

SITE-SPECIFIC QUALITY ASSURANCE TEST PLAN

PARTICULATE MATTER CEMS DEMONSTRATION

**DuPont Inc.
Experimental Station On-Site Incinerator, Wilmington, DE**

Volume 1

DRAFT

prepared for:

H. Scott Rauenzahn
U. S. Environmental Protection Agency
Office of Solid Waste
2800 Crystal Drive, Crystal City
6th Floor
Arlington, VA 22202

prepared under:

EPA Contract 68-D2-0164
Work Assignment 3-07

prepared by:

Energy and Environmental Research Corporation
1001 Aviation Parkway
Suite 100
Morrisville, NC 27560

Telephone (919) 460-1060
FAX (919) 460-1944

August 7, 1996



TABLE OF CONTENTS

Section
Page

1.0	PROJECT DESCRIPTION	1-1
1.1	Introduction	1-1
1.2	Objectives	1-4
1.3	Site Selection	1-5
1.4	Testing Approach	1-6
	1.4.1 CEMS and Reference Method Sampling Locations	1-6
	1.4.2 CEMS Performance Testing	1-7
	1.4.3 CEMS Endurance Testing	1-7
1.5	Schedule	1-8
2.0	SITE DESCRIPTION	2-1
2.1	Sampling Site Selection	2-1
2.2	General Facility Description	2-1
	2.2.1 Waste Feed System	2-3
	2.2.2 Primary Combustion Chamber	2-4
	2.2.3 Secondary Combustion Chamber (Afterburner)	2-5
	2.2.4 Combustion Air and Burner Systems	2-5
	2.2.5 Pollution Control Equipment	2-7
	2.2.6 Ash Handling	2-11
	2.2.7 Instrumentation and Control	2-11
	2.2.8 Continuous Emission Monitors	2-13
2.3	Pollution Control Equipment Operation	2-14
	2.3.1 Afterburner	2-14
	2.3.2 Spray Dryer	2-14
	2.3.3 Reverse Jet Gas Cooler/Condenser	2-14
	2.3.4 Venturi Scrubber	2-15
	2.3.5 Absorber	2-15
	2.3.6 EDV Units	2-15
2.4	On-Site Facilities and Communications	2-15
	2.4.1 Sample Recovery Areas	2-16
	2.4.2 Off-Site Communications	2-16
	2.4.3 On-Site Communications	2-16

TABLE OF CONTENTS (CONT.)

<u>Page</u>	<u>Section</u>	
2.5	Sampling Locations	2-17
2.5.1	Reference Method	2-17
2.5.2	CEMS	2-21
2.6	CEMS Utility Requirements	2-21
2.7	CEMS Descriptions	2-21
2.7.1	Verewa F-904-KD	2-27
2.7.2	Emissions SA Beta 5M	2-28
2.7.3	ESC P5A	2-28
2.7.4	Sigrist KTNR	2-28
2.7.5	Durag DR-300	2-28
2.7.6	Jonas, Inc.	2-30
3.0	TECHNICAL APPROACH	3-1
3.1	CEMS Installation/Site Preparation	3-1
3.1.1	Site Modifications	3-1
3.1.2	Data Acquisition	3-2
3.2	CEMS Performance Testing	3-2
3.2.1	Calibration and Zero Drift	3-3
3.2.2	Calibration of the CEMS	3-3
3.3	CEMS Endurance Testing	3-5
3.3.1	Monthly RCAs	3-5
3.3.2	Monthly ACAs	3-6
3.4	Test Methods	3-6
3.4.1	Reference Method	3-6
4.0	PROJECT ORGANIZATION, RESPONSIBILITIES, QA ORGANIZATION QA OBJECTIVES, AND TESTING SCHEDULE	4-1
4.1	Project Team Organization	4-1
4.2	Field Organization and Responsibilities	4-2
4.2.1	Test Program Investigator	4-2
4.2.2	Flue Gas Sampling Leader	4-5
4.2.3	Sample Recovery	4-7

TABLE OF CONTENTS (CONT.)

<u>Page</u>	<u>Section</u>	
4.3	Quality Assurance Program	4-8
4.3.1	Quality Assurance Approach	4-9
4.3.2	QA/QC Organization	4-11
4.3.3	Quality Assurance Objectives	4-11
4.3.4	Calculation of Quality Assurance Objectives	4-13
5.0	SAMPLING PROCEDURES	5-1
5.1	Flue Gas Sampling Procedures	5-1
5.2	Sample Train Description and Sampling Procedures	5-1
5.3	Calibration Procedures	5-9
5.4	On-Site Facilities and Communications	5-11
5.5	Summary of Plant Requirements	5-12
5.6	Sample Tracking, Shipping, Storage, and Custody Procedures	5-13
5.6.1	Sample Tracking	5-14
5.6.2	Sample Shipping	5-15
5.6.3	Sample Storage	5-16
5.6.4	Sample Custody	5-17
6.0	DATA REDUCTION, VALIDATION, AND REPORTING	6-1
6.1	Manual Methods Data Reduction	6-1
6.2	Process Data Reduction	6-4
6.3	Data Validation	6-4
6.4	Reporting	6-6
7.0	INTERNAL QUALITY CONTROL CHECKS	7-1
7.1	Quality Control Procedures	7-2
7.1.1	QC for Flue Gas Sampling and Analysis	7-2
7.1.2	Quality Control for Process Samples	7-4
7.2	Preventative Maintenance	7-6

TABLE OF CONTENTS (CONT.)

<u>Page</u>	<u>Section</u>	
8.0	SAFETY RESPONSIBILITIES AND AUTHORITY	8-1
8.1	Plant Requirements	8-1
8.2	EER Corporate Safety Program	8-1
8.3	On-Site Safety Procedures	8-3
APPENDIX	Draft Performance Specification 11	
	Environment USA	
	Jonas, Inc.	
	Monitor Labs	
	Lisle-Metrix, Ltd.	
	Durag, Inc.	
	Environmental Systems Corp. (ESC)	

LIST OF FIGURES

Section
Page

Figure 2-1	DuPont Incineration Schematic	2-2
Figure 2-2	Stack schematic at DuPont	2-18
Figure 2-3	Traverse point layout at DuPont	2-20
Figure 2-4	CEMS sampling locations	2-22
Figure 2-5	CEM port locations	2-26
Figure 4-1	Project organization for DuPont PM Demonstration	4-2
Figure 4-2	Field organization for DuPont PM Demonstration	4-4
Figure 4-3	QA/QC organization for DuPont PM Demonstration	4-12
Figure 5-1	EPA Method 5 sampling train schematic	5-5
Figure 5-2	Leak check procedures for EPA Reference Method 5	5-6
Figure 5-3	Sample recovery schematic for EPA Reference 5	5-8
Figure 8-1	On-site emergence response procedures	8-5

LIST OF TABLES

SectionPage

Table 2-1	CEMS utility requirements	2-21
Table 3-1	Matrix of Calibration Conditions	3-5
Table 5-1	Summary of Proposed Testing Activities with Ionizing Wet Scrubber	5-2
Table 7-1	Summary of QA/QC for stack gas samples	7-5

1.0 PROJECT DESCRIPTION

1.1 Introduction

The U.S. Environmental Protection Agency (EPA) regulates the burning of hazardous waste in incinerators under 40 CFR Part 264/265, Subpart O, and in boilers and industrial furnaces under 40 CFR Part 266, Subpart H. The Agency has proposed revised regulations applicable to these hazardous waste combustion (HWC) devices. This rule is scheduled to be promulgated in December of 1996. Included in the proposed regulations are draft performance specifications for total mercury continuous emissions monitoring systems (CEMS) and requirements for their use. In support of these proposed monitoring requirements, EPA requires the testing of commercially available particulate matter (PM) CEMS to ensure that such devices can meet the proposed performance specifications and data quality objectives. This testing will include an extended (six month) durability test.

PM CEMS were selected to participate in the demonstration based on proposals received by EPA in response to an announcement of the demonstration test plan and request for proposals that appeared in the Federal Register. Six proposals were received and reviewed by EPA. All six CEMS were accepted, and all six vendors elected to participate. The vendors and CEMS participating in the demonstration are:

- Monitor Labs, representing Verewa;
- Durag, Inc.;
- Environmental Systems Corporation (ESC);
- Lisle-Metrix Ltd., representing Sigrist;

- Environment USA, representing Emissions SA; and
- Jonas, Inc.

Details on the CEMS are given in Section 2, and the text of the Federal Register announcement can be found in the Appendix.

The overall scope of the PM CEMS demonstration will include pre-screening measurements, particle size distribution measurements, development and laboratory testing of a Modified Method 5 for low PM loading measurements, and field demonstration of the PM CEMS. The main elements are summarized below.

- *Site selection:* The on-site incinerator at the DuPont Experimental Station in Wilmington, Delaware was selected for the PM CEMS demonstration based on emission level, type of air pollution control system (APCS), and type of hazardous waste burned. For further details, see Section 1.3 and Section 2;
- *Pre-screening and particle size distribution:* DuPont will conduct these measurements as part of their facility characterization and permitting campaign following the retrofit of the facility with an electro-dynamic venturi (EDV) system (see Section 2). These results will be made available to the EPA for inclusion in the CEMS demonstration report; and
- Method 5 was not designed for PM measurements at the sub 0.030 gr/dscf level. Results from the preliminary demonstration testing that has been carried out by EPA/OSW has revealed that the precision of the reference method measurements made with Method 5 is one of the factors limiting the accuracy of the CEMS calibration. Therefore, a modified manual method designed to provide improved precision at low PM loadings will be developed, demonstrated, and used to calibrate the CEMS. The

modified train design will incorporate a light weight filter holder assembly that can be weighed before and after sampling without disassembly for recovery of the filter. This assembly will replace the current filter housing used in Method 5, and will be located in the heated box currently used in Method 5. The proposed modification to Method 5 is thus very slight, and will eliminate the filter recovery step, but not the probe rinse. Nevertheless, this modification should improve the precision of the measurement.

- *Demonstration testing of the CEMS:* This will consist of two main elements:
 - 1) A one week performance test to evaluate whether or not the CEMS can meet the requirements of the draft performance specifications (see Appendix). The performance specification requires the following:
 - Evaluation of zero and calibration drift over a one week period; and
 - Calibration through comparison to gravimetric Reference Method measurements.
 - 2) A six month endurance test. The draft data quality objectives (see Appendix) require response calibration audits (RCAs) every 1-1/2 years and quarterly checks of calibration error (absolute calibration audits, or ACAs). During the endurance test, RCAs and ACAs will be performed monthly. In addition, the reliability and maintenance requirements of the CEMS will be documented. The elements of the endurance test will therefore consist of:

Monthly RCAs (comparison to Reference Method measurements);

Monthly ACAs;

Continuous recording of CEMS data for six months;

Documentation of daily calibration and zero checks;

Documentation of all maintenance and adjustments performed on the CEMS;
and

Documentation of all periods of data non-availability for whatever reason.

An additional aspect of the PM CEMS demonstration is the evaluation of the draft performance specifications themselves. In particular, all instances of deviation in the demonstration test from the procedures and requirements of the performance specifications shall be noted. This is important because there may be requirements in the performance specifications that are either impossible, impractical, or too difficult to carry out. Where this is the case, the performance specifications will be modified as appropriate.

1.2 Objectives

The objectives of the PM CEMS demonstration are the following:

- 1) Evaluate Performance of CEMS. Determine whether CEMS are available that can meet the draft performance specifications. This will be accomplished by performing a seven day calibration and zero drift test and a calibration of the CEMS against manual gravimetric reference method measurements. The results of these tests will be documented and compared to the performance specification;
- 2) Evaluate Performance Specification. Instances where the testing actually carried out differs from that required in the performance specification will be noted;

3) Evaluate Long Term Endurance of CEMS. This will be accomplished by operating the CEMS continuously for six months. Maintenance requirements and data availability will be documented, and long term performance tested by monthly RCAs and ACAs; and

4) Develop Modified Method 5 for low PM Measurements. This will be accomplished by designing and fabricating low weight filter holder assemblies, making a series of laboratory measurements of assembly plus filter weights to establish the weighing precision, and evaluating precision in the field through the use of duplicate trains.

