - refer to the OP No. 21-15-003.1.

9.2 Instrument operation - refer to the appropriate instrument operating procedure.

10.0 **QUALITY CONTROL**

10.1 Calibration curves must consist of a blank and four standards. One standard must be at the reporting limit. Linear calibration curves must have a minimum correlation coefficient of 0.996, which must be reported with the raw data.

10.2 Immediately following calibration, and initial calibration verification check sample (ICV) and blank (ICB) are analyzed to gauge accuracy. At a frequency of 10% during the analytical run a continuing calibration verification standard (CCV) and a continuing calibration blank (CCB) are analyzed to determine instrument drift. These calibration check standards are obtained from a source independent of the calibration standards.

10.3 A minimum of one method blank (MB) must be analyzed with each digestion batch to determine if contamination has occurred.

10.4 Duplicate laboratory control samples (LCS) must be analyzed with each digestion batch of 20 samples. Refer to Table II for LCS concentrations.

10.5 Dilute samples if they are more concentrated than the highest standard.

10.6 When CLP QC protocols are requested refer to USEPA CLP SOW 788.

10.7 Refer to Table III for all quality control limits and appropriate corrective action prcedures.

11.0 CALCULATION

11.1 Plot a linear regression using calibration standard concentrations vs. absorbance values. Compare sample absorbance values to the curve to determine element concentration.

11.2 Initial sample concentrations are multiplied by any dilution factor and the digestion C/D factor to obtain a final result.

12.0 METHOD PERFORMANCE

12.1 Laboratory control charts will be maintained for laboratory control standards. Accuracy and precision will be based on the laboratory control standards.

13.0 ANALYSIS RATE

13.1 Instrument set up will take approximately one hour. This includes the time needed to run a calibration curve.

13.2 If CLP QC samples are run, the analysis rate is 4 to 5 samples per hour.

13.3 If standard QC samples are run, the analysis rate is 8 to 10 samples per hour.

14.0 SAFETY

When handling standards or samples, safety glasses and latex gloves must be worn.

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ELEMENT	WAVELENGTH (nm)	METHOD DETECTION LIMIT (ug/L)	OPTIMUM CONC. RANGE (ug/L)	EPA METHOD
Arsenic	193.7	1	10 - 50	206.2
Antimony	217.6	3	25 - 100	204.2
Cadmium	228.8	1	2.5 - 50	213.2
Chromium	357.9	1	10 - 50	218.2
Lead	283.3	1	5 - 50	239.2
Selenium	196.0	2	5 - 50	270.2
Silver	328.1	1	2.5 - 10	272.2
Thallium	276.8	1	10 - 50	279.2
Beryllium	234.9	0.2	1 - 30	210.2
Copper	324.8	1	5 - 100	220.2
Barium	455.4	2	10 - 200	208.1
Iron	259.9	1	5 - 100	236.1
Manganese	257.6	0.2	1 - 30	243.1

TABLE I. Wavelengths, detection limits, and concentration ranges.

ELEMENT	CALIBRATION STANDARDS (ug/L)					ICV/CCV (ug/L)	LCS (ug/L)	MATRIX SPIKE (ug/L)	BENCH SPIKE (ug/L)
	AZ	CRA	STD2	STD3	STD4				
Arsenic	0	10	15	25	50	30	30	40	20
Antimony	0	5	25	50	100	50	50	50	10
Cadmium	0	1	2.5	5	10	8	8	5	2
Chromium	0	10	15	25	50	50	30	20	20
Lead	0	5	10	25	50	30	30	20	10
Selenium	0	5	10	25	50	30	30	10	10
Silver	0	1	2.5	5	10	8	8	5	2
Thallium	0	10	15	25	50	30	30	50	20
Beryllium	0	0.2	0.6	1.5	3.0	2.4	2.4	0.6	10
Copper	0	2.5	10	50	100	40	40	25	50

TABLE II.

Calibration Standard Concentrations and Quality Control Standard Concentrations.

QC SAMPLE	IDENTIFICATION	FREQUENCY	CONTROL LIMIT	ACTION TO TAKE IF OUT OF CONTROL
MB	METHOD BLANK	5% 1 PER 20 SAMPLES DIGEST	<CRDL	NOTIFY SECTION MANAGEMENT
LCS	LABORATORY CONTROL STANDARD	5% 1 PER 20 SAMPLES DIGEST	80% -> 120%	NOTIFY SECTION MANAGEMENT
ICV	INITIAL CALIBRATION VERIFICATION STD.	ONCE IMMEDIATELY AFTER CALIBRATION	90% -> 110%	RECALIBRATE
ICB	INITIAL CALIBRATION BLANK	ONCE IMMEDIATELY AFTER ICV	<CRDL	RECALIBRATE
CCV	CONT. CALIBRATION VERIFICATION STD.	10% AFTER EVERY 10 SAMPLES	90% -> 110%	RECALIBRATE
CCB	CONTINUING CALIBRATION BLANK	10% AFTER EVERY CCV	<CRDL	RECALIBRATE
S	SPIKED SAMPLE	5% 1 PER 20 SAMPLES REC'D	75% -> 125%	NONE
R	REPLICATE SAMPLE	5% 1 PER 20 SAMPLES REC'D	*	NONE
BS	BENCH SPIKE	FOR CLP QC SAMPLES, EVERY SAMPLE	REFER TO SOW 787	REFER TO SOW 787

TABLE III. Quality Control Limits and Corrective Actions

* SR> 5 x CRDL = 20% RPD
SR< 5 x CRDL = ± CRDL

EXTRACTION PROCEDURE TOXICITY TEST METHOD

SW 846 METHOD 1310

WESTON SOP OP21-16-1310.3

0173L

INORGANIC ANALYSIS PROTOCOL
EXTRACTION PROCEDURE (EP) TOXICITY TEST METHOD

1.0 **PURPOSE**

1.1 The Extraction Procedure (EP) is designed to simulate the leaching a waste will undergo if disposed of in a landfill.

1.2 This method is employed to determine whether a waste exhibits the characteristic of Extraction Procedure Toxicity.

2.0 **REFERENCE**

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. SW846 2nd Edition, Chapter 7, Part 4, revised April, 1984.

3.0 **PRINCIPLE**

A representative sample is extracted with an aqueous acetic acid solution (pH 5.0 $\pm$ 0.2) to extract soluble materials. This extract is then analyzed to determine toxicity.

4.0 **REAGENTS**

4.1 Acetic Acid (0.5N) 57 mL glacial acetic acid diluted to 2 L deionized water.

5.0 **PROCEDURE**

5.1 By observation determine if the sample contains free liquid. If it does not, proceed to 5.3.

5.2 If the sample contains free liquid, separate the phases by filtering through a 0.45 um membrane filter. For filtration procedure see section 5.5. Save the filtrate and residue and determine the weight of each. For highly organic samples such as oils or solvents use a Teflon .45 um filter for filtration. If the sample will not filter, for example a heavy oil, it should be carried through the EP extraction as a solid (see 5.3).

5.2.1 If the % solids is <0.5% then the residue is discarded and the filtrate is treated as the extract.

5.2.2 If the sample contains >0.5% solids, then the solid residue obtained from the initial sample filtration must be subjected to the extraction procedure. (5.3)

5.3 The solid material obtained from step 5.2 and all materials that do not contain free liquids should be evaluated for particle size. If the surface area of the waste is >3.1 cm^2 or passes through a 9.5 mm standard sieve proceed to 5.3.1. If the surface area is smaller or the particle size larger than specified above, the solid material is prepared for extraction by crushing, cutting or grinding so that the material will pass through a 9.5 mm sieve.

5.3.1 Weigh an appropriate portion of solid sample (usually 100 g) into the container used for the extraction. Glass containers must be used if organics are to be analyzed, plastic can be used when only metals are to be analyzed.

5.3.2 Add deionized water in the amount of 16 times the weight of the sample to the extraction container. Shake well and take the initial pH. Adjust the pH to 5.0 ± 0.2 by the addition of 0.5N acetic acid. Record the amount of acid added. Place the sample container in the extractor and start rotation. Monitor pH (and adjust when necessary) ever 15 minutes, 30 minutes, 1 hour, 2 hours, 4 hours, etc. moving on the next time interval if the pH does not have to be adjusted >0.5 pH units. The adjustment procedure must continue for at least 6 hours. Do not exceed the maximum amount of acid which would make the total amount liquid added exceed that of 20X the weight of solid sample. The leachate must be extracted for 24 hours. At the end of extraction period if the pH is not 5.0 ± 0.2 (and the maximum amount of acid has not been added) adjust the pH for 4 additional hours, checking the pH each hour. Record all pH readings and acid additions.

5.3.3 At the end of the extraction period add deionized water to bring the volume up to 20X the weight of the solid sample. Use the following formula for determining the amount of deionized water necessary:

$$V = (20)(W) - 16\ (W) - A$$

where:

V = mL of deionized water to be added
W = wt in grams of solid sample extracted
A = mL of 0.5N acetic acid added during extraction period

5.4 After the final addition of deionized water mix the sample well then allow the solution to settle. Filter the supernatant through .45 um membrane filter, by using either vacuum or pressure filtration. (See section 5.5 for filtration procedures.) If the sample contained no free liquid initially the filtrate is then analyzed as the leachate. If there was

an initial filtration procedure as in step 4.2 the initial filtrate must be combined proportionally to the final filtered extract.

5.4.1 Use this formula to determine the amount of initial filtrate to be added to the final leachate.

$$A = \frac{R_1 \times V_1 \times V_3}{R_2 \times V_2}$$

where:

A = Volume or weight of initial filtrate to add to filtered leachate.
R_1 = Weight of residue used for extraction procedure
R_2 = Total weight of solid phase obtained from initial filtration.
V_1 = Volume of leachate filtered
V_2 = Final volume of leachate
V_3 = Total volume or weight of initial filtrate obtained from initial filtration.

5.5 Filtration

5.5.1 Vacuum filtration is used for easily filterable samples. For initial filtrations or difficult to filter samples a pressure filter is the most efficient means.

Note: The pressure filter apparatus can be hazardous if not used properly. Do not attempt to use without receiving personal instruction.

5.5.2 Assembly of the pressure filtration device.

5.5.2.1 Wash the pressure filter with soap and water (use a sponge or soft cloth only). Rinse with deionized water, acetone and then hexane if organics are to be analyzed for. Assemble using the appropriate filters as described in the method making sure the body of the device is seated on the filters in the grooved portion of the support. Secure top firmly and pour in sample. Clamp pressure hose tightly. After checking that inlet valve is off, turn tank on. Introduce pressure into the vessel slowly by turning the inlet valve on. Gradually increase pressure to a maximum of 80 psi. Do not exceed this pressure. After the sample is finished filtering turn inlet valve off and bleed trapped pressure out of the vessel by venting the relief valve located on top of assembly. After the pressure is released the pressure hose can be disconnected and the device can be disassembled.

6.0 QUALITY CONTROL

6.1 Prepare a leachate blank (i.e. 100 mL .5N Acetic Acid diluted to 2000 mL deionized water) with each batch of samples, or with each new batch of Acetic Acid. Extract and check pH along with samples. The blank will then be analyzed along with the samples to monitor possible contamination introduced through the leaching procedure.

6.2 Prepare enough leachate to ensure that there will be sufficient volume for the necessary quality control procedures used in analyzing the leachate.

7.0 ANALYSIS RATE

7.1 Analysis rate may vary significantly with sample matrix and quantity needed for the appropriate analysis. Usually one analyst can set up 10-15 samples per day, extract them for the required 24 hours and filter them after the extraction period the the following day. The time could be significantly increased if an initial filtration is required and the final filtrate does not settle readily. In such a case two extra days would be required to complete the entire procedure, one day for the initial filtration and one day to allow the samples to settle before and pressure filtration.

8.0 SAFETY

Fully fastened labcoat, safety glasses and latex gloves must be worn.

In the case of a known hazardous waste (ie. radiation, CN^- and Arsenic) all pH adjustments must be done carefully in a ventilation hood.

Immediately clean up any materials spilled on the floor, in hoods or on bench tops. All chemical containers should be clean and properly labeled. All damaged or broken glassware should be discarded immediately.

Use caution when operating the pressure filtration device. Do not attempt to operate without receiving proper instruction.

TOTAL SUSPENDED SOLIDS

EPA METHOD 209C

WESTON SOP OP21-15-0160.2

0173L

INORGANIC ANALYSIS PROTOCOL
Total Suspended Solids

1.0 PURPOSE

Determination of Total Suspended Solids

2.0 REFERENCE

EPA 600/4-79-020, Methods for Chemical Analysis of Water and Wastes, March 1979, Method 160.2.

3.0 PRINCIPLE

Total Suspended Solids is defined as the portion of total residue retained by a filter (filterable residue).

4.0 PROCEDURE SUMMARY

4.1 A well mixed sample is measured in the appropriate size graduated cylinder, then filtered through a pre-weighed crucible with glass fiber filter. Rinse the graduated cylinder thoroughly, pouring the ocntents into the crucible. The residue retained on the filter is dried to constant weight at 103-105°C.

5.0 INTERFERENCES

NA

6.0 OPTIMUM CONCENTRATION RANGE

4 mg/L - 20,000 mg/L

7.0 DETECTION LIMIT

5.0 mg/L

8.0 CALIBRATION STANDARDS/SENSITIVITY

NA

9.0 INSTRUMENT PARAMETERS

Drying oven 103 - 105°C
Analytical Balance (0.1 g)

10.0 QUALITY CONTROL

Calibration blanks and calibration verification (check standards) are analyzed at a 10% frequency. A blank, LCS (Lab Control Sample), duplicate and spike shall be analyzed with every 20 samples. The control limits for analysis of the LCS will be ±20% of the true value.

11.0 CALCULATION

$$\text{Total Suspended Solids mg/L} = \frac{(A-B) \times 1000}{C}$$

where:

A = wt of filter crucible + residue
B = wt of filter (crucible)
C = mL of sample filtered

12.0 SAFETY

Fully fastened labcoat and safety glasses must be worn. All damaged or broken glassware should be discarded immediately.

WESTON

DATE: _____

SOLIDS ANALYSIS LOG

LABORATORY NOTEBOOK #: _____

ROY F. WESTON NUMBER:									
SAMPLE DESCRIPTION									
GOOCH NUMBER									
S.V. mL									
TEMPERATURE _____ FINAL wt. g.									
TEMPERATURE _____ TARE wt. g.									
RESIDUE									
SS ppm									
FIRED									
VOLATILE									
VSS ppm									

BALANCE ID#: 4500210
BALANCE CALIBRATION
VERIFICATION: (100g - _____ g)

REVIEWED BY (INITIAL/DATE): _____

WFW 21 21 016/G 1/90

pH ELECTROMETRIC MEASUREMENT

EPA METHOD 423

WESTON SOP OP21-15-0150.1

0173L

INORGANIC ANALYSIS PROTOCOL
pH ELECTROMETRIC MEASURMENT (Aqueous Matrix)

1.0 **PURPOSE**

To measure the pH of aqueous wastes and those multiphase wastes where the aqueous phase constitutes at least 20% of the total volume of the waste. When measuring the pH of a solid waste consult OP# 21-15-9045.1.

2.0 **REFERENCE**

U.S. EPA SW-846, Test Methods for Evaluating Solid Waste, 3rd Edition, Volume IC, November 1986, Method 9040.

3.0 **PRINCIPLE**

The pH of the aqueous sample is determined electrometrically using a pH meter that has been calibrated or sloped using buffer solutions of known pH.

4.0 **INTERFERENCES**

Solvents and oils may impair the electrode response. If an electrode becomes coated with an organic material that will not risen free, follow the manufactures instructions for cleaning the electrode.

5.0 **METHOD DETECTION LIMIT**

0.01 pH Units

6.0 **OPTIMUM CONCENTRATION RANGE**

Normal range pH 0-14. However, some pH meters are able to read beyond this range.

7.0 **REAGENTS**

None

8.0 **STANDARDS**

pH buffers 4.00, 7.00 and 10.00

9.0 **INSTRUMENT PARAMETERS**

9.1 Beckman -- model 50 pH/ISE Meter

9.2 Beckman -- model 10 pH Meter

10.0 **PRESERVATION**
None

11.0 **HOLDING TIME**

24 Hours

12.0 **PROCEDURE**

12.1 Calibrate the pH meter by sloping on two buffers. Check calibration by reading three buffers of know pH.

12.1.1 Calibration of pH meter

12.1.1.1 Turn the meter on (0) and press the clear button (c).

12.1.1.2 Pour the first buffer into a small (25-50 mL) beaker and stir using a magnetic stir plate.

12.1.1.3 Carefully lower the pH and ATC probes into the buffer, push the pH button and then the standard button. Wait for the meter to stabilize. When meter is stabilized the (STD) Auto indicator will come on. Record all calibration data in the pH calibration log located by the meter.

12.1.1.4 Pour the second pH buffer into another beaker and stir as before.

12.1.1.5 Lower the probes and press the standard (STD) button only. Wait for AUTO indicator to come on and record result.

12.1.1.6 Pour a third buffer in a beaker and stir. Lower the probes as before and press the pH button. This is a buffer check. After the meter has stabilized and the AUTO indicator comes on record this result in the meter log also.

12.1.2 Calibrate the pH meter using two buffers that bracket the expected pH of the samples and are approximately three pH units or more apart. (i.e. calibrate on buffers 4 and 7 when measured pH values are $\leq$ 7. Calibrate using 7 and 10 buffers when measured pH values are $\geq$ 7.

12.1.3 Repeat calibration procedures until readings are within 0.05 pH units of the buffer solution's true value.

12.1.4 Record calibration and sloping data in the pH calibration log located by the pH meter. Record buffer checks in the pH data book.

12.2 Place the sample or buffer solution in a 50 mL clean glass beaker. Stir samples and buffers with a magnetic stirring bar to insure suspension of solids.

12.2.1 Lower the probes into the sample in such a way that the sensing elements of the electrodes are just covered. Use care not to let the probes make contact with the stirring bar.

12.2.2 The temperature of the samples should be close to the temperature of the buffers that the instrument was standardized on (within $2^{0}C$). Employ an automatic temperature compensator (ATC) probe along with a combination electrode so that the measure of pH values are corrected for temperature deviations.

12.3 Note and record the sample pH. Repeat measurement on each sample, until values differ by <0.1 pH units using a fresh volume of sample for each measurement. Two to three measurements are usually sufficient.

12.4 pH analysis must be completed within 24 hours of the sampling time. To ensure that this requirement has been met, record the time of the pH measurement in the data book.

13.0 **QUALITY CONTROL**

13.1 Slope the pH meter each day with any two of the 4.00, 7.00 and 10.00 buffers.

13.2 Run buffer checks on pH 4.00, 7.00 and 10.00 buffers.

13.3 Analyze a minimum of one duplicate sample each batch or every 20 samples. Run a buffer check every 10 samples to insure the integrity of the original calibration. The buffer check should be one of the buffers that the meter was calibrated with and should not differ by more than 0.05 pH units. If it does the pH meter should be recalibrated and the sample proceeding the buffer check should be repeated.

14.0 **CALCULATION**

N/A

15.0 **METHOD PERFORMANCE**

15.1 Forty-four analysts in twenty laboratories analyzed six synthetic water samples containing exact increments of hydrogen-hydroxyl ions, with the following results:

		Accuracy as	
pH Units	Standard Deviation pH Units	Bias %	Bias pH Units
3.5	0.10	-0.29	-0.01
3.5	0.11	-0.00	
7.1	0.20	+1.01	+0.07
7.2	0.18	-0.03	-0.002
8.0	0.13	-0.12	-0.01
8.0	0.12	+0.16	+0.01

16.0 **ANALYSIS RATE**

Calibration of the instrument requires 10 minutes to complete. One sample can be analyzed every 5 minutes.

17.0 **SAFETY**

Fully fastened lab coat, safety glasses and latex gloves must be worn.

Immediately clean up any materials spilled on the floor, in hoods or bench tops.

All damaged or broken glassware should be discarded immediately.

ROY F. WESTON Test_____
pH DATA
(Soil pH, Aqueous pH, Corrosivity by pH)

Batch #_____

Worksheet #_____

RFW #/Standard	pH		SOLID PREP/ COMMENT
	< 7.00	> 7.00	

Date:_____

Analyst:_____

Time:_____

sjd\sop\op2115\0150.1

CHLORIDE BY ION CHROMATOGRAPHY

EPA METHOD 300.0

WESTON SOP OP21-15-0333.0

0173L

INORGANIC ANALYSIS PROTOCOL
INORGANIC ANIONS IN WATER BY ION CHROMATOGRAPHY

1.0 PURPOSE

The determination of fluoride, chloride, bromide, nitrate-N, phosphate-P, sulfate in water by ion chromatography.

2.0 REFERENCE

EPA-600/4-79-020, Methods for Chemical Analysis of Water and Wastes, March 1979, Method 300.0.

Standard Methods for the Examination of Water and Wastes, 16th Edition, Method 429.

3.0 PRINCIPLE

A water sample is injected into a stream of carbonate-bicarbonate eluant and passed through a series of ion exchangers. The anions of interest are separated on the basis of their relative affinities for a low capacity, strongly basic anion exchanger (guard and separator column). The separated anions are directed onto a strongly acidic cation exchanger (suppressor column) where they are converted to their highly conductive acid form and the carbonate-bicarbonate eluant is converted to their highly conductive carbonic acid. The separated anions in their acid form are measured by conductivity. They are identified on the basis of retention time as compared to standards. Quantitation is by measurement of peak area or peak height.

4.0 INTERFERENCES

Any substance that has a retention time coinciding with or overlapping those of the anion of interest will interfere. A High concentration of any one anion may interfere with the resolution of the next eluting anion. Sample dilution and/or spiking can be used to solve most interference problems.

5.0 METHOD DETECTION LIMIT

0.5 mg/L for all anions

6.0 OPTIMUM CONCENTRATION RANGE

0.50 mg/L to 25.0 mg/L, range can be extended through dilution.

7.0 **REAGENTS**

7.1 Stock eluant solution - 0.3 M $NaHCO_3$/0.24 M Na_2CO_3.
In a 1 L volumetric flask containing approximately 750 mL of deionized water, dissolve 2.52 g of $NaHCO_3$ and 2.98 g of $Na_2CO_3 \cdot H_2O$. Dilute this solution to the mark and filter solution into a clean 1 L plastic bottle for storage.

7.2 Working eluant solution - 3 mM $NaHCO_3$/2.4mM Na_2CO_3.
Dilute 20 mL of stock eluant solution to 2000 mL in a 2 L volumetric flask. Prepare several of these, dispensing each into a 15L carboy. A sufficient quantity of a uniform eluant solution is required to complete the analysis.

7.3 Regenerant Solution - 25mN H_2SO_4.
Dilute 1.4 mL of stock (36N) concentrated Sulfuric Acid to 2000 mL in a 2L volumetric flask. Prepare several of these, dispensing each into a 15L carboy. A sufficient quantity of a uniform regenereant solution is required to complete the analysis.

8.0 **STANDARDS**

8.1 Calibration Standards

8.1.1 Stock Standard (1000 mg/L with respect to each Anion).

8.1.1.1 Obtain sufficient quantities (approximately 10 g) of the ACS reagent grade chemicals listed in section 8.1.1.2 and dry at 105°C for 30 minutes. Allow chemicals to cool and store them in a desiccator until ready for use, for no longer than 1 year.

8.1.1.2 In a 1 L volumetric flask containing approximately 800 mL of filtered deionized water add the following quantities of previously dried reagent grade chemicals accurately weighted to 0.0001 g:

Reagent	Mass (g)
Sodium Fluoride - NaF	2.2101
Potassium Chloride - KCl	2.1028
Potassium Phosphate - KH_2PO_4	1.4329
Potassium Bromide - KBr	1.4893
Sodium Nitrate - $NaNO_3$	1.3708
Potassium Sulfate - K_2SO_4	1.8141

When all chemicals are dissolved, dilute to the mark with filtered deionized water. Store this solution at 4°C. The limiting reagent in the stability of this stock standard solution is the phosphate ion. Therefore, the stability of stock solution will be monitored by using a batch of phosphate stock solution (not more than one month old) in the preparation of the calibration verification standard (See section 8.2.1.2).

8.1.2 Working Calibration Standards

To a series of 100 mL volumetric flasks add the indicated aliquots of the stock calibration standard. Dilute to the mark with deionized water.

Volume of Stock Standard mL	Concentration (mg/L)
0.000	0.00
0.050	0.50
0.100	1.00
0.500	5.00
1.000	10.00
1.500	15.00
2.500	25.00

8.2 Calibration Verification Standards

8.2.1 Calibration Verification Stock Solution

8.2.1.1 Prepare another stock standard from alternate salt sources as described in section 8.1.1.2.

8.2.1.2 Phosphate stock standard solution (1000 mg/L.)
In a 1 L volumetric flask containing approximately 900 mL of deionized water, dissolve 4.3937 g of KH_2PO_4. Dilute to the mark with deionized water. The stability of this solution, when stored at 4°C, is one month.

8.2.2 Calibration Verification Standard (CV) - (10 mg/L for all anions) to a 100 mL volumetric flask containing approximately 80 mL of deionized water add 1.0 mL of calibration verification stock solution and 1.0 mL of phosphate stock standard solution. Dilute to mark with deionized water.

9.0 **INSTRUMENT PARAMETERS**

9.1 Columns

9.1.1 AG4 or AG4A Guard column

9.1.2 AS4 or AS4A Separator Column

9.2 Eluant - 3mM $NaHCO_3$/2,4mMNa,CO_3

9.2.1 Flow Rate - 2.0 mL/min

9.3 Regenerant - 25 mN H_2SO_4

9.4 Detector - Conductivity Detector @ 10 uS full scale.

9.5 Sample Loop - 100 uL

9.6 Expected Instrument Conditions:

9.6.1 Pressure Reading - Approxmately 700psi

9.6.2 Suppressed Background Conductivity (SBC) - approxmately 25 uS.

9.6.3 Approximate Retention times at above instrument settings are:

Anion	Retention Time (min)
Fluoride	1.12
Chloride	1.65
Phosphate-P	2.32
Bromide	3.14
Nitrate-N	3.60
Sulfate	4.54

10.0 **PRESERVATION**

Anion	Preservation
Fluoride	None Required
Chloride	None Required
Phosphate-P	Cool to 4°C
Bromide	None Required
Nitrate-N	Cool to 4°C
Sulfate	Cool to 4°C

11.0 **HOLDING TIME**

Anion	Holding Time
Fluoride	28 Days
Chloride	28 Days
Phosphate-P	48 Hours
Bromide	28 Days
Nitrate-N	48 Hours
Sulfate	28 Days

12.0 **PROCEDURE**

12.1 Sample Preparation

12.1.1 Filter all samples using Whatman # 42 filter paper.

12.1.2 Prepare 1:10 dilutions on all samples.

12.2 Instrument Operation

12.2.1 Obtain stable chromatographic systems.

12.2.1.1 Ensure eluant and regenerant reservoirs are full.

12.2.1.2 Turn on pump and begin regenerant flow.

12.2.1.3 Obtain a stable suppressed background conductivity. It should normally be in the range of 25 uS. If it goes higher than around 30 to 35, then a problem may exists within the system. Check eluant and regenerant concentrations, as well as column bed supports.

12.2.2 Input schedule of the days run.

12.2.2.1 A typical schedule of the anaylsis run would look similar to the following:

Cycle #	Sample #
1	Blank
2	Autocal 1R
3	Autocal 2R
4	Autocal 3R
5	Autocal 4R
6	Autocal 5R
7	Blank
8	Mid Scale ICV
9	Mid Scale ICV
10	Sample X
11	Sample X, 1:10
12	etc.

12.2.2.2 Save the schedule using the following nomenclature.

SCH-----

Where ------ is the days date. For example, a schedule produced on 3/6 would be saved as SCH0306.

12.2.3 Prepare method file for operation.

12.2.3.1 Run test chromatogram to determine exact retention times under current operating parameters.

12.2.3.1.1 From execute menu (Key label 0) LOAD CIM (Label 2).

Default through each line providing the correct response by pushing the enter button. Normal responses include:

Use System : 1
Use Schedule : No (This time only)
Sample Name : Standard Concentration
Method File Name: This method containing the instrument control parameters. (SEE DIONEX user manuals.)
Data File Name: Use a general file in which to store the condition check standard analysis.
Default through remaining lines.

12.2.3.1.2 When CIM is successfully loaded start run (Key Label 7).

12.2.3.2 When test chromatogram is complete, return to main menu. Load method file.

12.2.3.3 From method menu, go into calibration parameters. Update all retention times.

12.2.3.4 From method menu go into report parameter. Update data file name with date corresponding to schedule file name. For example if the schedule name is SCH0306 then the data file will be DAT0306.

12.2.3.5 Save current method file. (Key Label 8). Return to main menu.

12.2.4 Load sample tray according to schedule.

12.2.5 Load execute menu (Key Label 0) and LOAD CIM (Key Label 2). Answer questions again except this time use schedule (give name). Start Run (Key Label 7).

13.0 QUALITY CONTROL

Calibration curves must be compose of a minimum of a blank and 5 standards. Linear calibration curves must have a minimum correlation coefficient of 0.996, which must be reported with the raw data.

Calibration curve must be verified with a mid-range check standard prepared independently from the calibration curve standards. The check standard must not vary more than ten (10%) percent from the true value.

Calibration verification will be performed with a calibration blank and check standard after every ten samples and at the end of the analysis. The check standard must not vary more than ten (10%) percent from the true value.

Dilute samples if they are more concentrated than the highest standard or if they fall on the plateau of a calibration curve.

A minimum of one preparation blank must be analyzed per sample batch to determine if contamination has occurred. For this parameter, the calibration check blank and preparation blank are equivalent.

~~A minimum~~ of one preparation blank must be analyzed per sample batch to determine if contamination has occurred. For this parameter, the calibration check blank and preparation blank are equivalent.

Duplicate laboratory control samples (LCS) will be included with each sample batch of 20 samples. The analyzed result must not vary more than 10% from the true value. For this parameter, the LCS and the calibration check standard are equivalent.

Matrix spike and duplicate samples must be analyzed as requested by the client.

14.0 CALCULATION

Perform a linear regression analysis of the calibration standard results for each of the anions. Compare the sample results to each curve to determine the anion concentration.

15.0 METHOD PERFORMANCE

Laboratory control charts will be maintained for blanks and laboratory control standards. Accuracy and precision will be based on the laboratory control standards.

16.0 **ANALYSIS RATE**

One analyst can set up a calibration curve in 15 minutes, sample and standard analysis is conducted at an approximate rate of one sample per 12 minutes.

17.0 **SAFETY**

Fully fastened lab coat and safety glasses must be worn.

All chemical containers should be clean and properly labeled.

All damaged or broken glassware should be discarded immediately.

Immediately clean up any materials spilled on the floor, in hoods or on bench tops.

MS313.RPT/sjd

APPENDIX F

SAMPLING AND ANALYTICAL METHODS FOR STACK GASES

- VOST
- SW 846 Method 5040
- Draft EMSL/Total Metals
- EPA Method 10
- EPA Method 3A
- EPA Method 3
- EPA Method 5
- EPA Method 1A

VOLATILE ORGANIC SAMPLING TRAIN (VOST)

Sampling Method For:

- Volatile Organics

0173L

METHOD 0030

VOLATILE ORGANIC SAMPLING TRAIN

1.0 PRINCIPLE AND APPLICATION

1.1 Principle

1.1.1 This method describes the collection of volatile principal organic hazardous constituents (POHCs) from the stack gas effluents of hazardous waste incinerators. For the purpose of definition, volatile POHCs are those POHCs with boiling points less than 100°C. If the boiling point of a POHC of interest is less than 30°C, the POHC may break through the sorbent under the conditions of the sample collection procedure.

1.1.2 Field application for POHCs of this type should be supported by laboratory data which demonstrate the efficiency of a volatile organic sampling train (VOST) to collect POHCs with boiling points less than 30°C. This may require using reduced sample volumes collected at flow rates between 250 and 500 mL/min. Many compounds which boil above 100°C (e.g., chlorobenzene) may also be efficiently collected and analyzed using this method. VOST collection efficiency for these compounds should be demonstrated, where necessary, by laboratory data of the type described above.

1.1.3 This method employs a 20-liter sample of effluent containing volatile POHCs which is withdrawn from a gaseous effluent source at a flow rate of 1 L/min, using a glass-lined probe and a volatile organic sampling train (VOST). (Operation of the VOST under these conditions has been called FAST-VOST.) The gas stream is cooled to 20°C by passage through a water-cooled condenser and volatile POHCs are collected on a pair of sorbent resin traps. Liquid condensate is collected in an impinger placed between the two resin traps. The first resin trap (front trap) contains approximately 1.6 g Tenax and the second trap (back trap) contains approximately 1 g each of Tenax and petroleum-based charcoal (SKC Lot 104 or equivalent), 3:1 by volume. A total of six pairs of sorbent traps may be used to collect volatile POHCs from the effluent gas stream.

1.1.4 An alternative set of conditions for sample collection has been used. This method involves collecting sample volume of 20 liters or less at reduced flow rate. (Operation of the VOST under these conditions has been referred to as SLO-VOST.) This method has been used to collect 5 liters of sample (0.25 L/min for 20 min) or 20 liters of sample (0.5 L/min for 40 min) on each pair of sorbent cartridges. Smaller sample volumes collected at lower flow rates should be considered when the boiling points of the POHCs of interest are below 35°C. A total of six pairs of sorbent traps may be used to collect volatile POHCs from the effluent gas stream.

1.1.5 Analysis of the traps is carried out by thermal desorption purge-and-trap by gas chromatography/mass spectrometry (see Method 5040). The VOST is designed to be operated at 1 L/min with traps being replaced every 20 min for a total sampling time of 2 hr. Traps may be analyzed separately or combined onto one trap to improve detection limit. However, additional flow rates and sampling times are acceptable. Recent experience has shown that when less than maximum detection ability is required, it is acceptable and probably preferable to operate the VOST at 0.5 L/min for a total of three 40-min periods. This preserves the 2-hr sampling period, but reduces the number of cartridge changes in the field as well as the number of analyses required.

1.2 Application

1.2.1 This method is applicable to the determination of volatile POHCs in the stack gas effluent of hazardous waste incinerators. This method is designed for use in calculating destruction and removal efficiency (DRE) for the volatile POHCs and to enable a determination that DRE values for removal of the volatile POHCs are equal to or greater than 99.99%.

1.2.2 The sensitivity of this method is dependent upon the level of interferences in the sample and the presence of detectable levels of volatile POHCs in blanks. The target detection limit of this method is 0.1 ug/m^3 (ng/L) of flue gas, to permit calculation of a DRE equal to or greater than 99.99% for volatile POHCs which may be present in the waste stream at 100 ppm. The upper end of the range of applicability of this method is limited by breakthrough of the volatile POHCs on the sorbent traps used to collect the sample. Laboratory development data have demonstrated a range of 0.1 to 100 ug/m^3 (ng/L) for selected volatile POHCs collected on a pair of sorbent traps using a total sample volume of 20 liters or less (see Paragraph 1.1.4).

1.2.3 This method is recommended for use only by experienced sampling personnel and analytical chemists or under close supervision by such qualified persons.

1.2.4 Interferences arise primarily from background contamination of sorbent traps prior to or after use in sample collection. Many potential interferences can be due to exposure of the sorbent materials to solvent vapors prior to assembly and exposure to significant concentrations of volatile POHCs in the ambient air at hazardous waste incinerator sites.

1.2.5 To avoid or minimize the low-level contamination of train components with volatile POHCs, care should be taken to avoid contact of all interior surface or train components with synthetic organic materials (e.g., organic solvents, lubricating and sealing greases), and train components should be carefully cleaned and conditioned according to the procedures described in this protocol.

2.0 APPARATUS

2.1 Volatile Organic Sampling Train: A schematic diagram of the principal components of the VOST is shown in Figure 1 and a diagram of one acceptable version of the VOST is shown in Figure 2. The VOST consists of a glass-lined probe followed by an isolation valve, a water-cooled glass condenser, a sorbent cartridge containing Tenax (1.6 g), an empty impinger for condensate removal, a second water-cooled glass condenser, a second sorbent cartridge containing Tenax and petroleum-based charcoal (3:1 by volume; approximately 1 g of each), a silica gel drying tube, a calibrated rotameter, a sampling pump, and a dry gas meter. The gas pressure during sampling and for leak-checking is monitored by pressure gauges which are in line and downstream of the silica gel drying tube. The components of the sampling train are described below.

2.1.1 Probe: The probe should be made of stainless steel with a borosilicate or quartz glass liner. The temperature of the probe is to be maintained above 130°C but low enough to ensure a resin temperature of 20°C. A water-cooled probe may be required at elevated stack temperatures to protect the probe and meet the above requirements. Isokinetic sample collection is not a requirement for the use of VOST since the compounds of interest are in the vapor phase at the point of sample collection.

2.1.2 Isolation valve: The isolation valve should be a greaseless stopcock with a glass bore and sliding Teflon plug with Teflon wipers (Ace 8193 or equivalent).

2.1.3 Condensers: The condensers (Ace 5979-14 or equivalent) should be of sufficient capacity to cool the gas stream to 20°C or less prior to passage through the first sorbent cartridge. The top connection of the condenser should be able to form a leak-free, vacuum-tight seal without using sealing greases.

2.1.4 Sorbent cartridges:

2.1.4.1 The sorbent cartridges used for the VOST may be used in either of two configurations: the inside-outside (I/O) configuration in which the cartridge is held within an outer glass tube and in a metal carrier, and the inside-inside (I/I) configuration in which only a single glass tube is used, with or without a metal carrier. In either case, the sorbent packing will be the same.

2.1.4.1.1 The first of a pair of sorbent cartridges shall be packed with approximately 1.6 g Tenax GC resin and the second cartridge of a pair shall be packed with Tenax GC and petroleum-based charcoal (3:1 by volume; approximately 1 g of each).

2.1.4.1.2 The second sorbent cartridge shall be packed so that the sample gas stream passes through the Tenax layer first and then through the charcoal layer.

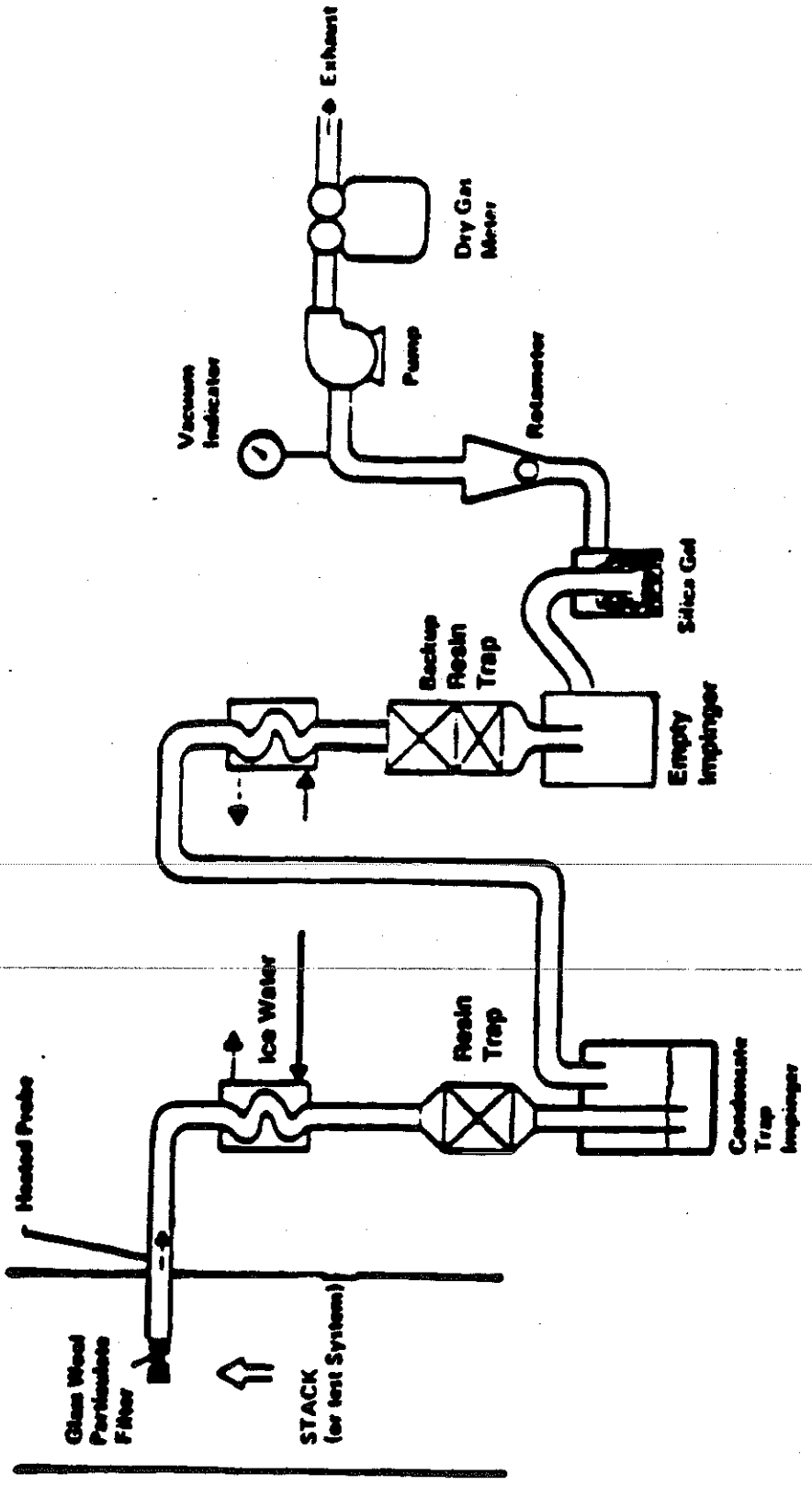


Figure 1. Schematic of Volatile Organic Sampling Train (VOST).

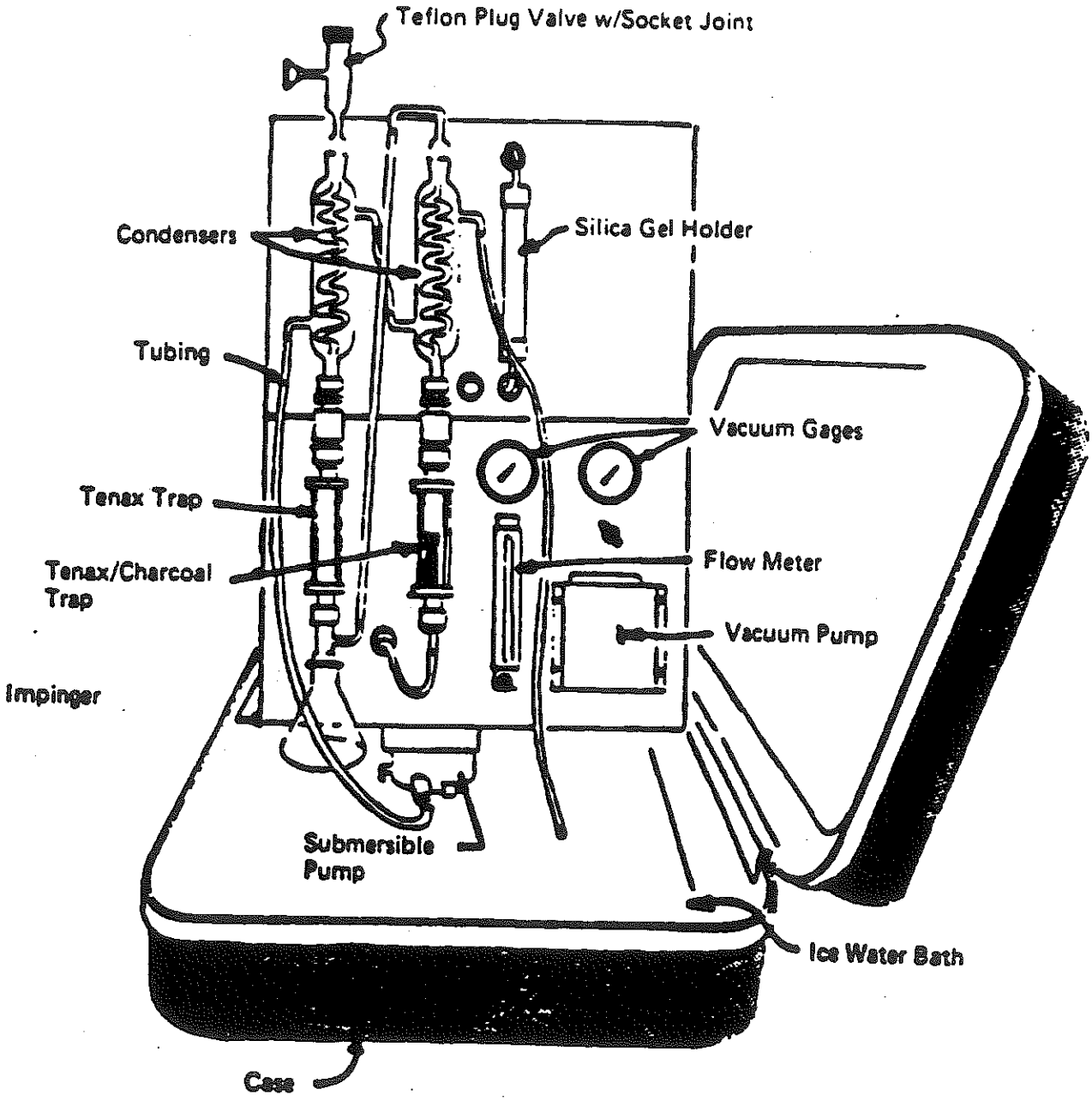


Figure 2. Volatile Organic Sampling Train (VOST).

2.1.4.2 The sorbent cartridges shall be glass tubes with approximate dimensions of 10 cm by 1.6 cm I.D. The two acceptable designs (I/O, I/I) for the sorbent cartridge are described in further detail below.

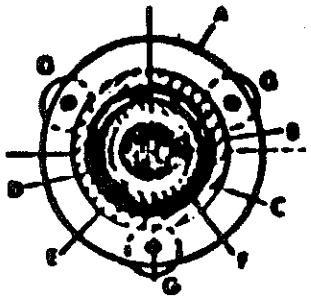
2.1.4.2.1 Inside/Inside sorbent cartridge: A diagram of an I/I sorbent cartridge is shown in Figure 3. This cartridge is a single glass tube (10 cm by 1.6 cm I.D.) which has the ends reduced in size to accommodate a 1/4- or 3/8-in. Swagelok or Cajon gas fitting. The resin is held in place by glass wool at each end of the resin layer. The amounts of each type of sorbent material used in the I/I design are the same as for the I/O design. Threaded end caps are placed on the sorbent cartridge after packing with sorbent to protect the sorbent from contamination during storage and transport.

2.1.4.2.2 Inside/Outside type sorbent cartridge: A diagram of an I/O sorbent cartridge is shown in Figure 4. In this design the sorbent materials are held in the glass tube with a fine mesh stainless steel screen and a C-clip. The glass tube is then placed within a larger diameter glass tube and held in place using Viton O-rings. The purpose of the outer glass tube is to protect the exterior of the resin-containing tube from contamination. The two glass tubes are held in a stainless steel cartridge holder, where the ends of the glass tubes are held in place by Viton O-rings placed in machine grooves in each metal end piece. The three cylindrical rods are secured in one of the metal end pieces and fastened to the other end piece using knurled nuts, thus sealing the glass tubes into the cartridge holder. The end pieces are fitted with a threaded nut onto which a threaded end cap is fitted with a Viton O-ring seal, to protect the resin from contamination during transport and storage.

2.1.5 Metering system: The metering system for VOST shall consist of vacuum gauges, a leak-free pump (Thomas Model 107 or equivalent, Thomas Industries, Sheboygan, Wisconsin), a calibrated rotameter (Linde Model 150, Linde Division of Union Carbide, Keasbey, New Jersey) for monitoring the gas flow rate, a dry gas meter with 2% accuracy at the required sampling rate, and related valves and equipment. Provisions should be made for monitoring the temperature of the sample gas stream between the first condenser and first sorbent cartridge. This can be done by placing a thermocouple on the exterior glass surface of the outlet from the first condenser. The temperature at that point should be less than 20°C. If it is not, an alternative condenser providing the required cooling capacity must be used.

2.1.6 Sample transfer lines: All sample transfer lines to connect the probe to the VOST shall be less than 5 ft in length, and shall be heat-traced Teflon with connecting fittings which are capable of forming leak-free, vacuum-tight connections without the use of sealing grease.

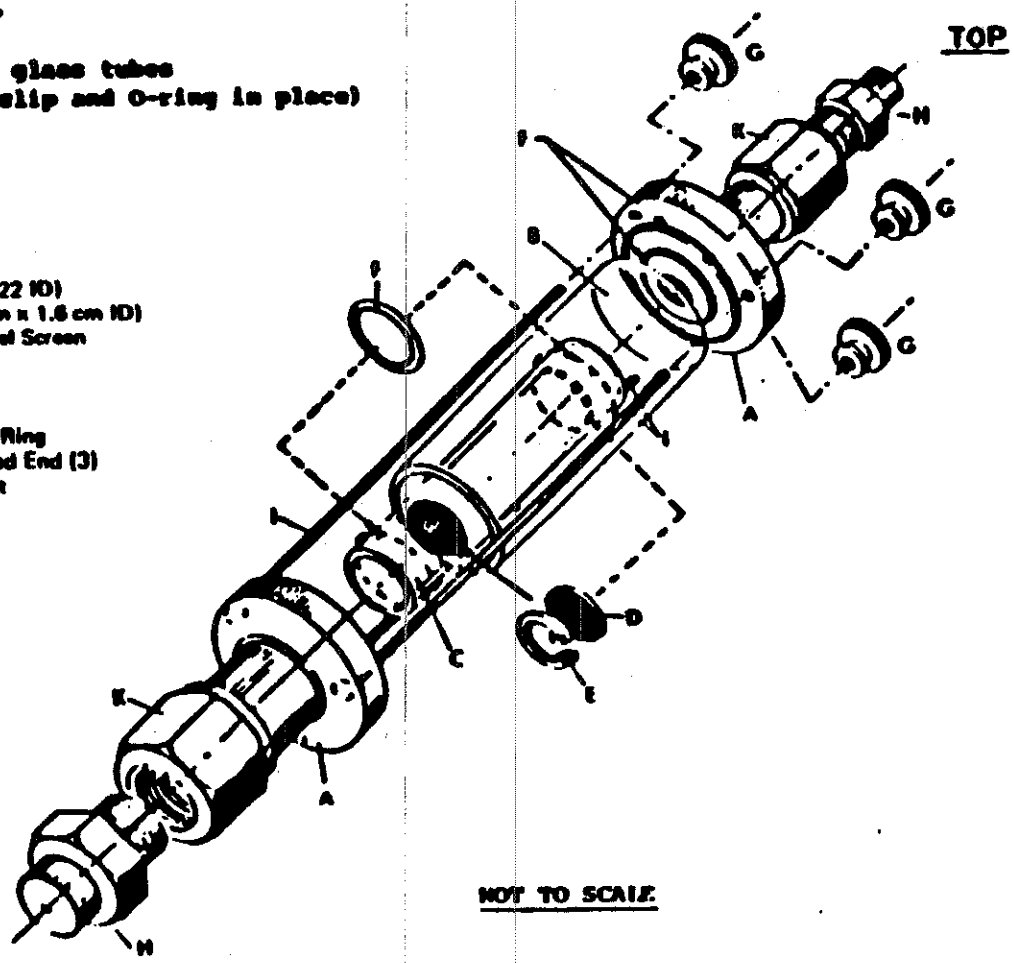
Figure 3. Inside-inside vost cartridge



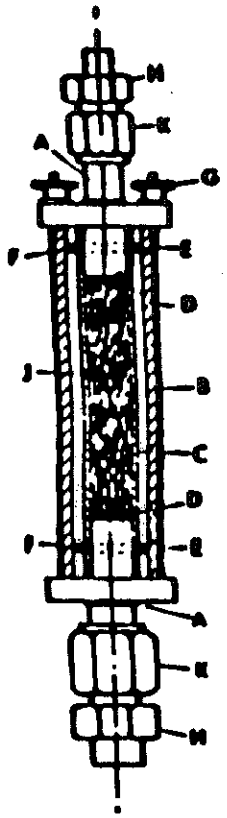
Section cut through glass tubes
(showing screen, C-clip and O-ring in place)

LEGEND

A - Stainless Steel Carrier
B - Glass Tube (9.84 L x 2.22 ID)
C - Small Glass Tube (10 cm x 1.6 cm ID)
D - Fine Mesh Stainless Steel Screen
E - Stainless Steel C-Clip
F - O Ring (Viton)
G - Nuts (1)
H - End Cap with Viton O-Ring
I - Metal Rod with Threaded End (3)
J - Tenax/Charcoal Sorbent
K - Cajon Fitting



NOT TO SCALE



Assembled Trap
NTS

Figure 4. Sorbent Trap Assembly (I/O)
Volatile Organic Sampling Train (VOST)

All other sample transfer lines used with the VOST shall be Teflon with connecting fittings that are capable of forming leak-free, vacuum-tight connections without the use of sealing grease.

3.0 REAGENTS AND MATERIALS

3.1 2,6-Diphenylene oxide polymer (Tenax, 35/60 mesh):

3.1.1 The new Tenax is Soxhlet extracted for 24 hr with methanol (Burdick & Jackson, pesticide grade or equivalent). The Tenax is dried for 6 hr in a vacuum oven at 50°C before use. Users of I/O and I/I sorbent cartridges have used slightly different thermal conditioning procedures. I/O sorbent cartridges packed with Tenax are thermally conditioned by flowing organic-free nitrogen (30 mL/min) through the resin while heating to 190°C. Some users have extracted new Tenax and charcoal with pentane to remove nonpolar impurities. However, these users have experienced problems with residual pentane in the sorbents during analysis.

3.1.2 If very high concentrations of volatile POHCs have been collected on the resin (e.g., micrograms of analytes), the sorbent may require Soxhlet extraction as described above. Previously used Tenax cartridges are thermally reconditioned by the method described above.

3.2 Charcoal (SKC petroleum-base or equivalent): New charcoal is prepared and charcoal is reconditioned as described in Paragraph 4.4. New charcoal does not require treatment prior to assembly into sorbent cartridges. Users of VOST have restricted the types of charcoal used in sorbent cartridges to only petroleum-based types. Criteria for other types of charcoal are acceptable if recovery of POHC in laboratory evaluations meet the criteria of 50 to 150%.

3.3 Viton-O-Ring: All O-rings used in VOST shall be Viton. Prior to use, these O-rings should be thermally conditioned at 200°C for 48 hr. O-rings should be stored in clean, screw-capped glass containers prior to use.

3.4 Glass tubes/Condensers: The glass resin tubes and condensers should be cleaned with a nonionic detergent in an ultrasonic bath, rinsed well with organic-free water, and dried at 110°C. Resin tubes of the I/O design should be assembled prior to storage as described in Paragraph 4.1. Resin tubes of the I/I design can be stored in glass culture tube containers with cotton cushioning and Teflon-lined screw caps. Condensers can be capped with appropriate end caps prior to use.

3.5 Metal parts: The stainless steel carriers, C-clips, end plugs, and screens used in the I/O VOST design are cleaned by ultrasonication in a warm nonionic detergent solution, rinsed with distilled water, air-dried, and heated in a muffle furnace for 2 hr at 400°C. Resin tubes of the I/I design require Swagelok or equivalent end caps with Supelco M-1 ferrules. These should be heated at 190°C along with the assembled cartridges.

3.6 Silica gel (Indicating type, 6-16 mesh): New silica gel may be used as received. Silica gel which has been previously used should be dried for 2 hr at 175°C (350°F).

3.7 Cold packs: Any commercially available reusable liquids or gels that can be repeatedly frozen are acceptable. They are typically sold in plastic containers as "Blue Ice" or "Ice-Packs." Enough should be used to keep cartridges at or near 4°C.

3.8 Water: Water used for cooling train components in the field may be tap water; and water used for rinsing glassware should be organic-free.

3.9 Glass wool: Glass wool should be Soxhlet extracted for 8 to 16 hr, using methanol, and oven dried at 110°C before use.

4.0 SAMPLE HANDLING AND PROCEDURE

4.1 Assembly:

4.1.1 The assembly and packing of the sorbent cartridges should be carried out in an area free of volatile organic material, preferably a laboratory in which no organic solvents are handled or stored and in which the laboratory air is charcoal filtered. Alternatively, the assembly procedures can be conducted in a glove box which can be purged with organic-free nitrogen.

4.2 Tenax cartridges:

4.2.1 The Tenax, glass tubes, and metal cartridge parts are cleaned and stored (see Section 3.0). Approximately 1.6 g of Tenax is weighed and packed into the sorbent tube which has a stainless steel screen and C-clip (I/O design) or glass wool (I/I design) in the downstream end. The Tenax is held in place by inserting a stainless steel screen and C-clips in the upstream end (I/O design) or glass wool (I/I design). Each cartridge should be marked, using an engraving tool, with an arrow to indicate the direction of sample flow, and a serial number.

4.2.2 Conditioned resin tubes of the I/O design are then assembled into the metal carriers according to the previously described inside/inside or inside/outside procedures (with end caps) and are placed on cold packs for storage and transport. Conditioned resin tubes of the I/I design are capped and placed on cold packs for storage and transport.

4.3 Tenax/Charcoal tubes

4.3.1 The Tenax, charcoal, and metal cartridge parts are cleaned and stored as previously described (see Section 3.0). The tubes are packed with approximately a 3:1 volume ratio of Tenax and charcoal (approximately 1 g each). The Tenax and charcoal are held in place by the stainless steel screens and C-clips (I/O design) or by glass wool (I/I design). The glass tubes containing the Tenax and charcoal are then

conditioned as described below (see Paragraph 4.4). Place the I/O glass tubes in the metal carriers (see Paragraph 2.1.4.2.2), put end caps on the assembled cartridges, mark direction of sample flow and serial number, and place the assembled cartridges on cold packs for storage and transport.

4.3.2 Glass tubes of the I/I design are conditioned, and stored in the same manner as the I/O tubes.

4.4 Trap Conditioning - QC

4.4.1 Following assembly and leak-checking, the traps are connected in reverse direction to sampling to a source of organic-free nitrogen, and nitrogen is passed through each trap at a flow rate of 40 mL/min, while the traps are heated to 190°C for 12-28 hr. The actual conditioning period may be determined based on adequacy of the resulting blank checks.

4.4.2 The following procedure is used to blank check each set of sampling cartridges prior to sampling to ensure cleanliness. The procedure provides semi-quantitative data for organic compounds with boiling points below 110°C on Tenax and Tenax/Charcoal cartridges. It is not intended as a substitute for Method 5040.

4.4.2.1 The procedure is based on thermal desorption of each set of two cartridges, cryofocusing with liquid nitrogen onto a trap packed with glass beads, followed by thermal desorption from the trap and analysis by GC/FID.

4.4.2.2 The detection limit is based on the analysis of Tenax cartridges spiked with benzene and toluene and is around 2 ng for each compound.

4.4.2.3 The results of analyzing spiked cartridges on a daily basis should not vary by more than 20 percent. If the results are outside this range, the analytical system must be evaluated for the probable cause and a second spiked cartridge analyzed.

4.4.2.4 The GC operating conditions are as follows:

GC Operating Conditions

Column: Packed column 6 ft x 1/8" stainless steel 1.0 percent SP-1000 on Carbopack B 60/80, or equivalent.
Temperature program: 50°C for 5 min, 20°C/min increase to 190°C, hold 13 min.
Injector: 200°C.
Detector: F.I.D. 250°C.
Carrier Gas: Helium at 25 mL/min.
Sample valve: Valco 6-port with 40" x 1/16" stainless steel trap packed with 60/80 mesh glass beads.
Cryogen: Liquid nitrogen.
Trap heater: Boiling water, hot oil, or electrically heated.

Desorption heater: Supelco "clam shell" (high capacity carrier gas purifier) heater and Variac, adjusted to 180°C to 200°C.

4.4.2.5 Calibration is accomplished by preparing a spiked Tenax cartridge with benzene and toluene and analyzing according to the standard operating procedure. A standard of benzene, toluene and bromofluorobenzene (BFB) is prepared by injecting 2.0 uL of benzene and toluene and 1.0 uL of BFB into 10 mL of methanol. The concentration of this stock is 175 ng/uL of benzene and toluene, and 150 ng/uL BFB. One microliter of the stock standard is injected onto a Tenax cartridge through a heated injection port set at 150°C. A GC oven can be used for this with the oven at room temperature. Helium carrier gas is set at 50 mL/min. The solvent flush technique should be used. After two min, remove the Tenax cartridge and place in the desorption heater for analysis. BFB is also used as an internal standard spike for GC/MS analysis which provides a good comparison between GC/FID and GC/MS. The results of this spike analysis should not vary more than 20 percent day to day. Initially and then periodically this spiked Tenax should be reanalyzed a second time to verify that the 10 min desorption time and 180-200°C temperature are adequate to remove all of the spiked components. It should be noted that only one spiked Tenax cartridge need be prepared and analyzed daily unless otherwise needed to ensure proper instrument operation.

An acceptable blank level is left to the discretion of the method analyst. An acceptable level is one that allows adequate determination of expected components emitted from the waste being burned.

4.4.3 After conditioning, traps are sealed and placed on cold packs until sampling is accomplished. Conditioned traps should be held for a minimum amount of time to prevent the possibility of contamination.

4.4.4 It may be useful to spike the Tenax and Tenax/charcoal traps with the compounds of interest to ensure that they can be thermally desorbed under laboratory conditions. After spiked traps are analyzed they may be reconditioned and packed for sampling.

4.5 Pretest preparation:

4.5.1 All train components shall be cleaned and assembled as previously described. A dry gas meter shall have been calibrated within 30 days prior to use, using an EPA-supplied standard orifice.

4.5.2 The VOST is assembled according to the schematic diagram in Figure 1. The cartridges should be positioned so that sample flow is

through the Tenax first and then the Tenax/charcoal. Cooling water should be circulated to the condensers and the temperature of the cooling water should be maintained near 0°C. The end caps of the sorbent cartridges should be placed in a clean screw-capped glass container during sample collection.

4.6 Leak-checking:

4.6.1 The train is leak-checked by closing the valve at the inlet to the first condenser and pulling a vacuum of 250 mm (10 in. Hg) above the normal operating pressure. The traps and condensers are isolated from the pump and the leak rate noted. The leak rate should be less than 2.5 mm Hg after 1 min. The train is then returned to atmospheric pressure by attaching a charcoal-filled tube to the train inlet and admitting ambient air filtered through the charcoal. This procedure will minimize contamination of the VOST components by excessive exposure to the fugitive emissions at hazardous waste incinerator sites.

4.7 Sample Collection

4.7.1 After leak-checking, sample collection is accomplished by opening the valve at the inlet to the first condenser, turning on the pump, and sampling at a rate of 1 liter/min for 20 min. The volume of sample for any pair of traps should not exceed 20 liters.

4.7.2 Following collection of 20 liters of sample, the train is leak-checked a second time at the highest pressure drop encountered during the run to minimize the chance of vacuum desorption of organics from the Tenax. The train is returned to atmospheric pressure, using the method discussed in Paragraph 4.1 and the two sorbent cartridges are removed. The end caps are replaced and the cartridges shall be placed in a suitable environment for storage and transport until analysis. The sample is considered invalid if the leak test does not meet specification.

4.7.3 A new pair of cartridges is placed in the VOST, the VOST leak-checked, and the sample collection process repeated as described above. Sample collection continues until six pairs of traps have been used.

4.7.4 All sample cartridges should be kept on cold packs until they are ready for analysis.

4.8 Blanks

4.8.1 Field blanks/trip blanks: Blank Tenax and Tenax/charcoal cartridges are taken to the sampling site and the end caps removed for the period of time required to exchange two pairs of traps on VOST. After the two VOST traps have been exchanged, the end caps are replaced on the blank Tenax and Tenax/charcoal tubes and these are returned to the cold packs and analyzed with the sample traps. At least one pair of field blanks (one Tenax, one Tenax/charcoal) shall be included with each

six pairs of sample cartridges collected (or for each field trial using VOST to collect volatile POHCs).

4.8.2 Trip blanks: At least one pair of blank cartridges (one Tenax, one Tenax/charcoal) shall be included with shipment of cartridges to a hazardous waste incinerator site. These "field blanks" will be treated like any other cartridges except that the end caps will not be removed during storage at the site. This pair of traps will be analyzed to monitor potential contamination which may occur during storage and shipment.

4.8.3 Laboratory blanks: One pair of blank cartridges (one Tenax, one Tenax/charcoal) will remain in the laboratory using the method of storage which is used for field samples. If the field and trip blanks contain high concentrations of contaminants (e.g., greater than 2 ng of a particular POHC), the laboratory blank shall be analyzed in order to identify the source of contamination.

5.0 CALCULATIONS (for sample volume)

5.1 The following nomenclature are used in the calculation of sample volume:

P_{bar} = Barometric pressure at the exit orifice of the dry gas meter, mm (in.) Hg.

P_{std} = Standard absolute pressure, 760 mm (29.92 in.) Hg.

T_m = Dry gas meter average absolute temperature, K (°R).

T_{std} = Standard absolute temperature, 293K (528°R).

V_m = Dry gas volume measured by dry gas meter, dcm (dcf).

$V_{m(std)}$ = Dry gas volume measured by dry gas meter, corrected to standard conditions, dscm (dscf).

γ = Dry gas meter calibration factor.

5.2 The volume of gas sampled is calculated as follows:

$$V_{m(std)} = V_m \gamma \frac{T_{std} P_{bar}}{T_m P_{std}} = K_1 \gamma \frac{V_m P_{bar}}{T_m}$$

where:

K_1 = 0.3858 K/mm Hg for metric units, or

K_1 = 17.64 °R/in. Hg for English units.

6.0 ANALYTICAL PROCEDURE

See Method 5040.

7.0 PRECISION AND ACCURACY REQUIREMENTS

7.1 Method Performance Check

Prior to field operation of the VOST at a hazardous waste incinerator, a method performance check should be conducted using either selected volatile POHCs of interest or two or more of the volatile POHCs for which data are available. This check may be conducted on the entire system (VOST/GC/MS) by analysis of a gas cylinder containing POHCs of interest or on only the analytical system by spiking of the POHCs onto the traps. The results of this check for replicate pairs of traps should demonstrate that recovery of the analytes fall within 50% to 150% of the expected values.

7.2 Performance Audit

During a trial burn a performance audit must be completed. The audit results should agree within 50% to 150% of the expected value for each specific target compound. This audit consists of collecting a gas sample containing one or more POHCs in the VOST from an EPA ppb gas cylinder. Collection of the audit sample in the VOST may be conducted either in the laboratory or at the trial burn site. Anaysis of the VOST audit sample must be by the same person, at the same time, and with the same analytical procedure as used for the regular VOST trail burn samples. EPA ppb gas cylinders currently available for VOST Audit are shown in Table 1 below.

The audit procedure, audit equipment and audit cylinder may be obtained by writing:

Audit Cylinder Gas Coordinator (MD-77B)
Quality Assurance Division
Environmental Monitoring Systems Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

or by calling the Audit Cylinder Gas Coordinator at (919) 541-4531.

The request for the audit must be made at least 30 days prior to the scheduled trial burn. If a POHC is selected for which EPA does not have an audit cylinder, this audit is not required.

8.0 REFERENCES

1. Protocol for the Collection and Analysis of Volatile POHCs Using VOST. EPA/600/8-84/007, March 1984.

2. Sykes, A.L., Standard Operating Procedure for Blanking Tenax and Tenax/Charcoal Sampling Cartridges for Volatile Organic Sampling Train (VOST), Radion Corporation, P.O. Box 13000, Research Triangle Park, NC 27709.

3. Validation of the Volatile Organic Sampling Train (VOST) Protocol, Vols. I and II, EPA/600/4-86/014a, January 1986.

TABLE 1: Organic Gases in the ppb Audit Repository

Group I	Ranges of cylinders currently available:
5 Organics in N_2:	7 - 90 ppb
Carbon tetrachloride	90 - 430 ppb
Chloroform	430 - 10,000 ppb
Perchloroethylene	
Vinyl chloride	
Benzene	

Group II	Ranges of cylinders currently available:
9 Organics in N_2	7 - 90 ppb
Trichloroethylene	90 - 430 ppb
1,2-Dichloroethane	
1,2-Dibromoethane	
F-12	
F-11	
Bromomethane	
Methyl ethyl ketone	
1,1,1-Trichloroethane	
Acetronitrile	

TABLE 1: Organic Gases in the ppb Audit Repository (Continued)

Group III	Ranges of cylinders currently available:
7 Organics in N_2:	7 - 90 ppb
Vinylidene chloride	99 - 430 ppb
F-113	
F-114	
Acetone	
1,4-Dioxane	
Toluene	
Chlorobenzene	

Group IV	Ranges of cylinders currently available:
6 Organics in N_2:	7 - 90 ppb
Acrylonitrile	430 - 10,000
1,3-Butadiene	
Ethylene oxide	
Methylene chloride	
Propylene oxide	
Ortho-xylene	

WESTON

MANAGERS DESIGNERS/CONSULTANTS

VOST ANALYSIS

SW 846 METHOD 5040

0173L

MODIFIED METHOD 5040
PROTOCOL FOR ANALYSIS OF SORBENT CARTRIDGES FROM VOLATILE ORGANIC SAMPLING TRAIN

1.0 SCOPE AND APPLICATION

1.1 Method 5040 was formerly Method 3720 in the Second Edition of this manual.

1.2 This method covers the determination of volatile principal organic hazardous constituents (POHCs), collected on Tenax and Tenax/charcoal sorbent cartridges using a volatile organic sampling train, VOST (1). Much of the description for purge-and-trap GC/MS analysis is described in Method 8240 of this chapter. Because the majority of gas streams sampled using VOST will contain a high concentration of water, the analytical method is based on the quantitative thermal desorption of volatile POHCs from the Tenax and Tenax/charcoal traps and analysis by purge-and-trap GC/MS. For the purposes of definition, volatile POHCs are those POHCs are those POHCs with boiling points less than 100°C.

1.3 This method is applicable to the analysis of Tenax and Tenax/ charcoal cartridges used to collect volatile POHCs from wet stack gas effluents from hazardous waste incinerators.

1.4 The sensitivity of the analytical method for a particular volatile POHC depends on the level of interferences and the presence of detectable levels of volatile POHCs in blanks. The desired target detection limit of the analytical method is 0.1 ng/L (20 ng on a single pair of traps) for a particular volatile POHC desorbed from either a single pair of Tenax and Tenax/charcoal cartridges or by thermal desorption of up to six pairs of traps onto a single pair of Tenax and Tenax/charcoal traps. The resulting single pair of traps is then thermally desorbed and analyzed by purge-and-trap GC/MS.

1.5 This method is recommended for use only by experienced mass spectroscopists or under the close supervision of such qualified persons.

2.0 **SUMMARY OF METHOD**

2.1 A schematic diagram of the analytical system is shown in Figure 1. The contents of the sorbent cartridges are spiked with an internal standard and thermally desorbed for 10 min at 180°C with organic-free nitrogen or helium gas (at a flow rate of 40 mL/min), bubbled through 5 mL of organic-free water, and trapped on an analytical adsorbent trap. After the 10-min desorption, the analytical adsorbent trap is rapidly heated to 180°C, with the carrier gas flow reversed so that the effluent flow from the analytical trap is directed into the GC/MS. The volatile POHCs are separated by temperature-programmed gas chromatograpahy and detected by low-resolution mass spectrometry. The concentrations of volatile POHCs are calculated using the internal standard technique.

3.0 **INTERFERENCES**

3.1 Refer to Methods 3500 and 8240.

4.0 **APPARATUS AND MATERIALS**

4.1 Thermal desorption unit:

4.1.1 The thermal desorption unit (for Inside/Inside VOST cartridges, use Supelco "clamshell" heater; for Inside/Outside VOST cartridges, user fabricated unit is required) should be capable of thermally desorbing the sorbent resin tubes. It should also be capable of heating the tubes to 280 ± 10°C with flow of organic-free nitrogen or helium through the tubes.

4.2 Purge-and-trap unit:

4.2.1 The purge-and-trap unit consists of three separate pieces of equipment: the sample purger, trap, and the desorber. It should be capable of meeting all requirements of Method 5030 for analysis of purgeable organic compounds from water.

4.3 GC/MS system: As described in method 8240. The analytical column will be DB 624 megabore capillary column (30mx 0.53mm I.D.) or equivalent.

Figure 1. Schematic diagram of trap desorption/analysis system.

5.0 **REAGENTS**

5.1 Reagent Water: Reagent water is defined as water in which an interferent is not observed at the method detection limit of the parameters of interest.

5.1.1 Reagent water may be generated by passing tap water through a carbon filter bed containing about 450 g of activated carbon (Calgon Corporation, Filtrasorb-300, or equivalent).

5.1.2 A water purification system (Millipore Super-Q or equivalent) may be used to generate reagent water.

5.1.3 Reagent water may also be prepared by boiling distilled water for 15 min. Subsequently, while maintaining the temperature at 90°C, bubble a contaminant-free inert gas through the water for 1 hr. Allow the water to cool to room temperature while continuing to bubble the inert gas through the water. This water should be transferred directly to purge-and-trap apparatus for use.

5.1.4 Other methods that can be shown to produce organic-free water can be used.

5.2 Analytical trap reagents:

5.2.1 2,6-Diphenylene oxide polymer: Tenax (60/80 mesh), chromatographic grade or equivalent.

5.2.2 Silica gel: Davison Chemical (35/00 mesh), Grade 15, or equivalent.

5.2.3 Charcoal: Petroleum-based (SKC Lot 104 or equivalent). (Tekmar 14-0124-003).

5.3 Stock standard solution:

5.3.1 Stock standard solutions will be prepared from pure standard materials or purchased as certified solutions. The stock standards should be prepared in methanol using assayed liquids or gases, as appropriate. Because of the toxicity of some of the organohalides,

primary dilutions of these materials should be prepared in a hood. A NIOSH/MASA-approved toxic gas respirator should be used when the analyst handles high concentrations of such materials.

5.3.2 Fresh stock standards should be prepared weekly for volatile POHCs with boiling points of <35°C. All other standards must be replaced monthly, or sooner if comparison with check standards indicates a problem.

5.4. Secondary dilution standards:

5.4.1 Using stock standard solutions, prepare in methanol secondary dilution standards that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the desorbed calibration standards will bracket the working range of the analytical system.

6.0 **SAMPLE COLLECTION, PRESERVATION, AND HANDLING**

6.1 Refer to Method 0030, Chapter Ten.

6.2 Sample trains obtained from the VOST should be analyzed within 2-6 weeks of sample collection.

7.0 **PROCEDURE**

7.1 Assembly of PTD device:

7.1.1 Assemble a purge-and-trap desorption device (PTD) that meets all the requirements of Method 5030 (refer to Figure 1).

7.1.2 Connect the thermal desorption device to the PTD. Calibrate the PTD-GC/MS system using the internal standard technique.

7.2 Internal standard calibration procedure:

7.2.1 This approach requires the use of chlorobenzene-d5 as the internal standard for tetrachloroethylene. Other internal standards may be proposed for use in certain situations. The important criteria for choosing a particular compound as an internal standard are that it

be similar in analytical behavior to the compounds of interest and that it can be demonstrated that the measurement of the internal standard be unaffectd by method or matrix interferences. Other internal standards that have been used are d_{10}-ethylbenzene and d_4-1,,2-dichloroethane. One adds 50 ng of BFB to all sorbent cartridges (in addition to one or more internal standards) to provide continuous monitoring of the GC/MS performance relative to BFB.

7.2.2 Prepare calibration standards at a minimum of three concentration levels for each analyte of interest.

7.2.3 The calibration standards are prepared by spiking a blank Tenax or Tenax/charcoal trap with a methanolic solution of the calibration standards (including 50 ng of the internal standard).

7.2.4 Analyze each calibration standard for both Tenax and Tenax/charcoal cartridges according to Section 7.3. Tabulate the area response of the characteristic ions of each analyte against the concentration of the internal standard and calculate response factor (RF) for each compound, using Equation 1.

$$RF = A_s C_{is} / A_{is} C_s \qquad (1)$$

Where:

A_s = Area of the characteristic ion for the analyte to be measured.

A_{is} = Area of the characteristic ion for the internal standard.

C_{is} = Amount (ng) of the internal standard.

C_s = Amount (ng) of the volatile POHC in calibration standard.

If the RF value over the working range is a constant (< 30% RSD), the RF can be assumed to be invariant, and the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_s/A_{is} versus RF.

7.2.5 The working calibration curve or RF must be verified on each working day by the measurement of one or more of the calibration standards. If the response varies by more than ± 25% for any analyte, a new calibration standard must be prepared and analyzed, for the analyte.

7.3 The schematic of the PTD-GC/MS system is shown in Figure 1. The sample cartridge is placed in the thermal desorption apparatus (for Inside/Inside VOST cartridges, use Supelco "clamshell" heater;) and desorbed in the purge-and-trap system by heating to 180°C for 10 min at a flow rate of 40 mL/min. The desorbed components pass into the bottom of the water column, are purged from the water, and collected on the analytical adsorbent trap. After the 10-min desorption period, the compounds are desorbed from the analytical adsorbent trap into the GC/MS system according to the procedures described in Method 8240.

7.4 Qualitative identification:

7.4.1 The procedure for qualitative identification of volatile POHCs using this protocol is described in Method 8240.

7.5 Calculations:

7.5.1 When an analyte has been qualitatively identified, quantification should be based on the integrated abundance from the EICP of the primary characteristic ion chosen for the analyte. If the sample produces an interference for the primary characteristic ion, a secondary characteristic ion should be used.

	Primary Ion	Secondary Ion
Chlorobenzene-d5(Internal Standard)	117	82
Tetrachloroethylene	164	166,131

7.5.1.1 Using the internal standard calibration procedure, the amount of analyte in the sample cartridge is calculated using the response factor (RF) determined in Paragraph 7.2.5 and Equation 2.

$$\text{Amount of POHC} = A_s C_{is} / A_{is} RF \qquad (2)$$

Where:

A_s = Area of the characteristic ion for the analyte to be measured.

A_{is} = Area for the characteristic ion of the internal standard.

C_{is} = Amount (ng) of internal standard.

7.5.1.2 The choice of methods for evaluating data collected using VOST for incinerator trial burns is a regulatory decision. The procedures used extensively by one user are outlined below.

7.5.1.3 The total amount of the POHCs of interest collected on a pair of traps should be summed. These values should then be blank corrected. Guidelines for blank correction of sample cartridges are outlined below.

7.5.1.3.1 After all blanks (field and trip) are analyzed, a paired t-test should be used to determine whether trip blanks are significantly different from field blanks. If no difference is found, then the mean and standard deviation of the combined field and trip blanks for each POHC of interest is calculated.

7.5.1.3.2 If, when using the paired t-test, the field and trip blanks are determined to be different, then the field blank (or the mean of multiple field blanks) associated with a particular run should be used as the blank value for that particular run.

7.5.1.4 Next, for each sample POHC combination, a determination must be made as to whether a particular sample is significantly different from the associated blank. If the mean of the trip and field blanks is used, then a sample is different from the blank if:

$$(\text{measured sample value}) - (\text{mean blank value}) > (3 \times \text{blank standard deviation})$$

(If an individual field blank is used as the blank value, the above criteria do no apply.) If the sample is determined to be different from the blank according to the above criteria, then the emission value of a particular POHC is blank-corrected by subtracting the mean blank value from the measured sample value.

7.5.1.5 If, according to the above procedures, the sample cannot be distinguished from the blank (i.e., for a given POHC there is a high sample value and high blank value or there is a low sample value and low blank value), the measured sample value is not blank-corrected. In this case, the measured sample value is used to calculate a maximum emission value (and therefore a minimum DRE value) for that particular run.

7.5.1.6 The observation of high concentrations of POHCs of interest in blank cartridges indicates possible residual contamination of the sorbent cartridges prior to shipment to and use at the site. Data that fall in this category (especially data indicating high concentrations of POHCs in blank sorbent cartridges) should be qualified with regard to validity, and blank data should be reported separately. The applicability of data of this type to the determination of DRE is a regulatory decision. Continued observation of high concentrations of POHCs in blank sorbent cartridges indicates that procedures for cleanup, monitoring, shipment, and storage of sorbent cartridges by a particular user be investigated to eliminate this problem.

7.5.1.7 If any internal standard recoveries fall outside the control limits established in Section 8.4, data for all analytes determined for that cartridge(s) must be qualified with the observation.

8.0 QUALITY CONTROL

8.1 Refer to chapter One for specific quality control procedures and Method 3500 for sample preparation procedures.

8.2 Each laboratory that uses this method is required to operate a formal quality control program. The minimum requirements of this program consist of an initial demonstration of laboratory capability and the analysis of blank Tenax and Tenax/charcoal cartridges spiked with the analytes of interest. The laboratory is required to maintain performance records to define the quality of data that are generated. Ongoing performance checks must be compared with established performance criteria to determine if results are within the expected precision and accuracy limits of the method.

8.2.1 Before performing any analyses, the analyst must demonstrate the ability to generate acceptable precision and accuracy with this method. This ability is established as described in Paragraph 7.2.

8.2.2 The laboratory must spike all Tenax and Tenax/charcoal cartridges with the internal standard(s) to monitor continuing laboratory performance. This procedure is described in Paragraph 7.2.

8.3 To establish the ability to generate acceptable accuracy and precision, the analyst must spike blank Tenax and Tenax/charcoal cartridges with the analytes of interest at two concentrations in the working range.

8.3.1 The average response factor (R) and the standard deviation (S) for each must be calculated.

8.3.2 The average recovery and standard deviation must fall within the expected range for determination of volatile POHCs using this method. The expected range for recovery of volatile POHCs using this method is 50-150%.

8.4 The analyst must calculate method performance criteria for the internal standard(s).

8.4.1 Calculate upper and lower control limits for method performances using the average area response (A) and standard deviation(s) for internal standard:

Upper Control Limit (UCL) = A + 3S.
Lower Control Limit (LCL) = A - 3S.

The UCL and LCL can be used to construct control charts that are useful in observing trends in performance. The control limits must be replaced by method performance criteria as they become available from the U.S. EPA.

8.5 The laboratory is required to spike all sample cartridges (Tenax and Tenax/charcoal) with internal standard.

8.6 Each day, the analyst must demonstrate through analysis of blank Tenax and Tenax/charcoal cartridges and reagent water that interferences from the analytical system are under control.

8.7 The daily GC/MS performance tests required for this method are described in Method 8240.

9.0 **METHOD PERFORMANCE**

9.1 Refer to the determinative methods for performance data.

10.0 **REFERENCES**

1. Protocol for Collection and Analysis of Volatile POHC's Using VOST. EPA/600/8-84-007, March 1984.

2. Validation of the Volatile Organic Sampling Train (VOST) Protocol. Volumes I and II. EPA/600/4-86-014a, January 1986.

sjd/misc misc/method/sw1129.op

DRAFT EMSL/TOTAL METALS

MULTI-METALS EMISSIONS IN EXHAUST GASES

0173L

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DRAFT 8/28/89

METHODOLOGY FOR THE DETERMINATION OF METALS EMISSIONS IN EXHAUST GASES FROM HAZARDOUS WASTE INCINERATION AND SIMILAR COMBUSTION PROCESSES

1. Applicability and Principle

1.1 Applicability. This method is applicable for the determination of total chromium (Cr), cadmium (Cd), arsenic (As), nickel (Ni), manganese (Mn), beryllium (Be), copper (Cu), zinc (Zn), lead (Pb), selenium (Se), phosphorus (P), thallium (Tl), silver (Ag), antimony (Sb), barium (Ba), and mercury (Hg) emissions from hazardous waste incinerators and similar combustion processes. This method may also be used for the determination of particulate emissions following the additional procedures described. Modifications to the sample recovery and analysis procedures described in this protocol for the purpose of determining particulate emissions may potentially impact the front half mercury determination.*

1.2 Principle. The stack sample is withdrawn isokinetically from the source, with particulate emissions collected in the probe and on a heated filter and gaseous emissions collected in a series of chilled impingers containing a solution of dilute nitric acid in hydrogen peroxide in two impingers, and acidic potassium permanganate solution in two (or one) impingers. Sampling train components are recovered and digested in separate front and back half fractions. Materials collected in the sampling train are digested with acid solutions to dissolve inorganics and to remove organic constituents that may create analytical interferences. Acid digestion is performed using conventional Parr® Bomb or microwave digestion techniques. The nitric acid and hydrogen peroxide impinger solution, the acidic potassium permanganate impinger solution, and the probe rinse and digested filter solutions are analyzed for mercury by cold vapor atomic absorption spectroscopy (CVAAS). Except for the permanganate solution, the remainder of the sampling

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*Field tests to date have shown that of the total amount of mercury measured by the method, only 0 to <2% was measured in the front half. Therefore, it is tentatively concluded, based on the above data, that particulate emissions may be measured by this train, without significantly altering the mercury results.

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train catches are analyzed for Cr, Cd, Ni, Mn, Be, Cu, Zn, Pb, Se, P, Tl, Ag, Sb, Ba, and As by inductively coupled argon plasma emission spectroscopy (ICAP) or atomic absorption spectroscopy (AAS). Graphite furnace atomic absorption spectroscopy (GFAAS) is used for analysis of antimony, arsenic, cadmium, lead, selenium, and thallium, if these elements require greater analytical sensitivity than can be obtained by ICAP. Additionally, if desired, the tester may use AAS for analyses of all metals if the resulting in-stack method detection limits meet the goal of the testing program. For convenience, aliquots of each digested sample fraction can be combined proportionally for a single analytical determination. The efficiency of the analytical procedure is quantified by the analysis of spiked quality control samples containing each of the target metals including actual sample matrix effects checks.

2. Range, Sensitivity, Precision, and Interferences

2.1 Range. For the analyses described in this methodology and for similar analyses, the ICAP response is linear over several orders of magnitude. Samples containing metal concentrations in the nanograms per milliliter (ng/ml) to micrograms per milliliter (ug/ml) range in the analytical finish solution can be analyzed using this technique. Samples containing greater than approximately 50 ug/ml of chromium, lead, or arsenic should be diluted to that level or lower for final analysis. Samples containing greater than approximately 20 ug/ml of cadmium should be diluted to that level before analysis.

2.2 Analytical Sensitivity. ICAP analytical detection limits for the sample solutions (based on SW-846, Method 6010) are approximately as follows: Sb (32 ng/ml), As (53 ng/ml), Ba (2 ng/ml), Be (0.3 ng/ml), Cd (4 ng/ml), Cr (7 ng/ml), Cu (6 ng/ml), Pb (42 ng/ml), Mn (2 ng/ml), Ni (15 ng/ml), P (75 ng/ml), Se (75 ng/ml), Ag (7 ng/ml), Ti (40 ng/ml), and Zn (2 ng/ml). The actual method detection limits are sample dependent and may vary as the sample matrix may affect the limits. The analytical detection limits for analysis by direct aspiration AAS (based on SW-846, Method 7000) are approximately as follows: Sb (200 ng/ml), As (2 ng/ml), Ba (100 ng/ml), Be (5 ng/ml), Cd (5 ng/ml), Cr (50 ng/ml), Cu (20 ng/ml), Pb (100 ng/ml), Mn (10 ng/ml), Ni (40 ng/ml), Se (2 ng/ml), Ag (10 ng/ml), Tl (100 ng/ml), and Zn (5 ng/ml). The detection limit for mercury by CVAAS is approximately 0.2 ng/ml. The use of GFAAS can give added sensitivity compared to the use of direct aspiration AAS for the

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following metals: Sb (3 ng/ml), As (1 ng/ml), Be (0.2 ng/ml), Cd (0.1 ng/ml), Cr (1 ng/ml), Pb (1 ng/ml), Se (2 ng/ml), and Tl (1 ng/ml).

Using (1) the procedures described in this method, (2) the analytical detection limits described in the previous paragraph, (3) a volume of 300 ml for the front half and 150 ml for the back half samples, and (4) a stack gas sample volume of 1.25 m^3, the corresponding in-stack method detection limits are presented in Table A-1 and calculated as shown:

$$\frac{A \times B}{C} = D$$

where: A = analytical detection limit, ug/ml.
B = volume of sample prior to aliquot for analysis, ml.
C = stack sample volume, dscm (dsm^3).
D = in-stack detection limit, ug/m^3.

Values in Table A-1 are calculated for the front and back half and/or the total train.

To ensure optimum sensitivity in obtaining the measurements, the concentrations of target metals in the solutions are suggested to be at least ten times the analytical detection limits. Under certain conditions, and with greater care in the analytical procedure, this concentration can be as low as approximately three times the analytical detection limit. In all cases, repetitive analyses, method of standard additions (MSA), serial dilution, or matrix spike addition should be used to establish the quality of the data.

Actual in-stack method detection limits will be determined based on actual source sampling parameters and analytical results as described above. If required, the method in-stack detection limits can be made more sensitive than those shown in Table A-1 for a specific test by using one or more of the following options:

- A normal 1-hour sampling run collects a stack gas sampling volume of about 1.25 m^3. If the sampling time is increased and 5 m^3 are collected, the in-stack method detection limits would be one fourth of the values shown in Table A-1 (this means that with this change, the method is four times more sensitive than normal).
- The in-stack detection limits assume that all of the sample is digested (with exception of the aliquot for mercury) and the final liquid volumes for analysis are 300 ml for the front half and 150 ml for the

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TABLE A-1. IN-STACK METHOD DETECTION LIMITS (ug/m^3)
FOR TRAIN FRACTIONS USING ICAP AND AAS

Metal	Front Half Fraction 1 Probe and Filter	Back Half$_1$ Fraction 2 Impingers 1-3	Back Half$_2$ Fraction 3 Impingers 4-5	Total Train
Antimony	7.7 (0.7)*	3.8 (0.4)*		11.5 (1.1)*
Arsenic	12.7 (0.3)*	6.4 (0.1)*		19.1 (0.4)*
Barium	0.5	0.3		0.8
Beryllium	0.07 (0.05)*	0.04 (0.03)*		0.11 (0.08)*
Cadmium	1.0 (0.02)*	0.5 (0.01)*		1.5 (0.03)*
Chromium	1.7 (0.2)*	0.8 (0.1)*		2.5 (0.3)*
Copper	1.4	0.7		2.1
Lead	10.1 (0.2)*	5.0 (0.1)*		15.1 (0.3)*
Manganese	0.5 (0.2)*	0.2 (0.1)*		0.7 (0.3)*
Mercury	0.05**	0.03**	0.03**	0.11**
Nickel	3.6	1.8		5.4
Phosphorus	18	9		27
Selenium	18 (0.5)*	9 (0.3)*		27 (0.8)*
Silver	1.7	0.9		2.6
Thallium	9.6 (0.2)*	4.8 (0.1)*		14.4 (0.3)*
Zinc	0.5	0.3		0.8

( )* Detection limit when analyzed by GFAAS.
** Detection limit when analyzed by CVAAS.
Actual method in-stack detection limits will be determined based on actual source sampling parameters and analytical results as described earlier in this section.

back half sample. If the front half volume is reduced from 300 ml to 30 ml, the front half in-stack detection limits would be one tenth of the values shown above (ten times more sensitive). If the back half volume is reduced from 150 ml to 25 ml, the in-stack detection limits would be one sixth of the above values. Matrix effects checks are necessary on analyses of samples and typically are of greater significance for samples that have been concentrated to less than the normal sample volume. A volume less than 25 ml may not allow resolubilization of the residue and may increase interference by other compounds.

- When both of the above two improvements are used on one sample at the same time, the resultant improvements are multiplicative. For example, where stack gas volume is increased by a factor of five and the total liquid sample digested volume of both the front and back halves is reduced by factor of six, the in-stack method detection limit is reduced by a factor of thirty (the method is thirty times more sensitive).

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- Conversely, reducing stack gas sample volume and increasing sample liquid volume will increase limits. The front half and back half, samples (Fractions 1 and 2) can be combined prior to analysis. The resultant liquid volume (excluding Fraction 3, which must be analyzed separately) is recorded. Combining the sample as described does not allow determination (whether front or back half) of where in the train the sample was captured. The in-stack method detection limit then becomes a single value for all metals except mercury, for which the contribution of Fraction 3 must be considered.
- The above discussion assumes no blank correction. Blank corrections are discussed later in this method.

2.3 Precision. The precisions (relative standard deviation) for each metal detected in a method development test at a sewage sludge incinerator, are as follows: Sb (12.7%), As (13.5%), Ba (20.6%), Cd (11.5%), Cr (11.2%), Cu (11.5%), Pb (11.6%), P (14.6%), Se (15.3%), Tl (12.3%), and Zn (11.8%). The precision for nickel was 7.7% for another test conducted at a source simulator. Beryllium, manganese and silver were not detected in the tests; however, based on the analytical sensitivity of the ICAP for these metals, it is assumed that their precisions should be similar to those for the other metals, when detected at similar levels.

2.4 Interferences. Iron can be a spectral interference during the analysis of arsenic, chromium, and cadmium by ICAP. Aluminum can be a spectral interference during the analysis of arsenic and lead by ICAP. Generally, these interferences can be reduced by diluting the sample, but this increases the method detection limit. Refer to EPA Method 6010 (SW-846) for details on potential interferences for this method. For all GFAAS analyses, matrix modifiers should be used to limit interferences, and standards should be matrix matched.

3. Apparatus

3.1 Sampling Train. A schematic of the sampling train is shown in Figure A-1. It is similar to the Method 5 train. The sampling train consists of the following components.

3.1.1 Probe Nozzle (Probe Tip) and Borosilicate or Quartz Glass Probe Liner. Same as Method 5, Sections 2.1.1 and 2.1.2. Glass nozzles are required unless an alternate probe tip prevents the possibility of contamination or

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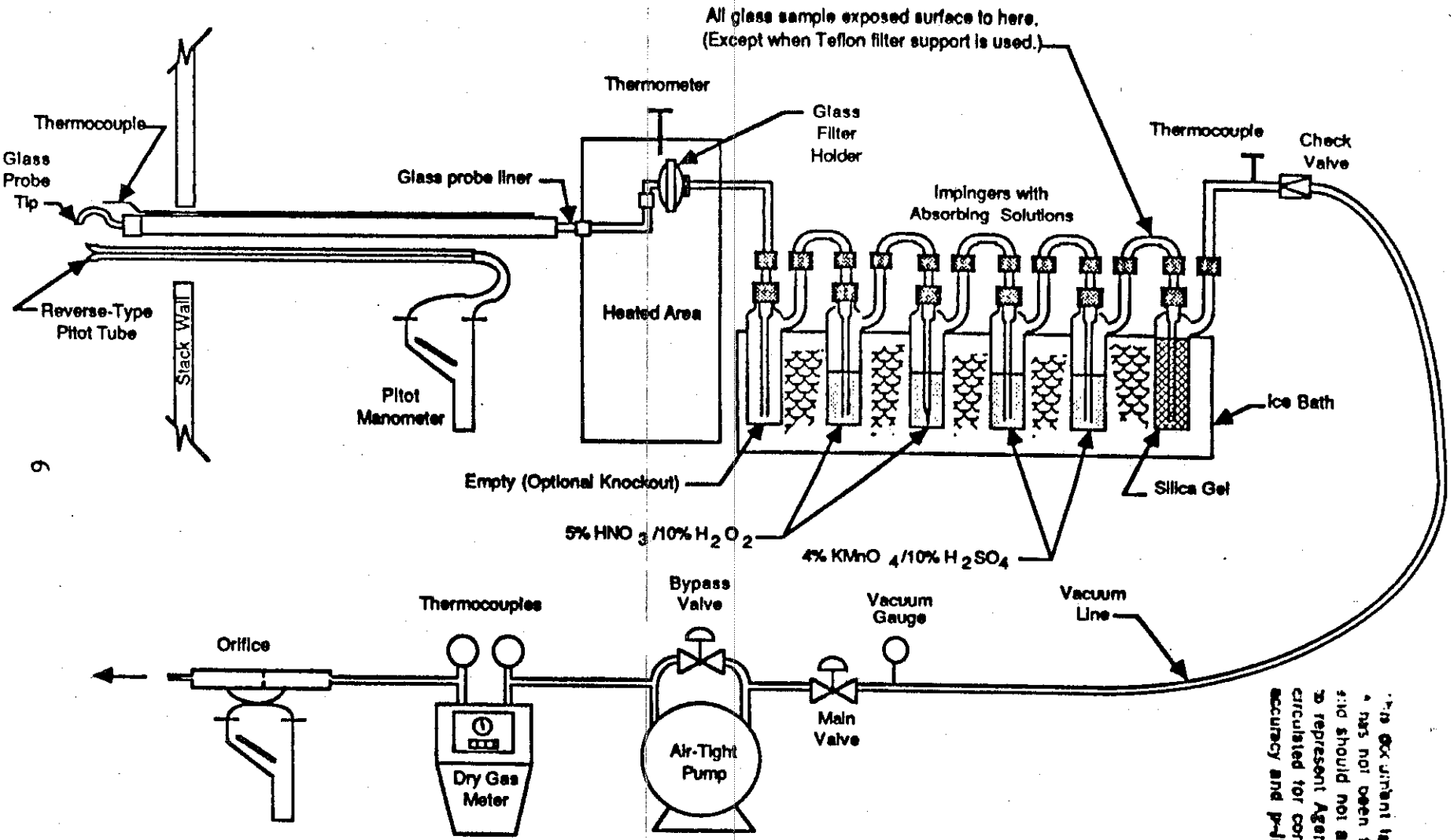

Figure A-1. Schematic of multiple metals sampling train.

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interference of the sample with its materials of construction. If a probe tip other than glass is used, no correction of the stack sample test results can be made because of the effect on the results by the probe tip.

3.1.2 Pitot Tube and Differential Pressure Gauge. Same as Method 2, Sections 2.1 and 2.2, respectively.

3.1.3 Filter Holder. Glass, same as Method 5, Section 2.1.5, except that a Teflon filter support must be used to replace the glass frit.

3.1.4 Filter Heating System. Same as Method 5, Section 2.1.6.

3.1.5 Condenser. The following system shall be used for the condensation and collection of gaseous metals and for determining the moisture content of the stack gas. The condensing system should consist of four to six impingers connected in series with leak-free ground glass fittings or other leak-free, non-contaminating fittings. The first impinger is optional and is recommended as a water knockout trap for use during test conditions which require such a trap. The impingers to be used in the metals train are now described. When the first impinger is used as a water knockout, it shall be appropriately-sized for an expected large moisture catch and constructed generally as described for the first impinger in Method 5, Paragraph 2.1.7. The second impinger (or the first HNO_3/H_2O_2 impinger) shall also be as described for the first impinger in Method 5. The third impinger (or the impinger used as the second HNO_3/H_2O_2 impinger) shall be the same as the Greenburg Smith impinger with the standard tip described as the second impinger in Method 5, Paragraph 2.1.7. All other impingers used in the metals train are the same as the second impinger (the first HNO_3/H_2O_2 impinger) previously described in this paragraph. In summary, the first impinger should be empty, the second and third shall contain known quantities of a nitric acid/hydrogen peroxide solution (Section 4.2.1), the fourth (and fifth, if required) shall contain a known quantity of acidic potassium permanganate solution (Section 4.2.2), and the last impinger shall contain a known quantity of silica gel or equivalent desiccant. A thermometer capable of measuring to within 1°C (2°F) shall be placed at the outlet of the last impinger. When the water knockout impinger is not needed, it is removed from the train and the other impingers remain the same. If mercury analysis is not needed, the potassium permanganate impingers are removed.

3.1.6 Metering System, Barometer, and Gas Density Determination Equipment. Same as Method 5, Sections 2.1.8 through 2.1.10, respectively.

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3.1.7 Teflon Tape. For capping openings and sealing connections on the sampling train.

3.2 Sample Recovery. Same as Method 5, Sections 2.2.1 through 2.2.8 (Nonmetallic Probe-Liner and Probe-Nozzle Brushes, Wash Bottles, Sample Storage Containers, Petri Dishes, Glass Graduated Cylinder, Plastic Storage Containers, Funnel and Rubber Policeman, and Glass Funnel), respectively, with the following exceptions and additions:

3.2.1 Nonmetallic Probe-Liner and Probe-Nozzle Brushes. For quantitative recovery of materials collected in the front half of the sampling train. Description of acceptable all-Teflon component brushes to be included in EPA's Emission Measurement Technical Information Center (EMTIC) files.

3.2.2 Sample Storage Containers. Glass bottles with Teflon-lined caps, 1000- and 500-ml, shall be used for $KMnO_4$-containing samples and blanks. Polyethylene bottles may be used for other sample types.

3.2.3 Graduated Cylinder. Glass or equivalent.

3.2.4 Funnel. Glass or equivalent.

3.2.5 Labels. For identification of samples.

3.2.6 Polypropylene Tweezers and/or Plastic Gloves. For recovery of the filter from the sampling train filter holder.

3.3 Sample Preparation and Analysis. For the analysis, the following equipment is needed:

3.3.1 Volumetric Flasks, 100 ml, 250 ml, and 1000 ml. For preparation of standards and sample dilution.

3.3.2 Graduated Cylinders. For preparation of reagents.

3.3.3 Parr® Bombs or Microwave Pressure Relief Vessels with Capping Station (CEM Corporation model or equivalent).

3.3.4 Beakers and Watchglasses. 250 ml beakers for sample digestion with watchglasses to cover the tops.

3.3.5 Ring Stands and Clamps. For securing equipment such as filtration apparatus.

3.3.6 Filter Funnels. For holding filter paper.

3.3.7 Whatman 541 Filter Paper (or equivalent). For filtration of digested samples.

3.3.8 Disposable Pasteur Pipets and Bulbs.

3.3.9 Volumetric Pipets.

3.3.10 Analytical Balance. Accurate to within 0.1 mg.

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3.3.11 Microwave or Conventional Oven. For heating samples at fixed power levels or temperatures.

3.3.12 Hot Plates.

3.3.13 Atomic Absorption Spectrometer (AAS). Equipped with a background corrector.

3.3.13.1 Graphite Furnace Attachment. With antimony, arsenic, cadmium, lead, selenium, thallium, and hollow cathode lamps (HCLs) or electrodeless discharge lamps (EDLs). Same as EPA Methods 7041 (antimony), 7060 (arsenic), 7131 (cadmium), 7421 (lead), 7740 (selenium), and 7841 (thallium).

3.3.13.2 Cold Vapor Mercury Attachment. With a mercury HCL or EDL. The equipment needed for the cold vapor mercury attachment includes an air recirculation pump, a quartz cell, an aerator apparatus, and a heat lamp or desiccator tube. The heat lamp should be capable of raising the ambient temperature at the quartz cell by 10°C such that no condensation forms on the wall of the quartz cell. Same as EPA Method 7470.

3.3.14 Inductively Coupled Argon Plasma Spectrometer. With either a direct or sequential reader and an alumina torch. Same as EPA Method 6010.

4. Reagents

Unless otherwise indicated, it is intended that all reagents conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available; otherwise, use the best available grade.

4.1 Sampling. The reagents used in sampling are as follows:

4.1.1 Filters. The filters shall contain less than 1.3 ug/in.^{2} of each of the metals to be measured. Analytical results provided by filter manufacturers are acceptable. However, if no such results are available, filter blanks must be analyzed for each target metal prior to emission testing. Quartz fiber or glass fiber filters without organic binders shall be used. The filters should exhibit at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D2986-71 (incorporated by reference). For particulate determination in sources containing SO_2 or SO_3, the filter material must be of a type that is unreactive to SO_2 or SO_3, as described in EPA Method 5. Quartz fiber filters meeting these requirements are recommended.

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4.1.2 Water. To conform to ASTM Specification D1193.77, Type II (incorporated by reference). Analyze the water for all target metals prior to field use. All target metals should be less than 1 ng/ml.

4.1.3 Nitric Acid. Concentrated. Baker Instra-analyzed or equivalent.

4.1.4 Hydrochloric Acid. Concentrated. Baker Instra-analyzed or equivalent.

4.1.5 Hydrogen Peroxide, 30 Percent (V/V).

4.1.6 Potassium Permanganate.

4.1.7 Sulfuric Acid. Concentrated.

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4.1.8 Silica Gel and Crushed Ice. Same as Method 5, Sections 3.1.2 and 3.1.4, respectively.

4.2 Pretest Preparation for Sampling Reagents.

4.2.1 Nitric Acid (HNO_3)/Hydrogen Peroxide (H_2O_2) Absorbing Solution, 5 Percent HNO_3/10 Percent H_2O_2. Add 50 ml of concentrated HNO_3 and 333 ml of 30 percent H_2O_2 to a 1000-ml volumetric flask or graduated cylinder containing approximately 500 ml of water. Dilute to volume with water. The reagent shall contain less than 2 ng/ml of each target metal.

4.2.2 Acidic Potassium Permanganate ($KMnO_4$) Absorbing Solution, 4 Percent $KMnO_4$ (W/V). Prepare fresh daily. Dissolve 40 g of $KMnO_4$ in sufficient 10 percent H_2SO_4 to make 1 liter. Prepare and store in glass bottles to prevent degradation. The reagent shall contain less than 2 ng/ml of Hg.

Precaution: To prevent autocatalytic decomposition of the permanganate solution, filter the solution through Whatman 541 filter paper. Also, due to reaction of the potassium permanganate with the acid, there may be pressure buildup in the sample storage bottle; these bottles should not be fully filled and should be vented both to relieve excess pressure and prevent explosion due to pressure buildup. Venting is highly recommended, but should not allow contamination of the sample; a No. 70-72 hole drilled in the container cap and Teflon liner has been used.