1.3 Site Selection

The site selected for the PM CEMS demonstration is the on-site incinerator at the DuPont Experimental Station in Wilmington, DE. The rationale for the selection of this site is the following:

1) An incinerator, commercial or on-site, was preferred for two reasons:

- Incinerators (commercial and some on-site, including this DuPont facility) burn a wide variety of waste as their primary feedstream. This has a higher potential, compared to other types of sources, to produce highly variable particulate, which is a worst case test for PM CEMS; and
- Incinerators have well controlled PM emissions, which allows testing at levels in a range commensurate with the new proposed emission limits (69 mg/dscm, or less if required as a result of metals emissions).

2) The DuPont facility at the Experimental Station in Wilmington, DE was chosen for the following reasons:

- Preliminary measurements show that PM emissions range from 0.005 to 0.075 gr/dscf, depending on how the facility is operated;
- The facility is willing to host the demonstration and allow the necessary modifications to be made;
- The facility is willing and able to vary operating conditions as required to perform the calibration of the CEMS; and
- A preliminary site visit determined that the required physical access to the stack was available, that there was room to site the CEMS analyzers within an acceptable distance from the sample point, and that the sample location meets EPA sampling criteria for particulate.

1.4 Testing Approach

In order to meet the objectives of PM CEMS demonstration project, the following testing approach outlined below will be followed.

1.4.1 *CEMS and Reference Method Sampling Locations*

The reference method measurements will be made using the pre-existing ports installed on the stack for that purpose. The CEMS will be located on the stack at ports specially installed for each CEMS. The CEMS will be located around the stack at three levels - three feet below, two feet above, and four feet above the plane of the reference method location. They will be arranged around the stack so that no CEMS measures directly downstream of another CEMS or the reference method trains.

1.4.2 *CEMS Performance Testing*

Performance testing will consist of the two main elements that follow:

1) Seven day calibration drift and zero drift test. Some of the CEMS have provisions for carrying out calibration and zero checks. The CEMS responses and automatic adjustments are reflected in the data output and will be recorded and documented. Zero checking will also be accomplished by recording CEMS output during regular plant shutdowns; and

2) CEMS calibration. The CEMS will be calibrated against simultaneous manual gravimetric reference measurements made using duplicate Modified Method 5 trains for low PM loadings. Fifteen one-hour runs will be made at 15 different facility operating conditions.

1.4.3 *CEMS Endurance Testing*

CEMS endurance testing will last for six months. During this time the maintenance requirements and data availability of the CEMS will be documented. Long term performance of the CEMS will be assessed by performing monthly RCAs and ACAs.

1.5 Schedule

Initial activities (site preparation for the CEMS) will commence one week prior to scheduled CEMS installation (7/29/96). CEMS installation is scheduled to start on 8/5/96, and performance testing to commence two weeks later on 8/19/96. The CEMS will then remain on site for the endurance test. Four weeks after the conclusion of the performance test, the first monthly RCA will be carried out, with the others following at approximately four week intervals as the facility schedule allows. The first ACA will occur two weeks after the first RCA (six weeks after the conclusion of the

performance test), with the subsequent monthly checks following at four week intervals. Thus, the CEMS will be audited every two weeks with alternating ACAs and RCAs. Regular CEMS maintenance and checkout of the data acquisition system will also made during these biweekly activities.

2.0 SITE DESCRIPTION

2.1 Sampling Site Selection

All testing for this program will occur at the DuPont Inc. Experimental Station on-site incinerator, located in Wilmington, Delaware. The facility address is:

DuPont Facilities Services
Environmental Services
Experimental Station, Building 268
Route 141
Wilmington, DE 19880-0268
Attention: Richard Vickery

2.2 General Facility Description

The incineration system is shown schematically in Figure 2-1 of this document. A Nichols Monohearth incinerator is used as the primary combustion chamber. Waste is fed to this combustion chamber using a ram feeder for solid waste, a cylindrical chute for batched waste material, and a Trane Thermal liquid/gas waste burner. The primary combustor exhausts to a secondary combustion chamber (afterburner) where waste is fed using a Trane Thermal burner. This afterburner chamber discharges to a spray dryer where the elevated temperature exhaust gases are used to dry the scrubber liquid in order to remove dissolved and suspended solids. The exhaust gas from the spray dryer discharges to a cyclone separator system where additional solids are removed from the gas stream. The exhaust gas from the cyclone system discharges to a reverse jet gas cooler/condenser which reduces the gas temperature to the dew point. The reverse jet gas cooler/condenser discharges into a variable throat venturi scrubber which is used to remove

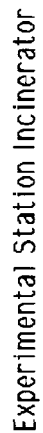


Figure 2-1. DuPont Incineration Schematic.

particulate matter and some acid gases. The venturi scrubber discharges into an absorber in which soda ash neutralized scrubbing solution is used to absorb acid gases. In addition, the gas is subcooled in the absorber by the utilization of cooled spray water before being exhausted through a chevron-type mist eliminator. After passing through the mist eliminator, the gas is directed to a set of electro-dynamic venturis (EDVs) which are used to remove fine particulate matter along with the metals that condense onto the fine particulates as a result of the gas subcooling. The gas then passes through a set of centrifugal droplet separators before being drawn through an induced draft (ID) fan which discharges the gas to the atmosphere through a stack. The stack gases are re-heated to reduce that visible stack steam plume. Each of the major component parts of the system is described below.

2.2.1 *Waste Feed System*

This incinerator is permitted to burn up to 1,600 lbs/hr of hazardous waste through the Trane Thermal vortex burner in the primary combustion chamber, up to 1,560 lbs/hr of hazardous waste material through the batch feed chute in the form of not more than four one gallon batches, by volume, per minute containing up to 6.5 lbs/batch of hazardous waste through the batch feed chute, up to 1,560 lbs/hr of hazardous waste material through the ram feeder system with not more than 3,000 lbs/hr (total) of solid waste material through the ram feeder system, up to 790 lbs/hr of hazardous waste through the Trane Thermal vortex burner in the secondary combustion chamber (or afterburner), and up to 480 lbs/hr of total chlorine content in the waste. The two cubic yard Burnzol ram feeder is also used to feed solid waste materials of Type O and Type 1 trash, which have a heating value of approximately 5,000 Btu/lb. In most operating conditions, the trash material, which is non-hazardous, is used as auxiliary fuel.

The primary combustion chamber has three means of feeding hazardous wastes to it. Liquid wastes, which are collected in large volumes at the Experimental Station, are transported to the incinerator site and are pumped into blend tanks and are then injected directly through the Trane Thermal burner. Liquids, slurries, and solids collected in small quantities are received in small batches (one gallon or less) that are manually fed through a specially constructed chute onto the grate section

of the primary combustion chamber. This batch feed system alleviates potential problems with clogged feed lines and clogged burner jets, and allows for safe disposal of reactive and/or corrosive wastes. The ram feed system is also used to feed hazardous waste materials to complement the small batch chute.

The secondary combustion chamber (or afterburner) contains a Trane vortex burner that burns fuel oil and/or hazardous and non-hazardous wastes. Wastes are pumped into a feed tank prior to injection through the burner.

2.2.2 *Primary Combustion Chamber*

The Nichols Monohearth unit was originally designed to burn up to 20 MMBtu/hr of solid waste material as a stand-alone incinerator. It now serves as the first stage of a modern, two-stage incineration system capable of destroying over 40 MMBtu/hr of solid and hazardous wastes. The combustion chamber is a vertical cylinder with a support grate at its base and a conical air distributor at the center of the grate. Rotating rabble arms stir the solid waste material on the grate, and combustion air is fed up through the grate area to ensure adequate oxygen for combustion. The solids ram feeder intermittently feeds solid waste material onto the grate area. Above the ram feeder is a batch chute which allows manual feed of batched waste so the batched wastes fall onto a bed built up in the grate area and are combusted at that point. Opposite the batch chute, but above the grate area, is a thermal burner which is used to inject hazardous waste liquids and combustion air. Above these three sources of waste material is a dome section which restricts the size of the primary combustion zone and causes mixing of the combustion gases at relatively high velocities. This dome section discharges into an additional combustion zone, or main chamber, which has an arched baffle across its diameter and a chimney section at the top. Combustion gases exit the chimney section and are routed to the afterburner. Nominal internal volume of the primary combustion chamber is 1,500 cubic feet. Construction materials are a carbon steel shell lined with 3,000°F refractory.

2.2.3 *Secondary Combustion Chamber (Afterburner)*

The afterburner serves as the second stage of the incinerator system and ensures high destruction removal efficiency over a wide range of operating conditions. The secondary combustion chamber consists of two cylindrical vessels, refractory lined, and intersection each other at a 90° angle. The cylindrical vessels have the same internal diameter (inside the refractory) of 977.5 inches. The first vessel (immediately downstream of the primary chamber) is 27 feet, 5 inches long. The second cylindrical vessel is 34 feet, 3 inches long. A transition duct section is also provided at the top of the spray dryer. This secondary combustion section has a volumetric capacity of 2,430 cubic feet. At a maximum gas flow condition of 73,400 acfm, the residence time in the afterburner is 1.99 seconds. Afterburner refractory is designed for a maximum continuous temperature of 2,500°F with peaks to 3,000°F. The normal operating temperature of the afterburner chamber is >1,775°F.

2.2.4 *Combustion Air and Burner Systems*

Combustion air is provided to the grate and cone section of the primary combustion chamber by a Buffalo Forge Model 490BL forced draft fan (or equivalent). This fan is equipped with a 15 hp TEFC drive motor (or equivalent) rated at 1,800 rpm. The fan motor is connected to a variable frequency speed controller which is controlled to provide adequate combustion air for the trash burn rate. The variable frequency controller is capable of allowing the fan to operate at 110% of rated motor speed, or 1,980 rpm.

Combustion air for the Trane Thermal burner in the primary combustion chamber is a New York Blower Model NW21 P-2 rated at 2,800 cfm and 33 inch W.G. static pressure (or equivalent) when operating at 3,550 rpm. This fan is equipped with a 25 hp, TEFC drive motor (or equivalent). The burner has an adjustable damper which controls the amount of air delivered by the New York Blower combustion air fan. The air flow control valve is mechanically linked to the fuel valve on the burner.

The combustion air fan for the Trane Thermal burner in the afterburner chamber is rated at 3,000 scfm and 45 in. W.G. differential pressure. This fan is equipped with a 25 hp TEFC drive motor

(or equivalent). The combustion air for the burner is controlled by a mechanically linked butterfly valve tied to the fuel valve position on the burner.

The liquid/gas waste burner in the primary combustion zone is a Trane Model LV-14 vortex-type unit (or equivalent), rated at 14 MMBtu/hr. This burner is operated such that combustion chamber temperatures of 1,800-2,000°F can be achieved.

The afterburner burner is a Trane Model LV-10 vortex burner (or equivalent), rated at 10 MMBtu/hr. A second set of air and fuel valves are used to control the afterburner exhaust gas temperature by controlling total mass flow.

A relatively constant Btu content fuel is delivered to the primary vortex burner by blending additional amounts of fuel oil with the liquid wastes being burned. To do this, the waste liquid control valve is automatically or manually adjusted by the operator, using a panel control, to a desired rate. The flame temperature, which approximates the Btu content of the fuel at a constant air-fuel mixture, is monitored. As the flame temperature decreases, more oil is added to bring the temperature up. If the flame temperature increases, the fuel oil valve closes and decreases the amount of oil mixed with the waste fuel. In addition, a second set of air and waste/fuel valves are mechanically linked together and are used to control the afterburner exhaust gas temperature by controlling total mass flow.

The mechanical linkage ensures that the proper fuel/air mass ratio is maintained and is designed to preclude a fuel rich condition. The set point is first established by a qualified specialist from Trane and/or a DuPont combustion expert based on burner performance. Burner performance is evaluated by making physical observations of the flame, utilizing measured fuel and air flows, and observing downstream oxygen concentrations to verify the proper ratio. The mechanical linkage set point cannot be changed by the operator.

The main ID fan for the incineration system is a Buffalo Forge Size 95-4 Type R SWSI fan (or equivalent). Operating at approximately 1,780 rpm, this fan is designed to provide a negative pressure

in the combustion chamber and pollution control equipment and can provide combustion air by supplementing the capabilities of the three combustion air fans.

2.2.5 *Pollution Control Equipment*

The pollution control system consists of a spray dryer which is designed to dry the scrubber liquid to remove solids, followed by a cyclone separator system, a reverse jet gas cooler/condenser, a variable throat venturi scrubber, an acid gas absorber (which also subcools the gas), a set of EDVs and ID fan, and a stack with re-heat for exhaust gas. In addition, a soda ash neutralized scrubbing liquid system is provided to deliver solution to the venturi, cooler/condenser, and absorber.

The spray dryer is an Andersen dryer with the gas and liquid flowing co-currently from the top of the dryer to the bottom of the dryer. Hot gas from the secondary combustion chamber is distributed across the inlet of the spray dryer by a refractory grid. The dryer has spray nozzles at the top. The nozzles are designed to control temperature in the spray dryer exhaust duct. Dried powder (or ash) which reaches the bottom of the spray dryer is removed by an ash removal system into containers for off-site disposal. The Permittee may remove the center funnel exhaust

and install a peripheral skirt exhaust to minimize gas/droplet impingement and increase the gas path length.

The cyclone system is designed to remove particles that carry over in the gas stream from the spray dryer. The particles (or ash) are removed from the bottom of the cyclone by an ash removal system into containers for off-site disposal.

The cooler/condenser is mounted directly above the inlet to the venturi scrubber. The gas stream enters the top of the cooler/condenser and exits through the venturi scrubber. The cooler/condenser is designed to cool the hot gases to their dew point using a spray of process fluid or water. Any excess or condensed liquid flows into the venturi scrubber. The cooler/condenser is

constructed of Hastelloy alloy C-276.

The gas then enters an Anderson 2000 Inc. Model WAV-152, wetted approach, variable throat venturi scrubber constructed of Hastelloy alloy C-276. Scrubbing liquid is provided to the venturi from the absorber. The excess or condensed liquid from the reverse jet cooler/condenser provides additional wetting in the venturi scrubber. Under maximum gas flow conditions, the scrubbing solution reduces the gas stream temperature to approximately 175°F.

The venturi discharges through a wetted elbow section into a fiberglass reinforced vinyl ester absorber. Variable flow in the venturi is accommodated by the adjustable venturi throat. Venturi discharge gas is then routed to an acid gas absorber constructed of fiberglass-reinforced vinyl ester. The liquid feed to the absorber is pumped to nozzles which are fed through a single external header. The nozzles create a dense curtain of spray promoting intimate liquid-gas contact. The absorber sprays utilize a dedicated recirculation pump which pumps recirculations (process) water from the bottom of the absorber through a water-cooled heat exchanger. The heat exchanger uses separate cooling water that is recirculated through a cooling tower without any contact between the process and cooling waters. The cooling water pressure is maintained at a higher pressure than the process water to prevent any leakage of process water to the cooling water system. After the heat exchanger, the process water is directed through the spray nozzles where the gas is cooled. Because the absorber is constructed of fiberglass reinforced vinyl ester, it is necessary to provide emergency quench water at the inlet to the absorber to ensure against any possibility of structural damage to the vessel in the event of pump failure.

The absorber discharges through a chevron mist eliminator at its top. The mist eliminator is an Andersen standard design using Inconel 625 blades. This chevron mist eliminator is washed intermittently by a freshwater spray controlled by a timed solenoid valve. The absorber then discharges to a set of EDVs.

The EDVs remove very fine particulate matter through an adiabatic expansion of the saturated

gas which results in a condensation effect that utilizes the fine particulate matter as a seed. The condensation on the fine particulate not only increases the size of the particles but also enables the particles to take on a negative charge which is created by a special high voltage electrode which is centered in each module. Before leaving the module, the gas passes through a filtering spray which is created by spray nozzles. The nozzle creates a hollow cone spray with a positive charge which is induced by the tip of the electrode. The spray removes the particulate matter by both impaction and electrostatic attraction. The spray nozzle is specially designed not to create mist.

The high voltage electrodes are powered by a transformer/rectifier (T/R) set which is automatically controlled. These controls are similar to those used on electrostatic precipitators and will control to the optimum conditions based on current, voltage, spark rate, and other parameters.

The nozzles are fed by a recirculation pump which pumps liquid from a separate recycle tank to which each of the modules is drained. All of the make-up water for the air pollution control system is added at this recycle tank. After passing through the EDVs, the gas passes through a set of centrifugal droplet separators before being discharged through the stack via an ID fan. A minimum of five EDV units with five centrifugal droplet separators will be used, however, the permittee may add additional units with gas recycle if necessary during the shakedown period. The recycle system would consist of a recycle loop around the EDV units with air supplied by a new fan. The gas recycle flow would be controlled by setting the flow to a constant rate in order to accommodate all flow conditions.

A stack re-heat system is used to reduce the stack steam plume.

Soda ash is stored at the incinerator site and then fed to a control valve adjacent to the absorber by a pump. The soda ash is continuously circulated through the feed line and back so sedimentation and pluggage do not occur. The soda ash feed line is heat traced and insulated. A control valve is then used to feed the soda ash slurry into the scrubbing system's recirculation tank (base of absorber) using pH control on the scrubbing liquid. Because pH is maintained at 6.5 in the

recirculation scrubbing solution, the base solubilizes as a salt. Thus, no difficulty with the pH controller fouling is anticipated. However, for absolute assurance against pH controller failure, an identical backup pH control system is provided and the operator is able to manually switch from one pH controller to the other from the control panel. In this fashion, one pH controller can be operated while the other pH controller is being calibrated. In addition, if either of the pH controllers fail, the other pH controller can be used.

Waste liquid from the scrubbing system is fed to a pump which delivers the waste liquid to the spray dryer nozzles.

For virtual absolute protection against spills of scrubbing liquid in the system, the spray dryer, cyclone system, reverse jet, venturi scrubber, filtration system (if installed), and absorber have been built on a concrete foundation which has a concrete curb around all sides and a sloped drain system draining to a sump. A sump pump is provided to take any collected liquid, including collected rain water, and pump this to the process sewer or the scrubbing system's recirculation tank (base of absorber). The EDVs are built on a structural steel support system on a concrete foundation which has been provided with containment draining to the existing sump system.

All liquid contacting parts are made of either nonmetallic materials, stainless steel, Hastelloy alloy C-276, or other equivalent corrosion resistant material. Thus, they are tolerant of any of the corrosive compounds found in the gas stream or in the liquid wastes or liquid solutions used. As further insurance against failure of any component part in the system, a 14-inch water main connected to a local water tower is used to supply water to the entire system. This water system provides adequate head to ensure that adequate water pressure will always be available for the temperature protection system on the absorber and for the spray dryer water feed system, which is used to control spray dryer temperature in the event of waste liquid not being available or when a power failure occurs.

2.2.6 *Ash Handling*

DuPont utilizes ash containers constructed of steel. One of these containers is located beneath the hopper under the primary combustion zone. This container is periodically removed and the ash disposed of in a hazardous waste disposal site. Dry ash from the spray dryer and cyclone system is handled in a similar fashion.

2.2.7 Instrumentation and Control

The incinerator is controlled by five key control loops. They are described below to show the relationships between different parts of the system.

1. Afterburner Chamber Temperature

The afterburner temperature is controlled by adjusting the firing rate of the burner in the afterburner chamber.

When the afterburner chamber temperature decreases, control action increased the firing rate of the burner to bring the temperature back up. If this temperature falls below 1750°F for a 60-minute rolling average (or 1700°F instantaneous), the hazardous waste feeds are shut down. Also, a temperature of >1925°F causes an alarm.

2. Negative Pressure in the Combustion System

To preclude fugitive emissions from the combustion system, the combustion gas rate is adjusted to hold negative pressure in the primary combustion chamber. The gas rate is controlled by adjusting the position of the plug in the throat of the venturi.

The position of the venturi plug is controlled by a pressure controller on the outlet duct from the primary combustion chamber. This pressure is set at -0.75 in. W.G. to maintain a

negative pressure on the combustion chamber. If the combustion chamber pressure begins to go more positive, the controller will automatically begin to open the venturi throat damper. A minimum differential pressure will be held on the venturi. If any failure in the system prevents the controller from achieving the necessary negative pressure, the venturi throat plug moves to the full open position. At this position, the differential pressure across the venturi is less than its shutdown setting of 37 inch W.G. (60 minute rolling average).

3. *Spray Dryer Outlet Temperature*

Spray dryer outlet temperature is controlled by flow of liquid spraying into the combustion gases as they enter the spray dryer.

Liquid flow to the spray dryer nozzles is controlled by a temperature controller that adjusts the flow to the spray dryer nozzles, increasing or decreasing the nozzle flow rate to maintain the desired spray dryer outlet temperature.

4. *Scrubbing Solution pH*

Scrubbing solution pH is controlled by adding soda ash to the base of the absorber. If solution pH decreases, more neutralizing agent is added. The system has an on-line spare pH probe.

5. *EDV Secondary Power*

EDV power is electronically controlled to assure optimal conditions based on current, voltage, spark rate, and other parameters.

2.2.8 *Continuous Emission Monitors*

1. *CO Monitor*

A non-dispersive infrared analyzer (Rosemount Analytical Model 880A or equivalent - primary and back-up) is used to continuously measure incinerator emissions for carbon monoxide concentration.

2. *Oxygen Monitor*

An oxygen analyzer (Rosemount Analytical Model 755R or equivalent - primary and back-up) is used to continuously measure exhaust gases for oxygen concentration.

2.3 Pollution Control Equipment Operation

2.3.1 *Afterburner*

This unit is operated with an exhaust gas set point on the controller of $>1,775^{\circ}\text{F}$ but less than $1,925^{\circ}\text{F}$. This controller will alarm and shut down hazardous waste feed if the temperature drops below $1,750^{\circ}\text{F}$ and alarm if the temperature exceeds $1,925^{\circ}\text{F}$.

2.3.2 *Spray Dryer*

The spray dryer utilizes a temperature controller at its exhaust gas port to control the flow rate of liquid to the nozzles in the dryer. The system is designed so that under no operating conditions will the liquid feed rate exceed the rate at which liquid can be evaporated in the spray dryer. The spray dryer is operated within a range of $750\text{-}1,000^{\circ}\text{F}$ outlet temperature.

2.3.3 *Reverse Jet Gas Cooler/Condenser*

The reverse jet gas cooler/condenser cools the gases using a spray of process fluid or water. Cooler/condenser operation is monitored using gas outlet temperature. Operating the cooler/condenser at an outlet gas temperature of approximately 175°F ensures that the gases are cooled to their dew point.

2.3.4 *Venturi Scrubber*

The venturi scrubber differential pressure is automatically controlled by a pressure control instrumentation system which monitors the outlet pressure from the primary combustion chamber. In order to maintain negative pressure in the combustion chamber, the venturi opens and closes to increase or decrease exhaust gas flow through the scrubbing system. The liquid flow is monitored by monitoring the pump pressure.

2.3.5 *Absorber*

The spray water flow rate to the absorber is monitored by monitoring absorber recirculation spray nozzle pressure.