4.2.3 Nitric Acid, 0.1 N. Add 6.3 ml of concentrated HNO_3 (70 percent) to a graduated cylinder containing approximately 900 ml of water. Dilute to 1000 ml with water. Mix well. The reagent shall contain less than 2 ng/ml of each target metal.

4.2.4 Hydrochloric Acid (HCl), 8 N. Add 690 ml of concentrated HCl to a graduated cylinder containing 250 ml of water. Dilute to 1000 ml with water. Mix well. The reagent shall contain less than 2 ng/ml of Hg.

4.3 Glassware Cleaning Reagents.

4.3.1 Nitric Acid, Concentrated. Fisher ACS grade or equivalent.

4.3.2 Water. To conform to ASTM Specifications D1193-77, Type II.

4.3.3 Nitric Acid, 10 Percent (V/V). Add 500 ml of concentrated HNO_3 to a graduated cylinder containing approximately 4000 ml of water. Dilute to 5000 ml with water.

4.4 Sample Digestion and Analysis Reagents.

4.4.1 Hydrochloric Acid, Concentrated.

4.4.2 Hydrofluoric Acid, Concentrated.

4.4.3 Nitric Acid, Concentrated. Baker Instra-analyzed or equivalent.

4.4.4 Nitric Acid, 10 Percent (V/V). Add 100 ml of concentrated HNO_3 to 800 ml of water. Dilute to 1000 ml with water. Mix well. Reagent shall contain less than 2 ng/ml of each target metal.

4.4.5 Nitric Acid, 5 Percent (V/V). Add 50 ml of concentrated HNO_3 to 800 ml of water. Dilute to 1000 ml with water. Reagent shall contain less than 2 ng/ml of each target metal.

4.4.6 Water. To conform to ASTM Specifications D1193-77, Type II.

4.4.7 Hydroxylamine Hydrochloride and Sodium Chloride Solution. See EPA Method 7470 for preparation.

4.4.8 Stannous Chloride.

4.4.9 Potassium Permanganate, 5 Percent (W/V).

4.4.10 Sulfuric Acid, Concentrated.

4.4.11 Nitric Acid, 50 Percent (V/V).

4.4.12 Potassium Persulfate, 5 Percent (W/V).

4.4.13 Nickel Nitrate, $Ni(NO_3)_2 \cdot 6H_2O$.

4.4.14 Lanthanum Oxide, La_2O_3.

4.4.15 AAS Grade Hg Standard, 1000 ug/ml.

4.4.16 AAS Grade Pb Standard, 1000 ug/ml.

4.4.17 AAS Grade As Standard, 1000 ug/ml.

4.4.18 AAS Grade Cd Standard, 1000 ug/ml.

4.4.19 AAS Grade Cr Standard, 1000 ug/ml.

4.4.20 AAS Grade Sb Standard, 1000 ug/ml.

4.4.21 AAS Grade Ba Standard, 1000 ug/ml.

4.4.22 AAS Grade Be Standard, 1000 ug/ml.

4.4.23 AAS Grade Cu Standard, 1000 ug/ml.

4.4.24 AAS Grade Mn Standard, 1000 ug/ml.

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4.4.25 AAS Grade Ni Standard, 1000 ug/ml.

4.4.26 AAS Grade P Standard, 1000 ug/ml.

4.4.27 AAS Grade Se Standard, 1000 ug/ml.

4.4.28 AAS Grade Ag Standard, 1000 ug/ml.

4.4.29 AAS Grade Tl Standard, 1000 ug/ml.

4.4.30 AAS Grade Zn Standard, 1000 ug/ml.

4.4.31 AAS Grade Al Standard, 1000 ug/ml.

4.4.32 AAS Grade Fe Standard, 1000 ug/ml.

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4.4.33 The metals standards may also be made from solid chemicals as described in EPA Method 200.7. EPA Method 7470 or Standard Methods for the Analysis of Water and Wastewater. 15th Edition, Method 303F should be referred to for additional information on mercury standards.

4.4.34 Mercury Standards and Quality Control Samples. Prepare fresh weekly a 10 ug/ml intermediate mercury standard by adding 5 ml of 1000 ug/ml mercury stock solution to a 500 ml volumetric flask; dilute to 500 ml by first adding 20 ml of 15 percent HNO_3 and then adding water. Prepare a working mercury standard solution fresh daily: add 5 ml of the 10 ug/ml intermediate standard to a 250 ml volumetric flask and dilute to 250 ml with 5 ml of 4 percent $KMnO_4$, 5 ml of 15 percent HNO_3, and then water. At least six separate aliquots of the working mercury standard solution should be used to prepare the standard curve. These aliquots should contain 0.0, 1.0, 2.0, 3.0, 4.0, and 5.0 ml of the working standard solution. Quality control samples should be prepared by making a separate 10 ug/ml standard and diluting until in the range of the calibration.

4.4.35 ICAP Standards and Quality Control Samples. Calibration standards for ICAP analysis can be combined into four different mixed standard solutions as shown below.

MIXED STANDARD SOLUTIONS FOR ICAP ANALYSIS

Solution	Elements
I	As, Be, Cd, Mn, Pb, Se, Zn
II	Ba, Cu, Fe
III	Al, Cr, Ni
IV	Ag, P, Sb, Tl

Prepare these standards by combining and diluting the appropriate volumes of the 1000 ug/ml solutions with 5 percent nitric acid. A minimum of one standard and a blank can be used to form each calibration curve. However, a

separate quality control sample spiked with known amounts of the target metals in quantities in the midrange of the calibration curve should be prepared. Suggested standard levels are 50 ug/ml for Al, 25 ug/ml for Cr and Pb, 15 ug/ml for Fe, and 10 ug/ml for the remaining elements. Standards containing less than 1 ug/ml of metal should be prepared daily. Standards containing greater than 1 ug/ml of metal should be stable for a minimum of 1 to 2 weeks.

4.4.36 Graphite Furnace AAS Standards for Antimony, Arsenic, Cadmium, Lead, Selenium, and Thallium. Prepare a 10 ug/ml standard by adding 1 ml of 1000 ug/ml standard to a 100 ml volumetric flask. Dilute to 100 ml with 10 percent nitric acid. For graphite furnace AAS, the standards must be matrix matched; e.g., if the samples contain 6 percent nitric acid and 4 percent hydrofluoric acid, the standards should also be made up with 6 percent nitric acid and 4 percent hydrofluoric acid. Prepare a 100 ng/ml standard by adding 1 ml of the 10 ug/ml standard to a 100 ml volumetric flask and dilute to 100 ml with the appropriate matrix solution. Other standards should be prepared by dilution of the 100 ng/ml standards. At least five standards should be used to make up the standard curve. Suggested levels are 0, 10, 50, 75, and 100 ng/ml. Quality control samples should be prepared by making a separate 10 ug/ml standard and diluting until it is in the range of the samples. Standards containing less than 1 ug/ml of metal should be prepared daily. Standards containing greater than 1 ug/ml of metal should be stable for a minimum of 1 to 2 weeks.

4.4.37 Matrix Modifiers.

4.4.37.1 Nickel Nitrate, 1 Percent (V/V). Dissolve 4.956 g of $Ni(NO_3)_2 \cdot 6H_2O$ in approximately 50 ml of water in a 100 ml volumetric flask. Dilute to 100 ml with water.

4.4.37.2 Nickel Nitrate, One-tenth Percent (V/V). Dilute 10 ml of 1 percent nickel nitrate solution to 100 ml with water. Inject an equal amount of sample and this modifier into the graphite furnace during AAS analysis for As.

4.4.37.3 Lanthanum. Dissolve 0.5864 g of La_2O_3 in 10 ml of concentrated HNO_3 and dilute to 100 ml with water. Inject an equal amount of sample and this modifier into the graphite furnace during AAS analysis for Pb.

5. Procedure

5.1 Sampling. The complexity of this method is such that, to obtain reliable results, testers should be trained and experienced with the test procedures.

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5.1.1 Pretest Preparation. Follow the same general procedure given in Method 5, Section 4.1.1, except that, unless particulate emissions are to be determined, the filter need not be desiccated or weighed. All sampling train glassware should first be rinsed with hot tap water and then washed in hot soapy water. Next, glassware should be rinsed three times with tap water, followed by three additional rinses with water. All glassware should then be soaked in a 10 percent (V/V) nitric acid solution for a minimum of 4 hours, rinsed three times with water, rinsed a final time with acetone, and allowed to air dry. All glassware openings where contamination can occur should be covered until the sampling train is assembled, prior to sampling.

5.1.2 Preliminary Determinations. Same as Method 5, Section 4.1.2.

5.1.3 Preparation of Sampling Train. Follow the same general procedures given in Method 5, Section 4.1.3, except place 100 ml of the nitric acid/hydrogen peroxide solution (Section 4.2.1) in the two HNO_3/H_2O_2 impingers (normally the second and third impingers), place 100 ml of the acidic potassium permanganate solution (Section 4.2.2) in the fourth and fifth impinger, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the last impinger. Alternatively, the silica gel may be weighed directly in the impinger just prior to train assembly.

Several options are available to the tester based on the sampling conditions. The use of an empty first impinger can be eliminated if the moisture to be collected in the impingers is calculated or determined to be less than 150 ml. The tester shall include two impingers containing the acidic potassium permanganate solution for the first test run, unless past testing experience at the same or similar sources has shown that only one is necessary. The last permanganate impinger may be discarded if both permanganate impingers have retained their original deep purple permanganate color. A maximum of 200 ml in each permanganate impinger (and a maximum of three permanganate impingers) may be used, if necessary, to maintain the desired color in the last permanganate impinger.

Retain for reagent blanks, 100 ml of the nitric acid/hydrogen peroxide solution and 100 ml of the acidic potassium permanganate solution. These solutions should be labeled and treated as described in Section 7. Set up the sampling train as shown in Figure A-1. If necessary to ensure leak-free sampling train connections, Teflon tape should be used instead of silicone grease to prevent contamination.

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Precaution: Extreme care should be taken to prevent contamination within the train. Prevent the mercury collection reagent (acidic potassium permanganate) from contacting any glassware of the train which is washed and analyzed for Mn. Prevent hydrogen peroxide from mixing with the acidic potassium permanganate.

5.1.4 Leak-Check Procedures. Follow the leak-check procedures given in Method 5, Section 4.1.4.1 (Pretest Leak-Check), Section 4.1.4.2 (Leak-Checks During the Sample Run), and Section 4.1.4.3 (Post-Test Leak-Checks).

5.1.5 Sampling Train Operation. Follow the procedures given in Method 5, Section 4.1.5. For each run, record the data required on a data sheet such as the one shown in Figure 5-2 of Method 5.

5.1.6 Calculation of Percent Isokinetic. Same as Method 5, Section 4.1.6.

5.2 Sample Recovery. Begin cleanup procedures as soon as the probe is removed from the stack at the end of a sampling period.

The probe should be allowed to cool prior to sample recovery. When it can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a rinsed, non-contaminating cap over the probe nozzle to prevent losing or gaining particulate matter. Do not cap the probe tip tightly while the sampling train is cooling. This normally causes a vacuum to form in the filter holder, thus causing the undesired result of drawing liquid from the impingers into the filter.

Before moving the sampling train to the cleanup site, remove the probe from the sampling train and cap the open outlet. Be careful not to lose any condensate that might be present. Cap the filter inlet where the probe was fastened. Remove the umbilical cord from the last impinger and cap the impinger. Cap off the filter holder outlet and impinger inlet. Use non-contaminating caps, whether ground-glass stoppers, plastic caps, serum caps, or Teflon tape to close these openings.

Alternatively, the train can be disassembled before the probe and filter holder/oven are completely cooled, if this procedure is followed: Initially disconnect the filter holder outlet/impinger inlet and loosely cap the open ends. Then disconnect the probe from the filter holder or cyclone inlet and loosely cap the open ends. Cap the probe tip and remove the umbilical cord as previously described.

Transfer the probe and filter-impinger assembly to a cleanup area that is clean and protected from the wind and other potential causes of contamination

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or loss of sample. Inspect the train before and during disassembly and note any abnormal conditions. The sample is recovered and treated as follows (see schematic in Figure A-2). Assure that all items necessary for recovery of the sample do not contaminate it.

5.2.1 Container No. 1 (Filter). Carefully remove the filter from the filter holder and place it in its identified petri dish container. Acid-washed polypropylene or Teflon coated tweezers or clean, disposable surgical gloves rinsed with water should be used to handle the filters. If it is necessary to fold the filter, make certain the particulate cake is inside the fold. Carefully transfer the filter and any particulate matter or filter fibers that adhere to the filter holder gasket to the petri dish by using a dry (acid-cleaned) nylon bristle brush. Do not use any metal-containing materials when recovering this train. Seal the labeled petri dish.

5.2.2 Container No. 2 (Acetone Rinse). Taking care to see that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover particulate matter and any condensate from the probe nozzle, probe fitting, probe liner, and front half of the filter holder by washing these components with 100 ml of acetone and placing the wash in a glass container. Note: The use of exactly 100 ml is necessary for the subsequent blank correction procedures. Distilled water may be used instead of acetone when approved by the Administrator and shall be used when specified by the Administrator; in these cases, save a water blank and follow the Administrator's directions on analysis. Perform the acetone rinses as follows: Carefully remove the probe nozzle and clean the inside surface by rinsing with acetone from a wash bottle and brushing with a nonmetallic brush. Brush until the acetone rinse shows no visible particles, after which make a final rinse of the inside surface with acetone.

Brush and rinse the inside parts of the Swagelok fitting with acetone in a similar way until no visible particles remain.

Rinse the probe liner with acetone by tilting and rotating the probe while squirting acetone into its upper end so that all inside surfaces will be wetted with acetone. Allow the acetone to drain from the lower end into the sample container. A funnel may be used to aid in transferring liquid washings to the container. Follow the acetone rinse with a nonmetallic probe brush. Hold the probe in an inclined position, squirt acetone into the upper end as the probe brush is being pushed with a twisting action through the probe; hold a sample

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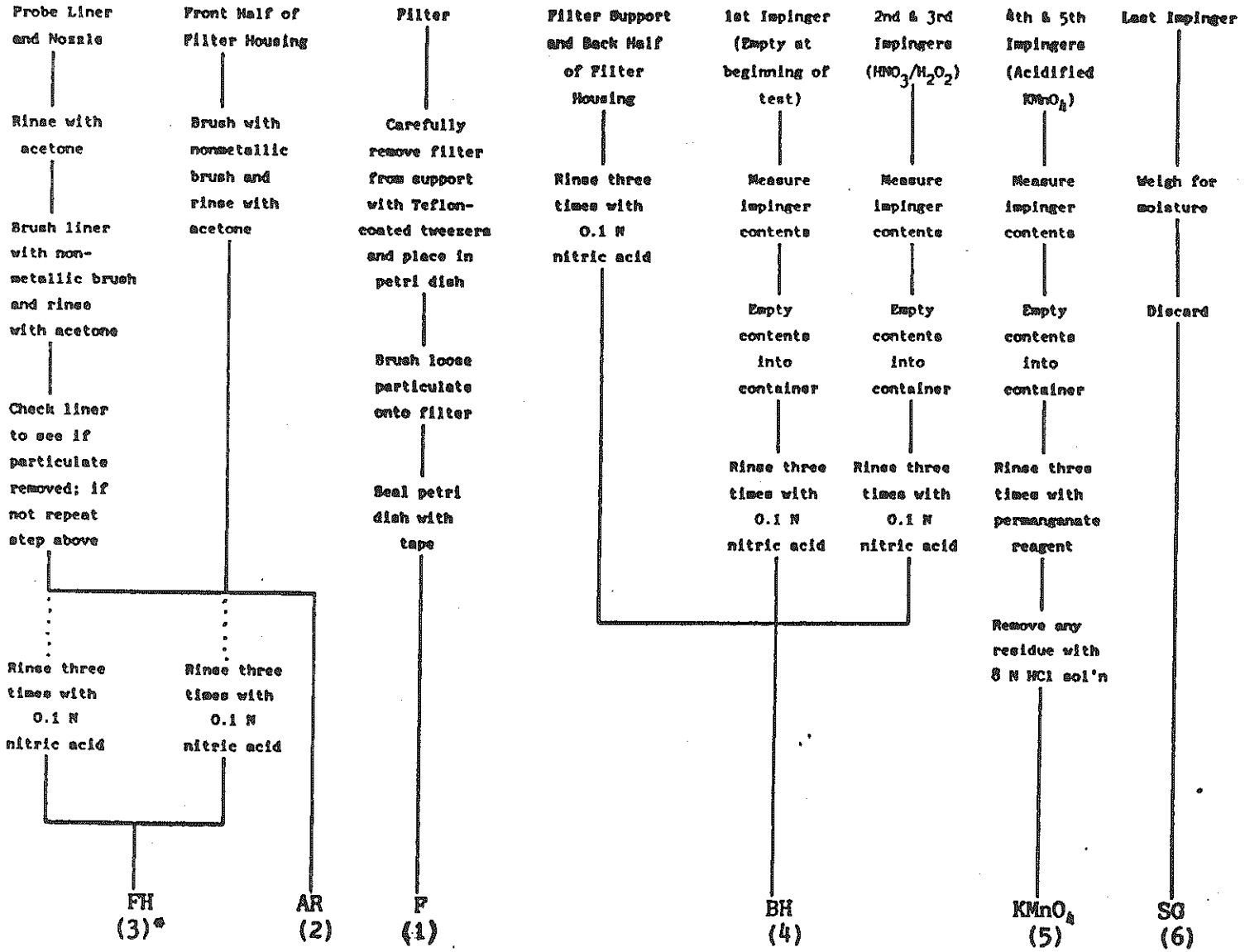

* Number in parantheses indicates container number.

Figure A-2. Sample recovery scheme.

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container underneath the lower end of the probe, and catch any acetone and particulate matter which is brushed through the probe three times or more until no visible particulate matter is carried out with the acetone or until none remains in the probe liner on visual inspection. Rinse the brush with acetone, and quantitatively collect these washings in the sample container. After the brushing, make a final acetone rinse of the probe as described above.

It is recommended that two people clean the probe to minimize sample losses. Between sampling runs, keep brushes clean and protected from contamination.

Clean the inside of the front half of the filter holder by rubbing the surfaces with a nonmetallic nylon bristle brush and rinsing with acetone. Rinse each surface three times or more if needed to remove visible particulate. Make a final rinse of the brush and filter holder. After all acetone washings and particulate matter have been collected in the sample container, tighten the lid on the sample container so that acetone will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether or not leakage occurred during transport. Label the container clearly to identify its contents.

5.2.3 Container No. 3 (Probe Rinse). Rinse the probe liner, probe nozzle, and front half of the filter holder thoroughly with 100 ml of 0.1 N nitric acid and place the wash into a sample storage container. Note: The use of exactly 100 ml is necessary for the subsequent blank correction procedures. Perform the rinses as described in Method 12, Section 5.2.2. Record the volume of the combined rinse. Mark the height of the fluid level on the outside of the storage container and use this mark to determine if leakage occurs during transport. Seal the container and clearly label the contents. Finally, rinse the nozzle, probe liner, and front half of the filter holder with water followed by acetone and discard these rinses.

5.2.4 Container No. 4 (Impingers 1 through 3, Contents and Rinses). Due to the large quantity of liquid involved, the tester may place the impinger solutions in more than one container. Measure the liquid in the first three impingers volumetrically to within 0.5 ml using a graduated cylinder. Record the volume of liquid present. This information is required to calculate the moisture content of the sampled flue gas. Clean each of the first three impingers, the filter support, the back half of the filter housing, and connecting glassware by thoroughly rinsing with 100 ml of 0.1 N nitric acid as

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described in Method 12, Section 5.2.4. Note: The use of exactly 100 ml of 0.1 N nitric acid rinse is necessary for the subsequent blank correction procedures. Combine the rinses and impinger solutions, measure and record the volume. Calculate the 0.1 N nitric acid rinse volume by difference. Mark the height of the fluid level on the outside of the container to determine if leakage occurs during transport. Seal the container and clearly label the contents.

5.2.5 Container No. 5 (Acidified Potassium Permanganate Solution and Rinses, Impingers No. 4 & 5). Pour all the liquid from the permanganate impingers (fourth and fifth, if two permanganate impingers are used) into a graduated cylinder and measure the volume to within 0.5 ml. This information is required to calculate the moisture content of the sampled flue gas. Using 100 ml total of the acidified potassium permanganate solution, rinse the permanganate impinger(s) and connecting glass pieces a minimum of three times. Combine the rinses with the permanganate impinger solution. Finally, rinse the permanganate impinger(s) and connecting glassware with 50 ml of 8 N HCl to remove any residue. Note: The use of exactly 100 ml and 50 ml for the two rinses is necessary for the subsequent blank correction procedures. Place the combined rinses and impinger contents in a labeled glass storage bottle. Mark the height of the fluid level on the outside of the bottle to determine if leakage occurs during transport. See the following note and the Precaution in Paragraph 4.2.2 and properly seal the bottle and clearly label the contents.

Note: Due to the potential reaction of the potassium permanganate with the acid, there may be pressure buildup in the sample storage bottles. These bottles should not be filled full and should be vented to relieve excess pressure. Venting is highly recommended. A No. 70-72 hole drilled in the container cap and Teflon liner has been found to allow adequate venting without loss of sample.

5.2.6 Container No. 6 (Silica Gel). Note the color of the indicating silica gel to determine whether it has been completely spent and make a notation of its condition. Transfer the silica gel from its impinger to its original container and seal. The tester may use a funnel to pour the silica gel and a rubber policeman to remove the silica gel from the impinger. The small amount of particles that may adhere to the impinger wall need not be removed. Do not use water or other liquids to transfer the silica gel since weight gained in the silica gel impinger is used for moisture calculations.

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Alternatively, if a balance is available in the field, record the weight of the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g.

5.2.7 Container No. 7 (Acetone Blank). Once during each field test, place 100 ml of the acetone used in the sample recovery process into a labeled container for use in the front half field reagent blank. Seal the container.

5.2.8 Container No. 8 (0.1 N Nitric Acid Blank). Once during each field test, place 200 ml of the 0.1 N nitric acid solution used in the sample recovery process into a labeled container for use in the front half and back half field reagent blanks. Seal the container.

5.2.9 Container No. 9 (5% Nitric Acid/10% Hydrogen Peroxide Blank). Once during each field test, place 200 ml of the 5% nitric acid/10% hydrogen peroxide solution used as the nitric acid impinger reagent into a labeled container for use in the back half field reagent blank. Seal the container.

5.2.10 Container No. 10 (Acidified Potassium Permanganate Blank). Once during each field test, place 300 ml of the acidified potassium permanganate solution used as the impinger solution and in the sample recovery process into a labeled container for use in the back half field reagent blank for mercury analysis. Seal the container.

Note: This container should be vented, as described in Section 5.2.4, to relieve excess pressure.

5.2.11 Container No. 11 (8 N HCl Blank). Once during each field test, place 50 ml of the 8 N hydrochloric acid used to rinse the acidified potassium permanganate impingers into a labeled container for use in the back half reagent blank for mercury.

5.2.12 Container No. 12 (Filter Blank). Once during each field test, place an unused filter from the same lot as the sampling filters in a labeled petri dish. Seal the petri dish. This will be used in the front half field reagent blank.

5.3 Sample Preparation. Note the level of the liquid in each of the containers and determine if any sample was lost during shipment. If a noticeable amount of leakage has occurred, either void the sample or use methods, subject to the approval of the Administrator, to correct the final results. A diagram illustrating sample preparation and analysis procedures for each of the sample train components is shown in Figure A-3.

5.3.1 Container No. 1 (Filter). If particulatre emissions are being determined, then desiccate the filter and filter catch without heat and weigh to

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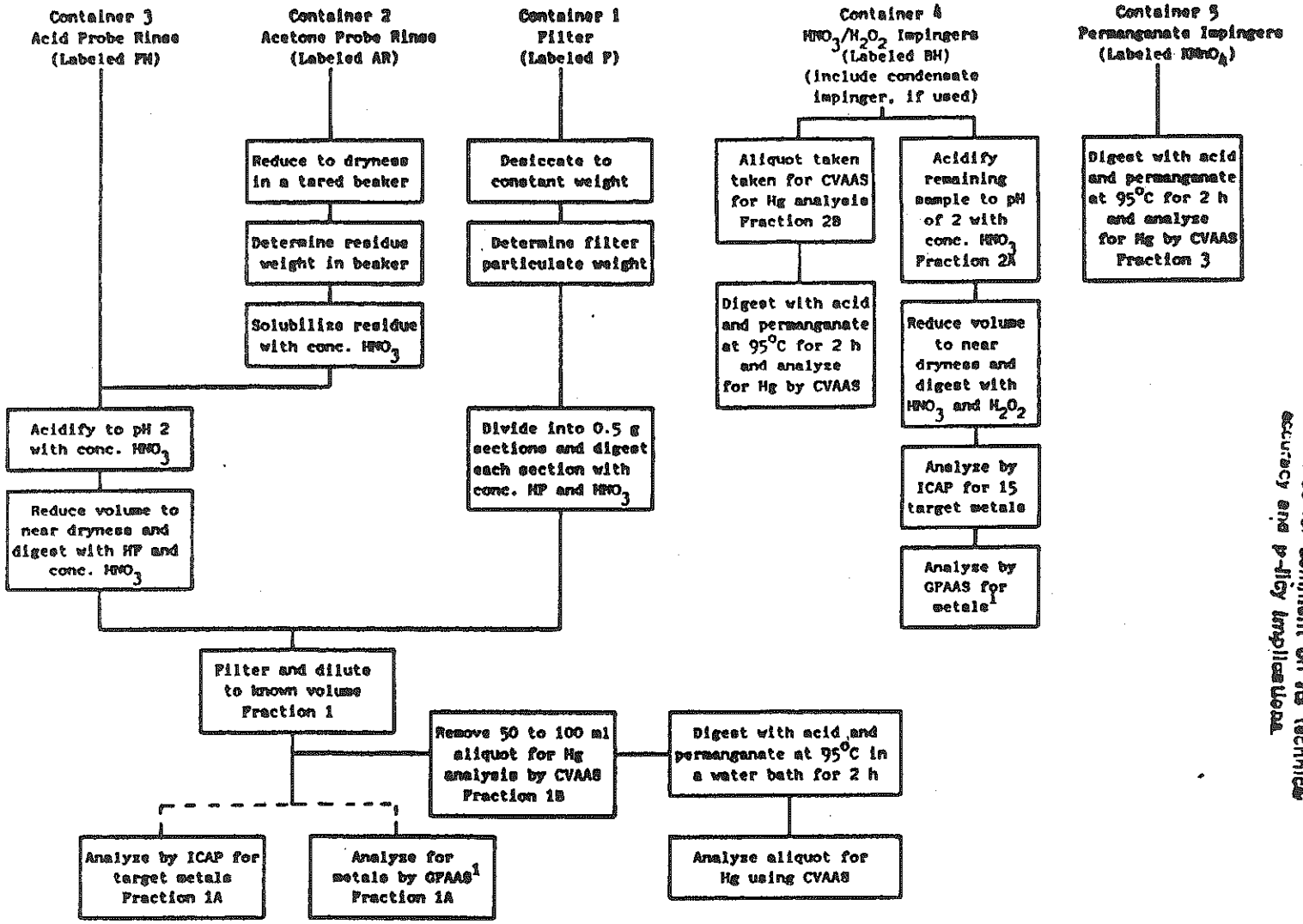

[1]Analysis by AAS for metals found at less than 2 ug/ml in digestate solution, if desired. Or analyze for each metal by AAS, if desired.

Figure A-3. Sample preparation and analysis scheme.

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a constant weight as described in Section 4.3 of Method 5. For analysis of metals, divide the filter with its filter catch into portions containing approximately 0.5 g each and place into the analyst's choice of either individual microwave pressure relief vessels or Parr® Bombs. Add 6 ml of concentrated nitric acid and 4 ml of concentrated hydrofluoric acid to each vessel. For microwave heating, microwave the sample vessels for approximately 12-15 minutes in intervals of 1 to 2 minutes at 600 Watts. For conventional heating, heat the Parr Bombs at 140°C (285°F) for 6 hours. Then cool the samples to room temperature and combine with the acid digested probe rinse as required in Section 5.3.3, below.

Notes: 1. Suggested microwave heating times are approximate and are dependent upon the number of samples being digested. Twelve to 15 minute heating times have been found to be acceptable for simultaneous digestion of up to 12 individual samples. Sufficient heating is evidenced by sorbent reflux within the vessel.

2. If the sampling train uses an optional cyclone, the cyclone catch should be prepared and digested using the same procedures described for the filters and combined with the digested filter samples.

5.3.2 Container No. 2 (Acetone Rinse). Note the level of liquid in the container and confirm on the analysis sheet whether or not leakage occurred during transport. If a noticeable amount of leakage has occurred, either void the sample or use methods, subject to the approval of the Administrator, to correct the final results. Measure the liquid in this container either volumetrically to ±1 ml or gravimetrically to ±0.5 g. Transfer the contents to an acid-cleaned tared 250-ml beaker and evaporate to dryness at ambient temperature and pressure. If particulate emissions are being determined, desiccate for 24 hours without heat, weigh to a constant weight according to the procedures described in Section 4.3 of Method 5, and report the results to the nearest 0.1 mg. Resolubilize the residue with concentrated nitric acid and combine the resultant sample including all liquid and any particulate matter with Container No. 3 prior to beginning the following Section 5.3.3.

5.3.3 Container No. 3 (Probe Rinse). The pH of this sample shall be 2 or lower. If the pH is higher, the sample should be acidified with concentrated nitric acid to pH 2. The sample should be rinsed into a beaker with water and the beaker should be covered with a ribbed watchglass. The sample volume should be reduced to approximately 50 ml by heating on a hot plate at a temperature

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just below boiling. Inspect the sample for visible particulate matter, and depending on the results of the inspection, perform one of the following. If no particulate matter is observed, combine the sample directly with the acid digested portions of the filter prepared previously in Section 5.3.1. If particulate matter is observed, digest the sample in microwave vessels or Parr® Bombs following the procedures described in Section 5.3.1; then combine the resultant sample directly with the acid digested portions of the filter prepared previously in Section 5.3.1. The resultant combined sample is referred to as Fraction 1. Filter the combined solution of the acid digested filter and probe rinse samples using Whatman 541 filter paper. Dilute to 300 ml (or the appropriate volume for the expected metals concentration) with water. Measure and record the combined volume of the Fraction 1 solution to within 0.1 ml. Quantitatively remove a 50 ml aliquot and label as Fraction 1B. Label the remaining 250 ml portion as Fraction 1A. Fraction 1A is used for ICAP or AAS analysis. Fraction 1B is used for the determination of front half mercury.

5.3.4 Container No. 4 (Impingers 1-3). Measure and record the total volume of this sample (Fraction 2) to within 0.5 ml. Remove a 50 ml aliquot for mercury analysis and label as Fraction 2B. Label the remaining portion of Container No. 4 as Fraction 2A. The Fraction 2B aliquot should be prepared and analyzed as described in Section 5.4.3. Fraction 2A shall be pH 2 or lower. If necessary, use concentrated nitric acid to lower Fraction 2A to pH 2. The sample should be rinsed into a beaker with water and the beaker should be covered with a ribbed watchglass. The sample volume should be reduced to approximately 20 ml by heating on a hot plate at a temperature just below boiling. Then follow either of the digestion procedures described in Sections 5.3.4.1 and 5.3.4.2, below.

5.3.4.1 Conventional Digestion Procedure. Add 30 ml of 50 percent nitric acid and heat for 30 minutes on a hot plate to just below boiling. Add 10 ml of 3 percent hydrogen peroxide and heat for 10 more minutes. Add 50 ml of hot water and heat the sample for an additional 20 minutes. Cool, filter the sample, and dilute to 150 ml (or the appropriate volume for the expected metals concentrations) with water.

5.3.4.2 Microwave Digestion Procedure. Add 10 ml of 50 percent nitric acid and heat for 6 minutes in intervals of 1 to 2 minutes at 600 Watts. Allow the sample to cool. Add 10 ml of 3 percent hydrogen peroxide and heat for 2 more minutes. Add 50 ml of hot water and heat for an additional 5 minutes.

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Cool, filter the sample, and dilute to 150 ml (or the appropriate volume for the expected metals concentrations) with water.

Note: All microwave heating times given are approximate and are dependent upon the number of samples being digested at a time. Heating times as given above have been found acceptable for simultaneous digestion of up to 12 individual samples. Sufficient heating is evidenced by solvent reflux within the vessel.

5.3.5 Container No. 5 (Impingers 4 & 5). Measure and record the total volume of this sample to within 0.5 ml. This sample is referred to as Fraction 3. Follow the analysis procedures described in Section 5.4.3.

5.3.6 Container No. 6 (Silica Gel). Weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g using a balance. (This step may be conducted in the field.)

5.4 Sample Analysis. For each sampling train, five individual samples are generated for analysis. A schematic identifying each sample and the prescribed sample preparation and analysis scheme is shown in Figure A-3. The first two samples, labeled Fractions 1A and 1B, consist of the digested samples from the front half of the train. Fraction 1A is for ICAP or AAS analysis as described in Sections 5.4.1 and/or 5.4.2. Fraction 1B is for determination of front half mercury as described in Section 5.4.3.

The back half of the train was used to prepare the third through fifth samples. The third and fourth samples, labeled Fractions 2A and 2B, contain the digested samples from the H_2O and HNO_3/H_2O_2 Impingers 1 through 3. Fraction 2A is for ICAP or AAS analysis. Fraction 2B will be analyzed for mercury.

The fifth sample, labeled Fraction 3, consists of the impinger contents and rinses from the permanganate Impingers 4 and 5. This sample is analyzed for mercury as described in Section 5.4.3. The total back half mercury catch is determined from the sum of Fraction 2B and Fraction 3.

5.4.1 ICAP Analysis. Fraction 1A and Fraction 2A are analyzed by ICAP using EPA Method 200.7 (40 CFR 136, Appendix C). Calibrate the ICAP, and set up an analysis program as described in Method 200.7. The quality control procedures described in Section 7.3.1 of this method shall be followed. Recommended wavelengths for use in the analysis are listed below.

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Element	Wavelength (nm)
Aluminum	308.215
Antimony	206.833
Arsenic	193.696
Barium	455.403
Beryllium	313.042
Cadmium	226.502
Chromium	267.716
Copper	324.754
Iron	259.940
Lead	220.353
Manganese	257.610
Nickel	231.604
Selenium	196.026
Silver	328.068
Thallium	190.864
Zinc	213.856

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The wavelengths listed are recommended because of their sensitivity and overall acceptance. Other wavelengths may be substituted if they can provide the needed sensitivity and are treated with the same corrective techniques for spectral interference.

Initially, analyze all samples for the target metals plus iron and aluminum. If iron and aluminum are present in the sample, the sample may have to be diluted so that each of these elements is at a concentration of less than 50 ppm to reduce their spectral interferences on arsenic and lead.

Note: When analyzing samples in a hydrofluoric acid matrix, an alumina torch should be used; since all front half samples will contain hydrofluoric acid, use an alumina torch.

5.4.2 AAS by Direct Aspiration and/or Graphite Furnace. If analysis of metals in Fraction 1A and Fraction 2A using graphite furnace or direct aspiration AAS is desired, Table A-2 should be used to determine which techniques and methods should be applied for each target metal. Table A-2 should also be consulted to determine possible interferences and techniques to be followed for their minimization. Calibrate the instrument according to Section 6.3 and follow the quality control procedures specified in Section 7.3.2.

5.4.3 Cold Vapor AAS Mercury Analysis. Fraction 1B, Fraction 2B, and Fraction 3 should be analyzed for mercury using cold vapor atomic absorption spectroscopy following the method outlined in EPA Method 7470 or in Standard Methods for Water and Wastewater Analysis, 15th Edition, Method 303F. Set up

TABLE A-2. APPLICABLE TECHNIQUES, METHODS, AND MINIMIZATION OF INTEFERENCE FOR AAS ANALYSIS

Metal	Technique	Method No.	Wavelength (nm)	Interference	
				Cause	Minimization
Sb	Aspiration	7040	217.6	1000 mg/ml Pb Ni, Cu, or acid	Use secondary wavelenght of 231.1 nm. Match sample & standards acid concentration or use nitrous oxide/acetylene flame
Sb	Furnace	7041	217.6	High Pb	Secondary wavelength or Zeeman correction
As	Furnace	7060	193.7	Arsenic volati - zation Aluminium	Spiked samples & add nickel nitrate solution to digestates prior to analyses Use Zeeman background correction
Ba	Aspiration	7080	553.6	Calcium Barium ionization	High hollow cathode current & narrow band set 2 mL of KCl per 100 mL of sample
Be	Aspiration	7090	234.9	500 ppm Al High Mg & Si	Add 0.1% fluoride Use method of standard additions
Be	Furnace	7091	234.9	Be in optical path	Optimize parameters to miminize effects
Cd	Aspiration	7130	228.8	Absorption & light scattering	Background correction is required
Cd	Furnace	7131	228.8	As above Excess chloride Pipet tips	As above Ammonium phosphate used as a matrix modifier Use cadmium-free tips
Cr	Aspiration	7190	357.9	Alkali metal Absorption & scatt	KCl ionization suppressant in sample & stand Consult manufacturer's literature
Cr	Furnace	7191	357.9	200 mg/L calcium & phosphate	All calcium nitrate for a know constant effect and to eliminate effect of phosphate

(continued)

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TABLE A-2 (CONTINUED)

Metal	Technique	Method No.	Wavelength (nm)	Interference	
				Cause	Minimization
Cu	Aspiration	7210	324.7	Absorpt & scatter	Consult manufacturer's manual
Fe	Aspiration	7380	248.3	Contamination	Great care taken to aviod contamination
Pb	Aspiration	7420	283.3	217.0 nm alternat	Background correction required
Pb	Furnace	7421	283.3	Poor recoveries	Matrix modifier, add 10 uL of phosphorus acid to 1-mL of prepared sample in sampler cup
Mn	Aspiration	7460	279.5	403.1 nm alternat	Background correction required
Ni	Aspiration	7520	232.0	352.4 nm alternat	Background correction required
				Fe, Co, & Cr	Matrix matching or a nitrous-oxide/acety flame
				Nonlinear respons	Sample dilution or use 352.4 nm line
Se	Furnace	7740	196.0	Volitality	Spike samples & reference materials & add nickel nitrate to minimize volatilization
				Adsorpt & scatter	Background correction is required & Zeeman background correction can be useful
Ag	Aspiration	7760	328.1	Absorpt & scatter	Background correction is required
				AgCl insoluble	Avoid hydrochloric acid unless silver is in solution as a chloride complex
				Viscosity	Sample & standards monitored for apiration rate
Tl	Aspiration	7840	276.8		Background correction is required Hydrochloric acid should not be used
Tl	Furnace	7841	276.8	Hydrochloric acid or chloride	Background correction is required Verify that losses are not occuring for volitization by spiked samples or standad addt Palladium is a suitable matrix modifier
Zn	Aspiration	7950	213.9	High Si, Cu & P	Strontium removes Cu and phosphate
				Contamination	Care should be taken to avid contamination

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the calibration curve as described in Section 7.3 of Method 303F. Add approximately 5 ml of each sample to BOD bottles. Record the amount of sample added. The amount used is dependent upon the expected levels of mercury. Dilute to approximately 120 ml with mercury-free water. Add approximately 15 ml of 5 percent potassium permanganate solution to the Fraction 2B and Fraction 3 samples. Add 5 percent potassium permanganate solution to the Fraction 1B sample as needed to produce a purple solution lasting at least 15 minutes. A minimum of 25 ml is suggested. Add 5 ml of 50 percent nitric acid, 5 ml of concentrated sulfuric acid, and 9 ml of 5 percent potassium persulfate to each sample and each standard. Digest the solution in the capped BOD bottle at 95°C (205°F) in a convection oven or water bath for 2 hours. Cool. Add 5 ml of hydroxylamine hydrochloride solution and mix the sample. Then add 7 ml of stannous chloride to each sample and analyze immediately.

6. Calibration

Maintain a laboratory log of all calibrations.

6.1 Sampling Train Calibration. Calibrate the sampling train components according to the indicated sections of Method 5: Probe Nozzle (Section 5.1); Pitot Tube (Section 5.2); Metering System (Section 5.3); Probe Heater (Section 5.4); Temperature Gauges (Section 5.5); Leak-Check of the Metering System (Section 5.6); and Barometer (Section 5.7).

6.2 Inductively Coupled Argon Plasma Spectrometer Calibration. Prepare standards as outlined in Section 4.4. Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures using the above standards. The instrument calibration should be checked once per hour. If the instrument does not reproduce the concentrations of the standard within 10 percent, the complete calibration procedures should be performed.

6.3 Atomic Absorption Spectrometer - Direct Aspiration, Graphite Furnace and Cold Vapor Mercury Analyses. Prepare the standards as outlined in Section 4.4. Calibrate the spectrometer using these prepared standards. Calibration procedures are also outlined in the EPA methods referred to in Table A-2 and in Standard Methods for Water and Wastewater, 15th Edition, Method 303F (for mercury). Each standard curve should be run in duplicate and the mean values used to calculate the calibration line. The instrument should be recalibrated approximately once every 10 to 12 samples.

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7. Quality Control

7.1 Sampling. Field Reagent Blanks. The blank samples in Container Numbers 7 through 12 produced previously in Sections 5.2.7 through 5.2.11, respectively, shall be processed, digested, and analyzed as follows. Digest and process Container No. 12 contents per Section 5.3.1, Container No. 7 per Section 5.3.2, and half of Container No. 8 per Section 5.3.3. This produces Fraction Blank 1A and Fraction Blank 1B from Fraction Blank 1. Combine the remaining half of Container No. 8 with the contents of Container No. 9 and digest and process the resultant volume per Section 5.3.4. This produces Fraction Blank 2A and Fraction Blank 2B from Fraction Blank 2. Container No. 10 and Container No. 11 contents are Fraction Blank 3. Analyze Fraction Blank 1A and Fraction Blank 2A per Section 5.4.1 and/or 5.4.2. Analyze Fraction Blank 1B, Fraction Blank 2B, and Fraction Blank 3 per Section 5.4.3. The analysis of Fraction Blank 1A produces the front half reagent blank correction values for the metals except mercury; the analysis of Fraction Blank 1B produces the front half reagent blank correct value for mercury. The analysis of Fraction Blank 2A produces the back half reagent blank correction values for the metals except mercury, while separate analysis of Fraction Blanks 2B and 3 produce the back half reagent blank correction value for mercury.

7.2 An attempt may be made to determine if the laboratory reagents used in Section 5.3 caused contamination. They should be analyzed by the procedures in Section 5.4. The Administrator will determine whether or not the laboratory blank reagent values can be used in the calculation of the stationary source test results.

7.3 Quality Control Samples. The following quality control samples should be analyzed.

7.3.1 ICAP Analysis. Follow the quality control shown in Section 8 of Method 6010. For the purposes of a three run test series, these requirements have been modified to include the following: two instrument check standard runs, two calibration blank runs, one interference check sample at the beginning of the analysis (must be within 25% or analyze by standard addition), one quality control sample to check the accuracy of the calibration standards (must be within 25% of calibration), and one duplicate analysis (must be within 5% of average or repeat all analysis).

7.3.2 Direct Aspiration and/or Graphite Furnace AAS Analysis for Antimony, Arsenic, Barium, Beryllium, Cadmium, Copper, Chromium, Lead, Nickel, Manganese,

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Mercury, Phosphorus, Selenium, Silver, Thallium, and Zinc. All samples should be analyzed in duplicate. Perform a matrix spike on one front half sample and one back half sample or one combined sample. If recoveries of less than 75 percent or greater than 125 percent are obtained for the matrix spike, analyze each sample by the method of additions. A quality control sample should be analyzed to check the accuracy of the calibration standards. The results must be within 10% or the calibration repeated.

7.3.3 Cold Vapor AAS Analysis for Mercury. All samples should be analyzed in duplicate. A quality control sample should be analyzed to check the accuracy of the calibration standards (within 10% or repeat calibration). Perform a matrix spike on one sample from the nitric impinger portion (must be within 25% or samples must be analyzed by the method of standard additions). Additional information on quality control can be obtained from EPA Method 7470 or in Standard Methods for Water and Wastewater, 15th Edition, Method 303F.

8. Calculations

8.1 Dry Gas Volume. Using the data from this test, calculate $V_{m(std)}$, the dry gas sample volume at standard conditions as outlined in Section 6.3 of Method 5.

8.2 Volume of Water Vapor and Moisture Content. Using the data obtained from this test, calculate the volume of water vapor $V_{w(std)}$ and the moisture content B_{ws} of the stack gas. Use Equations 5-2 and 5-3 of Method 5.

8.3 Stack Gas Velocity. Using the data from this test and Equation 2-9 of Method 2, calculate the average stack gas velocity.

8.4 Metals (Except Mercury) in Source Sample.

8.4.1 Fraction 1A, Front Half, Metals (except Hg). Calculate the amount of each metal collected in Fraction 1 of the sampling train using the following equation:

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$$M_{fh} = C_a F_d V_{soln,1} \qquad \text{Eq. 1*}$$

*If Fractions 1A and 2A are combined, proportional aliquots must be used. Appropriate changes must be made in Equations 1-3 to reflect this approach.

where:

M_{fh} = total mass of each metal (except Hg) collected in the front half of the sampling train (Fraction 1), ug.
C_a = concentration of metal in sample Fraction 1A as read from the standard curve (ug/ml).
F_d = dilution factor (F_d = the inverse of the fractional portion of the concentrated sample in the solution actually used in the instrument to produce the reading C_a. For example, when the dilution of Fraction 1A is from 2 to 10 ml, F_d = 5).
$V_{soln,1}$ = total volume of digested sample solution (Fraction 1), ml.

8.4.2 Fraction 2A, Back Half, Metals (except Hg). Calculate the amount of each metal collected in Fraction 2 of the sampling train using the following equation.

$$M_{bh} = C_a F_a V_a \qquad \text{Eq. 2*}$$

where:

M_{bh} = total mass of each metal (except Hg) collected in the back half of the sampling train (Fraction 2), ug.
C_a = concentration of metal in sample Fraction 2A, as read from the standard curve (ug/ml).
F_a = aliquot factor, volume of Fraction 2 divided by volume of aliquot Fraction 2A.
V_a = volume of digested sample analyzed (concentrated Fraction 2A), ml.

8.4.3 Total Train, Metals (except Hg). Calculate the total amount of each of the quantified metals collected in the sampling train as follows:

$$M_t = (M_{fh} - M_{fhb}) + (M_{bh} - M_{bhb}) \qquad \text{Eq. 3*}$$

where:

M_t = total mass of each metal (separately stated for each metal) collected in the sampling train, ug.
M_{fhb} = blank correction value for mass of metal detected in front half field reagent blank, ug.
M_{bhb} = blank correction value for mass of metal detected in back half field reagent blank, ug.

*If Fractions 1A and 2A are combined, proportional aliquots must be used. Appropriate changes must be made in Equations 1-3 to reflect this approach.

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Note: If the measured blank value for the front half (m_{fhb}) is in the range 0.0 to A ug [where A ug equals the value determined by multiplying 1.4 ug per square inch (1.4 ug/in.^{2}) times the actual area in square inches (in.^{2}) of the filter used in the emission sample], m_{fhb} may be used to correct the emission sample value (m_{fh}); if m_{fhb} exceeds A ug, the greater of the two following values (either I. or II.) may be used:

I. A ug, or

II. the lesser of (a) m_{fhb}, or (b) 5 percent of m_{fh}.

If the measured blank value for the back half (m_{bhb}) is in the range 0.0 to 1 ug, m_{bhb} may be used to correct the emission sample value (m_{bh}); if m_{bhb} exceeds 1 ug, the greater of the two following values may be used: 1 ug or 5 percent of m_{bh}.

8.5 Mercury in Source Sample.

8.5.1 Fraction 1B, Front Half, Hg. Calculate the amount of mercury collected in the front half, Fraction 1, of the sampling train using the following equation:

$$Hg_{fh} = \frac{Q_{fh}}{V_{f1B}} \times V_{soln,1} \qquad \text{Eq. 4}$$

where:

Hg_{fh} = total mass of mercury collected in the front half of the sampling train (Fraction 1), ug.
Q_{fh} = quantity of mercury in analyzed sample, ug.
$V_{soln,1}$ = total volume of digested sample solution (Fraction 1), ml.
V_{f1B} = volume of Fraction 1B analyzed, ml. See the following Note.

Note: V_{f1B} is the actual amount of Fraction 1B analyzed. For example, if 1 ml of Fraction 1B were diluted to 100 ml to bring it into the proper analytical range, and 1 ml of the 100 ml dilution was analyzed, V_{f1B} would be 0.01.

8.5.2 Fraction 2B and Fraction 3, Back Half, Hg. Calculate the amount of mercury collected in Fractions 2 and 3 using Equations 5 and 6, respectively. Calculate the total amount of mercury collected in the back half of the sampling train using Equation 7.

$$Hg_{bh2} = \frac{Q_{bh2}}{V_{f1B}} \times V_{soln,2} \qquad \text{Eq. 5}$$

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where:

Hg_{bh2} = total mass of mercury collected in Fraction 2, ug.
Q_{bh2} = quantity of mercury in analyzed sample, ug.
V_{f2B} = volume of Fraction 2B analyzed, ml (see Note in Section 8.5.1).
$V_{soln,2}$ = total volume of Fraction 2, ml.

$$Hg_{bh3} = \frac{Q_{bh3}}{V_{f2B}} \times V_{soln,3} \qquad \text{Eq. 6}$$

where:

Hg_{bh3} = total mass of mercury collected in Fraction 3, ug.
Q_{bh3} = quantity of mercury in analyzed sample, ug.
V_{f3} = volume of Fraction 3 analyzed, ml (see Note in Section 8.5.1).
$V_{soln,3}$ = total volume of Fraction 3, ml.

$$Hg_{bh} = Hg_{bh2} + Hg_{bh3} \qquad \text{Eq. 7}$$

where:

Hg_{bh} = total mass of mercury collected in the back half of the sampling train, ug.

8.5.3 Total Train Mercury Catch. Calculate the total amount of mercury collected in the sampling train using Equation 8.

$$M_t = (Hg_{fh} - Hg_{fhb}) + (Hg_{bh} - Hg_{bhb}) \qquad \text{Eq. 8}$$

where:

M_t = total mass of mercury collected in the sampling train, ug.
Hg_{fhb} = blank correction value for mass of mercury detected in front half field reagent blank, ug.
Hg_{bhb} = blank correction value for mass of mercury detected in back half field reagent blank, ug.

Note: If the total of the measured blank values ($Hg_{fhb} + Hg_{bhb}$) is in the range of 0 to 3 ug, then the total may be used to correct the emission sample value ($Hg_{fh} + Hg_{bh}$); if it exceeds 3 ug, the greater of the following two values may be used: 3 ug or 5 percent of the emission sample value ($Hg_{fh} + Hg_{bh}$).

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8.6 Metal Concentration of Stack Gas. Calculate the cadmium, total chromium, arsenic, nickel, manganese, beryllium, copper, lead, phosphorus, thallium, silver, barium, zinc, selenium, antimony, and mercury concentrations in the stack gas (dry basis, adjusted to standard conditions) as follows:

$$C_s = K_4 \ (M_t / V_{m(std)}) \qquad \text{Eq.9}$$

where:

C_s = concentration of each metal in the stack gas, mg/dscm.
K_4 = 10^{-3} mg/ug.
M_t = total mass of each metal collected in the sampling train, ug.
$V_{m(std)}$ = volume of gas sample as measured by the dry gas meter, corrected to dry standard conditions, dscm.

8.7 Isokinetic Variation and Acceptable Results. Same as Method 5, Sections 6.11 and 6.12, respectively.

9. Bibliography

9.1 Method 303F in Standard Methods for the Examination of Water Wastewater, 15th Edition, 1980. Available from the American Public Health Association, 1015 18th Street N.W., Washington, D.C. 20036.

9.2 EPA Methods 6010, 7000, 7041, 7060, 7131, 7421, 7470, 7740, and 7841, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. SW-846, Third Edition. September 1988. Office of Solid Waste and Emergency Response, U. S. Environmental Protection Agency, Washington, D.C. 20460.

9.3 EPA Method 200.7, Code of Federal Regulations, Title 40, Part 136, Appendix C. July 1, 1987.

9.4 EPA Methods 1 through 5, Code of Federal Regulations, Title 40, Part 60, Appendix A, July 1, 1987.

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EPA METHOD 10

0173L

METHOD 10—DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES

1. *Principle and Applicability.*

1.1 *Principle.* An integrated or continuous gas sample is extracted from a sampling point and analyzed for carbon monoxide (CO) content using a Luft-type nondispersive infrared analyzer (NDIR) or equivalent.

1.2 *Applicability.* This method is applicable for the determination of carbon monoxide emissions from stationary sources only when specified by the test procedures for determining compliance with new source performance standards. The test procedure will indicate whether a continuous or an integrated sample is to be used.

2. *Range and sensitivity.*

2.1 *Range.* 0 to 1,000 ppm.

2.2 *Sensitivity.* Minimum detectable concentration is 20 ppm for a 0 to 1,000 ppm span.

3. *Interferences.* Any substance having a strong absorption of infrared energy will interfere to some extent. For example, discrimination ratios for water (H_2O) and carbon dioxide (CO_2) are 3.5 percent H_2O per 7 ppm CO and 10 percent CO_2 per 10 ppm CO, respectively, for devices measuring in the 1,500 to 3,000 ppm range. For devices measuring in the 0 to 100 ppm range, interference ratios can be as high as 3.5 percent H_2O per 25 ppm CO and 10 percent CO_2 per 50 ppm CO. The use of silica gel and ascarite traps will alleviate the major interference problems. The measured gas volume must be corrected if these traps are used.

4. *Precision and accuracy.*

4.1 *Precision.* The precision of most NDIR analyzers is approximately ±2 percent of span.

4.2 *Accuracy.* The accuracy of most NDIR analyzers is approximately ±5 percent of span after calibration.

5. *Apparatus.*

5.1 *Continuous sample* (Figure 10-1).

5.1.1 *Probe.* Stainless steel or sheathed Pyrex[1] glass, equipped with a filter to remove particulate matter.

5.1.2 *Air-cooled condenser or equivalent.* To remove any excess moisture.

5.2 *Integrated sample* (Figure 10-2).

5.2.1 *Probe.* Stainless steel or sheathed Pyrex glass, equipped with a filter to remove particulate matter.

5.2.2 *Air-cooled condenser or equivalent.* To remove any excess moisture.

5.2.3 *Valve.* Needle valve, or equivalent, to to adjust flow rate.

5.2.4 *Pump.* Leak-free diaphragm type, or equivalent, to transport gas.

5.2.5 *Rate meter.* Rotameter, or equivalent, to measure a flow range from 0 to 1.0 liter per min. (0.035 cfm).

5.2.6 *Flexible bag.* Tedlar, or equivalent, with a capacity of 60 to 90 liters (2 to 3 ft^3). Leak-test the bag in the laboratory before using by evacuating bag with a pump fol-

[1]Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

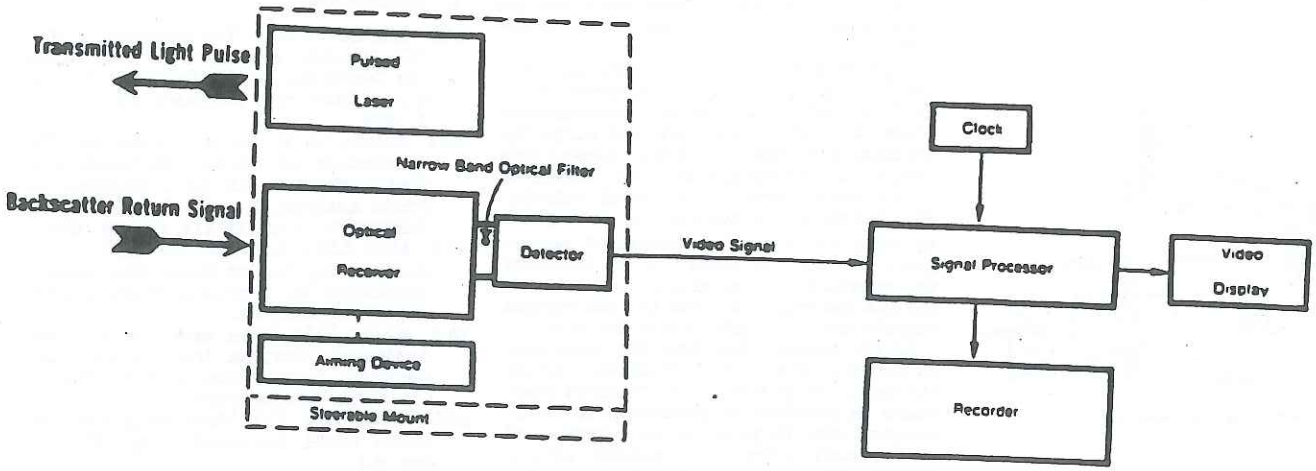

Figure AM1-VII. Functional Block Diagram of a Basic Lidar System

lowed by a dry gas meter. When evacuation is complete, there should be no flow through the meter.

5.2.7 *Pitot tube.* Type S, or equivalent, attached to the probe so that the sampling rate can be regulated proportional to the stack gas velocity when velocity is varying with the time or a sample traverse is conducted.

5.3 *Analysis* (Figure 10-3).

5.3.1 *Carbon monoxide analyzer.* Nondispersive infrared spectrometer, or equivalent. This instrument should be demonstrated, preferably by the manufacturer, to meet or exceed manufacturer's specifications and those described in this method.

5.3.2 *Drying tube.* To contain approximately 200 g of silica gel.

5.3.3 *Calibration gas.* Refer to paragraph 6.1.

5.3.4 *Filter.* As recommended by NDIR manufacturer.

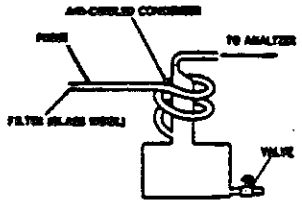

Figure 10-1. Continuous sampling train.

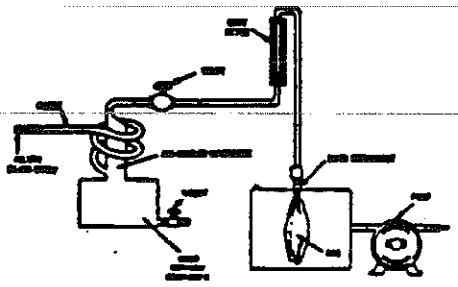

Figure 10-2. Integrated gas sampling train.

5.3.5 CO_2 removal tube. To contain approximately 500 g of ascarite.

5.3.6 *Ice water bath.* For ascarite and silica gel tubes.

5.3.7 *Valve.* Needle valve, or equivalent, to adjust flow rate

5.3.8 *Rate meter.* Rotameter or equivalent to measure gas flow rate of 0 to 1.0 liter per min. (0.035 cfm) through NDIR.

5.3.9 *Recorder (optional).* To provide permanent record of NDIR readings.

6. *Reagents.*

6.1 *Calibration gases.* Known concentration of CO in nitrogen (N_2) for instrument span, prepurified grade of N_2 for zero, and two additional concentrations corresponding approximately to 60 percent and 30 percent span. The span concentration shall not exceed 1.5 times the applicable source performance standard. The calibration gases shall be certified by the manufacturer to be within ±2 percent of the specified concentration.

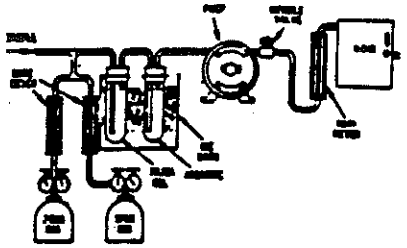

Figure 10-3. Analyzer calibration.

6.2 *Silica gel.* Indicating type, 6 to 16 mesh, dried at 175° C (347° F) for 2 hours.

6.3 *Ascarite.* Commercially available.

7. *Procedure.*

7.1 *Sampling.*

7.1.1 *Continuous sampling.* Set up the equipment as shown in Figure 10-1 making sure all connections are leak free. Place the probe in the stack at a sampling point and purge the sampling line. Connect the analyzer and begin drawing sample into the analyzer. Allow 5 minutes for the system to stabilize, then record the analyzer reading as required by the test procedure. (See ¶ 7.2 and 8). CO_2 content of the gas may be determined by using the Method 3 integrated sample procedure (36 FR 24886), or by weighing the ascarite CO_2 removal tube and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube.

7.1.2 *Integrated sampling.* Evacuate the flexible bag. Set up the equipment as shown in Figure 10-2 with the bag disconnected. Place the probe in the stack and purge the sampling line. Connect the bag, making sure that all connections are leak free. Sample at a rate proportional to the stack velocity. CO_2 content of the gas may be determined by using the Method 3 integrated sample procedures (36 FR 24886), or by weighing the ascarite CO_2 removal tube and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube.

7.2 *CO Analysis.* Assemble the apparatus as shown in Figure 10-3, calibrate the instrument, and perform other required operations as described in paragraph 8. Purge analyzer with N_2 prior to introduction of each sample. Direct the sample stream through the instrument for the test period, recording the readings. Check the zero and span again after the test to assure that any drift or malfunction is detected. Record the sample data on Table 10-1.

8. *Calibration.* Assemble the apparatus according to Figure 10-3. Generally an instrument requires a warm-up period before stability is obtained. Follow the manufacturer's instructions for specific procedure. Allow a minimum time of 1 hour for warm-up. During this time check the sample conditioning apparatus, i.e., filter, condenser, drying tube, and CO_2 removal tube, to ensure that each component is in good operating condition. Zero and calibrate the instrument according to the manufacturer's procedures using, respectively, nitrogen and the calibration gases.

TABLE 10-1—FIELD DATA

Clock time	Rotameter setting, liters per minute (cubic feet per minute)	Comments
Location		
Test		
Date		
Operator		

9. *Calculation—Concentration of carbon monoxide.* Calculate the concentration of carbon monoxide in the stack using equation 10-1.

$$C_{CO\ stack} = C_{CO\ NDIR}(1 - F_{CO_2})$$

where:

$C_{CO\ stack}$ = concentration of CO in stack, ppm by volume (dry basis).

$C_{CO\ NDIR}$ = concentration of CO measured by NDIR analyzer, ppm by volume (dry basis).

F_{CO_2} = volume fraction of CO_2 in sample, i.e., percent CO_2 from Orsat analysis divided by 100.

10. *Bibliography.*

10.1 McElroy, Frank. The Intertech NDIR-CO Analyzer. Presented at 11th Methods Conference on Air Pollution. University of California, Berkeley, Calif., April 1, 1970.

10.2 Jacobs, M. B., et al., Continuous Determination of Carbon Monoxide and Hydrocarbons in Air by a Modified Infrared Analyzer. J. Air Pollution Control Association. 9(2): 110-114, August 1959.

10.3 MSA LIRA Infrared Gas and Liquid Analyzer Instruction Book. Mine Safety Appliances Co., Technical Products Division, Pittsburgh, Pa.

10.4 Models 215A, 315A, and 415A Infrared Analyzers. Beckman Instruments, Inc., Beckman Instructions 1635-B, Fullerton, Calif., October 1967.

10.5 Continuous CO Monitoring System. Model A5611, Intertech Corp., Princeton, N.J.

10.6 UNOR Infrared Gas Analyzers. Bendix Corp., Ronceverte, West Virginia.

ADDENDA—A. PERFORMANCE SPECIFICATIONS FOR NDIR CARBON MONOXIDE ANALYZERS.

Range (minimum)	0-1000 ppm.
Output (minimum)	0-10mV.
Minimum detectable sensitivity.	20 ppm.
Rise time, 90 percent (maximum).	30 seconds.
Fall time, 90 percent (maximum).	30 seconds.
Zero drift (maximum)	10% in 8 hours.
Span drift (maximum)	10% in 8 hours.
Precision (minimum)	±2% of full scale.
Noise (maximum)	±1% of full scale.
Linearity (maximum deviation)	2% of full scale.
Interference rejection ratio	CO_2—1000 to 1, H_2O—500 to 1.

EPA METHOD 3A

B. *Definitions of Performance Specifications.*

Range—The minimum and maximum measurement limits.

Output—Electrical signal which is proportional to the measurement; intended for connection to readout or data processing devices. Usually expressed as millivolts or milliamps full scale at a given impedance.

Full scale—The maximum measuring limit for a given range.

Minimum detectable sensitivity—The smallest amount of input concentration that can be detected as the concentration approaches zero.

Accuracy—The degree of agreement between a measured value and the true value; usually expressed as ± percent of full scale.

Time to 90 percent response—The time interval from a step change in the input concentration at the instrument inlet to a reading of 90 percent of the ultimate recorded concentration.

Rise Time (90 percent)—The interval between initial response time and time to 90 percent response after a step increase in the inlet concentration.

Fall Time (90 percent)—The interval between initial response time and time to 90 percent response after a step decrease in the inlet concentration.

Zero Drift—The change in instrument output over a stated time period, usually 24 hours, of unadjusted continuous operation when the input concentration is zero; usually expressed as percent full scale.

Span Drift—The change in instrument output over a stated time period, usually 24 hours, of unadjusted continuous operation when the input concentration is a stated upscale value; usually expressed as percent full scale.

Precision—The degree of agreement between repeated measurements of the same concentration, expressed as the average deviation of the single results from the mean.

Noise—Spontaneous deviations from a mean output not caused by input concentration changes.

Linearity—The maximum deviation between an actual instrument reading and the reading predicted by a straight line drawn between upper and lower calibration points.

Method 3A—Determination of Oxygen and Carbon Dioxide Concentrations in Emissions From Stationary Sources (Instrumental Analyzer Procedure)

1. *Applicability and Principle.*

1.1 Applicability. This method is applicable to the determination of oxygen (O_2) and carbon dioxide (CO_2) concentrations in emissions from stationary sources only when specified within the regulations.

1.2 Principle. A sample is continuously extracted from the effluent stream; a portion of the sample stream is conveyed to an instrumental analyzer(s) for determination of O_2 and CO_2 concentration(s). Performance specifications and test procedures are provided to ensure reliable data.

2. *Range and Sensitivity.*

Same as Method 6C, Sections 2.1 and 2.2, except that the span of the monitoring system shall be selected such that the average O_2 or CO_2 concentration is not less than 20 percent of the span.

3. *Definitions.*

3.1 Measurement System. The total equipment required for the determination of the O_2 or CO_2 concentration. The measurement system consists of the same major subsystems as defined in Method 6C, Sections 3.1.1, 3.1.2, and 3.1.3.

3.2 Span, Calibration Gas, Analyzer Calibration Error, Sampling System Bias, Zero Drift, Calibration Drift, Response Time, and Calibration Curve. Same as Method 6C, Sections 3.2 through 3.8, and 3.10.

3.3 Interference Response. The output response of the measurement system to a component in the sample gas, other than the gas component being measured.

4. *Measurement System Performance Specifications.*

Same as Method 6C, Sections 4.1 through 4.4.

5. *Apparatus and Reagents.*

5.1 Measurement System. Any measurement system for O_2 or CO_2 that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 6C-1 of Method 6C. The essential components of the measurement system are described below:

5.1.1 Sample Probe. A leak-free probe, of sufficient length to traverse the sample points.

5.1.2 Sample Line. Tubing, to transport the sample gas from the probe to the moisture removal system. A heated sample line is not required for systems that measure the O_2 or CO_2 concentration on a dry basis, or transport dry gases.

5.1.3 Sample Transport Line, Calibration Value Assembly, Moisture Removal System, Particulate Filter, Sample Pump, Sample Flow Rate Control, Sample Gas Manifold, and Data Recorder. Same as Method 6C, Sections 5.1.3 through 5.1.9, and 5.1.11, except that the requirements to use stainless steel, Teflon, and nonreactive glass filters do not apply.

5.1.4 Gas Analyzer. An analyzer to determine continuously the O_2 or CO_2 concentration in the sample gas stream. The analyzer shall meet the applicable performance specifications of Section 4. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate (e.g., precision rotameter, pressure gauge downstream of all flow controls, etc.) shall be provided at the analyzer. The requirements for measuring and controlling the analyzer flow rate are not applicable if data are presented that demonstrate the analyzer is insensitive to flow variations over the range encountered during the test.

5.2 Calibration Gases. The calibration gases for CO_2 analyzers shall be CO_2 in N_2 or CO_2 in air. Alternatively, CO_2/SO_2, O_2/SO_2, or $O_2/CO_2/SO_2$ gas mixtures in N_2 may be used. Three calibration gases, as specified Section 5.3.1 through 5.3.3 of Method 6C, shall be used. For O_2 monitors that cannot analyze zero gas, a calibration gas concentration equivalent to less than 10 percent of the span may be used in place of zero gas.

6. *Measurement System Performance Test Procedures.*

Perform the following procedures before measurement of emissions (Section 7).

6.1 Calibration Concentration Verification. Follow Section 6.1 of Method 6C, except if calibration gas analysis is required, use Method 3 and change the acceptance criteria for agreement among Method 3 results to 3 percent (or 0.2 percent by volume, whichever is greater).

6.2 Interference Response. Conduct an interference response test of the analyzer prior to its initial use in the field. Thereafter, recheck the measurement system if changes are made in the instrumentation that could alter the interference response (e.g., changes in the type of gas detector). Conduct the interference response in accordance with Section 5.4 of Method 20.

6.3 Measurement System Preparation, Analyzer Calibration Error, and Sampling System Bias Check. Follow Sections 6.2 through 6.4 of Method 6C.

7. *Emission Test Procedure.*

7.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling points using the same criteria that are applicable to tests performed using Method 3.

7.2 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as used during the sampling system bias check. Maintain constant rate sampling (i.e., ±10 percent) during the entire run. The sampling time per run shall be the same as for tests conducted using Method 3 plus twice the system response time. For each run, use only those measurements obtained after twice the response time of the measurement system has elapsed to determine the average effluent concentration.

7.3 Zero and Calibration Drift Test. Follow Section 7.4 of Method 6C.

8. *Quality Control Procedures.*

The following quality control procedures are recommended when the results of this method are used for an emission rate correction factor, or excess air determination. The tester should select one of the following options for validating measurement results:

8.1 If both O_2 and CO_2 are measured using Method 3A, the procedures described in Section 4.4 of Method 3 should be followed to validate the O_2 and CO_2 measurement results.

8.2 If only O_2 is measured using Method 3A, measurements of the sample stream CO_2 concentration should be obtained at the sample by-pass vent discharge using an Orsat or Fyrite analyzer, or equivalent. Duplicate samples should be obtained concurrent with at least one run. Average the duplicate Orsat or Fyrite analysis results for each run. Use the average CO_2 values for comparison with the O_2 measurements in accordance with the procedures described in Section 4.4 of Method 3.

8.3 If only CO_2 is measured using Method 3A, concurrent measurements of the sample stream CO_2 concentration should be obtained using an Orsat or Fyrite analyzer as described in Section 8.2. For each run, differences greater than 0.5 percent between the Method 3A results and the average of the duplicate Fyrite analysis should be investigated.

9. *Emission Calculation.*

For all CO_2 analyzers, and for O_2 analyzers that can be calibrated with zero gas, follow Section 8 of Method 6C, except express all concentrations as percent, rather than ppm.

For O_2 analyzers that use a low-level calibration gas in place of a zero gas, calculate the effluent gas concentration using Equation 3A-1.

$$C_{ma} = \frac{C_{ma} - C_{ao}}{C_{ma} - C_{ao}} \cdot (\bar{C} - C_{ao}) + C_{ma}$$

Eq. 3A-1

where:

C_{ma} = Effluent gas concentration, dry basis, percent.

C_{ma} = Actual concentration of the upscale calibration gas, percent.

C_{ma} = Actual concentration of the low-level calibration gas, percent.

C_{ao} = Average of initial and final system calibration bias check responses for the upscale calibration gas, percent.

C_{ao} = Average of initial and final system calibration bias check responses for the low-level gas, percent.

$\bar{C}$ = Average gas concentration indicated by the gas analyzer, dry basis, percent.

10. *Bibliography.*

Same as bibliography of Method 6C.

EPA METHOD 3

METHOD 3—GAS ANALYSIS FOR CARBON DIOXIDE, OXYGEN, EXCESS AIR, AND DRY MOLECULAR WEIGHT

1. *Principle and Applicability*

1.1 Principle. A gas sample is extracted from a stack, by one of the following methods: (1) single-point, grab sampling; (2) single-point, integrated sampling; or (3) multi-point, integrated sampling. The gas sample is analyzed for percent carbon dioxide (CO_2), percent oxygen (O_2), and, if necessary, percent carbon monoxide (CO). If a dry molecular weight determination is to be made, either an Orsat or a Fyrite [1] analyzer may be used for the analysis; for excess air or emission rate correction factor determination, an Orsat analyzer must be used.

1.2 Applicability. This method is applicable for determining CO_2 and O_2 concentrations, excess air, and dry molecular weight of a sample from a gas stream of a fossil-fuel combustion process. The method may also be applicable to other processes where it has been determined that compounds other than CO_2, O_2, CO, and nitrogen (N_2) are not present in concentrations sufficient to affect the results.

Other methods, as well as modifications to the procedure described herein, are also applicable for some or all of the above determinations. Examples of specific methods and modifications include: (1) a multi-point sampling method using an Orsat analyzer to analyze individual grab samples obtained at each point; (2) a method using CO_2 or O_2 and stoichiometric calculations to determine dry molecular weight and excess air; (3) assigning a value of 30.0 for dry molecular weight, in lieu of actual measurements, for processes burning natural gas, coal, or oil. These methods and modifications may be used, but are subject to the approval of the Administrator, U.S. Environmental Protection Agency.

2. *Apparatus*

As an alternative to the sampling apparatus and systems described herein, other sampling systems (e.g., liquid displacement) may be used provided such systems are capable of obtaining a representative sample and maintaining a constant sampling rate, and are otherwise capable of yielding acceptable results. Use of such systems is subject to the approval of the Administrator.

2.1 Grab Sampling (Figure 3-1).

2.1.1 Probe. The probe should be made of stainless steel or borosilicate glass tubing and should be equipped with an in-stack or out-stack filter to remove particulate matter (a plug of glass wool is satisfactory for this purpose). Any other materials inert to O_2, CO_2, CO, and N_2 and resistant to temperature at sampling conditions may be used for the probe; examples of such material are aluminum, copper, quartz glass and Teflon.

2.1.2 Pump. A one-way squeeze bulb, or equivalent, is used to transport the gas sample to the analyzer.

2.2 Integrated Sampling (Figure 3-2).

2.2.1 Probe. A probe such as that described in Section 2.1.1 is suitable.

2.2.2 Condenser. An air-cooled or water-cooled condenser, or other condenser that will not remove O_2, CO_2, CO, and N_2, may be used to remove excess moisture which would interfere with the operation of the pump and flow meter.

2.2.3 Valve. A needle valve is used to adjust sample gas flow rate.

2.2.4 Pump. A leak-free, diaphragm-type pump, or equivalent, is used to transport sample gas to the flexible bag. Install a small surge tank between the pump and rate meter to eliminate the pulsation effect of the diaphragm pump on the rotameter.

2.2.5 Rate Meter. The rotameter, or equivalent rate meter, used should be capable of measuring flow rate to within ±2 percent of the selected flow rate. A flow rate range of 500 to 1000 cm^3/min is suggested.

2.2.6 Flexible Bag. Any leak-free plastic (e.g., Tedlar, Mylar, Teflon) or plastic-coated aluminum (e.g., aluminized Mylar) bag, or equivalent, having a capacity consistent with the selected flow rate and time length of the test run, may be used. A capacity in the range of 55 to 90 liters is suggested.

To leak-check the bag, connect it to a water manometer and pressurize the bag to 5 to 10 cm H_2O (2 to 4 in. H_2O). Allow to stand for 10 minutes. Any displacement in the water manometer indicates a leak. An alternative leak-check method is to pressurize the bag to 5 to 10 cm H_2O (2 to 4 in. H_2O) and allow to stand overnight. A deflated bag indicates a leak.

2.2.7 Pressure Gauge. A water-filled U-tube manometer, or equivalent, of about 100 cm (12 in.) is used for the flexible bag leak-check.

2.2.8 Vacuum Gauge. A mercury manometer, or equivalent, of at least 760 mm Hg (30 in. Hg) is used for the sampling train leak-check.

2.3 Analysis. For Orsat and Fyrite analyzer maintenance and operation procedures, follow the instructions recommended by the manufacturer, unless otherwise specified herein.

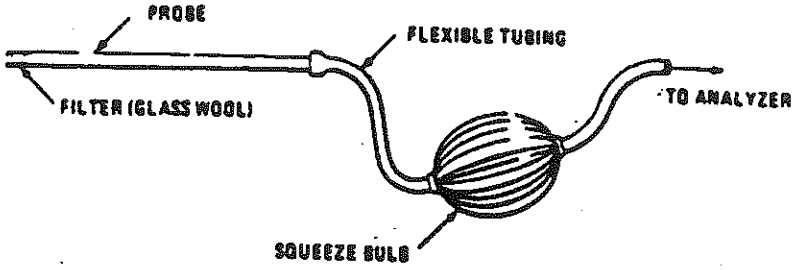

Figure 3-1. Grab sampling train.

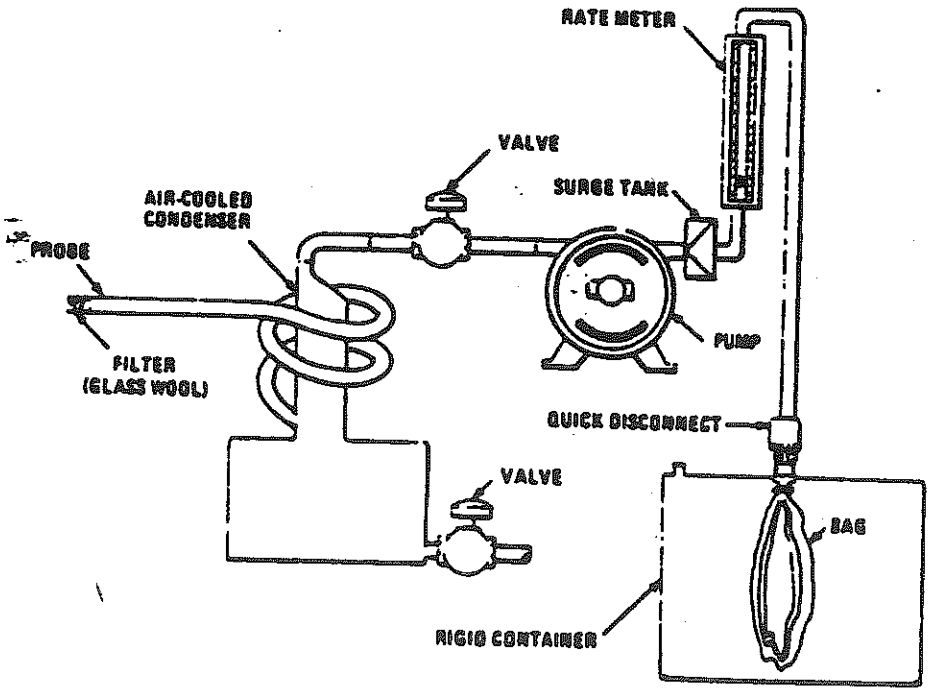

Figure 3-2. Integrated gas-sampling train.

[1] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

2.3.1 Dry Molecular Weight Determination. An Orsat analyzer or Fyrite type combustion gas analyzer may be used.

2.3.2 Emission Rate Correction Factor or Excess Air Determination. An Orsat analyzer must be used. For low CO_2 (less than 4.0 percent) or high O_2 (greater that 15.0 percent) concentrations, the measuring burette of the Orsat must have at least 0.1 percent subdivisions.

. Dry Molecular Weight Determination

Any of the three sampling and analytical procedures described below may be used for determining the dry molecular weight.

3.1 Single-Point, Grab Sampling and Analytical Procedure.

3.1.1 The sampling point in the duct shall either be at the centroid of the cross section or at a point no closer to the walls than 1.00 m (3.3 ft), unless otherwise specified by the Administrator.

3.1.2 Set up the equipment as shown in Figure 3-1, making sure all connections ahead of the analyzer are tight and leak-free. If and Orsat analyzer is used, it is recommended that the analyzer be leak-checked by following the procedure in Section 5; however, the leak-check is optional.

3.1.3 Place the probe in the stack, with the tip of the probe positioned at the sampling point; purge the sampling line. Draw a sample into the analyzer and immediately analyze it for percent CO_2 and percent O_2. Determine the percentage of the gas that is N, and CO by subtracting the sum of the percent CO_2 and percent O_2 from 100 percent. Calculate the dry molecular weight as indicated in Section 6.3.

3.1.4 Repeat the sampling, analysis, and calculation procedures, until the dry molecular weights of any three grab samples differ from their mean by no more than 0.3 g/g-mole (0.3 lb/lb-mole). Average these three molecular weights, and report the results to the nearest 0.1 g/g-mole (lb/lb-mole).

3.2 Single-Point, Integrated Sampling and Analytical Procedure.

3.2.1 The sampling point in the duct shall be located as specified in Section 3.1.1.

3.2.2 Leak-check (optional) the flexible bag as in Section 2.2.6. Set up the equipment as shown in Figure 3-2. Just prior to sampling, leak-check (optional) the train by placing a vacuum gauge at the condenser inlet, pulling a vacuum of at least 250 mm Hg (10 in. Hg), plugging the outlet at the quick disconnect, and then turning off the pump. The vacuum should remain stable for at least 0.5 minute. Evacuate the flexible bag. Connect the probe and place it in the stack, with the tip of the probe positioned at the sampling point; purge the sampling line. Next, connect the bag and make sure that all connections are tight and leak free.

3.2.3 Sample at a constant rate. The sampling run should be simultaneous with, and for the same total length of time as, the pollutant emission rate determination. Collection of at least 30 liters (1.00 ft^3) of sample gas is recommended; however, smaller volumes may be collected, if desired.

3.2.4 Obtain one integrated flue gas sample during each pollutant emission rate determination. Within 8 hours after the sample is taken, analyze it for percent CO_2 and percent O_2, using either an Orsat analyzer or a Fyrite-type combustion gas analyzer.

If an Orsat analyzer is used, it is recommended that the Orsat leak-check described in Section 5 be performed before this determination; however, the check is optional. Determine the percentage of the gas that is N, and CO by subtracting the sum of the percent CO_2 and percent O_2 from 100 percent. Calculate the dry molecular weight as indicated in Section 6.3.

3.2.5 Repeat the analysis and calculation procedures until the individual dry molecular weights for any three analyses differ from their mean by no more than 0.3 g/g-mole (0.3 lb/lb-mole). Average these three molecular weights, and report the results to the nearest 0.1 g/g-mole (0.1 lb/lb-mole).

3.3 Multi-Point, Integrated Sampling and Analytical Procedure.

3.3.1 Unless otherwise specified by the Administrator, a minimum of eight traverse points shall be used for circular stacks having diameters less than 0.61 m (24 in.), a minimum of nine shall be used for rectangular stacks having equivalent diameters less than 0.61 m (24 in.), and a minimum of twelve traverse points shall be used for all other cases. The traverse points shall be located according to Method 1. The use of fewer points is subject to approval of the Administrator.

3.3.2 Follow the procedures outlined in sections 3.2.2 throught 3.2.5, except for the following: traverse all sampling points and sample at each point for an equal length of time. Record sampling data as shown in Figure 3-3.

4. Emission Rate Correction Factor or Excess Air Determination

NOTE: A Fyrite-type combustion gas analyzer is not acceptable for excess air or emission rate correction factor determination, unless approved by the Administrator. If both percent CO_2 and percent O_2 are measured, the analytical results of any of the three procedures given below may also be used for calculating the dry molecular weight.

Each of the three procedures below shall be used only when specified in an applicable subpart of the standards. The use of these procedures for other purposes must have specific prior approval of the Administrator.

4.1 Single-Point, Grab Sampling and Analytical Procedure.

4.1.1 The sampling point in the duct shall either be at the centroid of the cross-section or at a point no closer to the walls than 1.00 m (3.3 ft), unless otherwise specified by the Administrator.

4.1.2 Set up the equipment as shown in Figure 3-1, making sure all connections ahead of the analyzer are tight and leak-free. Leak-check the Orsat analyzer according to the procedure described in Section 5. This leak-check is mandatory.

FIGURE 3-3—SAMPLING RATE DATA

Time	Traverse pt.	Q (cfm	% dev.*
Average			

*% Dev. = $(Q - Q_{avg})/Q_{avg}$ x 100 (Must be ≤ 10%)

4.1.3 Place the probe in the stack, with the tip of the probe positioned at the sampling point; purge the sampling line. Draw a sample into the analyzer. For emission rate correction factor determination, immediately analyze the sample, as outlined in Sections 4.1.4 and 4.1.5, for percent CO_2 or percent O_2. If excess air is desired, proceed as follows: (1) immediately analyze the sample, as in Sections 4.1.4 and 4.1.5, for percent CO_2, O_2, and CO; (2) determine the percentage of the gas that is N, by subtracting the sum of the percent CO_2, percent O_2, and percent CO from 100 percent; and (3) calculate percent excess air as outlined in Section 6.2.

4.1.4 To insure complete absorption of the CO_2, O_2, or if applicable, CO, make repeated passes through each absorbing solution until two consecutive readings are the same. Several passes (three or four) should be made between readings. (If constant readings cannot be obtained after three consecutive readings, replace the absorbing solution.)

4.1.5 After the analysis is completed, leak-check (mandatory) the Orsat analyzer once again, as described in Section 5. For the results of the analysis to be valid, the Orsat analyzer must pass this leak test before and after the analysis.

NOTE: Since this single-point, grab sampling and analytical procedure in normally conducted in conjunction with a single-point, grab sampling and analytical procedure for a pollutant, only one analysis is ordinarily conducted. Therefore, great care must be taken to obtain a valid sample and analysis. Although in most cases only CO_2 or O_2 is required, it is recommended that both CO_2 and O_2 be measured, and that Section 4.4 be used to validate the analytical data.

4.2 Single-Point, Integrated Sampling and Analytical Procedure.

4.2.1 The sampling point in the duct shall be located as specified in Section 4.1.1.

4.2.2 Leak-check (mandatory) the flexible bag as in Section 2.2.6. Set up the equipment as shown in Figure 3-2. Just prior to sampling, leak-check (mandatory) the train by placing a vacuum gauge at the condenser inlet, pulling a vacuum of a least 250 mm Hg (10 in. Hg), plugging the outlet at the quick disconnect, and then turning off the pump. The vacuum shall remain stable for at least 0.5 minute. Evacuate the flexible bag. Connect the probe and place it in the stack, with the tip of the probe positioned at the sampling point; purge the sampling line. Next, connect the bag and make sure that all connections are tight and leak free.

4.2.3 Sample at a constant rate, or as specified by the Administrator. The sampling run must be simultaneous with, and for the same total lengh of time as, the pollutant emission rate determination. Collect at least 30 liters (1.00 ft^3) of sample gas. Smaller volumes may be collected, subject to approval of the Administrator.

4.2.4 Obtain one integrated flue gas sample during each pollutant emission rate determination. For emission rate correction factor determination, analyze the sample within 4 hours after it is taken for percent CO_2 or percent O_2 (as outlined in Sections 4.2.5 through 4.2.7). The Orsat analyzer must be leak-check (see Section 5) before the analysis. If excess air is desired, proceed as follows: (1) within 4 hours after the sample is taken, analyze it (as in Sections 4.2.5 through 4.2.7) for percent CO_2, O_2, and CO; (2) determine the percentage of the gas that is N, by subtracting the sum of the percent CO_2, percent O_2, and percent CO from 100 percent; (3) calculate percent excess air, as outlined in Section 6.2.

4.2.5 To insure complete absorption of the CO_2, O_2, or if applicable, CO, make repeated passes through each absorbing solution until two consecutive readings are the same. Several passes (three or four) should be make between readings. (If constant readings cannot be obtained after three consecutive readings, replace the absorbing solution.)

4.2.6 Repeat the analysis until the following criteria are met:

4.2.6.1 For percent CO_2, repeat the analytical procedure until the results of any three analyses differ by no more that (a) 0.3 percent by volume when CO_2 is greater than 4.0 percent or (b) 0.2 percent by volume when CO_2 is less than or equal to 4.0 percent. Average the three acceptable values of percent CO_2 and report the results to the nearest 0.1 percent.

4.2.6.2 For percent O_2, repeat the analytical procedure until the results of any three analyses differ by no more than (a) 0.3 percent by volume when O_2 is less than 15.0 percent or (b) 0.2 percent by volume when O_2 is greater than or equal to 15.0 percent. Average the three acceptable values of percent O_2 and report the results to the nearest 0.1 percent.

4.2.6.3 For percent CO, repeat the analytical procedure until the results of any three analyses differ by no more than 0.3 percent. Average the three acceptable values of percent CO and report the results to the nearest 0.1 percent.

4.2.7 After the analysis is completed, leak-check (mandatory) the Orsat analyzer once again, as described in Section 5. For the results of the analysis to be valid, the Orsat analyzer must pass this leak test before an after the analysis.

NOTE: Although in most instances only CO_2 or O_2 is required, it is recommended that both CO_2 and O_2 be measured, and that Section 4.4.1 be used to validate the analytical data.

4.3 Multi-Point, Integrated Sampling and Analytical Procedure.

4.3.1 Both the minimum number of sampling points and the sampling point location shall be as specified in Section 3.3.1 of this method. The use of fewer points than specified is subject to the approval of the Administrator.

4.3.2 Follow the procedures outlined in Sections 4.2.2 through 4.2.7, except for the following: Traverse all sampling points and sample at each point for an equal length of time. Record sampling data as shown in Figure 3-3.

4.4 Quality Control Procedures.

4.4.1 Data Validation When Both CO_2 and O_2 Are Measured. Although in most instances, only CO_2 or O_2 measurement is required, it is recommended that both CO_2 and O_2 be measured to provide a check on the quality of the data. The following quality control procedure is suggested.

NOTE: Since the method for validating the CO_2 and O_2 analyses is based on combustion of organic and fossil fuels and dilution of the gas stream with air, this method does not apply to sources that (1) remove CO_2 or O_2 through processes other than combustion, (2) add O_2 (e.g., oxygen enrichment) and N_2 in proportions different from that of air, (3) add CO_2 (e.g., cement or lime kilns), or (4) have no fuel factor, F_o, values obtainable (e.g., extremely variable waste mixtures). This method validates the measured proportions of CO_2 and O_2 for the fuel type, but the method does not detect sample dilution resulting from leaks during or after sample collection. The method is applicable for samples collected downstream of most lime or limestone flue-gas desulfurization units as the CO_2 added or removed from the gas stream is not significant in relation to the total CO_2 concentration. The CO_2 concentrations from other types of scrubbers using only water or basic slurry can be significantly affected and would render the F_o check minimally useful.

4.4.1.1 Calculate a fuel factor, F_o, using the following equation:

$$F_o = \frac{20.9 - \%O_2}{\%CO_2}$$

Eq. 3-3

Where:
$\%O_2$ = Percent O_2 by volume (dry basis).
$\%CO_2$ = Percent CO_2 by volume (dry basis).
20.9 = Percent O_2 by volume in ambient air.

If CO is present in quantities measurable by this method, adjust the O_2 and CO_2 values before performing the calculation for F_o as follows:

$$\%CO_2(adj) = \%CO_2 + \%CO$$

$$\%O_2(adj) = \%O_2 - 0.5\ \%CO$$

Where: %CO = Percent CO by volume (dry basis).

4.4.1.2 Compare the calculated F_o factor with the expected F_o values. The following table may be used in establishing acceptable ranges for the expected F_o if the fuel being burned is known. When fuels are burned in combination, calculate the combined fuel F_c and F_o factors (as defined in Method 19) according to the procedure in Method 19 Section 5.2.3. Then calculate the F_o factor as follows:

$$F_o = \frac{0.209\ F_c}{F_c}$$

Eq. 3-4

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

Calculated F_o values beyond the acceptable ranges shown in this table should be investigated before accepting the test results. For example, the strength of the solutions in the gas analyzer and the analyzing technique should be checked by sampling and analyzing a known concentration, such as air; the fuel factor should be reviewed and verified. An acceptability range of ±12 percent is appropriate for the F_o factor of mixed fuels with variable fuel ratios. The level of the emission rate relative to the compliance level should be considered in determining if a retest is appropriate, i.e., if the measured emissions are much lower or much greater than the compliance limit, repetition of the test would not significantly change the compliance status of the source and would be unnecessarily time-consuming and costly.

5. *Leak-Check Procedure for Orsat Analyzers*

Moving an Orsat analyzer frequently causes it to leak. Therefore, an Orsat analyzer should be throughly leak-checked on site before the flue gas sample is introduced into it. The procedure for leak-checking an Orsat analyzer is:

5.1.1 Bring the liquid level in each pipette up to the reference mark on the capillary tubing and then close the pipette stopcock.

5.1.2 Raise the leveling bulb sufficiently to bring the confining liquid meniscus onto the graduated portion of the burette and then close the manifold stopcock.

5.1.3 Record the meniscus position.

5.1.4 Observe the meniscus in the burette and the liquid level in the pipette for movement over the next 4 minutes.

5.1.5 For the Orsat analyzer to pass the leak-check, two conditions must be met.

5.1.5.1 The liquid level in each pipette must not fall below the bottom of the capillary tubing during this 4-minute interval.

5.1.5.2 The meniscus in the burette must not change by more than 0.2 ml during this 4-minute interval.

5.1.6 If the analyzer fails the leak-check procedure, all rubber connections and stopcocks should be checked until the cause of the leak is identified. Leaking stopcocks must be disassembled, cleaned, and regreased. Leaking rubber connections must be replaced. After the analyzer is reassembled, the leak-check procedure must be repeated.

6. *Calculations*

6.1 Nomenclature.

M_d = Dry molecular weight, g/g-mole (lb/lb-mole).
%EA = Percent excess air.
$\%CO_2$ = Percent CO_2 by volume (dry basis).
$\%O_2$ = Percent O_2 by volume (dry basis).
%CO = Percent CO by volume (dry basis).
$\%N_2$ = Percent N_2 by volume (dry basis).
0.264 = Ratio of O_2 to N_2 in air, v/v.
0.280 = Molecular weight of N_2 or CO, divided by 100.
0.320 = Molecular weight of O_2 divided by 100.
0.440 = Molecular weight of CO_2 divided by 100.

6.2 Percent Excess Air. Calculate the percent excess air (if applicable), by substituting the appropriate values of percent O_2, CO, and N_2 (obtained from Section 4.1.3 or 4.2.4) into Equation 3-1.

$$\%EA = \frac{\%O_2 - 0.5\%\ CO}{0.264\%\ N_2 - (\%O_2 - 0.5\ \%\ CO)} \times 100$$

Equation 3-1

NOTE: The equation above assumes that ambient air is used as the source of O_2 and that the fuel does not contain appreciable amounts of N_2 (as do coke oven or blast furnace gases). For those cases when appreciable amounts of N_2 are present (coal, oil, and natural gas do not contain appreciable amounts of N_2) or when oxygen enrichment is used, alternate methods, subject to approval of the Administrator, are required.

6.3 Dry Molecular Weight. Use Equation 3-2 to calculate the dry molecular weight of the stack gas

$$M_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$$

Equation 3-2

Note: The above equation does not consider argon in air (about 0.9 percent, molecular weight of 37.7). A negative error of about 0.4 percent is introduced. The tester may opt to include argon in the analysis using procedures subject to approval of the Administrator.

7. *Bibliography*

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EPA METHOD 5

METHOD 5—DETERMINATION OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES

1. *Principle and Applicability*

1.1 Principle. Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature in the range of 120±14° C (248±25° F) or such other temperature as specified by an applicable subpart of the standards or approved by Administrator, U.S. Environmental Protection Agency, for a particular application. The particulate mass, which includes any material that condenses at or above the filtration temperature, is determined gravimetrically after removal of uncombined water.

1.2 Applicability. This method is applicable for the determination of particulate emissions from stationary sources.

2. *Apparatus*

2.1 Sampling Train. A schematic of the sampling train used in this method is shown in Figure 5-1. Complete construction details are given in APTD-0581 (Citation 2 in Bibliography); commercial models of this train are also available. For changes from APTD-0581 and for allowable modifications of the train shown in Figure 5-1, see the following subsections.

The operating and maintenance procedures for the sampling train are described in APTD-0576 (Citation 3 in Bibliography). Since correct usage is important in obtaining valid results, all users should read APTD-0576 and adopt the operating and maintenance procedures outlined in it, unless otherwise specified herein. The sampling train consists of the following components:

2.1.1 Probe Nozzle. Stainless steel (316) or glass with sharp, tapered leading edge. The angle of taper shall be ≤30° and the taper shall be on the outside to preserve a constant internal diameter. The probe nozzle shall be of the button-hook or elbow design, unless otherwise specified by the Administrator. If made of stainless steel, the nozzle shall be constructed from seamless tubing; other materials of construction may be used, subject to the approval of the Administrator.

A range of nozzle sizes suitable for isokinetic sampling should be available, e.g., 0.32 to 1.27 cm (⅛ to ½ in.)—or larger if higher volume sampling trains are used—inside diameter (ID) nozzles in increments of 0.16 cm (1/16 in.). Each nozzle shall be calibrated according to the procedures outlined in Section 5.

2.1.2 Probe Liner. Borosilicate or quartz glass tubing with a heating system capable of maintaining a gas temperature at the exit end during sampling of 120±14° C (248±25° F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application. (The tester may opt to operate the equipment at a temperature lower than that specified.) Since the actual temperature at the outlet of the probe is not usually monitored during sampling, probes constructed according to APTD-0581 and utilizing the calibration curves of APTD-0576 (or calibrated according to the procedure outlined in APTD-0576) will be considered acceptable.

Either borosilicate or quartz glass probe liners may be used for stack temperatures up to about 480° C (900° F); quartz liners shall be used for temperatures between 480 and 900° C (900 and 1,650° F). Both types of liners may be used at higher temperatures than specified for short periods of time, subject to the approval of the Administrator. The softening temperature for borosilicate is 820° C (1,508° F), and for quartz it is 1,500° C (2,732° F).

Whenever practical, every effort should be made to use borosilicate or quartz glass probe liners. Alternatively, metal liners (e.g., 316 stainless steel, Incoloy 825,[1] or other corrosion resistant metals) made of seamless tubing may be used, subject to the approval of the Administrator.

2.1.3 Pitot Tube. Type S, as described in Section 2.1 of Method 2, or other device approved by the Administrator. The pitot tube shall be attached to the probe (as shown in Figure 5-1) to allow constant monitoring of the stack gas velocity. The impact (high pressure) opening plane of the pitot tube shall be even with or above the nozzle entry plane (see Method 2, Figure 2-6b) during sampling. The Type S pitot tube assembly shall have a known coefficient, determined as outlined in Section 4 of Method 2.

[1]Mention of trade names or specific product does not constitute endorsement by the Environmental Protection Agency.

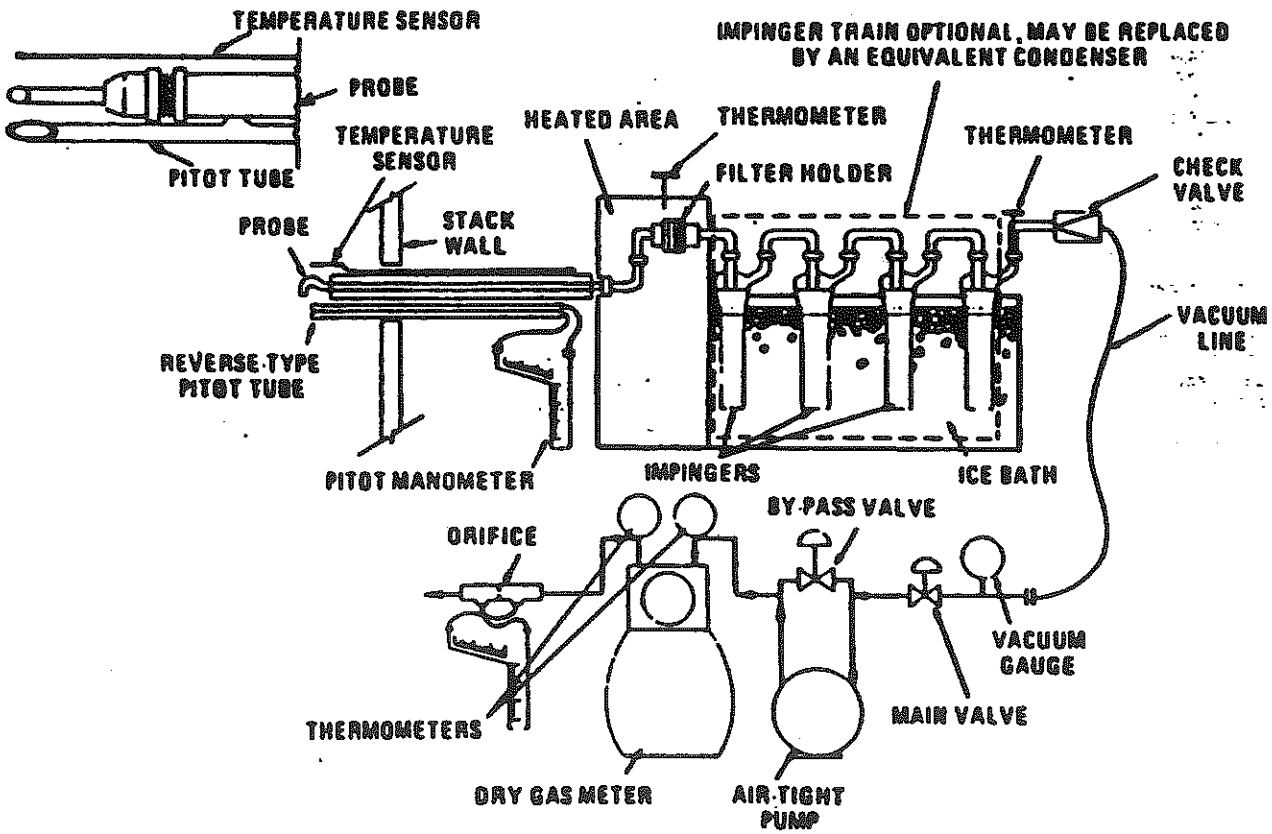

Figure 5-1. Particulate-sampling train.

2.1.4 Differential Pressure Gauge. Inclined manometer or equivalent device (two), as described in Section 2.2 of Method 2. One manometer shall be used for velocity head (Δp) readings, and the other, for orifice differential pressure readings.

2.1.5 Filter Holder. Borosilicate glass, with a glass frit filter support and a silicone rubber gasket. Other materials of construction (e.g., stainless steel, Teflon, Viton) may be used, subject to approval of the Administrator. The holder design shall provide a positive seal against leakage from the outside or around the filter. The holder shall be attached immediately at the outlet of the probe (or cyclone, if used).

2.1.6 Filter Heating System. Any heating system capable of maintaining a temperature around the filter holder during sampling of 120±14° C (248±25° F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application. Alternatively, the tester may opt to operate the equipment at a temperature lower than that specified. A temperature gauge capable of measuring temperature to within 3° C (5.4° F) shall be installed so that the temperature around the filter holder can be regulated and monitored during sampling. Heating systems other than the one shown in APTD-0581 may be used.

2.1.7 Condenser. The following system shall be used to determine the stack gas moisture content: Four impingers connected in series with leak-free ground glass fittings or any similar leak-free non-contaminating fittings. The first, third, and fourth impingers shall be of the Greenburg-Smith design, modified by replacing the tip with 1.3 cm (½ in.) ID glass tube extending to about 1.3 cm (½ in.) from the bottom of the flask. The second impinger shall be of the Greenburg-Smith design with the standard tip. Modifications (e.g., using flexible connections between the impingers, using materials other than glass, or using flexible vacuum lines to connect the filter holder to the condenser) may be used, subject to the approval of the Administrator. The first and second impingers shall contain known quantities of water (Section 4.1.3), the third shall be empty, and the fourth shall contain a known weight of silica gel, or equivalent desiccant. A thermometer, capable of measuring temperture to within 1° C (2° F) shall be placed at the outlet of the fourth impinger for monitoring purposes.

Alternatively, any system that cools the sample gas stream and allows measurement of the water condensed and moisture leaving the condenser, each to within 1 ml or 1 g, may be used, subject to the approval of the Administrator. Acceptable means are to measure the condensed water either gravimetrically or volumetrically and to measure the moisture leaving the condenser by: (1) monitoring the temperature and pressure at the exit of the condenser and using Dalton's law of partial pressures; or (2) passing the sample gas stream through a tared silica gel (or equivalent desiccant) trap with exit gases kept below 20° C (68° F) and determining the weight gain.

If means other than silica gel are used to determine the amount of moisture leaving the condenser, it is recommended that silica gel (or equivalent) still be used between the condenser system and pump to prevent moisture condensation in the pump and metering devices and to avoid the need to make corrections for moisture in the metered volume.

Note: If a determination of the particulate matter collected in the impingers is desired in addition to moisture content, the impinger system described above shall be used, without modification. Individual States or control agencies requiring this information shall be contacted as to the sample recovery and analysis of the impinger contents.

2.1.8 Metering System. Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3° C (5.4° F), dry gas meter capable of measuring volume to within 2 percent, and related equipment, as shown in Figure 5-1. Other metering systems capable of maintaining sampling rates within 10 percent of isokinetic and of determining sample volumes to within 2 percent may be used, subject to the approval of the Administrator. When the metering system is used in conjunction with a pitot tube, the system shall enable checks of isokinetic rates.