2.3.6 *EDV Units*

Since the recirculation rate to the electro-dynamic venturi units is a totally isolated recirculation loop, little variation in flow is expected. The flow rate is monitored by monitoring EDV spray nozzle pressure.

2.4 On-Site Facilities and Communications

Sampling and analysis will be supported from a fixed base trailer to be moved onto site

specifically for these test activities. Sampling and analysis activities will revolve around the process itself and will be supported from EER's laboratory recovery area.

The continuous emissions monitoring systems (CEMS) and data acquisition system (DAS) will be located on the stack. The CEMS are weatherized, and in general will require minimal to no protection. The DAS will be located in a weatherized and air-conditioned rack also placed on the stack platform (this will minimize data cable runs). Power, air, and a phone line for remote communication with the DAS will be supplied on the platform.

2.4.1 *Sample Recovery Areas*

The recovery area will be chemical free and will be configured for recovery of particulate matter sampling trains. The trailer will be equipped with a desiccator and microbalance for on-site analysis of the samples. A fume hood will be installed for working with the recovery materials.

Personnel traffic through the recovery areas will be restricted to only those persons directly involved with recovery activities. Smoking will be prohibited inside all trailers and in the immediately surrounding areas. Signs will be posted to this effect.

2.4.2 *Off-Site Communications*

Communications between the sampling and analysis team will be facilitated by telephone. A separate telephone line will be installed in the recovery area.

2.4.3 *On-Site Communications*

Communications among the EER Field Manager, On-Site QA Coordinator, Process Coordinator, and key crew leaders (e.g., CEM Operator, Boiler Stack Leader, Process Sampling Coordinator) will be facilitated by wireless FM two-way radios. These will ensure that the personnel

assigned to each station can be in immediate contact with the EER Field Manager, or with each other, if problems arise.

2.5 Sampling Locations

2.5.1 *Reference Method*

The flue gas sampling will utilize Modified Method 5 for particulate matter as the reference method. The reference method measurements will be conducted on the stack using the two sampling ports already installed. These ports are located 90° apart. Traversing measurements will be made using duplicate trains. The current port locations on the stack are easily accessible from the platform surrounding the stack. The ports were configured for performing compliance tests and meet all necessary EPA Method 1 criteria for upstream and downstream disturbances. The stack is round with a four foot inner diameter. The sampling platform is located about 90 feet above ground level. The nearest flow disturbance is five diameters upstream and two diameters downstream of the sampling location. A schematic of the stack configuration is shown in Figure 2-2. Figure 2-3 shows the traverse points that will be used for the Modified Method 5 measurements. The port lengths, insulation thickness, and actual stack dimensions will be measured on-site and the appropriate adjustments to the traverse points will be implemented. Flue gas conditions at this sampling location are anticipated to be as follows:

Temperature:	175	°F (no reheat)
Temperature:	330	°F (with reheat)
Pressure:	+1	inches of water
Flow Rate:	15,000	dscfm
Velocity:	35	ft/sec
Moisture:	20-50	%
Dust Loading:	0.01 - 0.08	gr/dscf at 7% O ₂

At the stack sample location, at least four 110-volt, 15-ampere AC circuits will be supplied. EER will also require lighting.

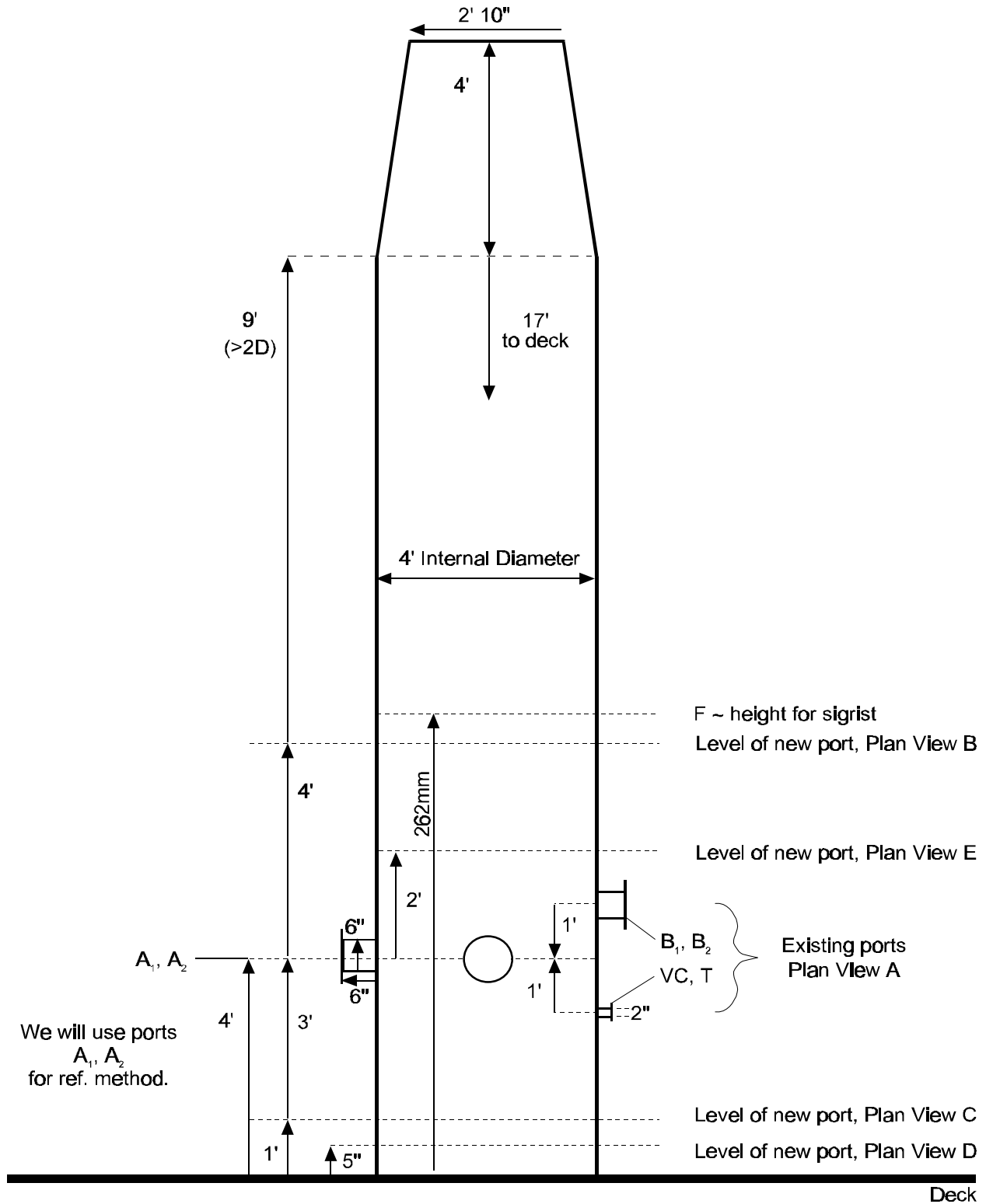
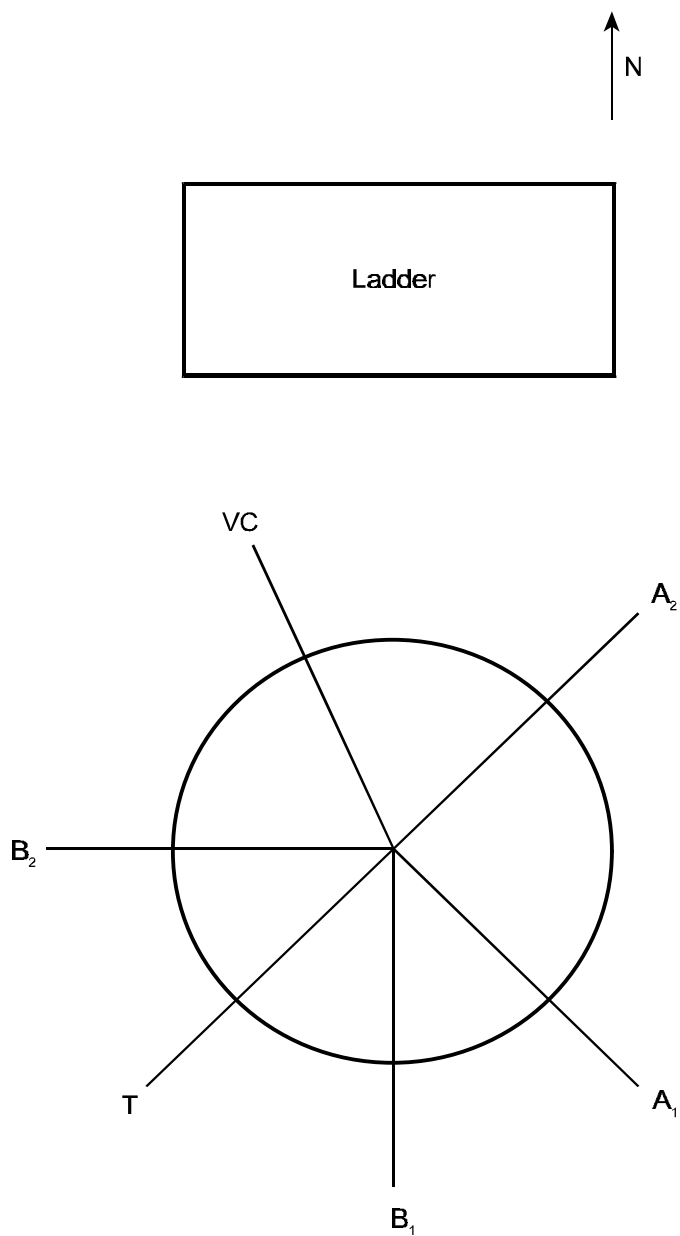


Figure 2-2a. Stack schematic.

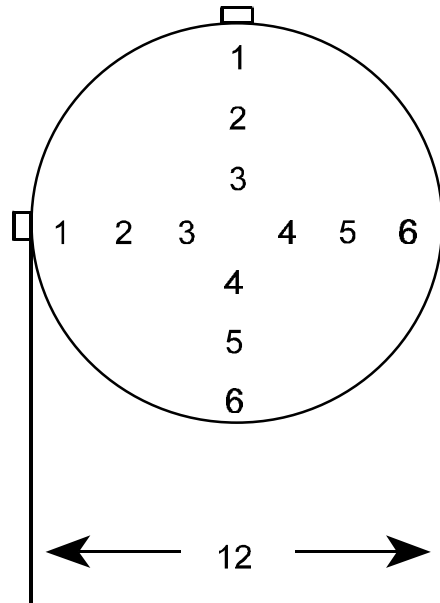


A₁, A₂ used for reference method

Use port VC for pitot

4' above deck

Figure 2-2b. Plan View
A.



Point	Distance from wall
1	.52
2	1.75
3	3.55
4	8.44
5	10.25
6	11.50

All measurements in inches.

Figure 2-3. Sampling port configuration and traverse points for slip stream duct at DuPont.

2.5.2 CEMS

The CEMS sampling locations will be arranged around the stack at the platform location as shown in Figure 2-4. Some of the CEMS will be downstream of the reference method location, others upstream. Ports as required for each CEMS will be installed at the locations indicated in Figure 2-5. No CEMS probes will extend more than 1-1/2 feet into the stack.