Sampling trains utilizing metering systems designed for higher flow rates than that decribed in APTD-0581 or APDT-0576 may be used provided that the specifications of this method are met.

2.1.9 Barometer. Mercury aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg). In many cases the barometric reading may be obtained from a nearby national weather service station, in which case the station value (which is the absolute barometric pressure) shall be requested and an adjustment for elevation differences between the weather station and sampling point shall be applied at a rate of minus 2.5 mm Hg (0.1 in. Hg) per 30 m (100 ft) elevation increase or vice versa for elevation decrease.

2.1.10 Gas Density Determination Equipment. Temperature sensor and pressure gauge, as described in Sections 2.3 and 2.4 of Method 2, and gas analyzer, if necessary, as described in Method 3. The temperature sensor shall, preferably, be permanently attached to the pitot tube or sampling probe in a fixed configuration, such that the tip of the sensor extends beyond the leading edge of the probe sheath and does not touch any metal. Alternatively, the sensor may be attached just prior to use in the field. Note, however, that if the temperature sensor is attached in the field, the sensor must be placed in an interference-free arrangement with respect to the Type S pitot tube openings (see Method 2, Figure 2-7). As a second alternative, if a difference of not more than 1 percent in the average velocity measurement is to be introduced, the temperature gauge need not be attached to the probe or pitot tube. (This alternative is subject to the approval of the Administrator.)

2.2 Sample Recovery. The following items are needed.

2.2.1 Probe-Liner and Probe-Nozzle Brushes. Nylon bristle brushes with stainless steel wire handles. The probe brush shall have extensions (at least as long as the probe) of stainless steel, Nylon, Teflon, or similarly inert material. The brushes shall be properly sized and shaped to brush out the probe liner and nozzle.

2.2.2 Wash Bottles—Two. Glass wash bottles are recommended; polyethylene wash bottles may be used at the option of the tester. It is recommended that acetone not be stored in polyethylene bottles for longer than a month.

2.2.3 Glass Sample Storage Containers. Chemically resistant, borosilicate glass bottles, for acetone washes, 500 ml or 1000 ml. Screw cap liners shall either be rubber-backed Teflon or shall be constructed so as to be leak-free and resistant to chemical attack by acetone. (Narrow mouth glass bottles have been found to be less prone to leakage.) Alternatively, polyethylene bottles may be used.

2.2.4 Petri Dishes. For filter samples, glass or polyethylene, unless otherwise specified by the Administrator.

2.2.5 Graduated Cylinder and/or Balance. To measure condensed water to within 1 ml or 1 g. Graduated cylinders shall have subdivisions no greater than 2 ml. Most laboratory balances are capable of weighing to the nearest 0.5 g or less. Any of these balances is suitable for use here and in Section 2.3.4.

2.2.6 Plastic Storage Containers. Airtight containers to store silica gel.

2.2.7 Funnel and Rubber Policeman. To aid in transfer of silica gel to container; not

2.2.8 Funnel. Glass or polyethylene, to aid in sample recovery.

2.3 Analysis. For analysis, the following equipment is needed.

2.3.1 Glass Weighing Dishes.

2.3.2 Desiccator.

2.3.3 Analytical Balance. To measure to within 0.1 mg.

2.3.4 Balance. To measure to within 0.5 g.

2.3.5 Beakers. 250 ml.

2.3.6 Hygrometer. To measure the relative humidity of the laboratory environment.

2.3.7 Temperature Gauge. To measure the temperature of the laboratory environment.

3. *Reagents*

3.1 Sampling. The reagents used in sampling are as follows:

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM standard method D2986-71 (Reapproved 1978) (incorporated by reference—see § 60.17). Test data from the supplier's quality control program are sufficient for this purpose. In sources containing SO_2 or SO_3, the filter material must be of a type that is unreactive to SO_2 or SO_3. Citation 18 in Section 7 Bibliography, may be used to select the appropriate filter.

3.1.2 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175° C (350° F) for 2 hours. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.3 Water. When analysis of the material caught in the impingers is required, distilled water shall be used. Run blanks prior to field use to eliminate a high blank on test samples.

3.1.4 Crushed Ice.

3.1.5 Stopcock Grease. Acetone-insoluble, heat-stable silicone grease. This is not necessary if screw-on connectors with Teflon sleeves, or similar, are used. Alternatively, other types of stopcock grease may be used, subject to the approval of the Administrator.

3.2 Sample Recovery. Acetone-reagent grade, <0.001 percent residue, in glass bottles is required. Acetone from metal containers generally has a high residue blank and should not be used. Sometimes, suppliers transfer acetone to glass bottles from metal containers; thus, acetone blanks shall be run prior to field use and only acetone with low blank values (<0.001 percent) shall be used. In no case shall a blank value of greater than 0.001 percent of the weight of acetone used be subtracted from the sample weight.

3.3 Analysis. Two reagents are required for the analysis:

3.3.1 Acetone. Same as 3.2.

3.3.2 Desiccant. Anhydrous calcium sulfate, indicating type. Alternatively, other types of desiccants may be used, subject to the approval of the Administrator.

4. Procedure

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation. It is suggested that sampling equipment be maintained according to the procedures described in APTD-0576.

Weigh several 200 to 300 g portions of silica gel in air-tight containers to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel need not be preweighed, but may be weighed directly in the impinger or sampling holder just prior to train assembly.

Check filters visually against light for irregularities and flaws or pinhole leaks. Label filters of the proper diameter on the back side near the edge using numbering machine ink. As an alternative, label the shipping containers (glass or plastic petri dishes) and keep the filters in these containers at all times except during sampling and weighing.

Desiccate the filters at 20±5.6° C (68±10° F) and ambient pressure for at least 24 hours and weigh at intervals of at least 6 hours to a constant weight, i.e., 0.5 mg change from previous weighing; record results to the nearest 0.1 mg. During each weighing the filter must not be exposed to the laboratory atmosphere for a period greater than 2 minutes and a relative humidity above 50 percent. Alternatively (unless otherwise specified by the Administrator), the filters may be oven dried at 105° C (220° F) for 2 to 3 hours, desiccated for 2 hours, and weighed. Procedures other than those described, which account for relative humidity effects, may be used, subject to the approval of the Administrator.

4.1.2 Preliminary Determinations. Select the sampling site and the minimum number of sampling points according to Method 1 or as specified by the Administrator. Determine the stack pressure, temperature, and the range of velocity heads using Method 2; it is recommended that a leak-check of the pitot lines (see Method 2, Section 3.1) be performed. Determine the moisture content using Approximation Method 4 or its alternatives for the purpose of making isokinetic sampling rate settings. Determine the stack gas dry molecular weight, as described in Method 2, Section 3.6; if integrated Method 3 sampling is used for molecular weight determination, the integrated bag sample shall be taken simultaneously with, and for the same total length of time as, the particulate sample run.

Select a nozzle size based on the range of velocity heads, such that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates. During the run, do not change the nozzle size. Ensure that the proper differential pressure gauge is chosen for the range of velocity heads encountered (see Section 2.2 of Method 2).

Select a suitable probe liner and probe length such that all traverse points can be sampled. For large stacks, consider sampling from opposite sides of the stack to reduce the length of probes.

Select a total sampling time greater than or equal to the minimum total sampling time specified in the test procedures for the specific industry such that (1) the sampling time per point is not less than 2 min (or some greater time interval as specified by the Administrator), and (2) the sample volume taken (corrected to standard conditions) will exceed the required minimum total gas sample volume. The latter is based on an approximate average sampling rate.

It is recommended that the number of minutes sampled at each point be an integer or an integer plus one-half minute, in order to avoid timekeeping errors. The sampling time at each point shall be the same.

In some circumstances, e.g., batch cycles, it may be necessary to sample for shorter times at the traverse points and to obtain smaller gas sample volumes. In these cases, the Administrator's approval must first be obtained.

4.1.3 Preparation of Collection Train. During preparation and assembly of the sampling train, keep all openings where contamination can occur covered until just prior to assembly or until sampling is about to begin.

Place 100 ml of water in each of the first two impingers, leave the third impinger empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fourth impinger. More silica gel may be used, but care should be taken to ensure that it is not entrained and carried out from the impinger during sampling. Place the container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

Using a tweezer or clean disposable surgical gloves, place a labeled (identified) and weighed filter in the filter holder. Be sure that the filter is properly centered and the gasket properly placed so as to prevent the sample gas stream from circumventing the filter. Check the filter for tears after assembly is completed.

When glass liners are used, install the selected nozzle using a Viton A O-ring when stack temperatures are less than 260° C (500° F) and an asbestos string gasket when temperatures are higher. See APTD-0576 for details. Other connecting systems using either 316 stainless steel or Teflon ferrules may be used. When metal liners are used, install the nozzle as above or by a leak-free direct mechanical connection. Mark the probe with heat resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point.

Set up the train as in Figure 5-1, using (if necessary) a very light coat of silicone grease on all ground glass joints, greasing only the outer portion (see APTD-0576) to avoid possibility of contamination by the silicone grease. Subject to the approval of the Administrator, a glass cyclone may be used between the probe and filter holder when the total particulate catch is expected to exceed 100 mg or when water droplets are present in the stack gas.

Place crushed ice around the impingers.

4.1.4 Leak-Check Procedures.

4.1.4.1 Pretest Leak-Check. A pretest leak-check is recommended, but not required. If the tester opts to conduct the pretest leak-check, the following procedure shall be used.

After the sampling train has been assembled, turn on and set the filter and probe heating systems at the desired operating temperatures. Allow time for the temperatures to stabilize. If a Viton A O-ring or other leak-free connection is used in assembling the probe nozzle to the probe liner, leak-check the train at the sampling site by plugging the nozzle and pulling a 380 mm Hg (15 in. Hg) vacuum.

NOTE: A lower vacuum may be used, provided that it is not exceeded during the test.

If an asbestos string is used, do not connect the probe to the train during the leak-check. Instead, leak-check the train by first plugging the inlet to the filter holder (cyclone, if applicable) and pulling a 380 mm Hg (15 in. Hg) vacuum (see Note immediately above). Then connect the probe to the train and leak-check at about 25 mm Hg (1 in. Hg) vacuum; alternatively, the probe may be leak-checked with the rest of the sampling train, in one step, at 380 mm Hg (15 in. Hg) vacuum. Leakage rates in excess of 4 percent of the average sampling rate or 0.00057 m³/min (0.02 cfm), whichever is less, are unacceptable.

The following leak-check instructions for the sampling train described in APTD-0576 and APTD-0581 may be helpful. Start the pump with bypass valve fully open and coarse adjust valve completely closed. Partially open the coarse adjust valve and slowly close the bypass valve until the desired vacuum is reached. Do not reverse direction of bypass valve; this will cause water to back up into the filter holder. If the desired vacuum is exceeded, either leak-check at this higher vacuum or end the leak-check as shown below and start over.

When the leak-check is completed, first slowly remove the plug from the inlet to the probe, filter holder, or cyclone (if applicable) and immediately turn off the vacuum pump. This prevents the water in the impingers from being forced backward into the filter holder and silica gel from being entrained backward into the third impinger.

4.1.4.2 Leak-Checks During Sample Run. If, during the sampling run, a component (e.g., filter assembly or impinger) change becomes unnecessary, a leak-check shall be conducted immediately before the change is made. The leak-check shall be done according to the procedure outlined in Section 4.1.4.1 above, except that it shall be done at a vacuum equal to or greater than the maximum value recorded up to that point in the test. If the leakage rate is found to be no greater than 0.00057 m³/min (0.02 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction will need to be applied to the total volume of dry gas metered;

...f, however, a higher leakage rate is obtained, the tester shall either record the leakage rate and plan to correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

Immediately after component changes, leak-checks are optional; if such leak-checks are done, the procedure outlined in Section 4.1.4.1 above shall be used.

4.1.4.3 Post-test Leak-Check. A leak-check is mandatory at the conclusion of each sampling run. The leak-check shall be done in accordance with the procedures outlined in Section 4.1.4.1, except that it shall be conducted at a vacuum equal to or greater than the maximum value reached during the sampling run. If the leakage rate is found to be no greater than 0.00057 m³/min (0.02 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction need be applied to the total volume of dry gas metered.

If, however, a higher leakage rate is obtained, the tester shall either record the leakage rate and correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

4.1.5 Particulate Train Operation. During the sampling run, maintain an isokinetic sampling rate (within 10 percent of true isokinetic unless otherwise specified by the Administrator) and a temperature around the filter of 120±14° C (248±25° F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator.

For each run, record the data required on a data sheet such as the one shown in Figure 5-2. Be sure to record the initial dry gas meter reading. Record the dry gas meter readings at the beginning and end of each sampling time increment, when changes in flow rates are made, before and after each leak-check, and when sampling is halted. Take other readings required by Figure 5-2 at least once at each sample point during each time increment and additional readings when significant changes (20 percent variation in velocity head readings) necessitate additional adjustments in flow rate. Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse.

Clean the portholes prior to the test run to minimize the chance of sampling deposited material. To begin sampling, remove the nozzle cap, verify that the filter and probe heating systems are up to temperature, and that the pitot tube and probe are properly positioned. Position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Nomographs are available, which aid in the rapid adjustment of the isokinetic sampling rate without excessive computations. These nomographs are designed for use when the Type S pitot tube coefficient is 0.85±0.02, and the stack gas equivalent density (dry molecular weight) is equal to 29±4. APTD-0576 details the procedure for using the nomographs. If C_p and M_d are outside the above stated ranges do not use the nomographs unless appropriate steps (see Citation 7 in Bibliography) are taken to compensate for the deviations.

When the stack is under significant negative pressure (height of impinger stem), take care to close the coarse adjust valve before inserting the probe into the stack to prevent water from backing into the filter holder. If necessary, the pump may be turned on with the coarse adjust valve closed.

When the probe is in position, block off the openings around the probe and porthole to prevent unrepresentative dilution of the gas stream.

Traverse the stack cross-section, as required by Method 1 or as specified by the Administrator, being careful not to bump the probe nozzle into the stack walls when sampling near the walls or when removing or inserting the probe through the portholes; this minimizes the chance of extracting deposited material.

During the test run, make periodic adjustments to keep the temperature around the filter holder at the proper level; add more ice and, if necessary, salt to maintain a temperature of less than 20° C (68° F) at the condenser/silica gel outlet. Also, periodically check the level and zero of the manometer.

If the pressure drop across the filter becomes too high, making isokinetic sampling difficult to maintain, the filter may be replaced in the midst of a sample run. It is recommended that another complete filter assembly be used rather than attempting to change the filter itself. Before a new filter assembly is installed, conduct a leak-check (see Section 4.1.4.2). The total particulate weight shall include the summation of all filter assembly catches.

A single train shall be used for the entire sample run, except in cases where simultaneous sampling is required in two or more separate ducts or at two or more different locations within the same duct, or, in cases where equipment failure necessitates a change of trains. In all other situations, the use of two or more trains will be subject to the approval of the Administrator.

FIGURE 5-2—PARTICULATE FIELD DATA

Plant ....
Location ....
Operator ....
Date ....
Run No. ....
Sample box No. ....
Meter box No. ....
Meter ΔH@ ....
Meter ....
Pitot tube coefficient, C_p ....

Ambient temperature ....
Barometric pressure ....
Assumed moisture, % ....
Probe length, m (ft.) ....
Nozzle identification No. ....
Average calibrated nozzle diameter, cm (in.) ....
Probe heater setting ....
Leak rate, m³/min. (cfm) ....
Probe liner material ....
Static pressure, mm Hg (in. Hg) ....
Filter No. ....

SCHEMATIC OF STACK CROSS SECTION

Traverse point number	Sampling time (θ), min.	Vacuum, mm Hg (in. Hg)	Stack temperature (T_s), °C (°F)	Velocity head (ΔP_s), mm (in.) H_2O	Pressure differential across orifice meter, mm H_2O (in. H_2O)	Gas sample volume, m^3 (ft^3)	Gas sample temperature at dry gas meter: Inlet, °C (°F)	Gas sample temperature at dry gas meter: Outlet, °C (°F)	Filter holder temperature, °C (°F)	Temperature of gas leaving condenser or last impinger, °C (°F)
Total							Avg.	Avg.		
Average							Avg.			

Note that when two or more trains are used, separate analyses of the front-half and (if applicable) impinger catches from each train shall be performed, unless identical nozzle sizes were used on all trains, in which case, the front-half catches from the individual trains may be combined (as may the impinger catches) and one analysis of front-half catch and one analysis of impinger catch may be performed. Consult with the Administrator for details concerning the calculation of results when two or more trains are used.

At the end of the sample run, turn off the coarse adjust valve, remove the probe and nozzle from the stack, turn off the pump, record the final dry gas meter reading, and conduct a post-test leak-check, as outlined in Section 4.1.4.3. Also, leak-check the pitot lines as described in Method 2, Section 3.1; the lines must pass this leak-check, in order to validate the velocity head data.

4.1.6 Calculation of Percent Isokinetic. Calculate percent isokinetic (see Calculations, Section 6) to determine whether the run was valid or another test run should be made. If there was difficulty in maintaining isokinetic rates due to source conditions, consult with the Administrator for possible variance on the isokinetic rates.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Allow the probe to cool.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a cap over it to prevent losing or gaining particulate matter. Do not cap off the probe tip tightly while the sampling train is cooling down as this would create a vacuum in the filter holder, thus drawing water from the impingers into the filter holder.

Before moving the sample train to the cleanup site, remove the probe from the sample train, wipe off the silicone grease, and cap the open outlet of the probe. Be careful not to lose any condensate that might be present. Wipe off the silicone grease from the filter inlet where the probe was fastened and cap it. Remove the umbilical cord from the last impinger and cap the impinger. If a flexible line is used between the first impinger or condenser and the filter holder, disconnect the line at the filter holder and let any condensed water or liquid drain into the impingers or condenser. After wiping off the silicone grease, cap off the filter holder outlet and impinger inlet. Either ground-glass stoppers, plastic caps, or serum caps may be used to close these openings.

Transfer the probe and filter-impinger assembly to the cleanup area. This area should be clean and protected from the wind so that the chances of contaminating or losing the sample will be minimized.

Save a portion of the acetone used for cleanup as a blank. Take 200 ml of this acetone directly from the wash bottle being used and place it in a glass sample container labeled "acetone blank."

Inspect the train prior to and during disassembly and note any abnormal conditions. Treat the samples as follows:

Container No. 1. Carefully remove the filter from the filter holder and place it in its identified petri dish container. Use a pair of tweezers and/or clean disposable surgical gloves to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the petri dish any particulate matter and/or filter fibers which adhere to the filter holder gasket, by using a dry Nylon bristle brush and/or a sharp-edged blade. Seal the container.

Container No. 2. Taking care to see that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover particulate matter or any condensate from the probe nozzle, probe fitting, probe liner, and front half of the filter holder by washing these components with acetone and placing the wash in a glass container. Distilled water may be used instead of acetone when approved by the Administrator and shall be used when specified by the Administrator; in these cases, save a water blank and follow the Administrator's directions on analysis. Perform the acetone rinses as follows:

Carefully remove the probe nozzle and clean the inside surface by rinsing with acetone from a wash bottle and brushing with a Nylon bristle brush. Brush until the acetone rinse shows no visible particles, after which make a final rinse of the inside surface with acetone.

Brush and rinse the inside parts of the Swagelok fitting with acetone in a similar way until no visible particles remain.

Rinse the probe liner with acetone by tilting and rotating the probe while squirting acetone into its upper end so that all inside surfaces will be wetted with acetone. Let the acetone drain from the lower end into the sample container. A funnel (glass or polyethylene) may be used to aid in transferring liquid washes to the container. Follow the acetone rinse with a probe brush. Hold the probe in an inclined position, squirt acetone into the upper end as the probe brush is being pushed with a twisting action through the probe; hold a sample container underneath the lower end of the probe, and catch any acetone and particulate matter which is brushed from the probe. Run the brush through the probe three times or more until no visible particulate matter is carried out with the acetone or until none remains in the probe liner on visual inspection. With stainless steel or other metal probes, run the brush through in the above prescribed manner at least six times since metal probes have small crevices in which particulate matter can be entrapped. Rinse the brush with acetone, and quantitatively collect these washings in the sample container. After the brushing, make a final acetone rinse of the probe as described above.

It is recommended that two people clean the probe to minimize sample losses. Between sampling runs, keep brushes clean and protected from contamination.

After ensuring that all joints have been wiped clean of silicone grease, clean the inside of the front half of the filter holder by rubbing the surfaces with a Nylon bristle brush and rinsing with acetone. Rinse each surface three times or more if needed to remove visible particulate. Make a final rinse of the brush and filter holder. Carefully rinse out the glass cyclone, also (if applicable). After all acetone washings and particulate matter have been collected in the sample container, tighten the lid on the sample container so that acetone will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether or not leakage occured during transport. Label the container to clearly identify its contents.

Container No. 3. Note the color of the indicating silica gel to determine if it has been completely spent and make a notation of its condition. Transfer the silica gel from the fourth impinger to its original container and seal. A funnel may make it easier to pour the silica gel without spilling. A rubber policeman may be used as an aid in removing the silica gel from the impinger. It is not necessary to remove the small amount of dust particles that may adhere to the impinger wall and are difficult to remove. Since the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, follow the procedure for container No. 3 in Section 4.3.

Impinger Water. Treat the impingers as follows: Make a notation of any color or film in the liquid catch. Measure the liquid which is in the first three impingers to within ±1 ml by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance (if one is available). Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight, unless analysis of the impinger catch is required (see Note, Section 2.1.7).

If a different type of condenser is used, measure the amount of moisture condensed either volumetrically or gravimetrically.

Whenever possible, containers should be shipped in such a way that they remain upright at all times.

4.3 Analysis. Record the data required on a sheet such as the one shown in Figure 5-3. Handle each sample container as follows:

FIGURE 5-3—ANALYTICAL DATA

Plant _____
Date _____
Run No. _____
Filter No. _____
Amount liquid lost during transport _____
Acetone blank volume, ml _____
Acetone wash volume, ml _____
Acetone blank concentration, mg/mg (equation 5-4) _____
Acetone wash blank, mg (equation 5-5) _____

Container number	Weight of particulate collected, mg		
	Final weight	Tare weight	Weight gain
1			
2			
Total			
Less acetone blank			
Weight of particulate matter			

	Volume of liquid water collected	
	Impinger volume, ml	Silica gel weight, g
Final		
Initial		
Liquid collected		
Total volume collected		g* ml

*Convert weight of water to volume by dividing total weight increase by density of water (1 g/ml).

$$\frac{\text{Increase, g}}{(1\ \text{g/ml})} = \text{Volume water, ml}$$

Container No. 1. Leave the contents in the shipping container or transfer the filter and any loose particulate from the sample container to a tared glass weighing dish. Desiccate for 24 hours in a desiccator containing anhydrous calcium sulfate. Weigh to a constant weight and report the results to the nearest 0.1 mg. For purposes of this Section, 4.3, the term "constant weight" means a difference of no more than 0.5 mg or 1 percent of total weight less tare weight, whichever is greater, between two consecutive weighings, with no less than 6 hours of desiccation time between weighings.

Alternatively, the sample may be oven dried at 105° C (220° F) for 2 to 3 hours, cooled in the desiccator, and weighed to a constant weight, unless otherwise specified by the Administrator. The tester may also opt to oven dry the sample at 105° C (220° F) for 2 to 3 hours, weigh the sample, and use this weight as a final weight.

Container No. 2. Note the level of liquid in the container and confirm on the analysis sheet whether or not leakage occurred during transport. If a noticeable amount of leakage has occurred, either void the sample or use methods, subject to the approval of the Administrator, to correct the final results. Measure the liquid in this container either volumetrically to ±1 ml or gravimetrically to ±0.5 g. Transfer the contents to a tared 250-ml beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 mg.

Container No. 3. Weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g using a balance. This step may be conducted in the field.

"Acetone Blank" Container. Measure acetone in this container either volumentrically or gravimetrically. Transfer the acetone to a tared 250-ml beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 mg.

NOTE: At the option of the tester, the contents of Container No. 2 as well as the acetone blank container may be evaporated at temperatures higher than ambient. If evaporation is done at an elevated temperature, the temperature must be below the boiling point of the solvent; also, to prevent "bumping," the evaporation process must be closely supervised, and the contents of the beaker must be swirled occasionally to maintain an even temperature. Use extreme care, as acetone is highly flammable and has a low flash point.

4.4 Quality Control Procedures. The following quality control procedures are suggested to check the volume metering system calibration values at the field test site prior to sample collection. These procedures are optional for the tester.

4.4.1 Meter Orifice Check. Using the calibration data obtained during the calibration procedure described in Section 5.3, determine the $\Delta H_@$ for the metering system orifice. The $\Delta H_@$ is the orifice pressure differential in units of in. H_2O that correlates to .75 cfm of air at 528°R and 29.92 in. Hg. The $\Delta H_@$ is calculated as follows:

$$\Delta H_@ = 0.0319\ \Delta H \frac{T_m}{P_{bar}} \frac{\Theta^2}{Y^2 V_m^2}$$

Eq. 5-9

Where:

ΔH = Average pressure differential across the orifice meter, in. H_2O.

T_m = Absolute average dry gas meter temperature, °R.

P_{bar} = Barometric pressure, in. Hg.

Θ = Total sampling time, min.

Y = Dry gas meter calibration factor, dimensionless.

V_m = Volume of gas sample as measured by dry gas meter, dcf.

0.0319 = (0.0567 in. Hg/°R) x (0.75 cfm)²

Before beginning the field test (a set of three runs usually constitutes a field test), operate the metering system (i.e., pump, volume meter, and orifice) at the $\Delta H_@$ pressure differential for 10 minutes. Record the volume collected, the dry gas meter temperature, and the barometric pressure. Calculate a dry gas meter calibration check value, Y_c, as follows:

$$Y_c = \frac{10}{V_m} \left[\frac{0.0319\ T_m}{P_{bar}} \right] \Theta$$

Eq. 5-10

Where:

Y_c = Dry gas meter calibration check value, dimensionless.

10 = 10 minutes of run time.

Compare the Y_c value with the dry gas meter calibration factor Y to determine that:

$0.97Y < Y_c < 1.03Y$

If the Y_c value is not within this range, the volume metering system should be investigated before beginning the test.

4.4.2 Calibration Critical Orifice. A calibrated critical orifice, calibrated against a wet test meter or spirometer and designed to be inserted at the inlet of the sampling meter box, may be used as a quality control check by following the procedure of Section 7.2.

5. *Calibration*

Maintain a laboratory log of all calibrations.

5.1 Probe Nozzle. Probe nozzles shall be calibrated before their initial use in the field. Using a micrometer, measure the inside diameter of the nozzle to the nearest 0.025 mm (0.001 in.). Make three separate measurements using different diameters each time, and obtain the average of the measurements. The difference between the high and low numbers shall not exceed 0.1 mm (0.004 in.). When nozzles become nicked, dented, or corroded, they shall be reshaped, sharpened, and recalibrated before use. Each nozzle shall be permanently and uniquely identified.

5.2 Pitot Tube. The Type S pitot tube assembly shall be calibrated according to the procedure outlined in Section 4 of Method 2.

5.3 Metering System. Before its initial use in the field, the metering system shall be calibrated according to the procedure outlined in APTD-0576. Instead of physically adjusting the dry gas meter dial readings to correspond to the wet test meter readings, calibration factors may be used to mathematically correct the gas meter dial readings to the proper values. Before calibrating the metering system, it is suggested that a leak-check be conducted. For metering systems having diaphragm pumps, the normal leak-check procedure will not detect leakages within the pump, for these cases the following leak-check procedure is suggested: make a 10-minute calibration run at 0.0057 m³/min (0.02 cfm); at the end of the run, take the difference of the measured wet test meter and dry gas meter volumes; divide the difference by 10, to get the leak rate. The leak rate should not exceed 0.00057 m³/min (0.02 cfm).

After each field use, the calibration of the metering system shall be checked by performing three calibration runs at a single, intermediate orifice setting (based on the previous field test), with the vacuum set at the maximum value reached during the test series. To adjust the vacuum, insert a valve between the wet test meter and the inlet of the metering system. Calculate the average value of the calibration factor. If the calibration has changed by more than 5 percent, recalibrate the meter over the full range of orifice settings, as outlined in APTD-0576.

Alternative procedures, e.g., using the orifice meter coefficients, maybe used, subject to the approval of the Administrator.

NOTE: If the dry gas meter coefficient values obtained before and after a test series differ by more than 5 percent, the test series shall either be voided, or calculations for test series shall be performed using whichever meter coefficient value (i.e., before or after) gives the lower value of total sample volume.

5.3.1 Calibration Prior to Use. Before its initial use in the field, the metering system shall be calibrated as follows: Connect the metering system inlet to the outlet of a wet test meter that is accurate to within 1 percent. Refer to Figure 5.5. The wet test meter should have a capacity of 30 liters/rev (1 ft³/rev). A spirometer of 400 liters (14 ft³) or more capacity, or equivalent, may be used for this calibration, although a wet test meter is usually more practical. The wet test meter should be periodically calibrated with a spirometer or a liquid displacement meter to ensure the accuracy of the wet test meter. Spirometers or wet test meters of other sizes may be used, provided that the specified accuracies of the procedure are maintained. Run the metering system pump for about 15 minutes with the orifice manometer indicating a median reading as expected in field use to allow the pump to warm up and to permit the interior surface of the wet test meter to be thoroughly wetted. Then, at each of a minimum of three orifice manometer settings, pass an exact quantity of gas through the wet test meter and note the gas volume indicated by the dry gas meter. Also note the barometric pressure, and the temperatures of the wet test meter, the inlet of the dry gas meter, and the outlet of the dry gas meter. Select the highest and lowest orifice settings to bracket the expected field operating range of the orifice. Use a minimum volume of 0.15 m³ (5 cf) at all orifice settings. Record all the data on a form similar to Figure 5.6, and calculate Y, the dry gas meter calibration factor, and $\Delta H@$, the orifice calibration factor, at each orifice setting as shown on Figure 5.6. Allowable tolerances for individual Y and $\Delta H@$ values are given in Figure 5.6. Use the average of the Y values in the calculations in Section 6.

Before calibrating the metering system, it is suggested that a leak-check be conducted. For metering systems having diaphragm pumps, the normal leak-check procedure will not detect leakages within the pump. For these cases the following leak-check procedure is suggested: make a 10-minute calibration run at 0.00057 m^3/min (0.02 cfm); at the end of the run, take the difference of the measured wet test meter and dry gas meter volumes; divided the difference by 10, to get the leak rate. The leak rate should not exceed 0.00057 m^3/min (0.02 cfm).

5.3.2 Calibration After Use. After each filed use, the calibration of the metering system shall be checked by performing three calibration runs at a single, intermediate orifice setting (based on the previous field test), with the vacuum set at the maximum value reached during the test series. To adjust the vacuum, inset a valve between the wet test meter and the inlet of the metering system. Calculate the average value of the dry gas meter calibration factor. If the value has changed by more than 5 percent, recalibrate the meter over the full range of orifice settings, as previously detailed.

Alternative procedures, e.g., rechecking the orifice meter coefficient may be used, subject to the approval of the Administrator.

5.3.3 Acceptable Variation in Calibration. If the dry gas meter coefficient values obtained before and after a test series differ by more than 5 percent, the test series shall either be voided, or calculations for the test series shall be performed using whichever meter coefficient value (i.e., before or after) gives the lower value of total sample volume.

5.4 Probe Heater Calibration. The probe heating system shall be calibrated before its initial use in the field.

Use a heat source to generate air heated to selected temperatures that approximate those expected to occur in the sources to be sampled. Pass this air through the probe at a typical sample flow rate while measuring the probe inlet and outlet temperatures at various probe heater settings. For each air temperature generated, construct a graph of probe heating system setting versus probe outlet temperature. The procedure outlined in APTD-0576 can also be used. Probes constructed according to APTD-0581 need not be calibrated if the calibration curves in APTD-0576 are used. Also, probes with outlet temperature monitoring capabilities do not require calibration.

5.5 Temperature Gauges. Use the procedure in Section 4.3 of Method 2 to calibrate in-stack temperature gauges. Dial thermometers, such as are used for the dry gas meter and condenser outlet, shall be calibrated against mercury-in-glass thermometers.

5.6 Leak Check of Metering System Shown in Figure 5-1. That portion of the sampling train from the pump to the orifice meter should be leak checked prior to initial use and after each shipment. Leakage after the pump will result in less volume being recorded than is actually sampled. The follow-

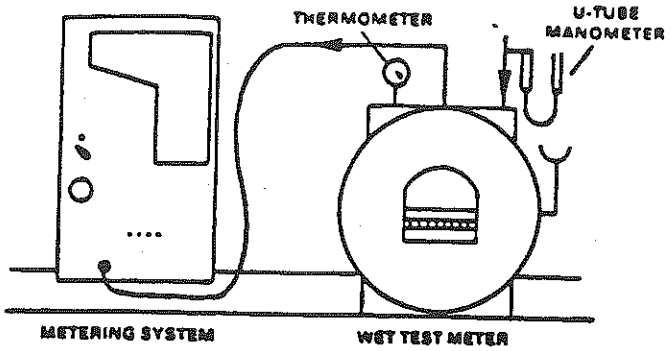

Figure 5.5 Equipment arrangement for metering system calibration.

Date _____ Metering System Identification: _____

Barometric pressure, P_b = _____ in. Hg

Orifice manometer setting ΔH in. H_2O	Spirometer (wet meter) gas volume (V_w) ft^3	Dry gas meter volume (V_d) ft^3	Temperatures: Spirometer (wet meter) (t_w) °F	Dry Gas Meter: Inlet (t_{d_i}) °F	Dry Gas Meter: Outlet (t_{d_o}) °F	Dry Gas Meter: Average (t_d) °F	Time (θ) min

Calculations

ΔH in. H_2O	Y	$\Delta H_@$
	$\frac{V_w P_b (t_d + 460)}{\Delta H \, V_d (P_b + 13.6)(t_w + 460)}$	$\frac{0.0317 \, \Delta H}{P_b} \left[\frac{(t_d + 460)}{(t_w + 460)}\right]$
Average		

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values ≤0.02 from average.

$\Delta H_@$ = Orifice pressure differential that equates to 0.75 cfm of air @ 68°F and 29.92 inches of mercury, in. H_2O; tolerance for individual values ≤0.20 from average.

Figure 5.6. Example data sheet for calibration of metering system (English units).

ing procedure is suggested (see Figure 5-4): Close the main valve on the meter box. Insert a one-hole rubber stopper with rubber tubing attached into the orifice exhaust pipe. Disconnect and vent the low side of the orifice manometer. Close off the low side orifice tap. Pressurize the system to 13 to 18 cm (5 to 7 in.) water column by blowing into the rubber tubing. Pinch off the tubing and observe the manometer for one minute. A loss of pressure on the manometer indicates a leak in the meter box; leaks, if present, must be corrected.

5.7 Barometer. Calibrate against a mercury barometer.

6. *Calculations*

Carry out calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after the final calculation. Other forms of the equations may be used as long as they give equivalent results.

6.1 Nomenclature

A_n = Cross-sectional area of nozzle, m^2 (ft^2).

B_{ws} = Water vapor in the gas stream, proportion by volume.

C_a = Acetone blank residue concentration, mg/mg.

c_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, g/dscm (g/dscf).

I = Percent of isokinetic sampling.

L_a = Maximum acceptable leakage rate for either a pretest leak check or for a leak check following a component change; equal to 0.0057 m^3/min (0.02 cfm) or 4 percent of the average sampling rate, whichever is less.

L_i = Individual leakage rate observed during the leak check conducted prior to the "ith" component change (i = 1, 2, 3....n), m^3/min (cfm).

L_p = Leakage rate observed during the post-test leak check, m^3/min (cfm).

m_a = Total amount of particulate matter collected, mg.

M_w = Molecular weight of water, 18.0 g/g-mole (18.0lb/lb-mole).

m_a = Mass of residue of acteone after evaporation, mg.

P_{bar} = Barometric pressure at the sampling site, mm Hg (in. Hg).

P_g = Absolute stack gas pressure, mm Hg (in. Hg).

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

R = Ideal gas constant, 0.06236 mm Hg-m^3/°K-g-mole (21.85 in. Hg-ft^3/°R-lb-mole).

T_m = Absolute average dry gas meter temperature (see Figure 5-2), °K (°R).

T_s = Absolute average stack gas temperature (see Figure 5-2), °K (°R).

T_{std} = Standard absolute temperature, 293° K (528° R).

V_a = Volume of acetone blank, ml.

V_{aw} = Volume of acetone used in wash, ml.

V_{lc} = Total volume of liquid collected in impingers and silica gel (see Figure 5-3), ml.

V_m = Volume of gas sample as measured by dry gas meter, dcm (dcf).

$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscm (dscf).

$V_{w(std)}$ = Volume of water vapor in the gas sample, corrected to standard conditions, scm (scf).

v_s = Stack gas velocity, calculated by Method 2, Equation 2-9, using data obtained from Method 5, m/sec (ft/sec).

W_a = Weight of residue in acetone wash, mg.

Y = Dry gas meter calibration factor.

ΔH = Average pressure differential across the orifice meter (see Figure 5-2), mm H_2O (in. H_2O).

ρ_a = Density of acetone, mg/ml (see label on bottle).

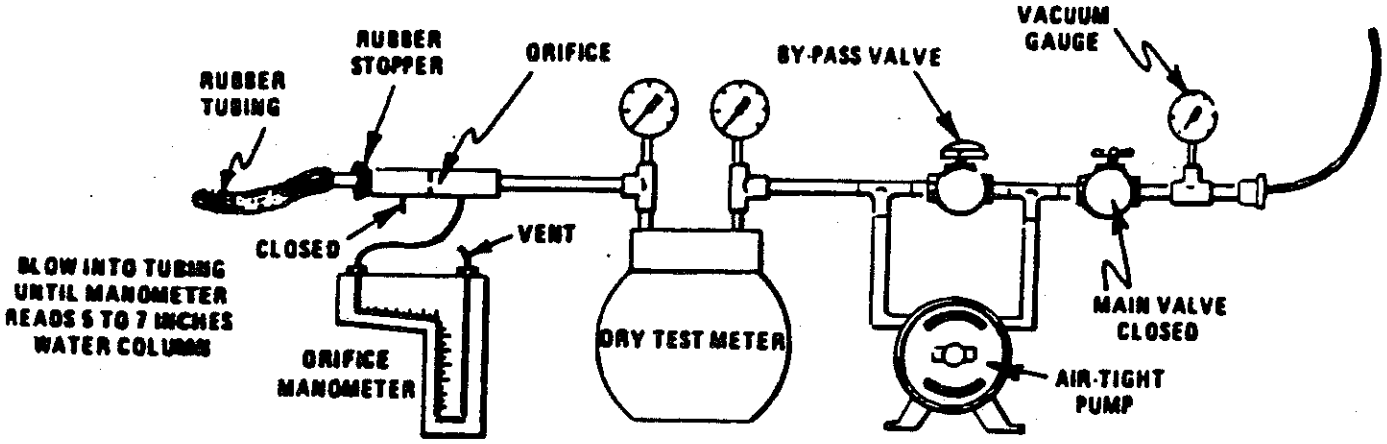

Figure 5-4. Leak check of meter box.

ρ_w = Density of water, 0.9982 g/ml (0.002201 lb/ml).
= Total sampling time, min.
= Sampling time interval, from the beginning of a run until the first component change, min.
θ_i = Sampling time interval, between two successive component changes, beginning with the interval between the first and second changes, min.
θ_p = Sampling time interval, from the final (n^{th}) component change until the end of the sampling run, min.
13.6 = Specific gravity of mercury.
60 = Sec/min.
100 = Conversion to percent.

6.2 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 5-2).

6.3 Dry Gas Volume. Correct the sample volume measured by the dry gas meter to standard conditions (20° C, 760 mm Hg or 68° F, 29.92 in. Hg) by using Equation 5-1.

$$V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m}\right)\left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{std}}\right]$$

$$= K_1 V_m Y \frac{P_{bar} + (\Delta H/13.6)}{T_m}$$

Equation 5-1

where:
K_1 = 0.3858 °K/mm Hg for metric units
= 17.64 °R/in. Hg for English units

NOTE: Equation 5-1 can be used as written unless the leakage rate observed during any of the mandatory leak checks (i.e., the post-test leak check or leak checks conducted prior to component changes) exceeds L_a. If L_p or L_i exceeds L_a, Equation 5-1 must be modified as follows:

(a) Case I. No component changes made during sampling run. In this case, replace V_m in Equation 5-1 with the expression:

$$V_m - (L_p - L_a)\theta$$

(b) Case II. One or more component changes made during the sampling run. In this case, replace V_m in Equation 5-1 by the expression:

$$\left[V_m - (L_p - L_a)\theta_p - \sum_{i=1}^{n} (L_i - L_a)\theta_i - (L_p \text{ or } L_i - L_a)\theta_p\right]$$

and substitute only for those leakage rates (L_p or L_i) which exceed L_a.

6.4 Volume of water vapor.

Equation 5-2

$$V_{w(std)} = V_{lc}\left(\frac{\rho_w}{M_w}\right)\left(\frac{RT_{std}}{P_{std}}\right) = K_2 V_{lc}$$

where:
K_2 = 0.001333 m^3/ml for metric units
= 0.04707 ft^3/ml for English units.

6.5 Moisture Content.

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

Equation 5-3

NOTE: In saturated or water droplet-laden gas streams, two calculations of the moisture content of the stack gas shall be made, one from the impinger analysis (Equation 5-3), and a second from the assumption of saturated conditions. The lower of the two values of B_{ws} shall be considered correct. The procedure for determining the moisture content based upon assumption of saturated conditions is given in the Note of Section 1.2 of Method 4. For the purposes of this method, the average stack gas temperature from Figure 5-2 may be used to make this determination, provided that the accuracy of the in-stack temperature sensor is ±1° C (2° F).

6.6 Acetone Blank Concentration.

Equation 5-4

$$C_a = \frac{m_a}{V_{aw}\rho_a}$$

6.7 Acetone Wash Blank.

$$W_a = C_a V_{aw}\rho_a \qquad \text{Equation 5-5}$$

6.8 Total Particulate Weight. Determine the total particulate catch from the sum of the weights obtained from containers 1 and 2 less the acetone blank (see Figure 5-3).

NOTE: Refer to Section 4.1.5 to assist in calculation of results involving two or more filter assemblies or two or more sampling trains.

6.9 Particulate Concentration.

$$C_s = (0.001\ g/mg)\ (m_n/V_{m(std)}) \qquad \text{Equation 5-6}$$

6.10 Conversion Factors:

From	To	Multiply By
scf	m^3	0.02832
g/ft^3	g/m^3	15.43
lb/ft^3	lb/m^3	2.288×10^{-3}
g/ft^3	g/m^3	35.31
g	mg	0.001

6.11 Isokinetic Variation.

6.11.1 Calculation From Raw Data.

$$I = \frac{V_m T_s [K_3 V_{lc} + (P_{bar} + \Delta H/13.6)]}{60\theta_n P_s A_n}$$

Equation 5-7

where:
K_3 = 0.003454 mm Hg-m^3/ml-°K for metric units.
= 0.002669 in. Hg-ft^3/ml-°R for English units.

6.11.2 Calculation From Intermediate Values.

$$I = \frac{T_s V_{m(std)} P_{std} 100}{T_{std}\theta_n A_n P_s 60(1 - B_{ws})}$$

$$= K_4 \frac{T_s V_{m(std)}}{P_s v_s A_n \theta (1 - B_{ws})}$$

Equation 5-8

where:
K_4 = 4.320 for metric units
= 0.09450 for English units.

6.12 Acceptable Results. If 90 percent ≤ I ≤ 110 percent, the results are acceptable. If the particulate results are low in comparison to the standard, and I is over 110 percent or less than 90 percent, the Administrator may accept the results. Citation 4 in the bibliography section can be used to make acceptability judgments. If I is judged to be unacceptable, reject the particulate results and repeat the test.

6.13 Stack Gas Velocity and Volumetric Flow Rate. Calculate the average stack gas velocity and volumetric flow rate, if needed, using data obtained in this method and the equations in Sections 5.2 and 5.3 of Method 2.

7. *Alternative Procedures*

7.1 Dry Gas Meter as a Calibration Standard. A dry gas meter may be used as a calibration standard for volume measurements in place of the wet test meter specified in Section 5.3, provided that it is calibrated initially and recalibrated periodically as follows:

7.1.1 Standard Dry Gas Meter Calibration.

7.1.1.1 The dry gas meter to be calibrated and used as a secondary reference meter should be of high quality and have an appropriately sized capacity, e.g., 3 liters/rev (0.1 ft^3/rev). A spirometer (400 liters or more capacity), or equivalent, may be used for this calibration, although a wet test meter is usually more practical. The wet test meter should have a capacity of 30 liters/rev (1 ft^3/rev) and capable of measuring volume to within ±1.0 percent; wet test meters should be checked against a spirometer or a liquid displacement meter to ensure the accuracy of the wet test meter. Spirometers or wet test meters of other sizes may be used, provided that the specified accuracies of the procedure are maintained.

7.1.1.2 Set up the components as shown in Figure 5-7. A spirometer, or equivalent, may be used in place of the wet test meter in the system. Run the pump for at least 5 minutes at a flow rate of about 10 liters/min (0.35 cfm) to condition the interior surface of the wet test meter. The pressure drop indicated by the manometer at the inlet side of the dry gas meter should be minimized [no greater than 100 mm H_2O (4 in. H_2O) at a flow rate of 30 liters/min (1 cfm)]. This can be accomplished by using large diameter tubing connections and straight pipe fittings.

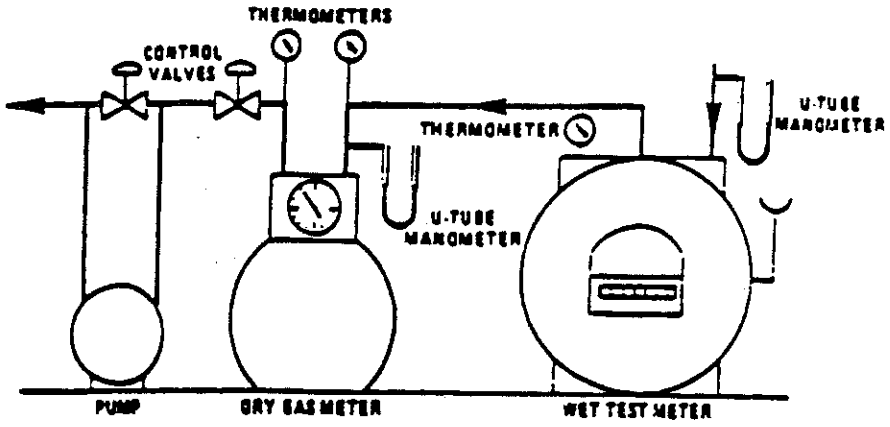

Figure 5.7 . Equipment arrangement for dry-gas meter calibration.

7.1.1.3 Collect the data as shown in the example data sheet (see Figure 5-8). Make triplicate runs at each of the flow rates and at no less than five different flow rates. The range of flow rates should be between 10 and 34 liters/min (0.35 and 1.2 cfm) or over the expected operating range.

DATE:_____

DRY GAS METER IDENTIFICATION:_____

BAROMETRIC PRESSURE (P_b):_____ in. Hg

APPROXIMATE FLOW RATE ($\bar{Q}$) cfm	SPIROMETER (WET METER) GAS VOLUME (V_s) ft^3	DRY GAS METER VOLUME (V_{dg}) ft^3	TEMPERATURES: SPIROMETER (WET METER) (t_s) °F	TEMPERATURES: DRY GAS METER: INLET (t_{di}) °F	TEMPERATURES: DRY GAS METER: OUTLET (t_{do}) °F	TEMPERATURES: DRY GAS METER: AVERAGE ($\bar{t}_d$) °F	DRY GAS METER PRESSURE (Δp) in. H_2O	TIME (θ) min.	FLOW RATE (Q) cfm	METER METER COEFFICIENT (Y_{dg})	AVERAGE METER COEFFICIENT ($\bar{Y}_{dg}$)
0.40											
0.80											
0.80											
1.00											
1.20											

$$Q = 17.65 \cdot \frac{V_s}{\theta} \cdot \frac{P_b}{(t_s + 460)}$$

$$Y_{dg} = \frac{V_s}{V_{dg}} \cdot \frac{(\bar{t}_d + 460)}{(t_s + 460)} \cdot \frac{P_b}{\left(P_b + \frac{\Delta p}{13.6}\right)}$$

Figure 5.8. Example data sheet for calibration of a standard dry gas meter for method 5 sampling equipment (English units).

7.1.1.4 Calculate flow rate, Q, for each run using the wet test meter gas volume, V_w, and the run time, θ. Calculate the dry gas meter coefficient, Y_{ca}, for each run. These calculations are as follows:

$$Q = K_1 \frac{P_{bar}}{t_w + t_{std}} \frac{V_w}{\theta}$$

$$Y_{ca} = \frac{V_w}{V_{ca}} \frac{(t_{ca} + t_{std})}{(t_w + t_{std})} \frac{P_{bar}}{\left(P_{bar} + \frac{\Delta p}{13.6}\right)}$$

Where:

K_1 = 0.3858 for international system of units (SI); 17.64 for English units.

V_w = Wet test meter volume, liters (ft^3).

V_{ca} = Dry gas meter volume, liters (ft^3).

t_{ca} = Average dry gas meter temperature, °C (°F).

t_{std} = 273° C for SI units; 460° F for English units.

t_w = Average wet test meter temperature, °C (°F).

P_{bar} = Barometric pressure, mm Hg (in. Hg).

Δp = Dry gas meter inlet differential pressure, mm H_2O (in. H_2O).

θ = Run time, min.

7.1.1.5 Compare the three Y_{ca} values at each of the flow rates and determine the maximum and minimum values. The difference between the maximum and minimum values at each flow rate should be no greater than 0.030. Extra sets of triplicate runs may be made in order to complete this requirement. In addition, the meter coefficients should be between 0.95 and 1.05. If these specifications cannot be met in three sets of successive triplicate runs, the meter is not suitable as a calibration standard and should not be used as such. If these specifications are met, average the three Y_{ca} values at each flow rate resulting in five average meter coefficients, $\bar{Y}_{ca}$.

7.1.1.6 Prepare a curve of meter coefficient, $\bar{Y}_{ca}$, versus flow rate, Q, for the dry gas meter. This curve shall be used as a reference when the meter is used to calibrate other dry gas meters and to determine whether recalibration is required.

7.1.2 Standard Dry Gas Meter Recalibration.

7.1.2.1 Recalibrate the standard dry gas meter against a wet test meter or spirometer annually or after every 200 hours of operation, whichever comes first. This requirement is valid provided the standard dry gas meter is kept in a laboratory and, if transported, cared for as any other laboratory instrument. Abuse to the standard meter may cause a change in the calibration and will require more frequent recalibrations.

7.1.2.2 As an alternative to full recalibration, a two-point calibration check may be made. Follow the same procedure and equipment arrangement as for a full recalibration, but run the meter at only two flow rates (suggested rates are 14 and 28 liters/min (0.5 and 1.0 cfm)). Calculate the meter coefficients for these two points, and compare the values with the meter calibration curve. If the two coefficients are within ±1.5 percent of the calibration curve values at the same flow rates, the meter need not be recalibrated until the next date for a recalibration check.

7.2 Critical Orifices As Calibration Standards. Critical orifices may be used as calibration standards in place of the wet test meter specified in Section 5.3, provided that they are selected, calibrated, and used as follows:

7.2.1 Section of Critical Orifices.

7.2.1.1 The procedure that follows describes the use of hypodermic needles or stainless steel needle tubings which have been found suitable for use as critical orifices. Other materials and critical orifice designs may be used provided the orifices act as true critical orifices; i.e., a critical vacuum can be obtained, as described in Section 7.2.2.2.3. Select five critical orifices that are appropriately sized to cover the range of flow rates between 10 and 34 liters/min or the expected operating range. Two of the critical orifices should bracket the expected operating range.

A minimum of three critical orifices will be needed to calibrate a Method 5 dry gas meter (DGM); the other two critical orifices can serve as spares and provide better selection for bracketing the range of operating flow rates. The needle sizes and tubing lengths shown below give the following approximate flow rates:

Gauge/cm	Flow rate (liters/min)	Gauge/cm	Flow rate (liters/min)
13/7.6	32.[illegible]	14/2.5	19.54
13/10.2	28.[illegible]	14/5.1	17.37
13/2.5	25.77	14/7.6	15.14
13/5.1	23.[illegible]	15/2.5	14.18
13/7.6	22.37	15/7.6	11.61
13/10.2	20.67	15/10.2	10.48

7.2.1.2 These needles can be adapted to a Method 5 type sampling train as follows: Insert a serum bottle stopper, 13- by 20-mm sleeve type, into a ½-inch Swagelok quick connect. Insert the needle into the stopper as shown in Figure 5-6.