2.6 CEMS Utility Requirements

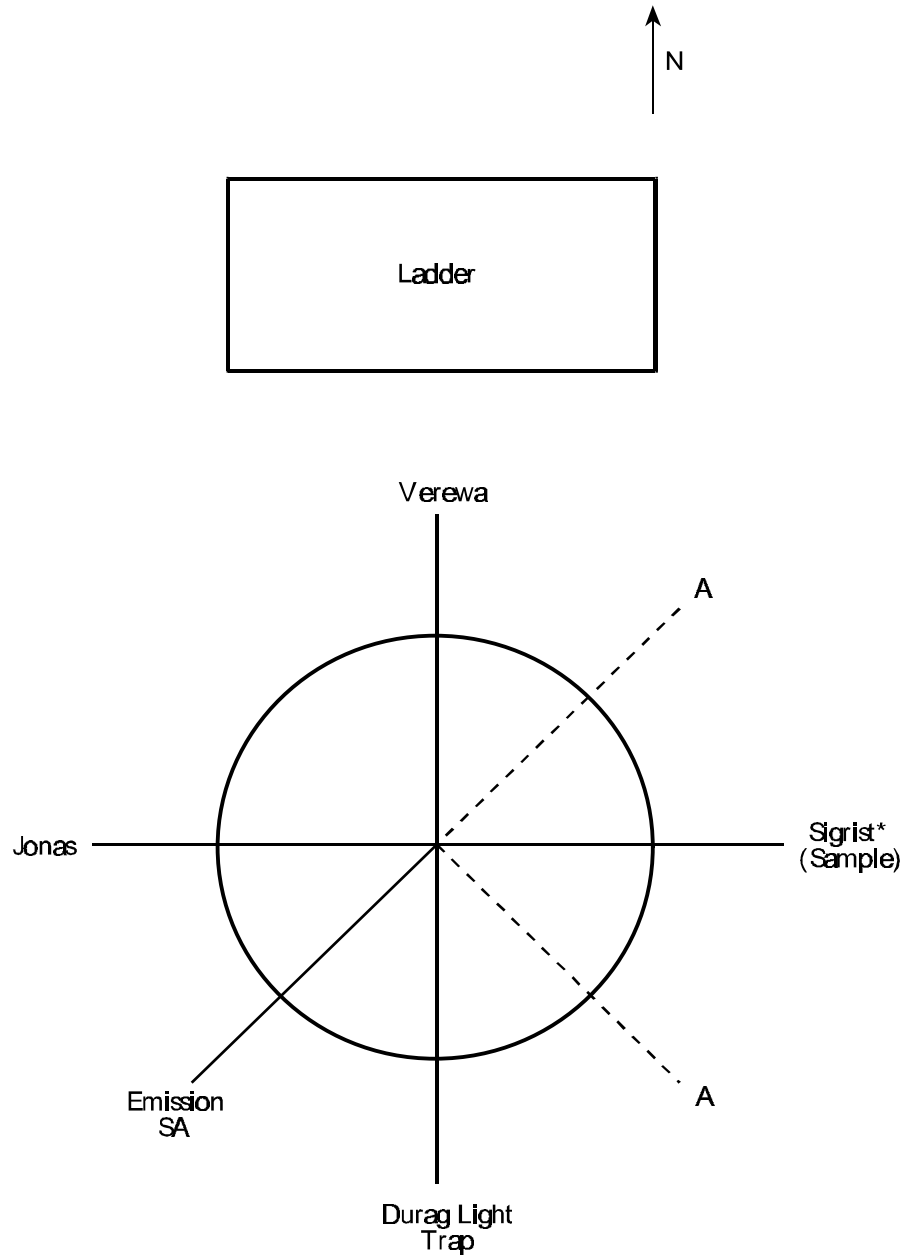
The CEMS will be provided with power and air as needed. The CEMS requirements are summarized in Table 2-1 below.

TABLE 2-1. CEMS UTILITY REQUIREMENTS

	ESC P5A	VEREWA F-904-KD	DURAG DR-300	ENVIRONMENT SA Beta 5M	SIGRIST KTNR	JONAS
POWER	1) 115V, 6A	1) 115V, 5KVA	1) 115V, 50W 2) 115V, 250W	1) 115V, 4 KVA	1) 115V 2) 220V	1) 115V
AIR				90 psig, 3/hr max		

2.7 CEMS Descriptions

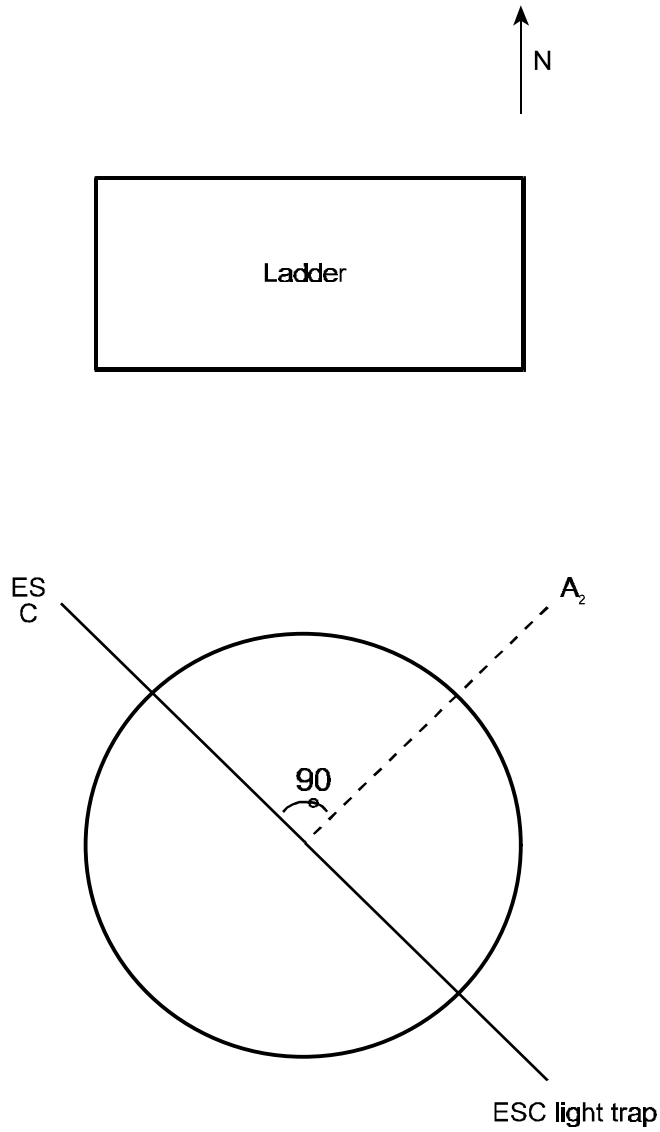
The six CEMS participating in the demonstration are described in detail below. Each CEMS vendor or vendor representative has agreed to the terms of the demonstration as published in the CEMS demonstration announcement and call for proposals that appeared in the Federal Register (see Appendix). Any exceptions to these terms are noted in the vendor proposals, which



* Sigris is not at this level, but at a level ~ 6" higher.
See side view level "F."

8' above deck
(4' above A)

Figure 2-4a. Plan View B.



ESC = standard 4" port & flange, same for light trap

1' above deck

Figure 2-4b. Plan View C - Port for
ESC.

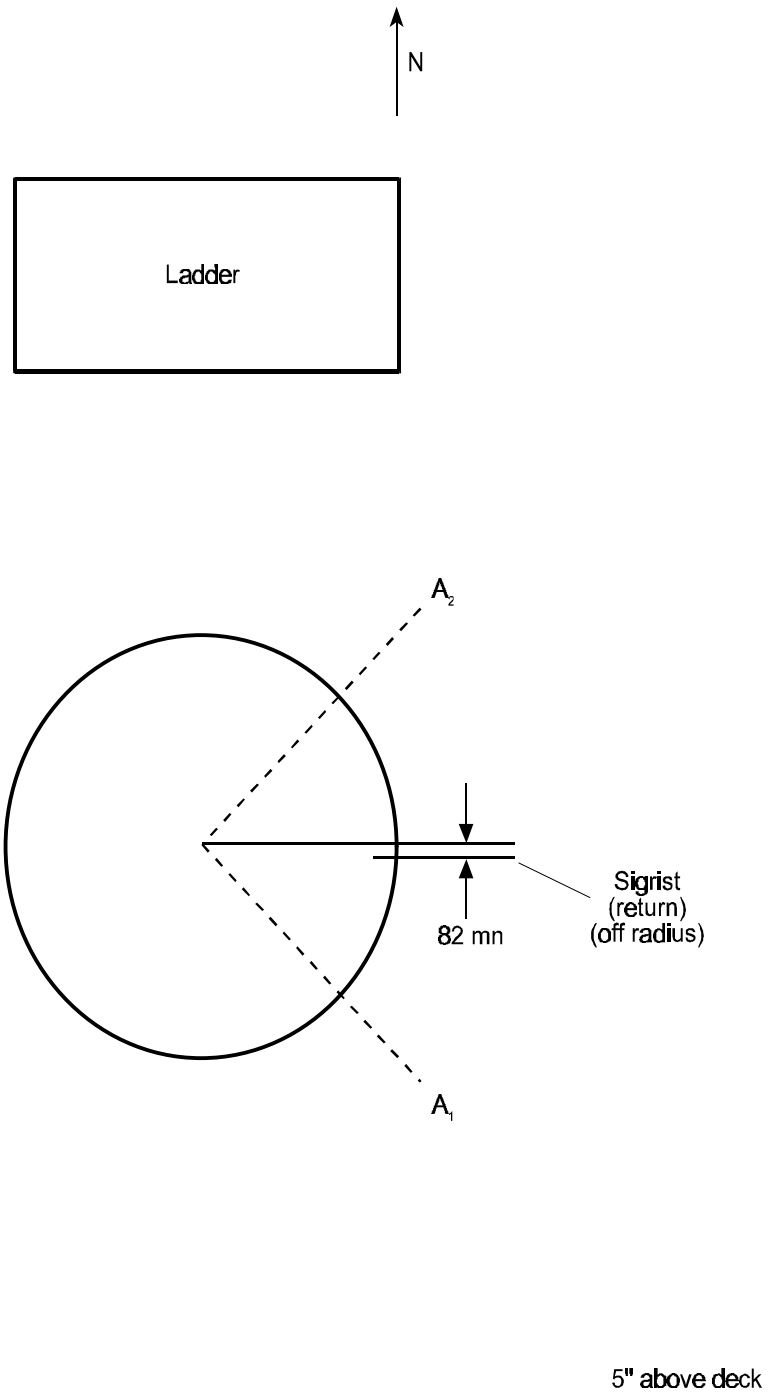
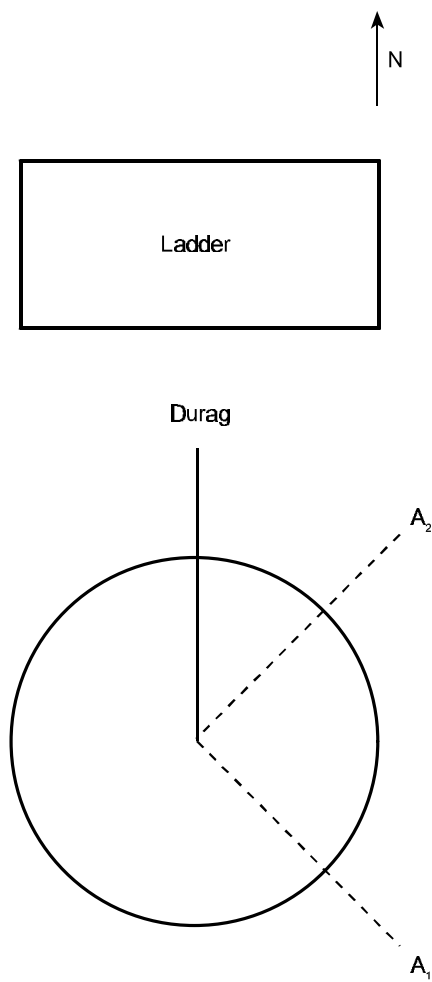


Figure 2-4c. Plan View D -
Sigrist.



6' above deck
(2' above A)

Figure 2-4d. Plan View
E .