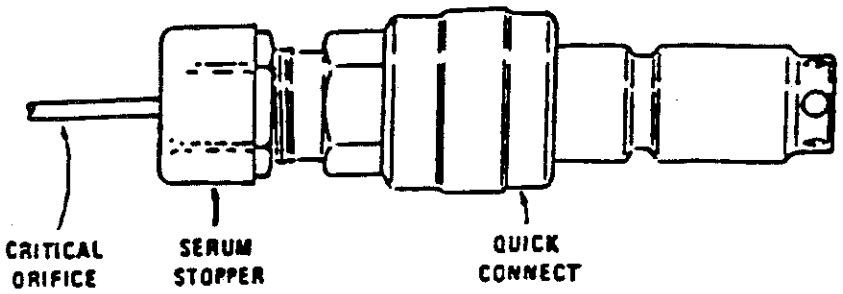

Figure 5-9. Critical orifice adaptation to Method 5 metering system.

7.2.2 Critical Orifice Calibration. The procedure described in this section uses the Method 5 meter box configuration with a DGM as described in Section 2.1.8 to calibrate the critical orifices. Other schemes may be used, subject to the approval of the Administrator.

7.2.2.1 Calibration of Meter Box. The critical orifices must be calibrated in the same configuration as they will be used; i.e., there should be no connections to the inlet of the orifice.

7.2.2.1.1 Before calibrating the meter box, leak check the system as follows: Fully open the coarse adjust valve, and completely close the by-pass valve. Plug the inlet. Then turn on the pump, and determine whether there is any leakage. The leakage rate shall be zero; i.e., no detectable movement of the DGM dial shall be seen for 1 minute.

7.2.2.1.2 Check also for leakages in that portion of the sampling train between the pump and the orifice meter. See Section 5.6 for the procedure; make any corrections, if necessary. If leakage is detected, check for cracked gaskets, loose fittings, worn O-rings, etc., and make the necessary repairs.

7.2.2.1.3 After determining that the meter box is leakless, calibrate the meter box according to the procedure given in Section 5.3. Make sure that the wet test meter meets the requirements stated in Section 7.1.1.1. Check the water level in the wet test meter. Record the DGM calibration factor, Y.

7.2.2.2 Calibration of Critical Orifices. Set up the apparatus as shown in Figure 5-10.

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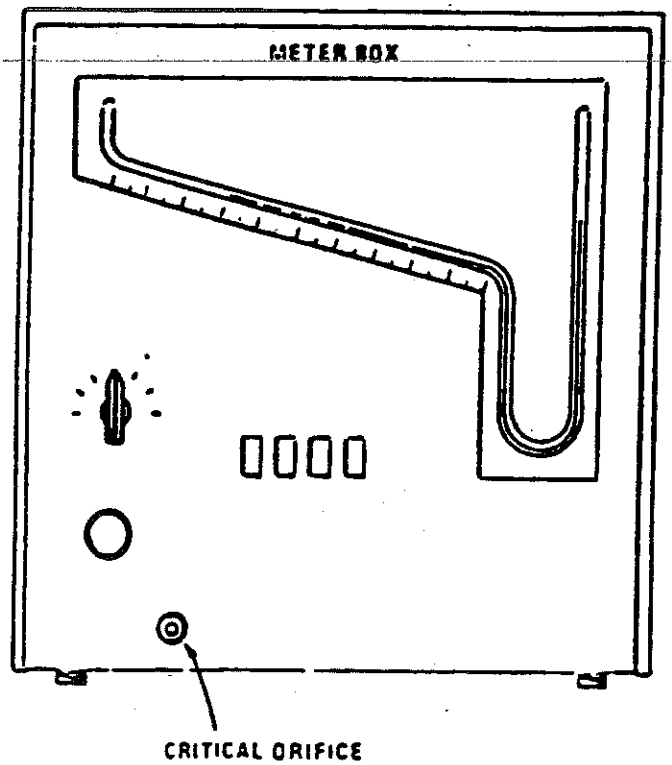

Figure 5-10. Apparatus setup.

7.2.2.2.1 Allow a warm-up time of 15 minutes. This step is important to equilibrate the temperature conditions through the DGM.

7.2.2.2.2 Leak check the system as in Section 7.2.2.1.1. The leakage rate shall be zero.

7.2.2.2.3 Before calibrating the critical orifice, determine its suitability and the appropriate operating vacuum as follows: Turn on the pump, fully open the coarse adjust valve, and adjust the by-pass valve to give a vacuum reading corresponding to about half of atmospheric pressure. Observe the meter box orifice manometer reading, H. Slowly increase the vacuum reading until a stable reading is obtained on the meter box orifice manometer. Record the critical vacuum for each orifice.

Orifices that do not reach a critical value shall not be used.

7.2.2.2.4 Obtain the barometric pressure using a barometer as described in Section 2.1.8. Record the barometric pressure, P_{bar}, in mm Hg (in. Hg).

7.2.2.2.5 Conduct duplicate runs at a vacuum of 25 to 50 mm Hg (1 to 2 in. Hg) above the critical vacuum. The runs shall be at least 5 minutes each. The DGM volume readings shall be in increments of 0.0028 m^3 (0.1 ft^3) or in increments of complete revolutions of the DGM. As a guideline, the times should not differ by more than 3.0 seconds (this includes allowance for changes in the DGM temperatures) to achieve ± 0.5 percent in K'. Record the information listed in Figure 5-11.

7.2.2.2.6 Calculate K' using Equation 5-8.

$$K' = \frac{K_1 V_m Y (P_{bar} + \Delta H/13.6) \sqrt{T_{amb}}}{P_{bar} T_m \theta} \quad \text{Eq. 5-8}$$

K' = Critical orifice coefficient.

$$\frac{(m^3)(^\circ K)^{1/2}}{(mm.\ Hg)(min)} \left[\frac{(ft^3)(^\circ R)^{1/2}}{(in.\ Hg)(min)} \right]$$

T_{amb} = Absolute ambient temperature, °K (°R).

Average the K' values. The individual K' values should not differ by more than ±0.5 percent from the average.

Sections 7.2.2.2.1 to 7.2.2.2.6. Record the information listed in Figure 5-12.

7.2.3 Using the Critical Orifices as Calibration Standards.

7.2.3.1 Record the barometric pressure.

Date _____ Train ID _____ DGM cal. factor _____ Critical orifice ID _____

Dry gas meter		Run No. 1	Run No. 2
Final reading	m^3 (ft^3)		
Initial reading	m^3 (ft^3)		
Difference, V_m	m^3 (ft^3)		
Inlet/Outlet temperatures:			
Initial	°C (°F)	/	/
Final	°C (°F)	/	/
Avg. Temperature,	°C (°F)		
Time, θ	min/sec	/	/
	min		
Orifice man. rdg., ΔH	mm (in.) H_2O.		
Bar. pressure, P_{bar}	mm (in.) Hg		
Ambient temperature, t_{amb}	°C (°F)		
Pump vacuum	mm (in.) Hg		
K' factor			
Average			

Figure 5-11. Data sheet for determining K' factor.

7.2.3.2 Calibrate the metering system according to the procedure outlined in

7.2.3.3 Calculate the standard volumes of air passed through the DGM and the critical orifices, and calculate the DGM calibration factor, Y, using the equations below:

$$V_m(std) = K_1 V_m \frac{P_{bar} + (\Delta H/13.6)}{T_m} \quad \text{Eq. 5-10}$$

$$V_{cr}(std) = K' \frac{P_{bar}\theta}{T_{amb}} \quad \text{Eq. 5-11}$$

$$Y = \frac{V_{cr(std)}}{V_{m(std)}} \quad \text{Eq. 5-12}$$

where:

$V_{cr(std)}$ = Volume of gas sample passed through the critical orifice, corrected to standard conditions, dcm^3 (dcf).

K_1 = 0.3858 °K/mm Hg for metric units = 17.64 °R/in. Hg for English units.

7.2.3.4 Average the DGM calibration values for each of the flow rates. The calibration factor, Y, at each of the flow rates should not differ by more than ±2 percent from the average.

7.2.3.5 To determine the need for recalibrating the critical orifices, compare the DGM Y factors obtained from two adjacent orifices each time a DGM is calibrated: for example, when checking 13/2.5, use orifices 12/10.2 and 13/5.1. If any critical orifice yields a DGM Y factor differing by more than 2 percent from the others, recalibrate the critical orifice according to Section 7.2.2.2.

Date _____ Train ID _____ Critical orifice ID _____ Critical orifice K' factor _____

Dry gas meter		Run No. 1	Run No. 2
Final reading	m^3 (ft^3)		
Initial reading	m^3 (ft^3)		
Difference, V_m	m^3 (ft^3)		
Inlet/outlet temperatures:			
Initial	°C (°F)	/	/
Final	°C (°F)	/	/
Avg. Temperature,	°C (°F)		
Time, θ	min/sec	/	/
	min		
Orifice man. rdg., ΔH	mm (in.) H_2O.		
Bar. pressure, P_{bar}	mm (in.) Hg		
Ambient temperature, t_{amb}	°C (°F)		
Pump vacuum	mm (in.) Hg		
$V_{cr(std)}$	m^3 (ft^3)		
$V_{m(std)}$	m^3 (ft^3)		
DGM cal. factor, Y			

Figure 5-12. Data sheet for determining DGM Y factor.

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[FR Doc. 87-6551 Filed 3-25-87; 8:45 am]

EPA METHOD 1A

Method 1A—Sample and Velocity Traverses for Stationary Sources with Small Stacks or Ducts

1. *Applicability and Principle*

The applicability and principle of this method are identical to Method 1, except its applicability is limited to stacks or ducts less than about 0.30 meter (12 in.) in diameter, or 0.071 m^2 (113 $in.^2$) in cross-sectional area, but equal to or greater than about 0.10 meter (4 in.) in diameter, or 0.0081 m^2 (12.57 $in.^2$) in cross-sectional area.

In these small diameter stacks or ducts the conventional pitot assembly (consisting of a Type S pitot tube attached to a sampling probe, equipped with a nozzle and thermocouple) blocks a significant cross-section of the duct and prevents a true traverse. Therefore, for particulate sampling in small stacks or ducts, the gas velocity is measured using a standard pitot tube downstream of the actual emission testing site. The straight run of duct between the sampling and velocity measurement sites allows the flow profile, temporarily disturbed by the presence of the sampling probe, to redevelop and stabilize.

The cross-sectional layout and location of traverse points and the verification of the absence of cyclonic flow are the same as in Method 1, Sections 2.3 and 2.4, respectively. Differences from Method 1, except as noted, are given below.

2. *Procedure*

2.1 Selection of Measurement Site.

2.1.1 Particulate Measurements—Steady or Unsteady Flow. Select a particulate measurement site located preferably at least eight equivalent stack or duct diameters downstream and 10 equivalent diameters upstream from any flow disturbances such as a bends, expansions, or contractions in the stack, or from a visible flame. Next, locate the velocity measurement site eight equivalent diameters downstream of the particulate measurement site. See Figure 1A-1. If such locations are not available, select an alternative particulate measurement location at least two equivalent stack or duct diameters downstream and two and one-half diameters upstream from any flow disturbance. Then, locate the velocity measurement site two equivalent diameters downstream from the particulate measurement site. (See Section 2.1 of Method 1 for calculating equivalent diameters for a rectangular cross-section.)

2.1.2 Particulate (Steady Flow) or Velocity (Steady or Unsteady Flow) Measurements. If the average total volumetric flow rate in a duct is constant with respect to time or if only velocity measurements are required use the same criterion as in Section 2.1 of Method 1.

2.2 Determining the Number of Traverse Points.

2.2.1 Particulate Measurements (Steady or Unsteady Flow). Use Figure 1-1 of Method 1 to determine the number of traverse points. Before referring to the figure, however, determine the distance between the velocity and sampling sites and the distances to the nearest upstream and downstream disturbances and divide each distance by the stack diameter or equivalent diameter to determine the distances in terms of the number of duct diameters. Then, determine the number of traverse points from Figure 1-1 of Method 1 corresponding to each of these three distances. Choose the highest of the three numbers of traverse points (or a greater number) so that for circular ducts the number is a multiple of four; for rectangular ducts use one of those numbers shown in Table 1.1 of Method 1.

2.2.2 Particulate (Steady Flow) and Velocity (Non-Particulate) Measurements. Use Figure 1A-3 to determine number of traverse points, following the same procedure used for particulate traverses as described in Section 2.2.1 of Method 1.

3. *Bibliography*

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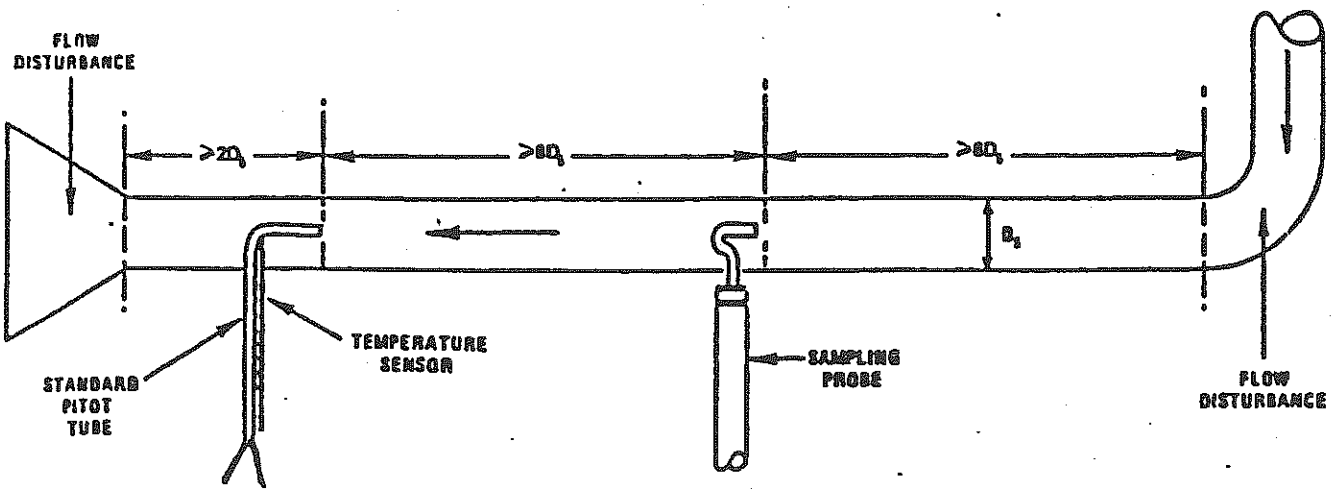

Figure 1A-1. Recommended sampling arrangement for small ducts.

APPENDIX G

DRAFT QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC) PLAN

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ATTACHMENT G-1 - FIELD OBSERVATIONS AND PROCEDURALS CHECKLIST

ATTACHMENT G-2 - LABORATORY QUALITY ASSURANCE PLAN

SECTION 1

PROJECT DESCRIPTION

1.1 BACKGROUND

The EG&G Mound Applied Technologies (EG&G) facility in Miamisburg, Ohio contains a glass melt furnace for thermal treatment of hazardous waste. EG&G proposes to conduct a trial burn program to demonstrate the effectiveness of the destruction of organic hazardous constituents in waste feed. The waste feed will contain metals and waste constituents regulated by the Resource Conservation and Recovery Act (RCRA). Through testing, the fate of the metals will be determined.

The trial burn program will consist of two operating scenarios: (1) treatment of a liquid waste with high heating value; and (2) treatment of an aqueous waste with a low heating value. Each scenario will consist of three independent tests. Metals will be included in the feed during each test run.

1.2 PURPOSE AND APPLICABILITY OF THIS PLAN

This Quality Assurance/Quality Control (QA/QC) Plan has been developed to detail the processes that will be applied in the performance of sampling, testing, and analysis activities during the trial burn. The purpose of the plan is to establish routine operating practices to ensure that all data generated during the trial burn conform to specific requirements for accuracy, precision, and completeness. This QA/QC Plan describes the organization and procedures to be applied for all testing procedures and analyses performed by the WESTON team during this program for the purpose of producing reliable data.

1.3 SAMPLING AND ANALYSIS PROCEDURES

The sampling and analytical procedures are detailed in Section 6 and Appendices E and F of the Trial Burn Plan.

1.4 DELIVERABLES

A final trial burn test report will be submitted for regulatory agency review within 90 days after completion of the trial burn.

1.5 REFERENCES

References consulted in the preparation of this plan include the following:

1. 40 CFR 60, Appendix A - Reference Methods 1, 2, 3, 3A, 5, and 10.

2. WESTON Quality Assurance Manual, ECON PM No. 301, 30 May 1982.

3. Quality Assurance Handbook for Air Pollution Measurement Systems, Volumes I and III, U.S. EPA, August 1977, as revised.

4. Laboratory Quality Assurance Plan for WESTON, October 1988, as revised.

5. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA, SW-846, November 1986, Method 0030.

6. Methodology for the Determination of Metals Emissions in Exhaust Gases from Hazardous Waste Incineration and Similar Combustion Processes, EPA Draft Procedure, 28 August 1989.

SECTION 2

PROJECT ORGANIZATION AND RESPONSIBILITIES FOR QUALITY ASSURANCE

Individuals responsible for implementing the QA/QC Plan are shown in Figure G-1. Their responsibilities are indicated below.

2.1 CORPORATE QA/QC OFFICER - EDWARD GILARDI, Ph.D., P.E.

As Corporate QA/QC Officer, Dr. Gilardi is responsible for overall corporate quality assurance, for reviewing and approving Division Quality Assurance Manuals, and for scheduling audits for selected projects to review their implementation of the quality assurance program.

2.2 PROJECT QA/QC OFFICER - JAMES SERNE, P.E.

Mr. Serne, as Project QA/QC Officer, is responsible for auditing compliance of the program with the plan. He will perform periodic audits to verify adherence of activities to the provisions of the QA/QC Plan.

2.3 FIELD QA/QC COORDINATOR - PAUL MEETER

As Field QA/QC Coordinator, Mr. Meeter is responsible for ensuring the implementation of this QA/QC Plan as it applies to all field sampling, testing, monitoring, and analysis processes performed during the investigations. Specifically, he is responsible for:

- Proper sample container preparation and labeling.
- Sample preservation and transportation.
- Sample chain of custody.
- Ensuring proper sampling procedures (i.e., analyzer calibration, isokinetic sampling, leak checks, cyclonic flow determinations, etc.) using checklist if necessary (see Attachment G-1).
- Field documentation.
- Field calibrations of equipment.
- Onsite performance audits.
- Accuracy of field calculations.

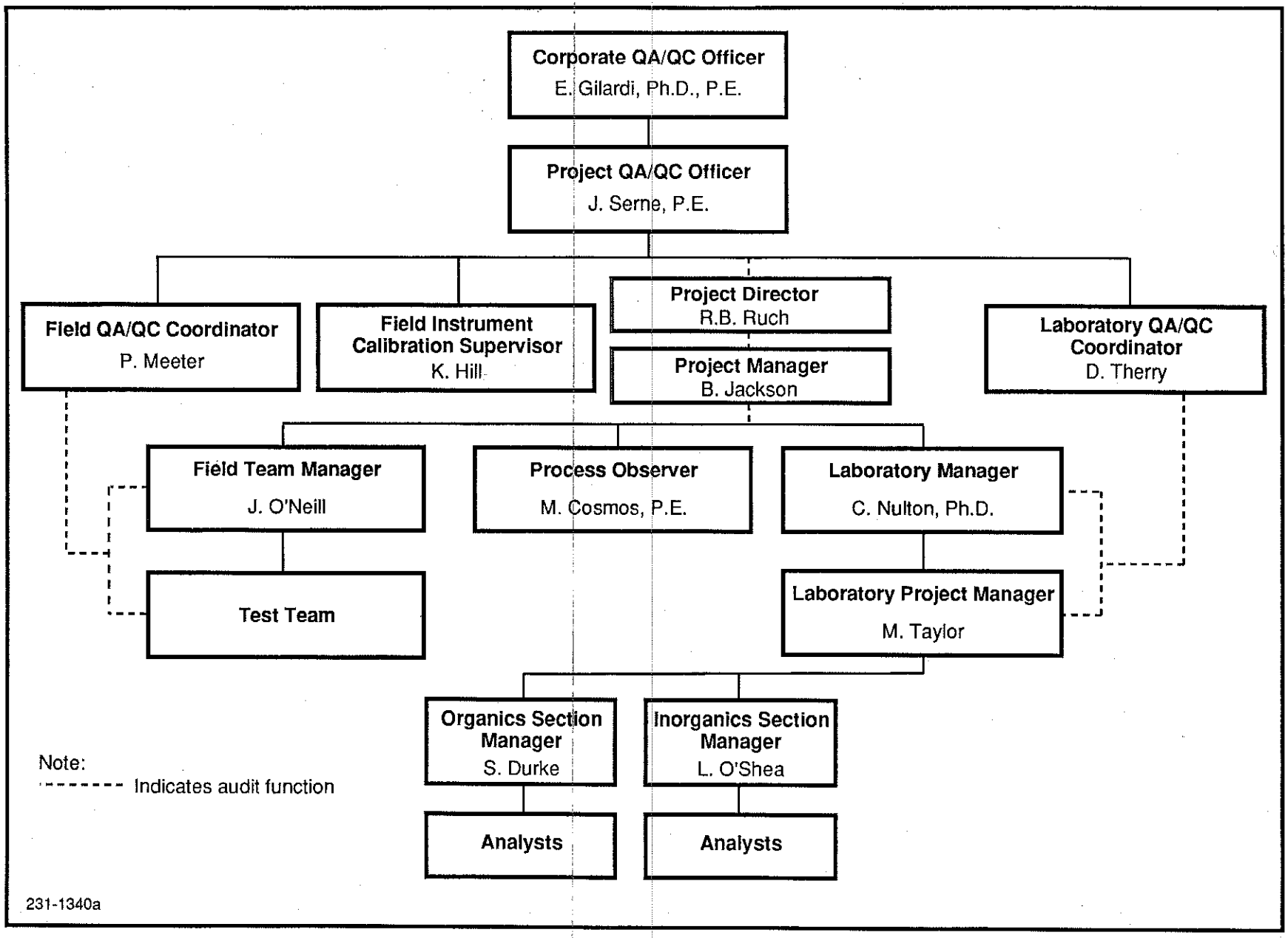

FIGURE G-1 PROJECT ORGANIZATION AND RESPONSIBILITY FOR QUALITY ASSURANCE

2.4 FIELD INSTRUMENT CALIBRATION SUPERVISOR - KEN HILL

The Field Instrument Calibration Supervisor, Mr. Hill, is responsible for all calibration and maintenance of field instrumentation and equipment used during the demonstration. All field instrumentation will be calibrated prior to use in the field and after completion of the field effort. Calibration data will be maintained on all instrumentation. Equipment items requiring calibration are:

- Velocity measurement devices.
- Gas volume metering equipment.
- Gas flow rate metering systems.
- Gas composition measurement apparati.

The calibration records, which include device numbers, calibration dates, methods, data, and results, are maintained on file at the WESTON West Chester, Pennsylvania, office and copies will be available at the job site, as appropriate.

2.5 LABORATORY RESPONSIBILITY

Laboratory responsibilities are those involving the performance of analytical services. WESTON's Analytics Division will be utilized to conduct specific analyses. The following responsibilities have been assigned for the trial burn.

2.5.1 Laboratory Project Manager - J.M. Taylor

The Laboratory Project Manager, Mr. Taylor, is responsible for meeting the project analytical objectives for WESTON's Analytics Division.

2.5.2 Lionville Laboratory QA/QC Coordinator - Dianne Therry

The Lionville Laboratory QA/QC Coordinator, Ms. Therry, is responsible for the quality assurance activities of the laboratory. The duties and responsibilities of the Laboratory QA/QC Coordinator are detailed in WESTON's Analytics Division Quality Assurance Plan, provided in Attachment G-2.

2.5.3 Laboratory Section Managers - S. Durke (Organics Section) and L. O'Shea (Inorganics Section)

The Laboratory Section Manager is responsible for the day-to-day operation of the corresponding laboratory functional groups, including:

- Analysis schedules.
- Personnel assignments.
- Provide resolution of out-of-control situations.

2.5.4 Analysts

Specific analysts will be assigned based on their background, experience, and availability when the field samples arrive at the laboratory. The analysts will be required to perform the following quality assurance/quality control functions:

- Maintain a calibration and maintenance notebook for the instrument they are using in an analysis.
- Perform instrument calibration.
- Record all data in bound laboratory notebooks.
- Follow the Standard Operating Procedure (SOP) for the analysis being performed, glassware handling, and the use of proper reagents.
- Report any unusual observations to the Section Manager.

2.5.5. Other Responsibilities

The duties and responsibilities of the following individuals are fully described in the referenced Standard Practice included in the Laboratory Quality Assurance Plan (Attachment G-2):

• Laboratory Support (Data) Manager	21-20-005
• Document Control Officer	21-20-007
• Sample Custodian	21-22-008

SECTION 3

QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

3.1 ACCURACY

The project QA goals for accuracy are indicated below.

3.1.1 Reference Materials

All reference materials used as calibration standards will be of the highest purity commercially available, generally 98 percent or greater.

3.1.2 Instrument Performance

A performance check will be made daily on each analytical instrument. Instrument response must be within criteria set forth in Section 6 for comparable measurements.

3.1.3 Recovery of Surrogates

The recovery of one or more surrogate compounds, added to all the organic samples prior to analysis, will be determined as follows:

$$\text{Recovery (percent)} = \frac{\text{ng surrogate found in sample}}{\text{ng surrogate added to sample}} \times 100$$

The equation assumes that the surrogate is not present in the sample.

The mean and standard deviation of the recovery data will be compiled on a cumulative basis for each surrogate compound in each type of sample matrix. The goals for recovery of surrogates are presented in Table 3-1 of Attachment G-2.

3.2 PRECISION

3.2.1 Analysis of Replicate Samples

Duplicate samples of the HCl samples will be analyzed as QC checks. The analysis goal for laboratory replicate samples will be a precision relative standard deviation of <10 percent.

3.2.2 Analysis of Surrogates

The relative standard deviation goal for analysis of surrogate compounds in replicate samples will be within the limits shown below:

Technique:	GC/MS
Sample Matrix and Analyte:	Liquid and solid samples for organics
Precision Relative Standard Deviation:	≤50 percent

3.3 COMPLETENESS

The completeness objective for this project is to obtain analytical results for >90 percent of collected samples.

3.4 REPRESENTATIVENESS

Reference method sampling and analytical procedures will be employed to help ensure the representativeness of the samples.

The factors which affect the representativeness of samples (sampling sites, sampling frequency, measurements system calibration status, sampling and analysis procedures, and sampling equipment) are addressed in the Trial Burn Plan.

3.5 COMPARABILITY

All data will be reported in the following units, as appropriate:

- Milligrams (mg), micrograms (ug), nanograms (ng), or pounds of analyte per liter, cubic meter, or cubic foot of original sample.
- Pounds per hour.
- Parts per million by volume (ppm/v) or parts per billion by volume (ppb/v), etc.

Recovery information and the corrected concentration data will be provided as applicable.

SECTION 4

SAMPLING PROCEDURES

Sampling and testing procedures will be as specified in Section 6 and Appendices E and F of the Trial Burn Plan.

SECTION 5

SAMPLE CUSTODY

All field samples generated during the test program will be closely supervised from recovery through analysis. Each sample will be assigned a predetermined sample code number onsite and sealed. Laboratory analyses data forms will accompany the samples through the various laboratories; all test results will be recorded in ink in bound workbooks, certified and dated by the analyst.

A chain-of-custody record will be maintained for all samples on forms accompanying the samples through the laboratory. All individuals who handle the samples at any stage of the project will be identified with appropriate dates and times. A sample chain-of-custody form is reproduced in Figure G-2. A typical sample label is shown in Figure G-3.

The Laboratory Supervisor is responsible for the EPA Reference Method sample analyses and for sample flow in the laboratory (see Figure G-4). The Field QA/QC Coordinator is responsible for the integrity of the field samples until the samples are transferred to the laboratory.

Custody Transfer Record/Lab Work Request

WESTON Analytics Use Only

Client _____

Work Order _____

Date Rec'd. _____ Date Due _____

RFW Contact _____

Client Contact/Phone _____

WA Use Only Lab ID	Client ID/Description	Matrix	Date Collected								

Refrigerator#									
#/Type Container									
Volume									
Preservative									
ANALYSES REQUESTED									

Matrix: S - Soil, SE - Sediment, SO - Solid; W - Water, O - Oil, A - Air, Wi - Wipe; DS - Drum Solids, DL - Drum Liquids, F - Fish, L - EP/TCLP Leachate, X - Other

Special Instructions:

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time

WESTON Analytics Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed)
Y N
NOTES:

4 Properly Preserved
Y N
NOTES:

5 Received Within Holding Times
Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

COC Record Was:
1 Present Upon Receipt of Samples Y N

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

7-115

RFW 21-21-001/A-12/88

FIGURE G-2 CHAIN OF CUSTODY

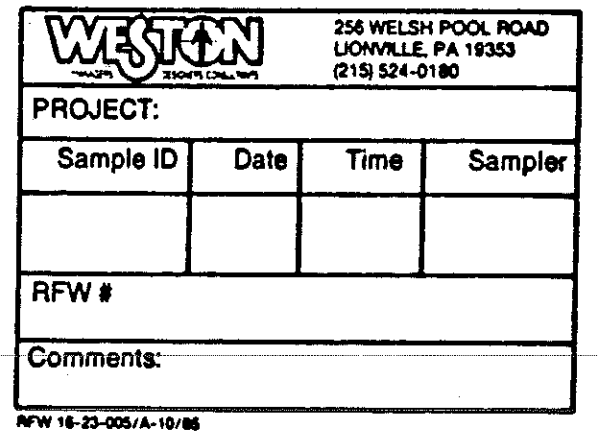

FIGURE G-3 SAMPLE LABEL

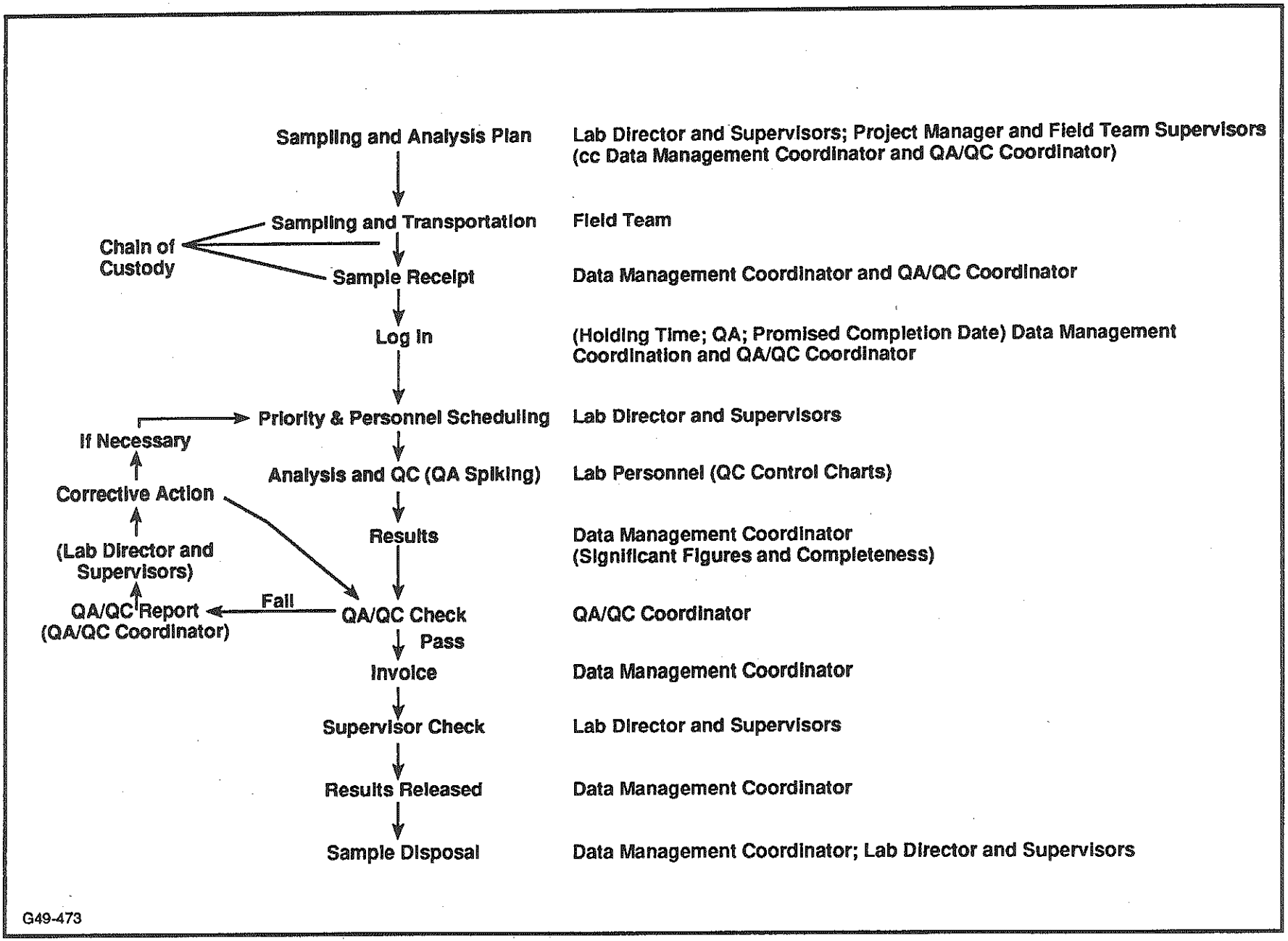

FIGURE G-4 LABORATORY SAMPLE FLOW CHART

SECTION 6

CALIBRATION PROCEDURES AND FREQUENCY

6.1 SAMPLING EQUIPMENT

The following equipment items will be calibrated before and after field usage:

- Velocity measurement devices.
- Gas volume metering equipment.
- Gas flow rate metering systems.
- Gas composition measurement apparatus (Orsat).

Acceptance limits are shown for each equipment item in Table G-1. The calibration records will include device numbers, calibration dates, methods, data and results, and will be maintained on file in workbooks at the WESTON offices. Copies of applicable calibration records will also be available at the job site.

6.2 CALIBRATION STANDARDS

All calibration standards will be prepared from American Chemical Society (ACS) reagent grade or better chemicals. The procurement of this material is the responsibility of the laboratory.

6.3 ANALYTICAL INSTRUMENTS

6.3.1 Instrument Maintenance

Instruments will be maintained in accordance with manufacturers' specifications. More frequent maintenance may be dictated dependent on operational performance. Instrument logs will be maintained to document the date and type of maintenance performed.

Contracts on major instruments with manufacturers and service agencies are used to provide routine preventive maintenance and to ensure rapid response for emergency repair service. Minimal instrument downtime is experienced through the use of these contracts.

6.3.2 Instrument Calibration

Before any instrument can be used as a measurement device, the instrumental response to known reference materials must be determined. The manner in which the various instruments are calibrated will be dependent on the particular instrument and the intended use of the instrument. All sample measurements will be made within the calibrated range of the instrument.

Table G-1

Activity Matrix for Calibration of Equipment[a]

Apparatus	Acceptance Limits	Frequency and Method of Measurement	Action If Requirements Are Not Met
Wet test meter	Capacity 3.4 m^3/h (120 ft/h); accuracy within $\pm$ 1.0 percent	Calibrate initially, and then yearly by liquid displacement	Adjust until specifications are met, or return to manufacturer
Dry gas meter	$Y_1 = Y \pm 0.02\ Y$	Calibrate vs. wet test meter initially, and when post-test check exceed $Y \pm 0.05\ Y$	Repair or replace and then recalibrate
Thermometer	Impinger thermometer $\pm$ 1°C (2°F); dry gas meter thermometer $\pm$ 3°C (5.4°F) over range; stack temperature sensor $\pm$ 1.5 percent 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° $\pm$ 14°C (248° $\pm$ 25°F) at a flow rate of 20 L/min (0.71 ft^3/min)	Calibrate component initially by APTD-0576 if constructed by APTD-0581, or use published calibration curves	Repair, or replace and then reverify 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

Table G-1

Activity Matrix for Calibration of Equipment[a]
(continued)

Apparatus	Acceptance Limits	Frequency and Method of Measurement	Action If Requirements Are Not Met
Probe Nozzle	Average 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
Type S pitot tube and/or probe assembly	All dimension specifications met, or calibrate according to referenced manual, and mount in an interference free manner	When purchased, use method in referenced manual; visually inspect after each field test	Do not use pitot tubes that do not meet face opening specifications; repair or replace as required
Stack gas temperature measurement system	Capable of measuring within 1.5 percent of minimum absolute stack temperature	When purchased and after each field test, calibrate against ASTM 63°C or 63°F thermometer	Adjust to agree with Hg bulb thermometer, or construct a calibration curve to correct the readings
Analytical balance	± 1 mg of Class-S weights	Check with Class-S weights upon receipt	Adjust or repair
Differential pressure gauge (does not include manometers)	Agree with 5 percent of inclined manometers	Initially and after each field use	Reject test results, or consult administrator if post-test calibration is out of specification

Table G-1

Activity Matrix for Calibration of Equipment[a]
(continued)

Apparatus	Acceptance Limits	Frequency and Method of Measurement	Action If Requirements Are Not Met
Orsat analyzer	Average of three replicates should be 20.9 ± 0.5 percent (absolute) or known concentration 0.5 (absolute)	Upon receipt and before any test in which the analyzer has not been checked during the previous 3 months determine percent O_2 in ambient air, or use a calibration gas with known CO, CO_2, and O_2 concentrations	Check Orsat analyzer for leaking valves, spent absorbing reagent, and/or operator techniques; take corrective action
Rotameter or rate meter	Smooth curve of rotameter actual flow rates with no evidence of error	Check with wet test meter or volume meter at 6-month intervals or at indication of erratic behavior	Repeat calibration steps until limits are attained

[a]EPA-600/9-76-005, Quality Assurance Handbook for Air Pollution Measurement Systems-Volume III, U.S. EPA, Office of Research and Development, Environmental Monitoring and Support Laboratory, Research Triangle Park, North Carolina, January 1976 as revised.

Laboratory balances will be calibrated annually and will be checked before use on a daily basis. A record of calibrations and daily checks will be kept in the balance log.

Oven and refrigerator thermometers will be calibrated annually against a National Bureau of Standards certified thermometer in the range of interest. Annual calibrations and daily readings will be maintained in the oven and refrigerator logs.

6.3.3 Personnel Training

Prior to conducting analyses on an independent basis, analysts are trained by experienced personnel in the complete performance of an analytical method. If instrumentation is particularly complicated, analysts may be trained at instrument manufacturers' training courses. The analyst is then required to independently generate data on several method and/or matrix spikes to demonstrate proficiency in that analytical method to be performed. Results of this "certification" are then reviewed by the appropriate supervisor for adequacy.

Since method blanks and method spikes are required routine samples in every lot, performance on a day-to-day basis can be monitored by comparison with the original and cumulative data on similar samples. Supervisors and the laboratory Quality Assurance/Quality Control Coordinator are responsible for ensuring that samples are analyzed by only competent analysts.

6.3.4 Standard Analytical Methods

General: Analytical methods are routinely conducted as outlined in published sources (EPA, Standard Methods, ATM, AOAC, etc.). Modifications to these methods may be necessary in order to provide accurate analyses of particularly complex matrices. When modifications to standard analytical methods are performed, the specific alterations as well as the reason for the change will be reported with the results of analyses.

6.3.5 Gas Chromatography/Mass Spectroscopy

6.3.5.1 Calibration

Mass spectrometers are tuned on a daily basis to manufacturer's specifications with FC-43. In addition, once per shift, these instruments are tuned with 4-bromo-fluorobenzene (BFB) for volatiles. Ion abundances will be within the windows dictated by the specific program requirements. Once an instrument has been tuned, initial calibration curves for analytes (appropriate to the analyses to be performed) are generated for at least three solutions containing known concentrations of authentic standards of compounds of concern. The calibration curve will bracket the anticipated working range of analyses.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain permanent records of instrument calibrations.

6.3.5.2 Quality Control

During each operating shift, a midpoint calibration standard is analyzed to verify that the instrument responses are still within the initial calibration determinations. The calibration check compounds will be those analytes used in the EPA Contract Laboratory Program's multicomponent analyses (e.g., priority pollutants and hazardous substances list) with the exception that benzene is used in place of vinyl chloride (volatiles).

The response factor drift (percent RSD) will be calculated and recorded. If significant (>30 percent) response factor drift is observed, appropriate corrective actions will be taken to restore confidence in the instrumental measurements.

All GC/MS analyses will include analysis of a method blank, a matrix spike, and a laboratory duplicate in each lot of 20 or fewer samples. The matrix spike solutions will contain the compounds listed in Table 3-2 of Attachment G-2 and will be used for both matrix spikes and blank spikes. In addition, appropriate surrogate compounds as specified in Table 3-1 of Attachment G-2 will be spiked into each sample. Recoveries from method spikes and surrogate compounds are calculated and recorded on control charts to maintain a history of system performance.

6.3.6 Spectrophotometric Methods

6.3.6.1 Calibration

Spectrophotometers will be calibrated prior to each day of use. Calibration standards will be prepared from reference materials appropriate to the analyses being performed, and working calibration standards will be prepared fresh daily. The working standards will include a blank and a minimum of 5 concentrations to cover the anticipated range of measurement. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of known versus found concentrations will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to analysis of samples.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

6.3.6.2 Quality Control

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

The method spikes will be examined to determine both precision and accuracy.

Accuracy will be measured by the percent recovery of the spikes. The recovery must be in an acceptable range (based on EPA data for the method of interest) in order to be considered acceptable.

6.3.7 Analysis of Integrated Flue Gas Samples for CO_2 by Orsat

The Orsat will be leak-checked prior to sample analysis using the procedure referenced in Section 5 of EPA Method 3. Ambient air will be analyzed to further leak-check the apparatus. Acceptable values can differ by no more than 0.2 percent by volume from each other in triplicate analyses of the same sample.

6.3.8 Gravimetric Analyses

The analytical balance will be checked daily with Class-S weights. The response will be within 1 mg of true before proceeding with sample determination.

SECTION 7

ANALYTICAL PROCEDURES

7.1 BOTTLE PREPARATION AND SAMPLE PRESERVATION

On request by the Project Manager, sample bottles will be prepared by the laboratory and made available to the sampling team. The bottles will be prepared according to WESTON standard operating procedures and will include sample preservatives appropriate to the analytes and matrices of concern. Addition of preservatives to samples shall be recorded in field notebooks and on chain-of-custody forms. WESTON adheres to the most recent recommendations from the U.S. Environmental Protection Agency (EPA) for proper sample containers and preservatives.

Following recovery, all field samples will be stored in a locked container under chain-of-custody until analyses are performed. Sorbent, VOST condensate, and other samples requiring analysis for volatiles will be maintained at 4°C until analysis is effected. No other special sample preservation procedures are required.

7.2 SAMPLE PREPARATION

The Laboratory Supervisor is responsible for the proper preparation of standards and analytical samples. The analysts will prepare the calibration and spiking standards. All preparation data will be recorded in the proper analysis log books. The Laboratory QA/QC Coordinator will audit the analysts' log books for completeness.

7.3 CHAIN-OF-CUSTODY

Chain-of-custody procedures document the history of samples and constitute a crucial part of sampling and analysis programs. Chain-of-custody documentation assists and enables the identification and tracing of a sample from the time of collection through the time of analysis.

When sample bottles are supplied by the laboratory, chain-of-custody forms will accompany the containers to the field. As samples are collected, entries are made on the chain-of-custody forms. Data to be noted include:

- Data.
- Samples.
- Sample description.
- Client/program.
- Container and preservative.
- Analyses required.
- Special instructions/notes.

Sample containers are also labeled with:

- Date.
- Sample description.
- Preservatives.
- Analyses required.
- Client/program.

When samples are received at the laboratory, the sample custodian will verify each and every sample against the chain-of-custody forms, note any discrepancies or losses of samples, and then sign for receipt of the samples. Samples will remain under the control of the sample custodian until samples are transferred to the analysts for processing. Analysts will acknowledge receipt of samples by signing the chain-of-custody forms.

A sample is considered to be in custody if it:

- Is in the physical possession of the responsible party.
- Is in view of the responsible party.
- Is secured by the responsible party to prevent tampering.
- Is secured by the responsible party in a restricted area.

7.4 SAMPLE RECEIPT

Samples received at the laboratory are inspected for integrity, and any field documentation is reviewed for accuracy and completeness. If chain-of-custody forms do not accompany the samples, the sample custodian will initiate these forms. When samples are received with missing or deficient chain-of-custody forms, the legal traceability of these samples cannot extend to the time of collection, but must begin at the time of laboratory receipt.

Chain-of-custody and sample integrity problems are noted and recorded during sample log-in. The Project Manager is informed of the deficiencies and will advise the laboratory on the desired disposition of the samples. Chain-of-custody forms and deficiency notices are maintained in the client file.

Each sample that is received by the laboratory is assigned a unique sequential WESTON sample number which will identify the sample in the laboratory's internal tracking system.

References to a sample in any communication will include the assigned sample number to specify which sample is of concern.

7.5 SAMPLE STORAGE

Samples requiring volatiles analyses will be stored in a locked refrigerator at 4°C. The temperature of the storage refrigerators will be monitored and recorded daily by the sample custodian. Sample fractions and extracts will also be stored under these same conditions.

7.6 METHODS DEVELOPMENT

When standard (published) methods of analyses are not applicable to analyses to be performed, methods can be developed to provide the desired information. However, the lack of a historical database does not obviate the necessity for documented quality control data to demonstrate the validity of the generated results. Reference material sources must be identified, and proof of compound identity and purity must be available. Instrumental operating parameters as well as calibration data must be documented, and specific procedures (to include sampling, if applicable) must be noted. Quality control samples (method blanks, method spikes, method spike duplicates, matrix spikes, and matrix duplicates) should be analyzed with greater frequency than with standard analytical methods to demonstrate the certainty and uncertainty of generated data. Exact requirements for demonstrating the reliability of developed methods are normally dictated by the specific program.

7.7 REFERENCE MATERIALS

Whenever possible, primary reference materials will be obtained from the National Bureau of Standards (NBS) or EPA. In the absence of available reference materials from these organizations, other reliable sources will be sought. These reference materials will be used for instrument calibration, quality control spikes, and/or performance evaluations. Secondary reference materials may be used for these functions provided that they are traceable to an NBS standard or have been compared to an NBS standard within the laboratory.

7.8 REAGENTS

Laboratory reagents will be of a quality to minimize or eliminate background concentrations of the analyte to be measured. Reagents must also not contain other contaminants that will interfere with the analyte of concern.

7.9 CORRECTIVE ACTIONS

When an analytical system is deemed to be questionable or out-of-control at any level of review, corrective actions are performed. If possible, the cause of the out-of-control situation is determined, and efforts are made to bring the system back into control. Demonstration of the restoration of a reliable

analytical system will normally be accomplished by generating satisfactory calibration and/or quality control sample data. The major consideration in performing corrective actions is to ensure that only reliable data are reported from the laboratory.

SECTION 8

DATA REDUCTION, VALIDATION, AND REPORTING

The equations that will be used to calculate all results are shown in the referenced documents.

8.1 CALCULATION PROCEDURES

8.1.1 Field Calculations

The several stages of data confirmation will begin with an initial series of calculations completed on the same day as the sampling effort to establish that the pretest assumptions were correct and that the test procedures completed to that point were performed in a correct manner. This enables the onsite test team to correct any faulty procedures and provides a greater understanding of the immediate problems. The Field Team Manager will assign the onsite data confirmation activities to an experienced field team member.

8.1.2 Office Calculations

All data averages will be "double-checked" to verify numerical accuracy by an experienced technician. Prior to utilization of the analytical data for calculation of test results, a reasonableness check will be applied to ascertain any obviously "out-of-line" results for reanalysis.

All results of calculations will be examined by another individual as assigned by the Project Manager. Depending on the complexity of the work, this person will either spot check certain calculations or repeat the entire effort as assigned by the Project Manager. When all data are summarized, a check will be made for test result reasonableness by the Project Manager. The Project QA/QC Officer will conduct audits to document that the checks are being performed and documented (with checker's initials and date).

Most manual test data and result calculations are performed on a TI-59/PC-100, on an HP-41CX, or on an IBM-PC computer system. Standard EPA reference method programs have been developed for the system to ensure that correct equations are utilized to generate results. The programs list all entry items (for proofing purposes) and produce calculated results in hard copy form. Reference method equations will be used to calculate the concentration and/or mass rate of each measured emission parameter.

8.2 DATA VALIDATION

All data will be compared to the acceptance criteria of the reference method. For example, particulate tests must be isokinetic ± 10 percent to be acceptable. Laboratory data will be acceptable only if calibration standards fall within the established control limits (see Section 6).

Outliers will be treated on a case-by-case basis. All questionable data will be scrutinized in an attempt to find a reason for rejection. If none is found, the WESTON Project Manager will contact EPA for resolution of the problem. All questionable data will be called out in the report.

8.3 DATA REVIEW

Data reviews are performed at all levels. The individual analysts review the quality of data through calibration checks, quality control sample results, and performance evaluation samples. These reviews are performed prior to submission to the Section Managers or the Analytical Project Manager.

The Section Manager and/or the Analytical Project Manager review data for consistency and reasonableness with other generated data and determine if program requirements have been satisfied. Selected hard copy output of data (chromatograms, spectra, etc.) will be reviewed to ensure that results are interpreted correctly. Unusual or unexpected results will be reviewed, and a resolution will be made as to whether the analysis should be repeated. In addition, the Analytical Project Manager or Section Manager and/or Analytical Project Manager for resolution.

The final routine review is performed by the Laboratory Manager prior to reporting the results to the client. Non-routine audits are performed by regulatory agencies and client representatives. The level of detail and the areas of concern during these reviews are dependent on the specific program requirements.

8.4 LABORATORY DATA REPORTS

It is the responsibility of the Laboratory Supervisor to present all of the data to the manager of the Data Management Group. The Laboratory QA/QC Coordinator is responsible for the quality control data and must sign each lot of sample before the Laboratory Supervisor can move the data to the Data Management Group for reporting.

Rejected data will be returned to the Laboratory Supervisor. The rejected data will be checked for the reason for rejection, and, if an error is found, the appropriate change will be made and the reason for change documented. If the data are corrected yet remain rejected, then the QA/QC Coordinator will notify the WESTON Project Manager and ask for the resolution of the rejected data.

Reports will contain final results (uncorrected for blanks and recoveries), methods of analysis, levels of detection, surrogate recovery data, and method blanks data. In addition, special analytical problems, and/or any modifications of referenced methods will be noted. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method. Consequently, most analytical results will be reported to no more than two (2) significant figures. Data are normally reported in units commonly used for the analyses performed. Concentrations in liquids are expressed in terms of weight per unit volume (e.g., milligrams per liter). Concentrations in solid or semi-solid matrices are expressed in terms of weight per unit of sample (e.g., micrograms per gram).

8.5 PROJECT REPORTS RELATED TO THE TRIAL BURN

The trial burn report will be submitted to the regulatory agency within 90 days after completion of the demonstration burn.

The Project Manager will review the analytical summary and field data for reasonableness. He will utilize appropriate data to calculate parameters required for regulatory compliance (destruction and removal efficiency, HCl removal efficiency, particulate emission rate, etc.). He will oversee compilation of the Trial Burn Summary Report and will review the completed document prior to submission.

8.6 DATA ARCHIVING

The laboratory will maintain on file all of the raw data, laboratory notebooks, and other documentation pertinent to the work on a given project. This file will be maintained for 5 years from the date of invoice unless a written request is received for an extended retention time.

Data retrieval from archives will be handled in a similar fashion to a request for analysis. Specifically, a written work request to include a quotation must be submitted for retrieval of data.

Client confidentiality will be maintained with retrieved data. Consequently, the laboratory can honor only those requests for data authorized by the original client.

SECTION 9

INTERNAL QUALITY CONTROL CHECKS

Quality control samples will be analyzed in the same way as, and interspaced with, the field samples. The results from analysis of the control samples will be used to establish the validity of the data and to control data quality within predetermined tolerance limits. The QC samples that will be incorporated into the project are defined below.

9.1 BLANK SAMPLES

Blank samples will be analyzed in order to assess possible contamination from the field and/or laboratory, so that corrective measures can be taken if necessary. The types of blank samples and their frequency of analysis are:

- Field Blanks - These blank samples will be exposed to field and sampling conditions, and analyzed in order to assess possible contamination from the field (one for each lot of samples analyzed).