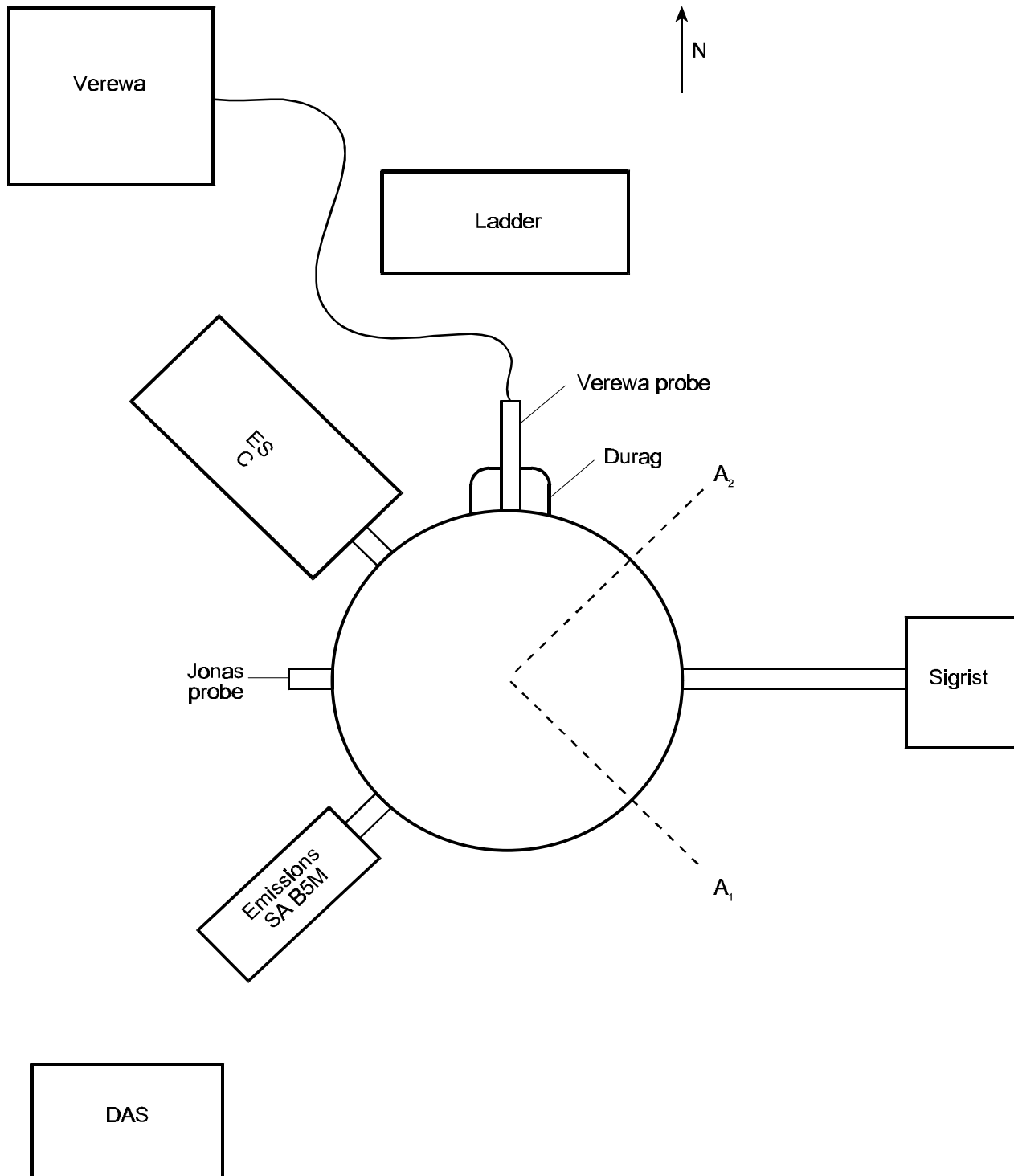


Figure 2-5. View down on all of the monitors.

include detailed descriptions of the CEMS and are reproduced in the Appendix. In the following sections, the CEMS are briefly described and their performance specifications summarized.

2.7.1 *Verewa F-904-KD*

The Verewa F-904-KD continuous particulate monitor extracts a sample from the stack under isokinetic conditions at a nominal design point. Isokinetic sampling is not actively maintained as stack flow changes. The stack sample is diluted for high dust loadings (>200 mg/dscm) or if the stack gas is wet or saturated, otherwise, it is measured directly without dilution. The sample passes through a heated probe and sample line and is collected on a filter. A filter tape mechanism allows long duration operation and positions the filter in either a “measurement” or “sample” location. In the “measurement” location, the attenuation of beta particles from a carbon-14 source is measured. Each filter location used for sampling is measured before and after sampling: the difference between these two measurements is representative of the particulate mass sampled. The attenuation of the beta particles is minimally sensitive to the composition of the particulate, thus a site-specific calibration is not generally required. The sampled gas is dried and the flow rate measured, thus allowing reporting on a dscm basis. The F-904-KD uses a dual source/detector arrangement to allow measurement of the previous sample while acquiring the current sample. Sampling and analysis is thus almost continuous. Zero and span calibration checks are carried out at programmable intervals. The zero check is performed by measuring the same location on the filter tape twice, in succession, without collecting a sample. The span calibration is checked using a radiation attenuator inserted into the measurement beam. A typical sample requires five minutes to collect, two minutes to perform the blank filter measurement, two minutes to measure the loaded filter, and about one minute of tape transport time. Using the dual source/detector configuration, measurements are thus reported every 7.5 minutes. These times are programmable, however, so different sample and reporting times can be obtained depending on the sample loading.

2.7.2 *Emissions SA Beta 5M*

The Emissions SA Beta 5M uses a heated sampling probe to obtain an isokinetic sample (isokinetic sampling is maintained automatically). The sample is collected on a filter, which, at the end of the sampling period, is moved (using a continuous filter tape mechanism) to a measurement location between a carbon 14 beta particle source and a detector. The beta transmission through each blank filter is determined before sampling begins. The sampling duration is programmable and determines the mass concentration detection limit. At high PM loadings it must be kept small enough to prevent sampling excessive amounts of particulate, and is usually set at two minutes for typical applications. Analysis takes six minutes, and thus a measurement is made every eight minutes. At the end of each sampling period, the probe nozzle is temporarily closed, opened, and closed again in order to re-entrain any particulate that may have deposited in the probe.

2.7.3 *ESC P5A*

Environmental Systems Corp. model P5A light scattering monitor monitors the back scattered light (180°) from an infrared light emitting diode (LED). The instrument has a roughly constant response to particles in the 0.1 to 10 μm range and a measurement range of 0.0005 to 8 gr/dscf. The probe volume is located 4.5 inches from the end of a probe containing both the transmitting and receiving optics that is inserted into the flow through a standard flange. The probe is purged with air to keep the optics clean. Only one point of access to the stack is required. The instrument automatically carries out zero and span calibrations.

2.7.4 *Sigrist KTNR*

The Sigrist model KTNR is an extractive light scattering monitor. This device extracts a heated slipstream from the stack, a small portion of which is sampled in turn and passes through a scattered light photometer. The entire sample is then returned to the duct. The sample rate is set up to be isokinetic at a normal stack flow, but isokinetic sampling is not actively maintained. Rather, a constant sample rate is maintained. The photometer measures the light scattered at 15° from a incandescent bulb emitting over the range 360 to 2800 nm. A double beam compensation measuring method is used

in which the light path is split and the intensity of the reference path adjusted by an attenuator to equal the intensity of the measurement path. The amount of adjustment necessary is the output signal. This approach makes the output independent of fluctuations or aging in the optical and electronic components, including the buildup of dirt on the optics. Drift of the calibration and zero point is absent. Periodic cleaning and checks with optical filters supplied with the instrument are carried out on a typical six to 12 month basis. Measuring ranges run from 0 to 0.1 mg/dscm to 0 to 1000 mg/dscm.

2.7.5 *Durag DR-300*

The Durag model D-R 300-40 light scattering monitor measures the light scattered at approximately 120° by the particulate. The light beam is generated by a halogen lamp (400-700 nm) modulated at 1.2 kHz., and the sample volume is located in a region 80 to 280 mm (centered at 150 mm) from the wall. Both the light source and the detector are located in a single unit, thus requiring only one point of access to the duct. The D-R 300-40 is designed to carry out automatic zero and span checks, and provides automatic compensation for dirt on the optics (although the optics are protected by an air purge system). Stray light from surface reflections of the transmitted beam is minimized through the use of a light trap mounted on the opposite of the duct. The D-R 300-40 is normally located directly on the duct wall, thus making an in-situ measurement. For applications where water droplets are expected, a hot bypass system is available, but this will not be provided for the demonstration.

2.7.6 *Jonas, Inc.*

The Jonas Consulting Acoustic Energy PM monitor uses shock waves caused by the impact of particles with a probe inserted into the flow to measure particle loading. The device counts the number of impacts and also measures the energy of each impact. This information, coupled with

knowledge of the flow velocity, allows calculation of the particle mass. Since the probe distorts the flow, changes in flow velocity and particle size distribution will, in principle, change the instrument response. This instrument can also report real-time particle size distributions.

3.0 TECHNICAL APPROACH

In this section the technical approach to be used for the particulate matter (PM) continuous emissions monitoring systems (CEMS) demonstration is presented. The intent is to provide an integrated picture of the testing. More detailed discussions of the various methods, analytical procedures, and data reduction procedures are presented in subsequent sections of this test plan.

3.1 CEMS Installation/Site Preparation

EER will prepare the site for the CEMS through the use of facility personnel and services and outside contractors as appropriate. The specific site modifications and utility services required are discussed in Section 3.1.1. EER will also coordinate the data collection from the CEMS. This involves ensuring that a data acquisition system (DAS) is available and that the appropriate status signals and timing sequences are used. It also entails ensuring that adequate logs are kept. These considerations are discussed in Section 3.1.2.

3.1.1 *Site Modifications*

The site modifications required for the CEMS are the following:

- Cutting ports and installing flanges. Port location and layout are discussed in Section 2.5;
- Providing an air-conditioned and weather-proofed cabinet for the DAS and CEMS electronics located on the stack platform;
- Providing power for the CEMS and DAS on the stack. The power requirements were listed in Table 2-1 and will be supplied by the plant; and

- Providing instrument air to the platform. This will be supplied from the plant air system.

3.1.2 *Data Acquisition*

The data acquisition system will be provided by Environmental Systems Corporation (ESC). The system is microprocessor based, accepts 4-20 ma analog inputs and digital relay status signals, and is fully programmable and capable of both storing the data and performing the required minute and hourly averages. It can also be accessed remotely by modem for downloading data and checking on instrument status.

Each instrument provides a 4-20 ma signal for data collection and digital outputs for status. EER will provide twisted pair shielded cable for connection to the DAS, but each vendor must supply the appropriate connectors, if needed. The digital status signals will be recorded and used to flag the data for zero and calibration or malfunction. The zero and calibration flagged data will be used to determine zero and calibration drift.

Vendor log books will be kept, noting all adjustments and service to the instruments, including routine maintenance. In addition, all vendor visits to the site must be arranged through EER. EER will also keep a record of all vendor approved routine activities performed by EER technicians.

3.2 CEMS Performance Testing

CEMS performance testing will take place over a one week period, as the relative accuracy tests, calibration error test, and interference tests can be conducted during the seven day zero/calibration drift test period. The details and schedule for these tests are discussed below.

3.2.1 *Calibration and Zero Drift*

Calibration and zero drift will be evaluated daily for a one week period. These tests will be conducted automatically by the CEMS. However, not all of the CEMS perform calibration drift (CD) and/or zero drift (ZD) tests. This is because in some instances the unit is driftless through design, and in others drift testing is not practical as currently configured. The zero drift of the devices can be checked during plant shutdowns, which occur every week. The CEMS output will be recorded and flagged during these tests to allow calculation of the drift.