- Method Blanks - These blanks will be prepared in the laboratory and analyzed in order to determine the background of each of the reagents (or solvent in the case of particulate samples) used in each type of analysis (one for each new lot number of solvent or reagent used).

9.2 ANALYTICAL REPLICATES

Replicate analysis of specific samples will be undertaken by the analyst to check on the validity of certain analogous samples. For example, if the internal standard response for a specific sample changes drastically from its prior value, a problem could be present in the instrument or in the sample work up. Repeat analyses of the sample in question and a previous "normal" sample will serve to indicate which of the possible problems is present.

All HCl sample analyses will be duplicate QC checks. The analysis goals for laboratory replicate samples will be a precision relative standard deviation of <10 percent.

9.3 CALIBRATION STANDARDS

Calibration standards and continuing calibration checks will be analyzed at the frequency described in Section 6. The value must fall within the stated criteria for the calibration data in order to continue with the remaining samples in the lot.

SECTION 10

PERFORMANCE AND SYSTEM AUDITS

The Project Manager, the Project QA/QC Officer, the Field QA/QC Coordinator, and the Laboratory QA/QC Coordinator will review data for accuracy and completeness and ensure that required QC checks are being made and protocols followed.

It is requested that the agency provide performance evaluation standards for auditing laboratory sample analysis procedures as external QC checks.

SECTION 11

PREVENTIVE MAINTENANCE

All source testing/monitoring equipment and analytical instrumentation that requires maintenance will be serviced prior to conducting the test program in order to increase measurement system reliability and, thus, data completeness.

Normal "spares" (control consoles, glassware, etc.) will be provided in the field to minimize testing delays caused by unexpected equipment failure or breakage.

SECTION 12

SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

12.1 CALCULATION OF MEAN VALUES AND ESTIMATES OF PRECISION

The mean $\bar{C}$, of a series of replicate measurements of mass C_i for HCl will be calculated as follows:

$$\bar{C} = \frac{1}{n} \sum_{i=1}^{n} Ci$$

where:

n = number of replicate measurements
$\bar{C}$, C_i = are both ug of analyte

The estimate of precision of a series of replicate measurements will be expressed as the relative standard deviation, RSD.

$$RSD = \frac{SD}{\bar{C}} \times 100 \text{ percent}$$

where:

$$SD = \text{Standard Deviation} = \sqrt{\frac{\sum_{i=1}^{n} (C_i - \bar{C})^2}{n-1}}$$

The standard deviations calculated will be compared on a frequent basis with the relative standard deviation goal of 10 percent.

12.2 ASSESSMENT OF ACCURACY

The accuracy of the HCl and specific organic sample results will be determined by comparing audit sample results with the true value expressed as percent recovery.

12.3 COMPLETENESS

Data completeness is defined as the percent of acceptable data obtained from that planned for the project. Completeness will be monitored frequently by the Project Manager, Project QA/QC Officer, and Field QA/QC Coordinator. The completeness goal for this project is to obtain acceptable data for >95 percent of the collected samples.

SECTION 13

CORRECTIVE ACTION

Corrective action will be instituted immediately by the individual noting a problem in a measurement system. An unresolved problem will be reported to the employee's immediate supervisor for further action.

If a problem is discovered during field operations, the individual noting the problem will immediately contact his/her direct supervisor who will contact the Field Team Manager and the Field QA/QC Coordinator and report the problem. It is the responsibility of the Field QA/QC Coordinator to resolve the problem in the measurement system. Significant problems or those which cannot be resolved in the field will be reported to the Project Manager for corrective action.

The comparable approach will be followed for problems noted in the laboratory. The individual noting a measurement system problem will immediately notify his/her section supervisor and the Laboratory QA/QC Coordinator. Significant problems or those not resolvable in the laboratory will be promptly reported to the Project Manager for corrective action.

The Project Manager will promptly discuss any noncorrectable problems with the agency for final resolution.

No further testing or analytical processes will be performed until the measurement system problem is corrected.

SECTION 14

QUALITY ASSURANCE REPORTS TO MANAGEMENT

Results of laboratory quality assurance efforts will be provided to the WESTON Project Manager and Project QA/QC Officer by the Laboratory QA/QC Coordinator to clearly define the quality and validity of the sample analytical work generated in this project. Each report will include:

- An assessment of measurement data accuracy, precision, and completeness.
- Results of performance audits.
- Significant QA problems and recommended solutions.

Additionally, the Field QA/QC Coordinator will inform the Project Manager and the Project QA/QC Officer immediately of any sampling, testing, or monitoring problem encountered so that swift corrective action can be instituted.

ATTACHMENT G-1

FIELD OBSERVATIONS AND PROCEDURALS CHECKLISTS

PLANT _____

RUN NO._____ PAGE _____ OF _____

FIELD OBSERVATION CHECKLIST

GENERAL SAMPLING SITE

Stack/Duct Cross-Section Dimensions: _____ Equivalent Dia._____

Material of Construction _____ Corroded _____ Leaks _____

Internal Appearance - Corroded ___ Caked Part. ___ Thickness ___

Insulation? _____ Thickness _____ Lining _____ Thickness _____

Nipple _____ I.D. _____ Length _____ Flush w/Inside Wall _____

Straight Run Before Ports _____ Cross-Sectional Dia. _____

Straight Run After Ports _____ Cross-Sectional Dia. _____

Drawing of Sampling Location:

Minimum information required on drawing: stack/duct dimension, location and description of major and minor disturbances, cross-sectional view showing dimensions and port locations.

PLANT _____

RUN NO. _____ PAGE _____ OF _____

METHOD 1 -- SAMPLE AND VELOCITY TRAVERSE

- Preliminary Procedural Checklist -

Stack/Duct Type (e.g., circular, rectangular) _____

Stack/Duct Cross-Sectional Dimensions _____

Equivalent Diameter (rectangular duct) _____

Nipple Type (e.g., flush w/stack wall) _____

Nipple Length _____ I.D. _____

Distance from Sampling Site to Nearest Upstream Disturbance ____

Number of Stack Diameters _____

Distance from Sampling Site to Nearest Downstream Disturbance __

Number of Stack Diameters _____

Number of Sampling Points/Traverse from Federal Register _____

Number of Sampling Points to be Used _____

Circular Stacks:

Traverse Points Located on Two Diameters? _____

Distance from First Traverse Point to Stack Wall $\geq$ 1.0in. _____

Modifications due to Size of Stack _____

Rectangular Stacks:

Grid Configuration _____ No. of Traverse Pts. _____

Traverse Points Located at Centroid of Areas? _____

Verification of Absence of Cyclonic Flow? _____

PLANT _____

RUN NO. _____ PAGE _____ OF _____

SAMPLING SYSTEM

Sampling Method (EPA 2) Stack Gas Velocity and Volumetric Flow Sampling Train Schematic Drawing:

Modifications to Standard Method _____

_____

Verification of Absence of Cyclonic Flow? _____

Type "S" Pitot Tube? _____ Other _____ Const. Mat'l. _____

Pitot Tube Connected To: Inclined Manometer _____

or Magnehelic Gauge _____

Range _____ Approx. Scale Length _____ Divisions _____

Pitot Tube Coefficient _____ Fluid Type _____

Temperature Gauge _____ Type _____ Attached to Pitot Tube? _____

Recent Calibration of Orifice Meter-Dry Gas Meter? _____

Pitot Tubes? __ Nozzles __ Thermometers or Thermocouples? __

Magnehelic Gauges? ____

Number of Sampling Points/Traverse from Fed. Reg. _____

No. to be Used ____

Length of Sampling Time/Point Desired _____ Time to be Used ____

PLANT _____

RUN NO. _____ PAGE _____ OF _____

SAMPLING SYSTEM

Sampling Method (EPA 3) Gas Analysis and Dry Molecular Weight Sampling Train Schematic Drawing:

Modifications to Standard Method _____

Method: Single Point Grab ____ Single Point Integrated ____

Multi-Point Integrated _____

Probe Type: Stainless Steel _____ Borosilicate Glass _____

Is there a Filter used to Remove Particulate Matter? _____

Type _____

Pump Type: One-Way Squeeze _____ Diaphragm _____

Other _____

Is a Condenser System Used? _____ Type _____

Flexible Bag: Tedlar _____ Mylar _____ Teflon _____

Other _____

Is a Pressure Gauge Used? _____ Type _____

Are all Connections Tight and Leak Free? _____

Is Sampling Train Leak Checked? _____ (optional)

Is Sampling Rate Held Constant? _____

PLANT _____

RUN NO. _____ PAGE _____ OF _____

PARTICULATE, AND HCl EMISSION TESTS

-PRELIMINARY PROCEDURAL CHECKLIST-

Sampling Train Schematic Drawing:

Apparatus:

Probe Nozzle: Stainless Steel _____ Glass _____

Design: Button-Hook _____ Elbow _____ Nozzle Size _____

Clean? _____

Probe Liner: Borosilicate _____ Quartz _____

Other _____ Clean? _____

Heating System _____

Pitot Tube: Type S _____ Other _____

Properly Attached to Probe? _____

Modifications _____

Pitot Tube Coefficient _____

Differential Pressure Gauge: 2 Inclined Monometers _____

Other _____

Filter Holder: Borosilicate Glass _____ Glass Frit _____

Filter Support _____ Silicone Gasket _____

Other _____ Clean? _____

PLANT _____

RUN NO. _____

If data sheets cannot be copied, record:

Approximate stack temp. _____ Volume metered _____

Sample Recovery:

Brushes: Nylon Bristle (non-metallic probe and nozzle) _____

Clean? _____ Other _____

Wash Bottles: Glass _____ Teflon _____ Clean? _____

Storage Containers: Borosilicate Glass _____

Other _____ Clean? _____ Leak-free? _____

Petri-Dishes: Glass _____ Polyethylene _____

Other _____ Clean? _____

Graduated Cylinder/or Balance:

Subdivisions < 2 ml? _____ Other _____

Balance: Type _____

Plastic Storage Containers:

Air-tight? _____ Clean? _____

Probe allowed to cool sufficiently? _____

Non-metallic cap placed over nozzle tip to prevent loss of particulate? _____

During sampling train dis-assembly:

Are all openings capped? _____

Clean-up Area: Description _____

Clean? _____ Protected from wind? _____

Filters: Glass Fiber or Quartz _____ Type _____

Silica Gel: Type (6 to 16 mesh)? _____

New _____ Used _____

Filter Handling: Non-metallic tweezers used? _____

Surgical gloves? _____ Other _____

Any particulate lost? _____

Water: Distilled? _____

Stopcock Grease: Acetone-Insoluble? _____

Heat-stable Silicone? _____ Other _____

Probe Handling: Acetone rinse _____

Nitric acid rinse _____

Particulate recovery from: Probe nozzle _____

Probe fitting _____ Probe liner _____

Front half of filter holder _____

Blank: Acetone _____ Nitric acid _____ Filter _____

Any visible particles on filter holder, inside probe: _____

_____

Impinger Handling: Description of impinger contents _____

_____

Volume increase measured and value recorded? _____

Solution transferred to sample jar? _____

Nitric acid or KMN04 rinse of impinger/connectors added to jar? _____

8N HCL rince of KMN04 impingers conducted? _____

Blank test train setup, lead checked and recovered? _____

HNO_3/H_2O_2 blank prepared? _____

KMN04 blank prepared? _____

8N HCL blank prepared? _____

Filter blank prepared? _____

Color of Silica Gel? _____ Condition _____

Method of Silica Gel transfer? _____

All jars adequately labeled? _____

Jars sealed tightly _____ liquid level marked on jars _____

Jars locked up? _____

Chain of custody forms completed? _____

PLANT _____

RUN NO. _____

VOLATILE ORGANIC SAMPLING TRAIN (VOST) EMISSION TESTS
-PRELIMINARY PROCEDURAL CHECKLIST-

Apparatus:

Probe Liner: Borosilicate _____ Quartz _____
Other _____ Prepared? _____ Clean? _____
Sealed prior to usage? _____
Heating system? _____

Vost Glassware: Prepared? _____ Clean? _____
Sealed prior to usage? _____

Vost Tubing Connectors: Prepared? _____ Clean? _____
Sealed prior to usage? _____

Vost Sample Box and Umbilical: Complete? _____ Clean? _____
Mechanical/electrical connectors ok? _____

Vost Control Console: Recent calibration _____
Vacuum and pressure leak test _____

Condenser Coolant System: Proper operation _____
Proper connectors _____

Vost Adsortion Tubes: Prepared _____ Sealed? _____
Maintained cool? _____

Barometer: Mercury _____ Aneroid _____
Other _____

Procedure:

Recent calibration? _____
Meter box _____ Thermometers/Thermocouples _____
Vost tubes check visually for irregularities? _____
Sampling site selected? _____ Stack Temp.? _____
Charcoal filter attached to sample/leak check valve assembly? _____
Pre-test leak check? _____ leakage? _____
Stack gas dry molecular weight? _____

PLANT _____

RUN NO. _____

election of sampling time? _____

All openings to sampling train plugged to prevent pre-test contamination? _____

Glassware properly assembled? _____

Type Probe-Liner: Glass _____ Quartz _____

Other _____

Meter box leveled? _____

Dry gas meter zeroed? _____

Probe heat uniform along length of probe? _____

Coolant water pump operational? _____

Care taken to avoid scraping nipple or stack wall? _____

Effective seal made around probe when in-stack _____

Probe positioned at stack centroid? _____

Data sheets complete and data properly recorded? _____

Post-test leak performed? (mandatory after each tube pair)

_____

Leakage rate _____ @ in. Hg. _____

Orsat analysis _____ from stack _____ Integrated _____

Fyrite combustion analysis _____ Sample location _____

Bag system leak-checked? _____

If data sheets cannot be copied, record:

Approximate stack temp. _____ Volume metered _____

Sample Recovery:

Brushes: Nylon bristle _____ Clean? _____ Other _____

Wash Bottles: Glass _____ Teflon _____ Clean _____

Storage Containers: Borosilicate VOA _____

Other _____ Clean? _____ Leak free? _____

Vost Tube Storage Containers: Air tight? _____ Clean? _____

Charcoal present? _____

Probe allowed to cool sufficiently? _____

Cap placed over probe tip and sample/leak check valve closed?

_____

During sampling train disassembly

All openings capped? _____

Clean Up Area: Description _____

Clean? _____ Protected from wind? _____

Vost Tube Handling: Vost tube tightly sealed? _____

Tubes placed in original containers? _____

Tubes labelled properly? _____

Tube pair site and trip blanks prepared? _____

Kept separate from solvents, solutions, etc. to avoid contamination? _____

Vost Glassware Handling:

Description of condensate _____

Volume of condensate _____

Solution transferred to VOA bottle? _____

All condensers, tubing, condenser drop out flask rinsed with HPLC water? _____

Rinse added to sample container? _____

Sample level topped off to eliminate head space? _____

Sample properly labelled? _____ HPLC blank prepared _____

Sample maintained on ice? _____

Vost train silica gel removed and regenerated? _____

Sample chain of custody properly completed? _____

Samples stored and located? _____

Maintained on ice? _____

PLANT _____

RUN NO. _____

MULTI-METALS EMISSION TESTS
PRELIMINARY PROCEDURAL CHECKLIST

Sampling Train Schematic Drawing:

Apparatus:

Probe Nozzle: Borosilicate Glass _____
Design: Button-Hook _____ Elbow _____ Nozzle Size _____
Clean? _____
Probe Liner: Borosilicate _____ Quartz _____
Other _____ Clean? _____
Heating System _____
Pitot Tube: Type S _____ Other _____
Properly Attached to Probe? _____
Modifications _____
Pitot Tube Coefficient _____
Differential Pressure Gauge: 2 Inclined Manometers _____
Other _____
Filter Holder: Borosilicate Glass _____
Filter Support _____ Silicone Gasket _____
Filter Type _____
Other _____ Clean? _____
Filter Heating System:
Description _____
Condenser: Number of Impingers _____ Clean? _____
Contents: 1st _____ 2nd _____ 3rd _____ 4th _____ 5th _____ 6th _____
Cooling System _____
Proper Connections? _____
Modifications _____
_____

PLANT _____

RUN NO. _____

Barometer: Mercury _____ Aneroid _____

Other _____

Gas Density Determination: Temp. Sensors Type _____

Pressure Gauge _____

Temp. Sensor Attached to Probe? _____

Other _____

Procedure:

Meter Box _____ Thermometers/Thermocouples _____

Sampling site selected? _____ Stack Temp.? _____

Velocity Heads? _____

Pre-test Leak Check? _____ (optional) Leakage? _____

Stack Gas Dry Molecular Wght.? _____

Selection of sampling time? _____

All openings to sampling train plugged to prevent pre-test contamination? _____

Type Probe-Liner: Glass _____ Quartz _____

Other _____

Meter Box Leveled? _____

Manometers Zeroed? _____

Probe heat uniform along length of Probe? _____

Care taken to avoid scraping nipple or stack walls? _____

Effective Seal made around probe when in-stack _____

Data sheets complete and data properly recorded? _____

Orifice pressure readings recorded accurately? _____

Post-test Leak Performed? (mandatory before and after each port change) _____

Leakage Rate _____ @ in. Hg. _____

Orsat analysis _____ from stack _____ Integrated _____

Fyrite Combustion Analysis _____ Sample Location _____

Bag System Leak-checked? _____

ATTACHMENT G-2

LABORATORY QUALITY ASSURANCE PLAN
(4 OCTOBER 1988)

0174L

LABORATORY QUALITY ASSURANCE PLAN

ROY F. WESTON, INC.
Analytics Division
208 Welsh Pool Road
Lionville, PA 19353

October 1988
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ROY F. WESTON, INC.
LABORATORY QUALITY ASSURANCE PLAN

1.0 Introduction

This document describes the Quality Assurance (QA) procedures employed by WESTON Analytics, a Division of Roy F. Weston, Inc., to ensure that all data generated in the laboratory conform to specific requirements for accuracy, precision, and completeness. These procedures are routinely incorporated into all analyses performed by the WESTON laboratory for the purpose of producing reliable data.

Customized, client-specific quality control measures can be added to or can supersede these basic guidelines to satisfy the needs of individual programs. Laboratory personnel are available to discuss the design, advantages, and disadvantages of other quality control options, and to aid the data user in developing a project specific Quality Assurance Project Plan (QAPP). At a minimum, the information provided for these project specific plans will include:

- background and overall project objectives,
- intended use of the acquired data,
- list of measurement parameters,
- number of samples to be taken,
- kinds of samples to be taken (e.g. soil, surface water, groundwater, biological, sludge, drums, etc.), and
- dates anticipated for project start and completion.

2.0 Organization Chart and Individual Responsibilities

2.1 Introduction

The organization of WESTON Analytics is shown in Figures 2-1 and 2-2. The specific duties and responsibilities of the Laboratory Manager, Quality Assurance Coordinator, Section Managers, Project Manager, Project Director, and Technical Director are described in detail in the relevant standard operating procedures (SOPs). These duties and responsibilities are summarized in the following sections.

2.2 Project Director and Project Manager

WESTON recognizes the importance of efficient project management. WESTON has established a Project Director (PD), Project Manager (PM) group which is responsible for managing all analytical projects. The PD is responsible for the overall direction of the project. The project managers are responsible for maintaining the laboratory schedule, ensuring that technical requirements are understood by the laboratory, and ensuring that project deliverables are submitted on-time and in the required format.

2.3 Technical Director

The WESTON Analytics Division Technical Director serves as technical liaison and assists in resolving any technical issues. He will coordinate these activities with the Project Manager and Quality Assurance Coordinator.

2.4 Laboratory Manager

The Laboratory Manager has the responsibility to see that all tasks performed in the laboratory are conducted according to the requirements of this Quality Assurance Plan (QAP).

2.5 Section Managers

The Section Managers are responsible for implementation of established polices and procedures. The responsibilities of the Section Managers are summarized below:

1. Provide technical direction to analysts in conformance with project requirements.

2. Monitor laboratory work schedules to ensure compliance with project commitments.

3. Review all analytical data prior to reporting to ensure conformance with this QAP.

4. With the Laboratory Manager and Quality Assurance Coordinator, identify and resolve technical problems consistent with the requirements of this QAP.

5. Ensure that assigned personnel are adequately trained to perform required analyses.

2.6 Chemists-Technicians

An effective laboratory quality assurance program depends on the performance of all laboratory staff who perform analyses. The responsibility of laboratory chemists and technicians include:

1. Initial review of QC data for acceptability.

2. Recording of data in bound laboratory notebooks (including any observations made during the analyses).

3. Informing direct supervisors of any problems with instruments or methods to ensure that prompt and effective corrective action is taken.

2.7 Quality Assurance Coordinator

The Laboratory Quality Assurance Coordinator has oversight responsibility for implementation of the quality assurance objectives. These responsibilities include:

1. Ensure that QA objectives of this QAP are met.

2. Submit performance samples for analysis appropriate to laboratory analytical requirements at least annually.

3. Provide an internal audit of representative analytical data reports.

4. Perform an internal laboratory systems audit at least once semi-annually.

5. Provide quality assurance reports to WESTON management.

6. Coordinate on-site QA laboratory audits and ensure that any questions regarding QA requirements are resolved.

2.8 Report Manager

The Laboratory Report Manager is responsible for monitoring the status of all samples in the laboratory and ensuring that data are reported in a timely manner and in the proper format.

FIGURE 2-1

WESTON ANALYTICS DIVISION ORGANIZATIONAL CHART

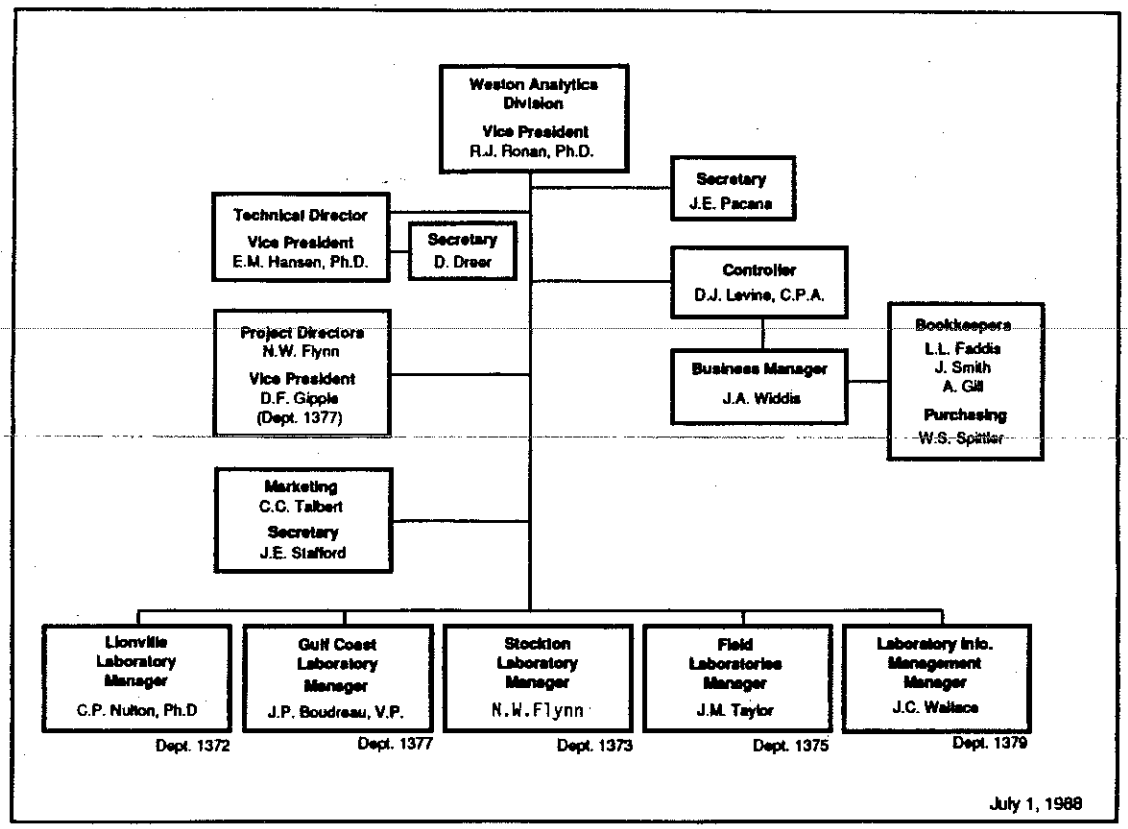

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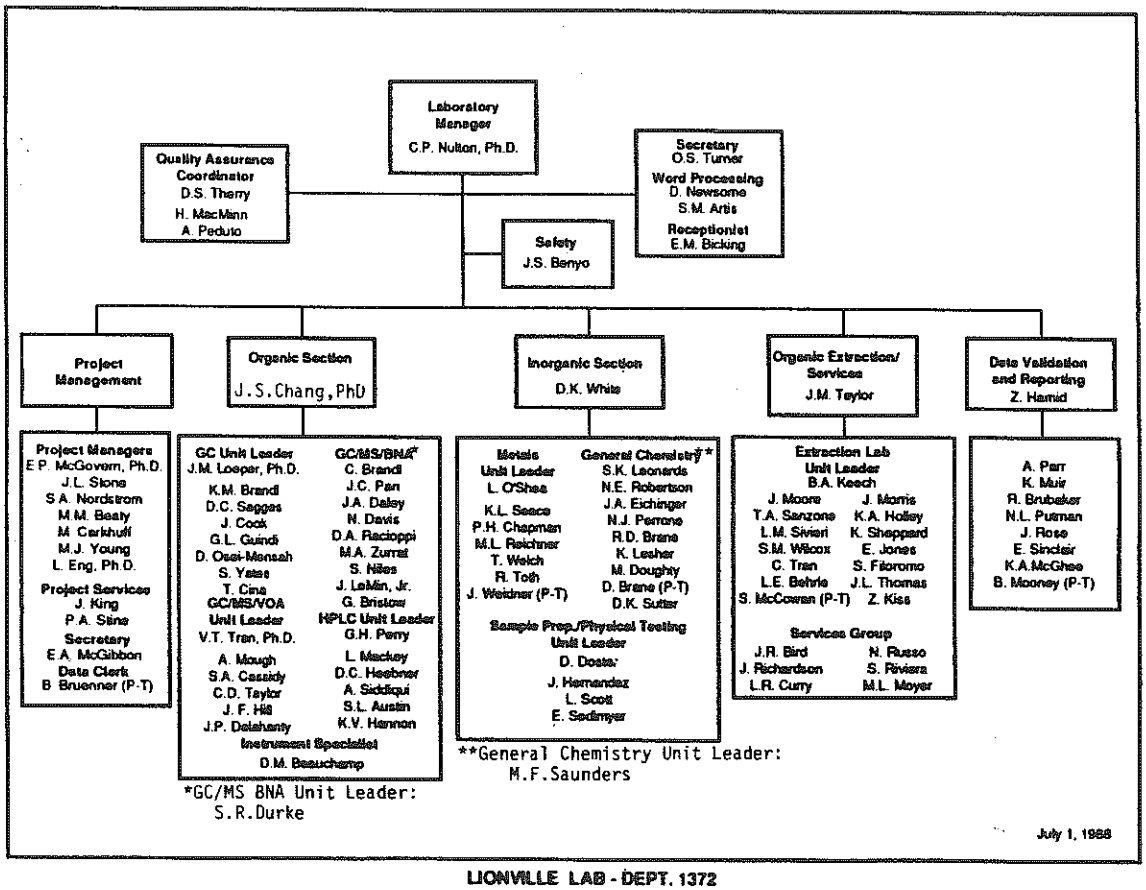
FIGURE 2-2

LIONVILLE LABORATORY ORGANIZATIONAL CHART



3.0 Quality Assurance Objectives

3.1 Introduction

The objective of this Quality Assurance Plan is to provide a framework to ensure that all analytical data which are reported are of known quality. The minimum requirements of an effective Quality Assurance program include:

- Sample Management: sampling, sample preservation, chain-of-custody
- Analytical Methodology: documented analytical procedures, calibration, data handling
- Laboratory Records: measurement data, maintenance records, equipment manuals
- Quality Control/Quality Assessment: control charts, quality control samples
- Data Review, Validation and Reporting
- Performance and System Audits/Corrective Action
- QA Reports to Management
- Personnel Training

All measurements made in this program will be representative of the matrix and conditions being measured. The data will be calculated and reported in units consistent with standard reporting conventions to enable comparability to existing data, standards, and/or regulatory action limits.

The specific procedures utilized by WESTON for these systems will be described in subsequent sections of this QAP. All of these systems help to establish the QA objectives, which are measured in terms of accuracy, precision, and completeness.

3.2 Quality Assurance Objectives for Accuracy

Analytical accuracy is expressed as the percent recovery of an analyte which has been used to fortify an investigative sample or a standard matrix (e.g., blank soil, analyte-free water, etc.) at a known concentration prior to analysis, and is expressed by the following formula:

$$\text{Accuracy} = \% \text{ Recovery} = \frac{A_T - A_0}{A_F} \times 100\%$$

where:

A_T = Total amount found in fortified sample

A_O = Amount found in unfortified sample
A_F = Amount added to sample

The fortified concentration will be specified by laboratory quality control requirements, or may be determined relative to background concentrations observed in the unfortified sample. In the latter case, the fortified concentration should be enough different (2 to 5 times higher) from the background concentration to permit a reliable recovery calculation.

The quality assurance objectives for organic and inorganic analyses are tailored to the analytical technique used, and are discussed separately in subsequent sections of this QAP.

3.2.1 Metals/Inorganics Analysis

For metals analysis, analytical accuracy is obtained from the analyte recovery measured in a laboratory control standard and/or a sample fortified with the element of interest. The QA objectives for accuracy in routine metals analysis for these QC samples are summarized below:

Sample	Recovery (%)
Laboratory Control Standard (LCS)	80-120*
Fortified Field Sample	75-125

Recovery values outside the QC limits for an LCS (* with the exception of antimony and silver) will trigger corrective action. Recovery values for fortified field samples are advisory only.

For non-routine metals and inorganic parameters, laboratory control charts have been established and will be used to define Quality Assurance objectives.

3.2.2 Organic Analysis (GC and GC/MS)

For organic analysis, analytical accuracy is obtained from the surrogate recovery measured in each sample and blank and/or from the analysis of samples or blanks which have been fortified with a select number of target analytes.

The Quality Assurance objectives for accuracy are summarized in Table 3-1 for GC/MS surrogates and in Table 3-2 for GC/MS target analytes from fortified samples. The recovery values for surrogates and target analytes in investigative sample analyses are advisory for routine laboratory analysis. Only recovery values for standard matrix samples (e.g., blanks) are used for triggering corrective action, except for work performed under U.S. EPA CLP contract conditions, at which time CLP requirements are followed.

3.3 Quality Assurance Objectives for Precision

Analytical precision is calculated by expressing as a percentage the difference between results of analysis of duplicate samples relative to the average of those results for a given analyte. Precision can be expressed by the formula:

$$\% \text{ RPD} = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100\%$$

where:

RPD = Relative Percent Difference
C_1 = Concentration of analyte in sample
C_2 = Concentration of analyte in replicate

On the occasion when three or more replicate analyses are performed, precision is calculated by expressing as a percentage, the standard deviation of the analytical results of the replicate determinations relative to the average of those results for a given analyte. This precision measurement, percent relative deviation (% RSD), will have QA objectives identical to those for % RPD, and can be expressed by the formula:

$$\% \text{ RSD} = \frac{\sqrt{(\Sigma C^2) - (\Sigma C)^2/n(n-1)}}{(C1 + C2 + \ldots Cn)/n} \times 100\%$$

where:

RSD = percent relative deviation
C = concentration of analyte in the sample, and $(C_1 + C_2 + \ldots C_n)$ represents the sum of the concentration of each replicate
n = number of replicate analyses
Σ = "the summation of"

The QA objectives for metals (and other inorganic parameters) analysis are different from those for organic analyses. These QA objectives are discussed separately in the sections below.

3.3.1 Metals and Miscellaneous Inorganic Analyses

For metals (except antimony and silver) and inorganic analyses the QA objective for precision is $\pm$ 20% relative percent difference (% RPD) between replicate analyses. % RPD values outside the QC limits for duplicate LCS analyses will trigger corrective action. % RPD for duplicate investigative sample analyses are advisory only.

3.3.2 Organic Analyses (GC, GC/MS)

For organic analyses, precision is measured by comparison of the recovery of surrogate compounds in the standard matrix (e.g., blank, blank spike) and/or by comparison of the recovery of a

select number of target analytes in duplicate fortified samples or duplicate fortified blanks (e.g., matrix spike/matrix spike duplicate: MS/MSD, and/or blank spike/blank spike duplicate: BS/BSD). The QA objectives for precision as expressed by the % RPD for duplicate analysis of target analytes are given in Table 3-2. For surrogate compounds, laboratory control charts have been established and will be used to define QA objectives. These RPD limits are advisory only for investigative samples. Only evaluation of precision for standard matrices will trigger corrective action.

3.4 QA Objective for Data Completeness

Completeness is a measure of the relative number of analytical data points which meet all the acceptance criteria for accuracy, precision, and any other criteria required by the specific analytical methods used. The level of completeness can also be affected by loss or breakage of samples during transport, as well as external problems which prohibit collection of the sample.

The WESTON QA objective for completeness is to have 80% of the data usable without qualification. The ability to meet or exceed this completeness objective is dependent on the nature of samples submitted for analysis. For example, if the analytical methods proposed for use (particularly for organics analyses) are intended for analysis of environmental samples of low and medium hazard, the applicability of these methods to non-routine matrices such as drum samples, wipes, air samples, etc. may result in poor method performance and therefore adversely impact achievement of the data completeness goal.

TABLE 3-1

**QUALITY ASSURANCE OBJECTIVES FOR ACCURACY
FOR
ORGANIC SURROGATE ANALYSES**

Fraction	Surrogate Compound	Percent Recovery Low/Medium Water	Percent Recovery Low/Medium Soil/Sediment
VOA	Toluene-d8	88-100	81-117
VOA	4-Bromofluorobenzene	86-115	74-121
VOA	1,2-Dichloroethane-d4	76-114	70-121
BNA	Nitrobenzene-d5	35-114	23-120
BNA	2-Fluorobiphenyl	43-116	30-115
BNA	p-Terphenyl-d14	33-~~114~~141 **	18-137
BNA	Phenol-d5	10- 94	24-113
BNA	2-Fluorophenol	21-100	25-121
BNA	2,4,6-Tribromophenol	10-123	19-122
PEST	Dibutylchlorendate	24-154*	20-150*

* These recoveries are advisory only. No corrective action (i.e., sample reanalysis) will be taken if these criteria are not met.

(** typo)

TABLE 3-2

QA OBJECTIVES FOR ACCURACY AND PRECISION FOR ORGANIC TARGET COMPOUND ANALYSES

Fraction	Matrix Spike Compound	% Recovery Limits Water	% Recovery Limits Soil/Sed	% RPD Limits Water	% RPD Limits Soil/Sed
VOA	1,1-Dichloroethene	61-145	59-172	14	22
VOA	Trichloroethene	71-120	62-137	14	24
VOA	Chlorobenzene	75-130	60-133	13	21
VOA	Toluene	76-125	59-139	13	21
VOA	Benzene	76-127	66-142	11	21
BN	1,2,4-Trichloro-benzene	39- 98	38-107	28	23
BN	Acenaphthene	46-118	31-137	31	19
BN	2,4-Dinitrotoluene	24- 96	28- 89	38	47
BN	Pyrene	26-127	35-142	31	36
BN	N-nitroso-di-N-propylamine	41-116	41-126	38	38
BN	1,4-Dichlorobenzene	36- 97	28-104	28	27
ACID	Pentachlorophenol	9-103	17-109	50	47
ACID	Phenol	12- 89	26- 90	42	35
ACID	2-Chlorophenol	27-123	25-102	40	50
ACID	4-Chloro-3-methyl-phenol	23- 97	26-103	42	33
ACID	4-Nitrophenol	10- 80	11-114	50	50
PEST	Lindane	56-123	46-127	15	50
PEST	Heptachlor	40-131	35-130	20	31
PEST	Aldrin	40-120	34-132	22	43
PEST	Dieldrin	56-126	31-134	18	38
PEST	Endrin	56-121	42-139	21	45
PEST	4,4-DDT	38-127	23-134	27	50
PCB	Arochlor 1254	Not Established		30	50

% RPD = Relative Percent Difference

This list includes those compounds most commonly used for QA/QC accuracy and precision control in the groups of analytes shown based on current U.S. EPA Contract Laboratory Program (CLP) requirements. (USEPA SOW 10/86 as revised through 8/87). Stated control limits will be updated to the current CLP protocol, as required.

4.0 Sampling Procedures

4.1 Introduction

While samples submitted to the laboratory for analysis are generally collected by non-laboratory personnel, WESTON fully recognizes the importance of the sample collection program in the overall assessment of data quality and usability. Sampling procedures must ensure the integrity of the samples collected, provide representative samples of the media being evaluated, and be compatible with planned laboratory analysis.

4.2 Sampling Plan

The objective of sampling is to obtain information that provides a qualitative and quantitative measure of site conditions, so that appropriate action can be taken relative to project goals. These goals encompass areas such as:

- preliminary site investigation,
- emergency cleanup operations,
- remedial response operations,
- backup for litigation purposes,
- monitoring, and
- research or technology transfer.

It is important, therefore, that the sampling effort be preceded by a well-planned, custom-tailored sampling plan for each project. This will help ensure that goals are met, that sampling is completed in a timely, cost effective manner, safety of sampling personnel is maximized, samples are representative of the site, sampling errors are reduced, and integrity of the sample is preserved during and after sampling.

The sampling plan should address: (1) the definition of objectives, (2) selection of representative sampling sites, (3) collection of sufficient volumes of material, (4) selection and preparation of proper sample containers, (5) preservation of sample integrity, (6) identification of samples, (7) proper sample holding times, (8) safe handling and transportation procedures, and (9) standard chain-of-custody procedures.

The following steps are essential in preparation of the sampling plan:

1. Research background information on the site and samples: evaluate the site history, review any data available from prior sampling excursions, review available geotechnical data, consider the materials to be sampled (composition, form, expected concentrations, etc.), determine what analyses will best address the issues at the site.

2. Determine safety requirements and arrange for equipment and procedural needs for safe sampling.

3. Consider proper locations for sampling.

4. Determine the sample volume required for each location, with special considerations given to the type of sample container and preservative needed for each analyte. Analytes with the same container/preservative requirement may be able to be combined into one larger container (i.e., 1 L rather than three 250 mL bottles). Allow sufficient volume for field and laboratory QC samples.

5. Determine the sampling equipment needed and arrange to have the necessary facilities and supplies for proper decontamination between samples.

6. Review procedures for sample collection and plan training or refresher courses for samplers.

7. Review procedures for containing and handling samples.

8. Properly execute chain-of-custody procedures, beginning with bottle preparation.

9. Identify necessary packaging, labeling, and shipping requirements, including the following:

   a. Identify samples and protect from tampering (secure evidence tape if available).

   b. Record all sample information in a bound field notebook.

   c. Fill out the chain-of-custody sample analysis request form.

10. Deliver or ship the samples to the laboratory for analysis.

11. Consider analyte holding times when determining shipping frequency. Many laboratory contractual agreements measure holding times from the date of receipt at the laboratory, while regulatory holding times are measured from the date of sample collection.

4.2.1 Safety

The sampling plan will delineate the safety procedures for sample collection, such as respiratory protection required while sampling concentrated sources, procedures for entering buildings

or enclosed structures, length of time personnel are to remain in protective clothing while sampling, and identification of the person handling the field samples. Proper procedures must be used when opening drums, tanks, or other vessels, and all personnel must be notified of potential hazards when closed containers will be opened.

The sampling plan will also list telephone numbers, addresses, and directions to the nearest medical facility, ambulance service, fire department, police department, and the client contact. The fire department should be alerted to possible incidents during a very hazardous inspection.

4.2.2 Sampling Points

A representative sample is crucial to decision-making and to enforcement proceedings and is dependent on proper selection of sampling points. Special consideration will be required for hazardous wastes, which are usually multi-phase mixtures and are stored in receptacles of different sizes and shapes. No single series of sampling points can be specified for all types of waste receptacles. Table 4-1 lists most types of receptacles used for hazardous waste and the corresponding recommended sampling points.

In some cases, it may be appropriate to conduct a preliminary survey of the facility prior to sampling. This would consist of a brief site visit and survey, during which time safety requirements for the site would be ascertained and a sampling plan established by the inspector.

4.2.3 Volume of Samples

Sufficient volume of a sample, representative of the main body of the water or waste, must be collected. This sample must be adequate in size for all needs, including laboratory analysis, splitting with other organizations involved, etc. In all cases, the laboratory should be consulted for guidance prior to sampling. As general guidance, the sample containers provided by the laboratory should be filled. This will provide adequate volumes to perform analysis once. Choose at least one sample per twenty (20) for each matrix and collect triple volumes for all analytes to allow sufficient sample for laboratory duplicate and spike analysis.

4.2.4 Sampling Equipment

Receptacles (i.e., drums, tanks, etc.), should only be sampled when necessary to meet enforcement or cleanup requirements. Opening of drums or other sealed receptacles may be hazardous to sampling personnel unless proper safety procedures are followed.

Samples of waste materials, water, soil, or sediments will be collected through the use of peristaltic, mechanical or automatic pumps, soil augers, sediment dredges, hand scoops, and other equipment (see Table 4-2) as required. All samples should be collected in a manner that assures no contamination between samples. When possible, dedicated equipment should be used for each site to avoid the need for field cleaning of utensils.

Samples from drums, bags, reservoirs, or other small vessels are generally obtained by a dip or insertion tube (coliwasa sampler). After agitation of the vessel or container, if possible, the tube is inserted diagonally, sealed, and removed. Thus, the sample obtained is a cross-sectional representative sample, avoiding bias due to stratification of material in the container. Sometimes it is difficult to obtain a representative sample of large containers, such as bulk liquid storage tanks. In these cases, often the only sampling location is a bottom valve, and the sample obtained is from the bottom layer within the tank. Many times this may be a "worst case" sample, especially for PCB's and other dense substances. Whenever possible, surface, middle, and bottom samples are collected from large bulk liquid storage tanks in order to avoid possible stratification bias. Using this tiered sampling technique helps to accurately characterize the overall concentration of the parameter of interest. A general list of usage of sampling equipment is given in Table 4-3.

Sampling personnel frequently are required to split samples collected with facility personnel or EPA laboratories. It is essential that a true duplicate split be made, otherwise analytical results will not be comparable.

To obtain a true duplicate, a large quantity of sampled material will be collected, thoroughly mixed, and equally proportioned into similar containers. If preservation is necessary, both are preserved with an appropriate chemical from a common dispenser at the same time. Both duplicates are labeled with the same sample location description and marked as splits and logged into a field notebook.

4.3 Sample Containers

Upon request from the client, WESTON will provide, within 7 days, the required number and type of sample containers for a specific sampling episode.

All containers provided by WESTON will be obtained from I-Chem, Hayward, California, or be of equivalent quality. I-Chem is the bottle contractor to the U.S. EPA-Contract Laboratory Program. These containers are cleaned by I-Chem in accordance with U. S. EPA protocols. The containers purchased from I-Chem are I-Chem Series 200 containers. Each lot of these containers is analyzed

in accordance with I-Chem quality control requirements and is not shipped by I-Chem unless the QC requirements are met.

All sample containers provided by WESTON will be shipped with chain-of-custody sheets (see Section 5). These chain-of-custody sheets will be completed by the field sampling personnel and returned with the samples.

4.4 Sample Preservation and Holding Times

The preservatives required for all analyses will be provided by WESTON with the sample containers. The required preservation methods will be in accordance with those given in 40 CFR, Part 136, No. 209, October 26, 1984, for water and in SW-846, Test Methods for Evaluating Solid Waste, Third Edition, November 1986, for soils.

The holding times for all required analyses are measured from sample collection, and are given in SW-846, Test Methods for Evaluating Solid Waste, Third Edition, November 1986. (This reference includes 40 CFR, Part 136, No. 209, October 1984 holding times for routine water samples, as well as holding times for waste samples.)

Some programs, e.g. the U.S. EPA Contract Laboratory Program (CLP) and CLP-type agency or client programs, measure holding times from verified time of sample receipt (VTSR) at the laboratory. Samples designated as CLP must specify in the project plan that holding times from sample collection are superseded by holding times from VTSR.

Upon sample receipt at the WESTON Laboratory all sample collection dates are noted by the sample custodian. The required date for completion of analysis (or extraction) is noted on the chain-of-custody sheet (see Section 5) and is keyed to the holding time if it falls sooner than the required reporting date for analyses.

All analyses which have holding times of 48 hours or less are identified by the sample custodian, and the appropriate section manager, unit leader and analyst are notified that samples are in house.

4.5 Sampling Procedures

Sampling procedures will vary depending on the medium sampled (liquid, solid, or gas) and the type of structure the waste is contained in, as indicated in Table 4-1. Sampling procedures to be used will be standardized as described in the "NPDES Compliance Sampling Manual, " U.S. EPA, Office of Water Enforcement (October, 1979), "Samplers and Sampling Procedures for Hazardous Waste Streams," U.S. EPA, Municipal Environmental

Research Laboratory (January, 1980), and SW-846 Test Methods for Evaluating Solid Waste, Third Edition (November 1986). Sample collection of project sites in the state of New Jersey will conform to the New Jersey Department of Environmental Protection Field Sampling Procedures Manual, February 1988.

4.6 Sample Handling and Packing

Sample handling and packing procedures are in accordance with the User's Guide to the U.S. EPA Contract Laboratory Program. The collected sample and its container represent one of the major avenues of personnel and environmental exposure. Precautions will be taken to ensure that all the samples removed from the site are within the sample container and that no residue remains on the outside of the container.

A unique code number is assigned to each sample. All sample bottles will be differentiated by use of a sample label. All information pertinent to the field activities will be recorded in bound field notebooks. The notebooks must contain the following information:

- source of sample (including plant name, location, and sample point description),
- analysis required and preservative type (where applicable),
- name of collector, date and time of collection, physical/environmental conditions during field activity,
- matrix sampled, sample collection method, number and volume of samples taken,
- sample identification number(s), custody seal numbers,
- any field measurements, and
- documentation of shipping dates and methods.

Samples will be packed and shipped following U.S. EPA recommended procedures and in accordance with applicable DOT regulations. Chain-of-custody is initiated in the field and will travel with the samples. Custody seals will be affixed to the shipping container. A detailed discussion of chain-of-custody procedures is found in Section 5.

Table 4-1

SAMPLING POINTS FOR MOST WASTE RECEPTACLES

Receptacles	Sampling Point
Drum, bung on one end	Withdraw sample through the bung opening.
Drum, bung on side	Sample drums only if they are laying on side with bung up. Withdraw sample through the bung opening.
Barrel, fiberdrum, buckets, sacks, bags	Withdraw samples through the top of barrels, fiberdrum, buckets, and similar receptacles. Withdraw samples through fill openings of bags and sacks. Withdraw samples through the center of the receptacles and to different points diagonally opposite the point of entry.
Vacuum truck and similar containers	Withdraw sample through open hatch. Sample all other hatches.
Pond, pit, lagoons	Divide surface area into an imaginary grid.* Take three samples, if possible; one sample near the surface, one sample at mid-depth or at center, and one sample at the bottom. Repeat the sampling at each grid section over the entire pond or site.
Waste pile	Withdraw samples through at least three different points near the top of pile to points diagonally opposite the point of entry.
Storage tank	Sample from the top through the sampling hole.
Soil	Divide the surface area into an imaginary grid.* Sample each grid section.

* The number of grid sections is determined by the desired number of samples to be collected which, when combined, should give a representative sample of the wastes.

Table 4-2

SAMPLING EQUIPMENT

Sampling plan
Sample containers (plastic and glass), caps, liners
Shovels
Soil Samplers (auger, scoop, steel spoon, etc.)
Stainless steel buckets
Remote barrel opener equipment, non-sparking bung wrench
Thermometer
Drager tubes
Tenax columns and power packs
Ambient air monitor
Surveyor's ribbon
Glass pipets and glass tubing
Wooden paddles (tongue depressors)
Monitoring well sampling equipment
Well sounder
Radiation detector (beta, gamma)
Explosimeter
pH paper
pH meter, spare probes

Table 4-3

SAMPLING EQUIPMENT FOR PARTICULAR WASTE TYPES

Type of Waste	Sampling Point: Drum	Sacks and Bags	Open Bed Truck	Closed Bed Truck	Storage Tanks or Bins	Waste Piles	Ponds, Lagoons & Pits	Conveyor Belt	Pipe
Free Flowing Liquids and Slurries	Coliwasa	N/A	N/A	Coliwasa	Weighted Bottle	N/A	Dipper	N/A	Dipper
Sludge	Scoop	N/A	Scoop	Scoop	Scoop	N/A		N/A	N/A
Moist Powders or Granules	Scoop	Scoop	Scoop	Scoop	Scoop	Scoop	Scoop	Shovel	
Dry Powders or Granules	Thief	Thief	Thief	Thief	Thief	Thief	Thief	Shovel	
Sand or Packed Powders	Auger	Auger	Auger	Auger				N/A	
Large Grained Solids	Large Scoop	Large Scoop	Large Scoop	Large Scoop	Large Scoop	Large Scoop	Large Scoop	Large Scoop	

5.0 Chain-of-Custody

5.1 Introduction

The purpose of chain-of-custody procedures is to document the history of sample containers and samples (and sample extracts or digestates) from the time of preparation of sample containers, through sample collection, shipment and analysis. An item is considered to be in one's custody if:

1. it is in the physical possession of the responsible party,
2. it is in the view of the responsible party,
3. it is secured by the responsible party to prevent tampering, or
4. it is secured by the responsible party in a restricted area.

As discussed in Section 4, when sample containers are provided by WESTON, chain-of-custody documentation (see Figure 5-1) will be shipped with the sample containers. These forms will be completed by field personnel, with acknowledgment of time and date of transfer and placed in the shipping container in the plastic Ziploc container provided.

The following sections describe chain-of-custody procedures associated with sample receipt, storage, preparation, and analysis and general security procedures.

5.2 Sample Receipt

A designated sample custodian is responsible for samples received at WESTON. This individual is trained in all custody requirements and in the potential hazards of dealing with hazardous waste materials. In addition to receiving samples, the sample custodian is also responsible for documentation of sample receipt, storage before and after sample analysis, and eventual proper disposal of samples.

1. Upon receipt, the sample custodian will inspect the sample container for integrity. The presence of leaking or broken containers will be noted on the chain-of-custody form (see Figure 5-1). The sample custodian will sign (with date and time of receipt) the chain-of-custody form, thus assuming custody of the samples. If chain-of-custody forms are not included, the sample custodian will initiate these forms.

2. The information on the chain-of-custody form will be compared with that on sample tags and labels to verify sample identity. Any inconsistencies will be resolved with the field sampling representative before sample analysis proceeds.

3. Samples will be moved to one of the locked sample storage refrigerators (maintained at $4^{o} \pm 2^{o}C$) for storage prior to analysis. The storage location will be recorded on the chain-of-custody form.

4. The sample custodian will maintain the original of the chain-of-custody form in the sample log-in area and require all analysts to sign receipt and return of the sample when it is obtained for analysis. Copies of the chain-of-custody are provided to the laboratory Report Manager, to each laboratory Section Manager, to the respective Unit Leaders, and to the Project Manager.

5. The sample custodian will alert appropriate section managers and analysts of any analyses requiring immediate attention because of short holding times.

6. The sample custodian will log the sample information into the Laboratory Information Management System (LIMS). These data include laboratory number, field sample number, dates collected and received, project or client identification, and parameters to be analyzed.

5.3 Sample Storage

Samples will be maintained in storage in one of the locked storage refrigerators prior to sample preparation and analysis. The standard operating procedures for sample storage are described in detail in WESTON SOPs; a summary of these procedures follows.

Storage refrigerators are maintained at $4^{o} \pm 2^{o}C$. The temperature is monitored by the laboratory security system and recorded daily in a bound log by the sample custodian. During working hours, if equipment failure (compressor failure, door left open, etc.) results in the temperature of the storage refrigerator exceeding the upper or lower control limits, an audible alarm will sound and the samples will be moved to suitably controlled storage until the problem has been corrected. During off working hours, the alarm is automatically transferred to the security agency who alerts (via beeper call) laboratory and maintenance personnel so that prompt corrective action can be taken.

Refrigerator storage is designed to segregate samples to prevent cross-contamination and to prevent sample mix-up. This includes

storage of volatiles samples separate from semivolatiles and inorganics samples. Within the refrigerators, samples are stored by RFW batch # for easy retrieval. Analysts request samples for analysis from the sample custodian. Both sign the chain-of-custody acknowledging transfer of custody to the analyst.

5.4 Sample Tracking

The standard operating procedures for sample tracking are described in detail in WESTON SOPs. They are summarized in this section.