3.2.2 *Calibration of the CEMS*

The CEMS calibration will be conducted by comparing simultaneous CEMS and manual gravimetric reference method measurements. The reference method used in this demonstration will be the Modified Method 5 train for low PM loadings, described in Section 3.4. The reference method measurements will be conducted at the standard stack sampling location described in Section 2. These measurements will be traversing and made in duplicate. Fifteen one-hour runs will be made covering a matrix of normal plant operating conditions. This matrix will include conditions that result in at least three different PM loadings, as described below. The calibration relation and associated statistics will be calculated as per the performance specification. The calibration will be conducted over the first five days of the performance test period. The feed stream (fuel and hazardous waste) information from the plant during the calibration will be collected in order to document the range of plant operation covered during the calibration and any feed stream effects on the performance of the CEMS.

The matrix of plant operating conditions over which the calibration of the CEMS will be performed will be obtained by varying air pollution control device (APCD) operation and feed stream composition. Three different APCD operating conditions will be used, which will result in three different PM loadings at the stack. These are:

- 1) Electro-dynamic venturi (EDV) at normal operating condition (high voltage) — designated “low” PM loading;

2) EDV at minimum operating efficiency (minimum voltage) — designated “medium” PM loading; and

3) EDV off — designated “high” PM loading.

Venturi pressure drop will not be varied because after the plant retrofit, which was just completed, it is always operated with the minimum possible pressure drop (throat wide open). The variation in feed stream will be accomplished using the following combinations of waste:

1) “L1” — non-chlorinated solvents only;

2) “L2” — chlorinated solvents;

3) “L1+S” — non-chlorinated solvents plus solid hazardous waste; and

4) “L2+S” — chlorinated solvents plus solid hazardous waste.

Solid hazardous waste consists of a variety of elements: gallon jugs of liquid waste, lab packs, shredded paper, potted plants, etc. However, the composition of the solid waste will not be controlled, only documented. The afterburner is always fired with fuel oil. The resulting matrix of test conditions for the calibration is shown in Table 3-1 below.

TABLE 3-1. MATRIX OF CALIBRATION CONDITIONS

Low	APCD Operation	
	Medium	High
L1	L1	L1
L2	L2	L2
L1+S	L1+S	L1+S

L2+S	L2+S	L2+S
Random	Random	Random

The entries of “random” indicate that for these conditions no attempt will be made to control the feed streams, rather the feed used will be documented.

3.3 CEMS Endurance Testing

During the endurance testing the CEMS performance will be documented in terms of data availability and maintenance requirements. This documentation will consist of the CEMS electronic data record, as well as log books kept by the vendors and the EER and plant technicians checking on the monitors. In addition, the following periodic testing will be carried out.

3.3.1 *Monthly RCAs*

Response calibration audits (RCAs) consisting of comparison to simultaneous reference method measurements will be conducted on a monthly basis. The Modified Method 5 will be the reference method, and duplicate measurements will be made. Nine runs will be made for each RCA, three at each APCD operating condition described in the previous section. No attempt will be made to control plant feed.

3.3.2 *Monthly ACAs*

Absolute calibration audits (ACAs) will also be conducted on a monthly basis, but two weeks out of phase with the RCAs. ACAs are carried out at three levels with NIST traceable calibration standards. These standards challenge the CEMS by simulating the presence of particulate and cause a known response against which the output of the CEMS can be calibrated. The standards will depend upon the CEMS (not all of the CEMS can be audited in this manner) and will be supplied by the vendor. Either the vendor will conduct the ACA with EPA oversight or EER personnel will be trained

to conduct the ACA.

3.4 Test Methods

3.4.1 *Reference Method*

The reference method used for this demonstration will be Method 5, modified to improve precision at low PM loadings. The modification involves using a different filter assembly that is extremely low in weight (20 g). The filter and assembly are pre-weighed. Then, after sampling, the entire assembly (including filter) is removed, desiccated, and weighed again. The filter is thus not removed from the assembly, which eliminates the filter recovery step in Method 5. All other aspects of the train and recovery are unchanged from those of Method 5. A more detailed description of the Modified Method 5 train for low PM loadings can be found in Section 5.

4.0 PROJECT ORGANIZATION, RESPONSIBILITIES, QA ORGANIZATION, QA OBJECTIVES, AND TESTING SCHEDULE

This section describes the specific responsibilities for the individuals responsible for setting and achieving all program goals. Section 4.1 defines the overall project team. Section 4.2 discusses the field sampling team. The quality assurance objectives are described in Section 4.3.

4.1 Project Team Organization

Figure 4-1 identifies principal members of the proposed project team and the lines of authority. The following organizations are participating in this project:

- U.S. Environmental Protection Agency's Office of Solid Waste Management (OSW);
- DuPont; and
- Energy and Environmental Research Corporation (EER).

Ms. Kathy Weant is the EPA Project Officer. Mr. Scott Rauenzahn of OSW is the Work Assignment Manager and is responsible for the project and its overall direction. EER is the prime contractor to EPA and is responsible for planning the tests, carrying out EPA's scope of testing, evaluating test data, and reporting. DuPont and its contractors will be responsible for the preparation and operation of the facility in a manner that will accommodate all data collection needs of the project and for specific measurements during the tests.

Mr. Wyman Clark is EER's Program Manager. Dr. W. Steven Lanier is the Principal Investigator. The overall responsibility for the testing program lies with Mr. Frank Stevens, who will serve as the Test Program Manager, and Mr. William Froberg, who will serve as Test Program Investigator. Mr. Stevens will be responsible primarily for liaison with EPA, field quality assurance and quality control (QA/QC), overall coordination of the testing effort,

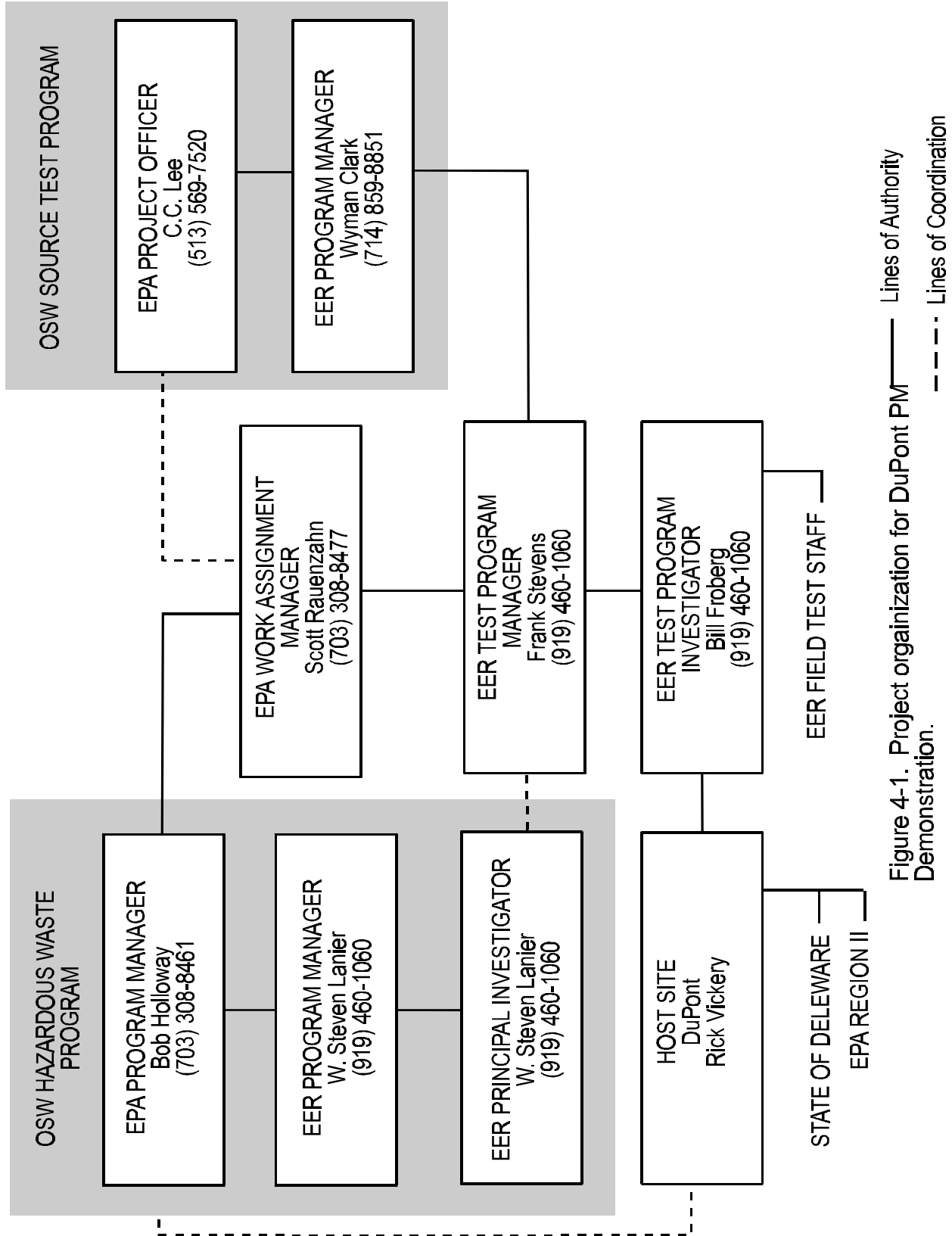


Figure 4-1. Project organization for DuPont PM Demonstration.

reporting, test plan development, selection of sampling and analysis methods, and execution of the test plan. Mr. Stevens and Mr. Froberg will work closely with EPA and the EER Principal Investigators to ensure that the program objectives are achieved. Mr. Froberg will direct the efforts of EER's field test staff and subcontractors.

4.2 Field Organization and Responsibilities

The organization and lines of authority for on-site testing personnel are illustrated in Figure 4-2. The key areas of responsibility in the field are:

- EER Test Program Investigator/QA Coordinator;
- Process Coordinator/Data Collection and Reduction;
- Flue Gas Sampling Leader; and
- Sample Recovery.

The responsibilities of each of the personnel for the above listed areas are described below in detail.

4.2.1 *Test Program Investigator*

The Test Program Investigator is responsible for the overall technical conduct of the project during mobilization, testing, and reporting. He provides the lines of communication and authority between DuPont, the project team, and the field testing team. The Test Program Investigator is also responsible for the project initiation and execution within the EER organization, as well as for the technical quality of work performed. He will work directly with the field team to ensure that sampling, sample analysis, and data reduction are performed efficiently and as scheduled.