5.4.1 Organic Analysis

Samples are received by the Organic Sample Preparation Section for extraction prior to analysis by gas chromatography, GC/MS, or liquid chromatography. All pertinent data are recorded in a bound laboratory notebook. This information is transferred to the Laboratory Information Management System (LIMS) and a hard-copy Sample Extraction Record is generated. A copy of this form is shown in Figure 5-2. The original is placed on the facing page of the laboratory notebook where extraction data have been entered and is used for custody transfer documentation to the analyst. Copies are provided to the analyst to inform them that extracts are ready for analysis.

Extracts are maintained by the Organic Sample Preparation Section in refrigerated storage until transferred to the analysts.

5.4.2 Metals Analysis

Samples are received by the Metals Sample Preparation Section for digestion prior to analysis for metals by Atomic Absorption Spectroscopy or Inductively Coupled Plasma Spectroscopy. When samples are prepared for digestion, the preparation technician records the pertinent information in a laboratory digestion notebook. This information is then transferred to LIMS and a hard-copy Sample Digestion Record is generated. A copy of this form is shown in Figure 5-3. The digestion record is maintained to acknowledge custody transfer of digestates to the metals analysis section. A copy of the Sample Digestion Record is provided to the metals analysis section to alert them that digestates are ready for analysis.

The original copy of the Sample Digestion Record is retained by the Metals Sample Preparation Section.

5.4.3 Record Keeping

Data related to all sample preparation and analysis procedures and observations by laboratory analysts are recorded in bound

laboratory notebooks which are issued by the Laboratory Quality Assurance Coordinator. Laboratory notebook pages are signed and dated daily by laboratory analysts. Corrections to notebook entries are made by drawing a single line through the erroneous entry and writing the correct entry next to the one crossed out. All corrections are initiated and dated by the analyst.

5.4.4 Building Security

The WESTON Laboratory maintains controlled building access at all times. During working hours, all non-WESTON laboratory personnel are required to sign in with the receptionist and are escorted by laboratory personnel while in the building.

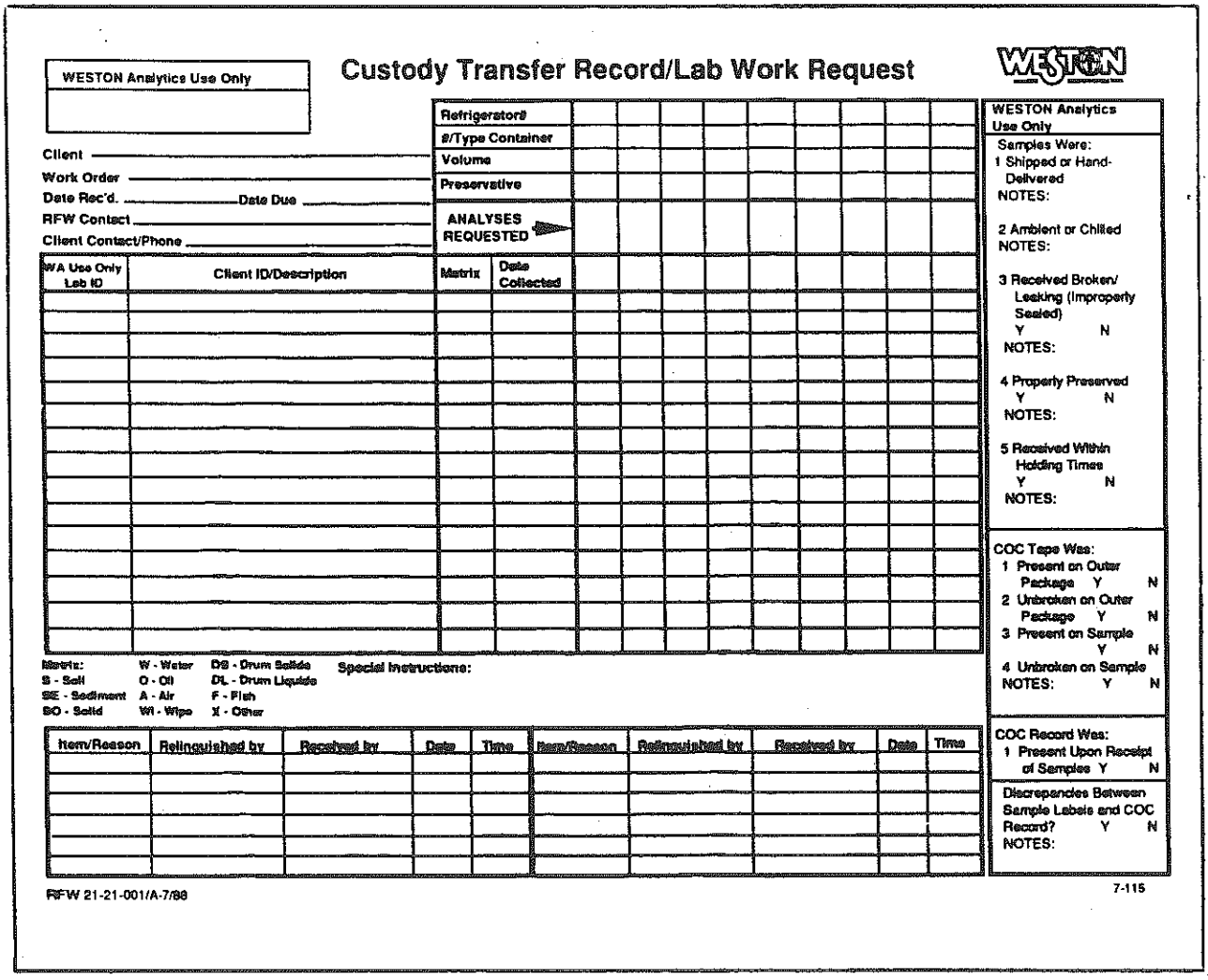
The laboratory is locked between the hours of 5:00 p.m. and 8:00 a.m. Monday through Friday and during the weekend. The building is secured during non-working hours by an ADT Security System. This security system not only monitors building access but also monitors the temperature in the sample storage refrigerators. If the control temperature range is exceeded during working hours, an audible alarm sounds. During non-working hours, a silent alarm alerts ADT. Response by laboratory personnel is described below.

The building is accessed by laboratory employees during non-working hours by using a key and the passcode for the Building Security System.

Any breach of security during non-working hours releases a silent alarm to the security agency who alert the local law enforcement agency and one of three laboratory personnel via beeper call. Police response to security alarms takes place within 5 minutes and laboratory personnel are on-site within 20 minutes.

FIGURE 5-1

WESTON CUSTODY TRANSFER-WORK REQUEST FORM



WESTON Analytics Use Only

Custody Transfer Record/Lab Work Request

WESTON

Client _____

Work Order _____

Date Rec'd. _____ Date Due _____

RFW Contact _____

Client Contact/Phone _____

WA Use Only Lab ID	Client ID/Description	Matrix	Date Collected	Refrigerator#	#/Type Container	Volume	Preservative	ANALYSES REQUESTED

Matrix: W - Water, DS - Drum Solids, S - Soil, O - Oil, DL - Drum Liquids, SE - Sediment, A - Air, F - Fish, SO - Solid, WI - Wipe, X - Other

Special Instructions:

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time

WESTON Analytics Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed)
Y N
NOTES:

4 Properly Preserved
Y N
NOTES:

5 Received Within Holding Times
Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

COC Record Was:
1 Present Upon Receipt of Samples Y N

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RFW 21-21-001/A-7/88

7-115

FIGURE 5-2

WESTON SAMPLE EXTRACTION FORM

SAMPLE EXTRACTION RECORD

Sheet No: 1

Extract. Date: Extraction Batch No: Analyst: Method:

Test: Cleanup Date: Analyst: Client:

Solvent: Adsorbent:

Sample No:	Client ID	pH	Initial WT/VOL	Surr. Mult.	Spike Mult.	Final VOL	Final VOL N/A	Split Mult.	% Solids	C/D FACTOR

Comments:
Surrogate:
Spike:

Extracts Transferred	Reliquished By	Date Time	Received By	Date Time	Reason for Transfer

FIGURE 5-3

WESTON SAMPLE DIGESTION RECORD

SAMPLE DIGESTION RECORD

Sheet No: 1 of 1

Digestion Date: Digestion Batch No: Analyst: Client:

Completion Date: Type of Prep.: Method: Matrix:

Parameters:

Type of Analysis:

Sample No:	Initial WT/VOL	Final VOL	Spike Mult.	pH <2>	% Solids	C/D FACTOR	Comments	PAN WT	WET WT	DRY WT

DIGESTION CUSTODY SHEET

Extracts Transferred	Relinquished By	Date Time	Received By	Date Time	Reason for Transfer

6.0 Calibration Procedures

Before any instrument is used as a measurement device, the instrumental response to known reference materials must be determined. The manner in which various instruments are calibrated is dependent on the particular type of instrument and its intended use. All sample measurements are made within the calibrated range of the instrument. Preparation of all reference materials used for calibration will be documented in a standards preparation notebook.

Instrument calibration typically consists of two types: initial calibration and continuing calibration. Initial calibration procedures establish the calibration range of the instrument and determine instrument response over that range. Typically, three to five analyte concentrations are used to establish instrument response over a concentration range. The instrument response over the range is generally absorbance, peak height, etc., which can be expressed as a linear model with a correlation coefficient (e.g. for Atomic Absorption, Inductively Coupled Plasma, UV-Visible-Infrared Spectrophotometry, Ion Chromatography) or as a response factor or amount vs. response plot (e.g. for Gas Chromatography, Gas Chromatography/Mass Spectrometry, High Performance Liquid Chromatography).

Continuing calibration usually includes measurement of the instrument response to fewer calibration standards and requires instrument response to compare with certain limits (e.g. $\pm$ 10%) of the initial measured instrument response. Continuing calibration may be used within an analytical sequence to verify stable calibration throughout the sequence, and/or to demonstrate that instrument response did not drift during a period of non-use of the instrument.

Specific instrument calibration procedures for various instruments are detailed in Section 7 of this QAP.

7.0 Analytical Procedures

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard methods may be necessary to provide accurate analyses of particularly complex matrices. When modifications to standard analytical methods are performed, the specific alterations, as well as the reason for the change, will be reported with the results of analysis. Choice of method is determined by the type of samples and the client/agency program represented. These programs include, but are not limited to the following:

- Drinking Water,
- Wastewater,
- Hazardous Waste, and
- Air.

For non-routine analytical services (e.g. special matrices, research projects, non-routine compound lists, etc.), the method of choice is selected based on client needs and available technology.

The laboratory's reported method detection limits (MDL's) are based on program requirements, sample matrix, and in-house instrument capabilities. These MDL's may be higher than published method detection limits. However, published MDL's are generally determined using clean matrices which are free of interferences, such as deionized water, and which are analyzed under optimal laboratory conditions. For actual sample analysis, these MDL's may not be routinely achievable. Procedures in place to demonstrate that reported detection limits are obtainable, are described in the ensuing subsections of this section.

Individual sample detection limits may vary from the laboratory's routinely reported detection limits. This may be due to dilution requirements, variability in sample weight or volume used to perform the analysis, dry weight adjustment for solid samples, the presence of analytical background contaminants, or other sample-related or analysis-related conditions.

7.1 Gas Chromatography/Mass Spectrometry (GC/MS)

7.1.1 Tuning and GC/MS Mass Calibration

Mass spectrometers are calibrated with perfluorotributylamine (FC-43) as required to ensure correct mass assignment. In addition, once per 12-hour shift these instruments are tuned with decafluorotriphenylphosphine (DFTPP) for semivolatiles analysis and 4-bromofluorobenzene for volatiles analysis . Ion abundances will be within the windows dictated by the specific program requirements.

7.1.2 GC/MS: Initial Calibration

Once an instrument has been tuned, initial calibration curves for analytes appropriate to the analyses to be performed are generated for at least five solutions containing known concentrations of authentic standards of compounds of concern. These solutions are generally cocktails of the method target analytes. The calibration curves will bracket the anticipated working range of analyses. For some compounds in the calibration standard cocktail, such as benzoic acid, 2,4-dinitrophenol, 2,4,5-trichlorophenol, 2-nitroaniline, 3-nitroaniline, 4-nitroaniline, 4-nitrophenol, 4,6-dinitro-2-methylphenol, and pentachlorophenol, the detection is difficult at the lowest calibration appropriate for the majority of the compounds in the mix. In these instances, a four-point initial calibration will be acceptable. Linearity is verified by evaluating the response factors (RF) for the initial calibration standards. For an acceptable calibration, the percent relative standard deviation (% RSD) for the RF's of specified Calibration Check Compounds (CCC's) will be <30 percent. In addition, a minimum average RF of 0.050 must be demonstrated for specified System Performance Check Compounds (SPCC's). These specified CCC's and SPCC's are listed in Table 7-1.

Calibration data, to include linearity verification, will be maintained in the laboratory's permanent records of instrument calibrations.

7.1.3 GC/MS: Continuing Calibration

During each 12-hour operating shift, a daily midpoint calibration standard is analyzed to verify that the instrument responses are still within the initial calibration determinations. The response factor for each target compound in the daily standard is calculated and recorded, then compared to the average RF from the initial calibration. If significant (>30%) RF drift is observed for the CCC's, appropriate corrective actions will be taken to restore confidence in the instrumental measurements. In addition, a minimum RF of 0.050 must be reported for SPCC's.

7.1.4 GC/MS: Quality Control

All GC/MS analyses will include analysis of a method blank, a method blank spike (semi-volatiles and pesticides/PCB's), a matrix spike, and a laboratory duplicate in each lot of twenty (20) or fewer samples. The matrix spike solutions will contain the compounds listed in Table 3-2 and will be used for both matrix spikes and blank spikes. In addition, appropriate surrogate compounds as specified in Table 3-1 will be spiked into each sample. Recoveries from method spikes and surrogate compounds are calculated and recorded on control charts to maintain a history of system performance.

A method blank spike duplicate sample may be analyzed in place of the matrix spike for analytical lots of less than ten (10) samples.

Audit samples will be analyzed periodically to compare and verify laboratory performance against standards prepared by outside sources.

7.1.5 GC/MS: Detection Limits

The laboratory's detection limits routinely used for reporting GC/MS data are compared with laboratory-determined instrument detection limits to ensure that the reported values are attainable. Instrument detection limits are determined from triplicate analysis of target compounds measured at three to five times the reporting limit. The calculated instrument detection limit is three times the standard deviation of the measured values.

7.2 Gas Chromatography (GC) and High Performance Liquid Chromatography (HPLC)

7.2.1 GC & HPLC: Initial Calibration

Gas chromatographs and high performance liquid chromatographs will be calibrated prior to each day of use. Calibration standard mixtures will be prepared from appropriate reference materials and will contain analytes appropriate for the method of analysis.

Working calibration standards for initial calibration will be prepared fresh daily. The working standards will include a calibration blank and five (5) calibration standards covering the anticipated range of measurement. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of this calibration must be equal to or greater than 0.990 to consider the response linear over a range. If a correlation coefficient of 0.990 cannot be achieved, additional standards must be analyzed to define the calibration curve.

7.2.2 GC & HPLC: Continuing Calibration

The response of the instrument will be verified for each analysis sequence by evaluation of a mid-range calibration check standard. In order to demonstrate that the initial calibration curve is still valid, the calibration check standard must be within ± twenty percent (20%) recovery of the initial calibration for the compounds of interest or the instrument must be recalibrated. For multi-analyte methods, this check standard may contain a representative number of target analytes rather than the full

list of target compounds. Optionally, initial calibration can be performed at the beginning of the analysis sequence.

Within the analysis sequence, instrument drift will be monitored by analysis of a mid-range calibration standard every 10 samples. The % difference (% D) in calibration factors (CF's) for the continuing calibration standard compared to the average CF from the initial calibration will be calculated and recorded. If significant (> 20%) calibration factor drift is observed for the compounds of interest, appropriate corrective actions will be taken to restore confidence in the instrumental measurements.

7.2.3 GC & HPLC: Quality Control

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limits.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

The method spikes will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery of the spikes. These recoveries will be plotted on control charts to monitor method accuracy. Precision will be measured by the reproducibility of both method spikes and will be calculated as relative percent difference (% RPD). These % RPD's will be plotted on control charts to monitor method precision.

7.2.4 GC & HPLC: Detection Limits

The laboratory's detection limits routinely used for reporting GC pesticide data are compared with laboratory determined instrument detection limits to ensure that the reporting values are attainable. Instrument detection limits are determined from triplicate analysis of target compounds measured at three to five times the reporting limit. The calculated instrument detection limit is three times the standard deviation of the measured values. For non-routine compounds, the reported detection limits will be limited by the lowest calibration standard analyzed for the respective method.

The reported detection limits for HPLC analyses are limited to the concentration of the lowest calibration standard analyzed on a particular day. The only exception to this for HPLC analyses are analyses conducted according to USATHAMA quality assurance plan," December 1985, 2nd Edition, March 1987 (U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, MD 21010-5401).

7.3 Atomic Absorption Spectrophotometry (AA): Flame & Furnace

7.3.1 AA: Initial Calibration

Atomic absorption spectrophotometers will be calibrated prior to each day of use. Calibration standards will be from appropriate reference materials, and working calibration standards prepared fresh daily. Initial calibration will include analysis of a calibration blank and a minimum of three (3) calibration standards covering the anticipated range of measurement. Duplicate injections will be made for each concentration. At least one of the calibration standards will be at or below the reported detection limit. The calibration curve generated must have a correlation coefficient equal to or greater than 0.996 in order to consider the responses linear over a range. If the correlation coefficient criteria of 0.996 are not met, the instrument will be recalibrated prior to analysis of samples.

Prior to analysis of samples, the initial calibration will be verified using a mid-range calibration standard from a source other than that used for initial calibration, and an initial calibration verification blank (ICB). The analysis result for the initial calibration verification standard (ICV) must be ± ten percent (10%) recovery of the true value. The ICB must be free of target analytes at and above the reporting limit. If the ICV or ICB are outside these criteria, the initial calibration must be repeated.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibration.

7.3.2 AA: Continuing Calibration

The initial calibration is verified during the analysis sequence by evaluation of a continuing calibration blank (CCB) and a continuing calibration verification standard (CCV) after every ten (10) samples are analyzed. The response of the continuing calibration verification standard must be within ± ten percent (10%) recovery of the true value. The continuing calibration blank must be free of target analytes at and above the reported detection limit.

7.3.3 AA: Quality Control

At least one method blank and two method blank spikes (laboratory control samples: LCS) will be included in each labortory lot of samples. Regardless of the matrix being processed, the LCS and blanks will be in aqueous media. The LCS will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory and will be analyzed at a frequency of one per analytical lot or five (5) percent of the samples, whichever is more frequent. The LCS will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must be within the range 80-120 percent to be considered acceptable, with the exception of antimony and silver, due to documented method deficiencies in achieving reliable recovery (reference EPA's Contract Laboratory Program). Additionally, the LCS % R will be plotted on control charts to monitor method performance.

Precision will be measured by the reproducibility of both LCS's and will be calculated as relative percent difference (% RPD). Results must agree within twenty (20) percent RPD in order to be considered acceptable. The LCS RPD will be plotted on control charts to monitor performance.

7.3.4 AA: Detection Limits

The laboratory's routinely reported detection limits are compared with laboratory-determined Instrument Detection Limits (IDL's) on a quarterly basis to ensure that the reported values are attainable. IDL's are determined from three nonconsecutive day's analysis of seven consecutive measurements of target compounds at three to five times the IDL. Each day's seven measured values are averaged and the respective standard deviation calculated. Three times the standard deviation of the average of the standard deviations obtained from the three days' analysis is defined as the IDL. The IDL's must be at or below the routinely reported detection limits.

7.4 Inductively Coupled Argon Plasma (ICP)

7.4.1 ICP: Initial Calibration

The inductively coupled argon plasma spectrophotometer will be calibrated prior to each day of use. Calibration standards will be prepared from reliable reference materials and will contain all metals for which analyses are being conducted. Working calibration standards will be prepared fresh daily. Quarterly, calibration will be performed with a blank and a minimum of five (5) concentrations to cover the anticipated range of measurement. Duplicate readings will be made for each concentration. At least one of the calibration standards will be at or below the reporting limit. The calibration curve generated must have a correlation coefficient equal to or greater than 0.996 in order to consider the responses linear over a range. If the correlation coefficient criteria of 0.996 are not met, the instrument will be recalibrated prior to analysis of samples.

On a daily basis, the instrument will be calibrated using a standard at the high end of the calibration range and a blank. Prior to analysis of samples, the initial calibration will be verified using a mid-range calibration standard from a source other than that used for initial calibration, and an initial calibration verification blank (ICB). The analysis result for the initial calibration verification standard (ICV) must be ± ten percent (10%) recovery of the true value. The ICB must be free of target analytes at and above the reporting limit. If the ICV or ICB are outside these criteria, the initial calibration must be repeated.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibration.

7.4.2 ICP: Continuing Calibration

The initial calibration is verified during the analysis sequence by analysis of a continuing calibration blank (CCB) and a continuing calibration verification standard (CCV) after every ten (10) samples are analyzed. The response of the continuing calibration verification standard must be within ± ten percent (10%) recovery of the true value. The continuing calibration blank must be free of target analytes at and above the reported detection limit.

7.4.3 ICP: Quality Control

At least one method blank and two method blank spikes (laboratory control sample: LCS) will be included in each laboratory lot of samples. Regardless of the matrix being processed, the LCS's and blanks will be in aqueous media. The LCS will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the labortory.

The LCS results will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must be within the range 80-120 percent to be considered acceptable. Additionally, the LCS % R will be plotted on control charts to monitor method accuracy.

Precision will be measured by the reproducibility of both LCS and will be calculated as relative percent difference (% RPD). Results must agree within twenty (20) percent RPD in order to be considered acceptable.

7.4.4 ICP: Detection Limits

The laboratory routinely reported detection limits are compared with laboratory-determined Instrument Detection Limits (IDL's) on a quarterly basis to ensure that the reported values are attainable. IDL's are determined from three nonconsecutive day's analysis of seven consecutive measurements of target compounds at three to five times the IDL. Each day's seven measured values are averaged and the respective standard deviation calculated. Three times the standard deviation of the average of the standard deviations obtained from the three days' analysis is defined as the IDL. The IDL's must be at or below the routinely reported detection limits.

7.5 Cold Vapor Mercury Analysis: Flameless AA (CVAA)

7.5.1 CVAA: Initial Calibration

The initial calibration procedures are as described in subsection 7.3.1 except that initial calibration requires analyses of a calibration blank and five (5) working standards. The correlation coefficient of the standard curve must be equal to or greater than 0.996. The initial calibration is verified by analysis of a calibration standard from an independent source prior to sample analysis. The response of the initial calibration verification standard must be within ± twenty percent (20%) recovery of the true value. If it is outside these limits, the instrument is recalibrated.

7.5.2 CVAA: Continuing Calibration

After every ten (10) samples, a continuing calibration blank (CCB) and continuing calibration verification standard (CCV) are analyzed. The response of the CCV must be within ± twenty percent (20%) recovery of the true value. The CCB must be free of target analyte at and above the reported detection limit.

7.5.3 CVAA: Quality Control

At least one method blank and two method blank spikes (laboratory control samples: LCS) will be included in each labortory lot of samples. Regardless of the matrix being processed, the LCS and blanks will be in aqueous media. The LCS will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory and will be analyzed at a frequency of one per analytical lot or five (5) percent of the samples, whichever is more frequent. The LCS will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must

be within the range 80-120 percent to be considered acceptable, with the exception of antimony and silver, due to documented method deficiencies in achieving reliable recovery (reference EPA's Contract Laboratory Program). Additionally, the LCS % R will be plotted on control charts to monitor method performance.

Precision will be measured by the reproducibility of both LCS's and will be calculated as relative percent difference (% RPD). Results must agree within twenty (20) percent RPD in order to be considered acceptable. The LCS RPD will be plotted on control charts to monitor performance.

7.5.4 CVAA: Detection Limits

The laboratory's routinely reported detection limits are compared with laboratory-determined Instrument Detection Limits (IDL's) on a quarterly basis to ensure that the reported values are attainable. IDL's are determined from three nonconsecutive day's analysis of seven consecutive measurements of target compounds at three to five times the IDL. Each day's seven measured values are averaged and the respective standard deviation calculated. Three times the standard deviation of the average of the standard deviations obtained from the three days' analysis is defined as the IDL. The IDL's must be at or below the routinely reported detection limits.

7.6 Total Organic Carbon (TOC)

7.6.1 TOC Initial Calibration

The total organic carbon analyzer will be calibrated prior to each day of use.

Calibration standards will be prepared from potassium hydrogen phthalate, and working calibration standards will be prepared fresh daily. The working standards will include a blank and a minimum of five (5) concentrations to cover the anticipated range of measurement.

At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of known versus found concentrations will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to analysis of samples. Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

7.6.2 TOC: Continuing Calibration

A continuing calibration standard and blank will be analyzed at a frequency of ten percent (10%) and at the end of the analysis shift. The response calculated as a percent recovery of the standard must be ± fifteen percent (15%) of the true value. The response of the blank must be less than the detection limit.

7.6.3 TOC Quality Control

At least one method blank and two method spikes will be included in each laboratory lot of samples. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory. The method spikes will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must be within the range 80-120 percent to be considered acceptable. In addition, % R will be plotted on control charts to monitor method accuracy.

Precision will be measured by the reproducibility of both method spikes and will be calculated as relative percent difference (% RPD). Results must agree within twenty percent (20%) RPD in order to be considered acceptable.

7.6.4 TOC Detection Limits

The detection limits are based on the concentration of the lowest standard analyzed. Results below the lowest standard are reported as below the detection limit.

7.7 Ion Chromatography (IC)

7.7.1 IC Initial Calibration

The ion chromatograph will be calibrated prior to each day of use. Calibration standards will be prepared from appropriate reference materials, and working calibration standards for the ions of interest will be prepared fresh daily. The working standards will include a blank and a minimum of five (5) concentrations to cover the anticipated range of measurements. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of known versus found concentrations will be at least 0.996 in order to consider the response linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to analysis of samples.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

7.7.2 IC: Continuing Calibration

A continuing calibration standard and blank will be analyzed at a frequency of ten percent (10%) and at the end of the analysis shift. The response calculated as a percent recovery of the standard must be ± fifteen percent (15%) of the true value. The response of the blank must be less than the detection limit.

7.7.3 IC: Quality Control

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

The method spikes will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must be within the range of 80-120% to be considered acceptable. Additionally, % R will be plotted on control charts to monitor method accuracy.

Precision will be measured by the reproducibility of both method spikes and will be calculated as relative percent difference (% RPD). Results must agree within twenty percent (20%) RPD in order to be considered acceptable.

7.7.4 IC: Detection Limits

The detection limits are based on the concentration of the lowest standard analyzed. Results below the lowest standard are reported as below the detection limit.

7.8 Spectrophotometry (Colorimetric Methods)

7.8.1. Spectrophotometry: Initial Calibration

Spectrophotometers will be calibrated prior to each day of use. The calibration standards will be prepared from reference materials appropriate to the analyses being performed, and working standards will include a minimum of five (5) concentrations which cover the anticipated range of measurement. At least one of the calibration standards will be at or below the desired detection limit. Additionally, a calibration blank will be analyzed. The requirement for an acceptable initial

calibration will be a correlation coefficient equal to or greater than 0.996 in order to consider the response linear over the measured range. If the correlation coefficient criteria of 0.996 is not met, the instrument will be recalibrated prior to analysis of samples. Calibration data, to include the correlation coefficient, will be entered into the laboratory notebook with the sample data to maintain a permanent record of instrument calibrations.

Before sample analysis, an initial calibration verification standard is analyzed. The response calculated as percent recovery of this standard must be within ± fifteen percent (15%) of the true value or the instrument is recalibrated.

7.8.2 Spectrophotometers: Continuing Calibration

A continuing calibration verification standard (CCV) and blank (CCB) will be analyzed at a frequency of ten percent (10%) and at the end of the analysis sequence. The response, calculated as a percent recovery of the true value, must be ± fifteen percent (15%) of the true value. The response of the blank must be less than the detection limit.

7.8.3 Spectrophotometers: Quality Control

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the labortory.

The method spikes will be examined to determine both precision and accuracy.

Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must be in the range (80-120 percent) in order to be considered acceptable. Additionally, % R will be plotted on control charts to monitor method accuracy.

Precision will be measured by the reproducibility of both method spikes and will be calculated as relative percent difference (% RPD). Results must agree within twenty (20) percent RPD in order to be considered acceptable.

7.8.4 Spectrophotometers: Detection Limits

The detection limits are based on the concentration of the lowest standard analyzed. Results below the lowest standard are reported as below the detection limit.

7.9 Balances

Laboratory balances will be calibrated and serviced annually by a factory representative. In addition, the analyst will check the balance before each use with two masses: one in the gram range and one in the milligram range. A record of calibrations and daily checks will be kept in the balance log.

The Class P weights used by the analysts for daily balance checks will be calibrated annually against a set of Class S certified weights.

7.10 Thermometers

Oven and refrigerator thermometers will be calibrated annually against a National Bureau of Standards (NBS) certified thermometer in the range of interest. Annual calibrations will be recorded in a calibration notebook. Daily readings will be recorded with the respective oven or refrigerator.

TABLE 7-1

GC/MS CALIBRATION CHECK COMPOUNDS (CCC's) AND SYSTEM PERFORMANCE CHECK COMPOUNDS (SPCC's)

Volatiles	Semivolatiles
# chloromethane	* phenol
* vinyl chloride	* 1,4-dichlorobenzene
* 1,1-dichloroethene	# N-nitroso-di-N-propylamine
# 1,1-dichloroethane	* 2-nitrophenol
* chloroform	* 2,4-dichlorophenol
* 1,2-dichloropropane	* hexachlorobutadiene
# bromoform	* 4-chloro-3-methylphenol
# 1,1,2,2-tetrachloroethane	# hexachlorocyclopentadiene
* toluene	* 2,4,6-trichlorophenol
# chlorobenzene	* acenaphthene
* ethylbenzene	# 2,4-dinitrophenol
	# 4-nitrophenol
	* N-nitrosodiphenylamine
	* pentachlorophenol
	* fluoranthene
	* di-N-octylphthalate
	* benzo-a-pyrene

* = calibration check compounds
(exception: di-N-octylphthalate is deleted from the list for all but specific EPA-CLP SOW contracts)

= system performance check compounds

(revised January 1989)

8.0 Data Reduction, Validation and Reporting

8.1 Introduction

All analytical data are recorded into bound laboratory notebooks issued by the QA Coordinator. Data are recorded and associated with a unique WESTON sample identification number and a client sample identity. These pages minimally contain the following information: analytical method, analyst, date, reagent concentrations, instrument settings (as applicable), and raw data.

The laboratory analysts sign and date all notebook entries daily. The notebook pages are reviewed periodically by the Section Manager. Copies of instrument outputs (chromatograms, strip charts, etc.) are maintained on file.

8.2 Data Reduction

Data reduction is performed by the individual analysts and consists of calculating concentrations in samples from the raw data obtained from the measuring instruments. The complexity of the data reduction will be dependent on the specific analytical method and the number of discrete operations (extractions, dilutions, and concentrations) involved in obtaining a sample that can be measured.

For those methods utilizing a calibration curve, sample response will be applied to the linear regression line to obtain an initial raw result which is then factored into equations to obtain the estimate of the concentration in the original sample. Rounding will not be performed until after the final result is obtained to minimize rounding errors, and results will not normally be expressed in more than two (2) significant figures.

Copies of all raw data and the calculations used to generate the final results will be retained on file to allow reconstruction of the data reduction process at a later date.

8.3 Data Review/Validation

System reviews are performed at all levels. The individual analyst constantly reviews the quality of data through calibration checks, quality control sample results, and performance evaluation samples. These reviews are performed prior to submission to the Section Managers or the Analytical Project Manager.

The Section Manager and/or the Analytical Project Manager review data for consistency and reasonableness with other generated data and determine if program requirements have been satisfied. Selected hard copy output of data (chromatograms, spectra, etc.)

will be reviewed to ensure that results are interpreted correctly. Unusual or unexpected results will be reviewed, and a resolution will be made as to whether the analysis should be repeated. In addition, the Analytical Project Manager or Section Manager will recalculate selected results to verify the calculation procedure.

The Quality Assurance Officer independently conducts a complete review of selected projects to determine if laboratory and client quality assurance/quality control requirements have been met. Discrepancies will be reported to the appropriate Section Manager and/or Analytical Project Manager for resolution.

The final routine review is performed by the Laboratory Manager prior to reporting the results to the client. Non-routine audits are performed by regulatory agencies and client representatives. The level of detail and the areas of concern during these reviews are dependent on the specific program requirements.

8.4 Data Reporting

Reports will contain final results (uncorrected for blanks and recoveries), methods of analysis, levels of detection, surrogate recovery data, and method blank data. In addition, special analytical problems, and/or any modifications of referenced methods will be noted. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method. Consequently, most analytical results will be reported to no more than two (2) significant figures. Data are normally reported in units commonly used for the analyses performed. Concentrations in liquids are expressed in terms of weight per unit volume (e.g., milligrams per liter). Concentrations in solid or semi-solid matrices are expressed in terms of weight per unit weight of sample (e.g., micrograms per gram).

Reported detection limits will be the concentration in the original matrix corresponding to the low level instrument calibration standard after concentration, dilution, and/or extraction factors are accounted for, unless otherwise specified by program requirements.

The final data report provided by WESTON Analytics conforms to one of three types:

1. Level 1: WESTON Standard Client Report,

2. Level 2: A Tier II Report (as specified by the State of New Jersey). This Report provides support data including a case narrative, quality control data, and a chain-of-custody report,

3. Level 3: U.S. EPA-CLP format report as described in WESTON OP 21-20-020, Section B, or

4. Level 4: Tier 1 Report (as specified by the State of New Jersey). This Report provides support data including a case narrative, quality control data, a methods summary, negative proofs of mass spectral quantitation library search "false positives", and a lab chronicle, and chain-of-custody for receipt and analyses. The basis submittal is U.S. EPA-CLP format (Level 3 above) with a few NJDEP-specified extras.

8.4.1 Level 1: Standard Client Report

The standard commercial report contains a transmittal letter and the following for Organic Analyses:

- cover page describing: data qualifiers, sample collection, extraction and analysis dates, and a description of any technical problems encountered with the analysis,
- spreadsheet sample data and QC result summaries, and
- five-peak library search report for GC-MS volatiles and semivolatiles.

QC for batches of twenty (20) samples or less includes a method blank, a method blank spike (semivolatiles and pesticide/PCB's), a matrix spike, a laboratory duplicate or spike duplicate, and surrogate recoveries. For sample batches of less than ten (10), laboratory duplicates and matrix spikes may be taken from other samples processed at the same time. Also, a method blank spike duplicate may be substituted for a matrix spike in smaller batches.

Although the EPA CLP methodology is used for Level 1, re-analyses will not be required for surrogate outliers unless poor recoveries are determined to be due to laboratory error.

Inorganic Analyses Level 1 reports contain a transmittal letter and the following:

- cover page describing: data qualifiers, sample receipt, digestion and analysis dates, and a description of any technical problems encountered with the analyses,
- sample data summary report including lab blanks, and
- QC summary report on laboratory control samples (accuracy).

8.4.2 Level 2: Tier II Report

The Level 2 report contains a transmittal letter and the following for Organic Analyses:

- cover page,
- chain of custody-sample request form,
- case narrative and laboratory chronicle,
- tune summaries,
- sample data results, with accompanying chromatograms and appropriate spectra, and
- QC data including:
  - method blanks,
  - surrogate recoveries, and
  - matrix spike-matrix spike duplicate recoveries.

Inorganic Analyses Level 2 reports contain a transmittal letter and the following:

- lab chronicle,
- cover page describing: data qualifiers, sample receipt, digestion and analysis dates, and a description of any technical problems encountered with the analyses,
- sample data summary report including lab blanks,
- QC summary report on laboratory control samples (accuracy),
- QC summary report on sample matrix spike (accuracy) and duplicate (precision analyses), and
- chain-of-custody/analysis request form.

9.0 Internal Quality Control Checks: Laboratory

The daily quality of analytical data generated in the WESTON laboratories is controlled by the implementation of this Analytical Laboratory Quality Assurance Plan. The types of internal quality control checks are described in this section.

- Method Blanks. Method blanks usually consist of laboratory reagent grade water treated in the same manner as the sample (i.e., digested, extracted, distilled, etc.) which is then analyzed and reported as a standard sample would be.

- Method Blank Spike. A method blank spike is a sample of laboratory reagent grade water fortified (spiked) with the analytes of interest which is prepared and analyzed with the associated sample batch. Method blank spikes are not included with volatiles analyses since the same function is served by the calibration standard analysis.

- Laboratory Control Sample for Inorganics. This is a standard solution with a certified concentration which is analyzed as a sample and is used to monitor analytical accuracy. (Equivalent to a method blank spike).

- Matrix Spikes. A matrix spike is an aliquot of an investigative sample which is fortified (spiked) with the analytes of interest and analyzed with an associated sample batch to monitor the effects of the investigative sample matrix (matrix effects) on the analytical method. Matrix spikes are performed only in association with selected protocols. Frequency of matrix spikes will be specified in the project-specific Quality Assurance Project Plan.

- Laboratory Duplicate Samples. Duplicate samples are obtained by splitting a field sample into two separate aliquots and performing two separate analyses on the aliquots. The analysis of laboratory duplicates monitors sample precision; however, it may be affected by sample inhomogeneity, particularly in the case of nonaqueous samples. Laboratory duplicates are performed only in association with selected protocols and at the client's request. Frequency of duplicates will be specified in the project-specific Quality Assurance Project Plan.

- Known QC Check Sample. This is a QC sample of known concentration obtained from the U.S. EPA, the National Bureau of Standards (NBS) or a commercial source. This

QC sample is to check the accuracy of an analytical procedure. It is particularly applicable when a minor revision or adjustment has been made to an analytical procedure or instrument.

9.1 QC Monitoring

The analyses of quality control samples are entered chronologically onto quality control charts specifically maintained for each analytical procedure. These control charts are labeled with upper and lower warning and control limits, the analysis which is being charted and the value (e.g., % recovery, % RPD, etc.) which is being monitored. Control charts are updated monthly and are used to demonstrate method performance and help identify system errors.

10.0 Performance and System Audits

10.1 External Audits

WESTON participates in several external audits sponsored by State Regulatory Agencies and the U.S. EPA. These audits include performance and system audits.

The performance audits are in the form of blind performance samples submitted by the auditing agency. System audits involve on-site evaluation of the WESTON laboratory systems. A representation of the number, type, and auditing agency are summarized in Table 10-1. WESTON is certified in over states, and many of these states (e.g., Ohio, Utah, Colorado, etc.) also perform on-site audits as part of their certification requirement.

10.2 Internal Audits

The laboratory QA Coordinator has overall responsibility for monitoring the internal Quality Assurance/Quality Control program. The QA Coordinator has a staff to provide in-house audits, and to review and validate analytical data packages. The QA Coordinator is also responsible for scheduling and coordinating external systems audits and reviewing data for performance samples received.

The QA Coordinator supplies blind performance samples to the laboratory at least semi-annually.

The QA Coordinator audits laboratory systems and procedures at least once annually. Unique client audit procedures and data requirements will be complied with as contractually specified. The internal audit consists of a review of laboratory systems, procedures and documentation. Any deficiencies and/or deviations are documented and a summary report is prepared. (See also Section 13)

TABLE 10-1

EXTERNAL PERFORMANCE AND SYSTEMS AUDITS
WESTON ANALYTICAL LABORATORIES

Agency	Parameters	Type	Frequency	Required for
Illinois EPA	WS-WP	Performance System	Semi-annually	Water/Waste Water Cert.
NY Dept of Health	WS-WP	Performance	Semi-annually	Water/Waste Water Cert.
NY State Dept. Env. Conserv.	Inorganic-Organic TCL	Performance System	EPA CLP Qtrly Blind	State Analytical Contract
NJ Dept. of Environ. Protection	WS-WP	Performance System	Annually Every 2 Yrs.	Water/Waste Water Cert.
	Haz.Waste	Performance	EPA CLP Qtrly	Haz.Waste Approval
Oklahoma WRB	WS-WP	Performance	Semi-annually	Water/Waste Water Cert.
PA Dept. of Environ. Res.	WS	Performance System	Annually Every 2 Yrs.	Water Cert.
	Haz.Waste	Performance	EPA CLP Qtrly	State Anal. Contract
U.S.EPA	Inorganic-Organic TCL	Performance System	Quarterly Every 2 Yrs.	Superfund Related Analytical Work
U.S. Army Corps of Engineers (DERA)	Inorganic-Organic	Performance System	As Contract Requires	Water/Waste Water, Superfund Analytical Work

- Last on-site by U.S.EPA was performed in May 1988
- Last PA DER on-site was performed in May 1987, and last IEPA on-site was performed in September 1988.

WS = Water Supply (Drinking Water)
WP = Water Pollution (Wastewater)

11.0 Preventive Maintenance

11.1 Introduction

The ability to generate valid analytical data requires that all analytical instrumentation be properly and regularly maintained. The WESTON Analytical Laboratory maintains full service contracts on all major instruments. These service contracts not only provide routine preventative maintenance but also emergency repair service. The elements of the maintenance program are discussed in the following sections.

11.2 Instrument Maintenance Log Books

Each analytical instrument is assigned an instrument log book. All maintenance activities are recorded in the instrument log. The information entered in the instrument log includes:

1. date of service,
2. person performing service,
3. type of service performed and reason for service,
4. replacement parts installed (if appropriate), and
5. miscellaneous information.

If service is performed by the manufacturer, a copy of the service record is taped into the page facing the notebook page where the above information is entered.

11.3 Instrument Calibration and Maintenance

The routine calibration procedures used for analytical instrumentation are described in Section 6 and shown in Table 11-1. Preventative maintenance and calibration by manufacturer service representatives are provided on a routine basis.

The maintenance procedures and frequencies for major analytical instrumentation are given in Table 11-2.

WESTON service agreements provide for preventative maintenance, emergency service, and emergency shipping of spare parts. For emergency response, service contracts on the Gas Chromatographs, GC/MS instruments and AA-ICP require on-site response within 48-72 hours. (Typically, service representatives are on site within 24 hours of a service call.) The service contracts also provide for 24-hour delivery of critical spare parts in response to a service request.

11.4 Spare Parts

WESTON Laboratory maintains an inventory of routinely required spare parts (for example, spare sources, vacuum pumps and filaments for GC/MS, spare torches, burner heads for AA-ICP).

The instrument operators have the responsibility, with the appropriate Section Manager, to ensure that an acceptable inventory of spare parts is maintained.

TABLE 11-1

CALIBRATION FREQUENCY AND MECHANISM FOR MAJOR INSTRUMENTS WESTON ANALYTICAL LABORATORY

Instrument	Frequency of Calibration	Standard	Indicator Parameters
GC/MS	Daily (or every 12 hrs)	Standard soln of analytes to be measured	Response-Sensitivity
GC (Hall, PID,EC,NPD, FID,FPD)	Daily (or more frequently as required)	Standard soln of analytes to be measured	Retention Time Response-Sensitivity
HPLC	Daily	Standard soln of analytes to be measured	Retention Time Response-Sensitivity
AA	Daily (or more frequently	Standard soln of analytes to be measured	Response Linear Range
ICP	Daily (or more more frequently)	Standard soln of analytes to be measured	Response Linear Range
Ion Chromatograph	Daily	Standard soln of analytes to be measured	Retention Time Response
Spectrophotometers	Daily	Standard soln of analytes to be measured	Response Linear Range
Technicon AutoAnalyzer	Daily	Standard soln of analytes to be measured	Response Linear Range
Conductivity Meter	Daily	Standard soln of analytes to be measured	Response
Analytical Balance	Daily, when used	Class S wts. (NBS cert)	Accuracy
Ovens	Quarterly	Thermometer (NBS-cert)	Accuracy

TABLE 11-2

INSTRUMENT MAINTENANCE SCHEDULE
WESTON ANALYTICAL LABORATORY

Instrument	Preventative Maintenance	Service Contract
Gas Chromatograph-Mass Spectrometer	Semi-annually	Yes
Gas Chromatographs	Semi-annually	Yes
GC Detectors (FID,EC,PID,Hall,NPD,FPD)	As needed	Yes
High Performance Liquid Chromatographs	As needed	No
Atomic Absorption Spectrometer (Flame and Furnace)	Semi-annually	Yes
Inductively Coupled Plasma Spectrophotometer	Semi-annually	Yes
Analytical Balance	Annually	Yes
Ion Chromatograph	Annually	Yes
Spectrophotometers	As needed	No
Cold Vapor Mercury AA	As needed	No
Technicon Autoanalyzer	As needed	No
Conductivity Meter	As needed	No
Ovens	As needed	No
pH-Specific Ion Meter	As needed	No

12.0 Procedures Used to Assess Data Quality

12.1 Introduction

The QA objectives for precision, accuracy, and completeness were given and discussed in Section 3. All analytical data are reviewed relative to these criteria and specific project requirements to assess the quality of the analytical data. Where all criteria are met, data are deemed acceptable without qualification. Where precision and accuracy goals are not met, the sample set is re-analyzed or reported with qualification in the case narrative. Some of the factors affecting this final sample disposition include:

- o project-specific QA/QC requirements,
- o availability of sufficient sample for re-analysis,
- o holding time considerations, and
- o regulatory action limits.

12.2 Precision

Precision is measured through analyses of replicate QC controls and field samples. Results from these measurements are calculated as relative percent difference (% RPD) or percent relative standard deviation (% RSD) and evaluated according to the criteria set forth in subsections 3.3-3.3.2. Laboratory QC control samples are used to demonstrate acceptable method performance, and are used to trigger corrective action when control limits are exceeded.

Precision measurements from field samples give an indication of sample homogeneity. Problems with sample homogeneity are more likely to occur with soil and sediment samples, water samples containing a noticeable amount of solids, and non-standard matrices.

12.3 Accuracy

Accuracy is measured through the analysis of fortified reagent free matrices and fortified field samples. Results from these measurements are calculated as percent recovery and evaluated according to the criteria set forth in subsections 3.2-3.2.2. Laboratory QC control samples are used to demonstrate acceptable method performance, and are used to trigger corrective action when control limits are exceeded.

Accuracy measurements from field samples give an indication of physical or chemical interferences present which can either enhance or mask the actual presence of target analytes. Determination of percent recovery (% R) requires analysis of a fortified sample and a non-fortified sample, so that any background analyte already present in the sample can be accounted

for in the recovery determination. Thus, sample homogeneity also becomes a factor in recovery determinations, as variable background can affect the apparent analyte recovery. Problems with sample recovery are more likely to occur with soil and sediment samples, water samples containing a noticeable amount of solids, and non-standard matrices.

12.4 Completeness

Completeness has been defined in subsection 3.4 as a measure of the amount of analytical data generated by an analytical method or system meeting all accuracy and precision criteria. As stated, the minimum goal for completeness is 80% and the ability to exceed this goal (especially for organic TCL analyses) is dependent on the applicability of the analytical methods to the sample matrices analyzed. However, even if data have not met this laboratory definition of data able to be reported without qualification, project completion goals may still be met if the qualified data, i.e. data of know quality even if not perfect, is suitable for specified project goals.

13.0 Corrective Action

The initial responsibility to monitor the quality of an analytical system lies with the analyst. In this pursuit, the analyst will verify that all quality control procedures are followed and results of analysis of quality control samples are within acceptance criteria. This requires that the analyst assess the correctness of all of the following items as appropriate:

- sample preparation procedure,
- initial calibration,
- calibration verification,
- method blank result,
- duplicate analysis,
- laboratory control standard, and
- fortified sample result.

If the assessment reveals that any of the QC acceptance criteria are not met, the analyst must immediately assess the analytical system to correct the problem. The analyst notifies the appropriate supervisor and the QA Coordinator of the problem and, if possible, identifies potential causes and corrective action.

The nature of the corrective action obviously depends on the nature of the problem. For example, if a continuing calibration verification is determined to be out of control, the corrective action may require recalibration of the analytical system and reanalysis of all samples since the last acceptable continuing calibration standard.

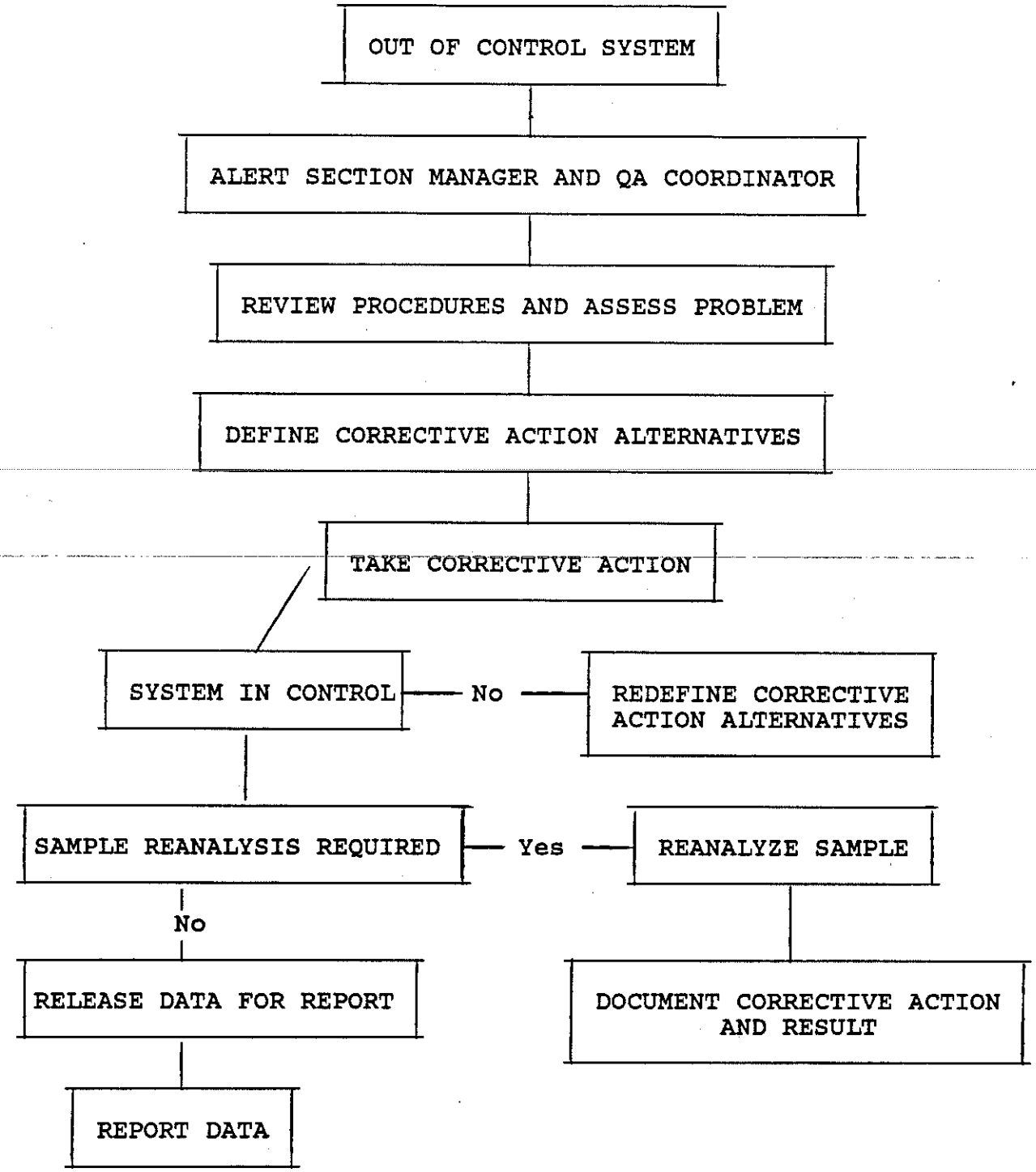
When the appropriate corrective action measures have been defined and the analytical system is determined to be "in control", the analyst documents the problem, and the corrective action. Copies of the form summarizing these actions are provided to the Section Manager and QA Coordinator.

Data generated concurrently with an out-of-control system will be evaluated for usability in light of the nature of the deficiency. If the deficiency does not impair the usability of the results, data will be reported and the deficiency noted in the case narrative. Where sample results are impaired, the Laboratory Project Manager is notified and appropriate corrective action (e.g., reanalysis) is taken.

The critical path for assessing the correctness and acceptability of analytical data is shown in Figure 13-1.

FIGURE 13-1

CRITICAL PATH FOR CORRECTIVE ACTION
IN THE WESTON LABORATORY



14.0 Quality Assurance Reports to Management

The QA Coordinator provides quarterly and annual reports to the WESTON management. These reports summarize QA activities for the reporting period including results of performance audits (external and internal), results of system audits (external and internal), summaries of corrective action to remedy out of control situations and recommendation for revision in laboratory procedures to improve the analytical systems. The Project Manager will be notified immediately of laboratory QA situations requiring immediate corrective action.