Mr. Bill Froberg will serve as Test Program Investigator for this testing program. His specific responsibilities will include:

- Assuming overall on-site responsibility for field sampling and analysis activities, including set up, sampling, sample recovery, sample custody, data reduction, and data validation;

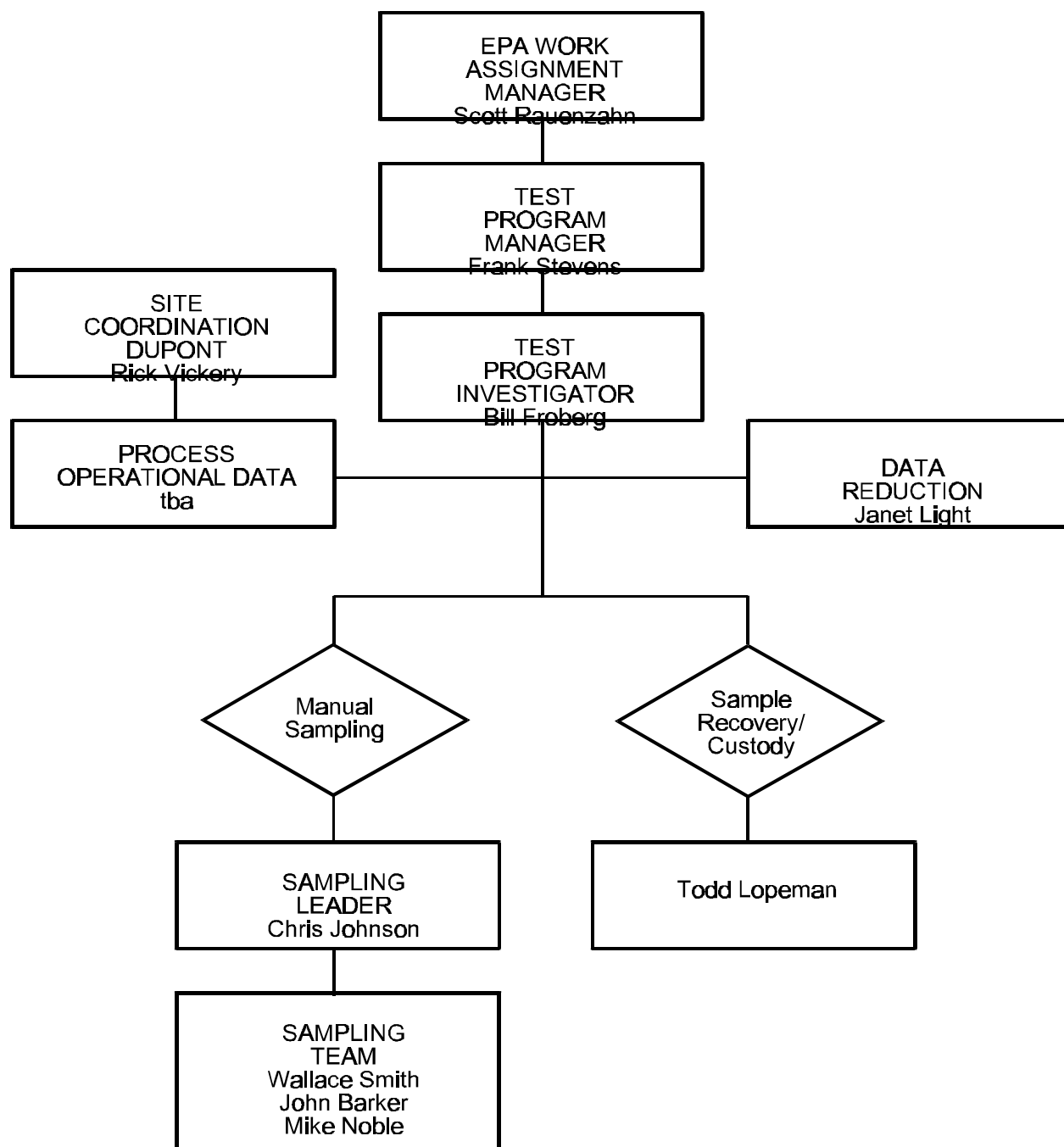


Figure 4-2. Field organization for DuPont PM Demonstration.

- Conducting daily test planning meetings with the test team and DuPont;
- Conducting test planning and test team coordination;
- Informing EER's Test Program Manager and EPA's on-site representative of any proposed deviations from the approved test plan;
- Resolving problems and coordinating the implementation of any plan deviations that are approved;
- Reviewing daily test results for compliance with acceptance criteria and identifying any invalid tests results;
- Discussing any information that may invalidate results and require retesting with EER's Test Program Manager and EPA's on-site representative;
- Monitoring the overall progress of the on-site sampling and analytical activities and maintaining a daily, written log of all events which occurred on-site; and
- Preparing daily summaries of all site activities.

4.2.2 *Flue Gas Sampling Leader*

Mr. Chris Johnson will serve as the coordinator for the manual flue gas sampling. The specific responsibilities of the Flue Gas Sampling Leader include:

- Coordinating the set up, operation, and breakdown of the sampling trains at each sampling location;
- Verifying that each location's sampling train has been properly prepared by the sample recovery team;

- Coordinating daily test planning meetings with each sampler to ensure that they are ready for the day's testing activities;
- Monitoring and coordinating operation of all manual sampling trains at each of the locations and ensuring compliance with all acceptance criteria identified in Section 7 (including leak checks, isokinetic ratio, simultaneous sampling, and minimum sampling volumes);
- Collecting all run sheets from the samplers at the end of each run and sending them to the person responsible for data reduction;
- Informing the EER Test Program Investigator of any sampling train problems which would require suspension of other simultaneous sampling activities;
- Informing the EER Test Program Investigator of any port-change or leak-check problems;
- Informing the EER Test Program Investigator of any deviations from the quality assurance project plan (QAPP) prior to implementing the deviations;
- Reviewing the run results with samplers to check for problems which would require a retest; and
- Maintaining a daily log of all manual sampling activities and events.

Each of the Samplers will be responsible for:

- Coordinating the set up, operation, and breakdown of the sampling trains at their sampling location;
- Verifying that each sampling train has been properly prepared by the sample recovery team;

- Coordinating, supervising, and assisting with the sample train breakdown, probe recovery, and impinger weighing operation;
- Collecting all run sheets from the Box Operators at the end of each run;
- Monitoring and coordinating operation of all manual sampling trains and ensuring compliance with all acceptance criteria identified in Section 7 (including leak checks, isokinetic ratio, simultaneous sampling, and minimum sampling volumes);
- Informing the EER Flue Gas Sampling Leader of any sampling train problems which would require suspension of other simultaneous sampling activities;
- Informing the EER Flue Gas Sampling Leader of any port-change or leak-check problems;
- Informing the EER Flue Gas Sampling Leader of any deviations from the QAPP prior to implementing the deviations; and
- Reviewing run results with the EER Flue Gas Sampling Leader for problems which would require a retest.

4.2.3 *Sample Recovery*

Mr. Todd Lopeman will have overall responsibility for sample recovery, storage, custody, and shipment to the appropriate laboratories. Specific responsibilities of this position will include:

- Coordinating and performing the set up of the sample recovery trailer area, including recovery equipment, reagents for the methods of concern, sample storage area, refrigerators, environmental controlled area for organics recovery, fume hoods, and pre-cleaned glassware inventory;
- Procuring, cleaning, and labeling sample containers in accordance with the requirements of Section 5;

- Performing daily processing of all required information on sample tracking, custody, and lab analysis request forms and maintaining a central file of completed forms and custody information;
- Performing sample recovery and train preparation in accordance with procedures specified in Section 5;
- Ensuring that all samples are stored in accordance with storage and holding time requirements, as specified in Section 4 and Section 5, until ready for shipping;
- Providing a complete, updated set of sample checklists and forms for the EER Test Program Investigator at the beginning of each day; identifying any problems such as incomplete sample label data, sample recovery errors, or missing samples; and recommending corrective action;
- Immediately informing the EER Test Program Investigator and QA Coordinator of any problems which may invalidate a sample;
- Performing pre-cleaning of any specialized process sampling equipment;
- Accepting custody of all samples at the completion of the program for delivery to the laboratory; and
- Maintaining a detailed log book of all sample recovery and custody activities.

4.3 Quality Assurance Program

Quality assurance is an integrated system of activities which involves planning, quality control, quality assessment, reporting, and quality improvement to ensure that the test program meets standards of quality with a stated level of confidence. Quality assurance encompasses the organization within which quality control activities are performed. The QC activities, which accompany testing, lab analysis, and other procedures, provide control of data and quantify the quality of data so that it meets the needs of the users as stated in the quality assurance objectives.

Each source test performed should include a QA program incorporating the principles and requirements presented in this section. Implementation of a QA program for each source test is paramount to the success of the test program. The importance of a QA program performed with the source test is three-fold. First, the QA program will assure higher quality, more reliable test results than may be obtained otherwise. Second, the QA program will provide a means to determine the level of data quality. Third, only by following a sound QA program will the test results be valid for regulatory compliance purposes.

Generally, EER's QA procedures follow the guidelines in the "Quality Assurance Handbook for Air Pollution Measurement Systems," Volumes I through III. These procedures outline pre-test preparation and calibrations of sampling equipment, post-test sample handling, and post-test calibrations. Standardized written procedures, calculator programs, and spreadsheets are used for test planning, pre-surveys, equipment checklists, preliminary calculations, data and sample collection, sample tracking, sample and data analysis, and reporting.

Test procedures follow applicable EPA test methods. Modifications of the analytical approaches have been, and will be, made to ensure the thoroughness and quality of the data. For each key measurement area, there are specific QC activities and checks to ensure that written procedures are followed during all preparation, validation, sampling, and recovery activities. There are also criteria to quantify and judge the performance of the measurements and corrective action procedures for correcting deficiencies.

QA aspects for this test program are found in the following sections:

Section 4.3.1	Quality Assurance Approach
Section 4.3.2	QA/QC Organization
Section 4.3.3	Quality Assurance Objectives
Section 7.0	Internal Quality Control Procedures

4.3.1 *Quality Assurance Approach*

The EPA has defined Categories I through IV to define the content of QA plans according to the goals of the program with which the QA plan is associated (Preparation Aids for the Development

of RREL Quality Assurance Project Plans, U.S. EPA, Risk Reduction Engineering Laboratory, Cincinnati, OH, 1989). The four categories are defined as follows:

Category	Description
I	Projects for support of enforcement, compliance, or litigation. This level QA is the highest possible for legal challenge. The cost of the QA program for this type of project is typically 20-30% of the total cost.
II	Projects for producing results used to complement (or in combination with) other projects of similar scope for rule making, regulation making, or policy making. Data quality indicators (DQIs) for completeness, representativeness, and comparability may not be easily defined. The cost of the QA program for this type of project is typically 10-30% of the total cost.
III	Projects for producing results used for engineering, technology development, feasibility studies, or preliminary assessments. QA requirements are more broadly defined, although definitive documentation of QC activities and results is still required for reports.
IV	Projects for producing results used in assessing suppositions, feasibility studies, or fundamental investigations.

The purpose of this test program is to: (1) generate data that accurately identifies and quantitates all toxic and non-toxic organic species emitted from a hazardous waste incinerator under normal operation; and (2) provide background data that can be used to enhance the risk assessments performed on emission sources regulated by a total hydrocarbon limit. Category II QA/QC will be implemented during this test program. Phase I will require an abbreviated form of the QA/QC required in a Category II program, since only one sample will be collected for each method.

4.3.2 QA/QC Organization

The QA/QC structure for this test project is shown in Figure 4-3. The Test Program Investigator is Mr. Bill Froberg of EER. EER's Quality Assurance Officer is Mr. Jerry Cole, and EER Project QA Coordinator will be Mr. William Froberg. Mr. Froberg will have overall responsibility for all project QA and will report on a regular basis to Mr. Cole. The QA Coordinator's activities will consist of test plan review, on-site performance and system audits, analytical system and performance audits, and reporting of all QA/QC activities and data. The QA activities will be performed independent of the persons responsible for the technical aspects of the testing.

The efforts of the QA coordinator are designed to assure that the specific goals for precision, accuracy, and completeness are achieved. The specific system of internal QC procedures to establish the performance of the measurement systems is presented in this section. This system of internal checks is an integral part of the emissions characterization program.

4.3.3 *Quality Assurance Objectives*

Quality assurance objectives are goals for test data accuracy, precision, and completeness. Accuracy is the degree of agreement of a measurement (or average of measurements) with an accepted reference or true value. Precision is a measure of mutual agreement of replicate measurements. Completeness is a measure of the amount of valid data compared to the amount that was expected to be obtained under correct operating conditions. QA objectives should be defined for all of the critical measurements of the test program. The objectives should be based on the limitations and requirements of the test methods, where available. The quality assurance objectives for the particulate matter are: completeness of 100%; precision of a constant weighing $\pm 1\%$; and accuracy of $\pm 6\%$.

Some of the data validation will not be complete until after the testing phase has ended. In this case, it may not be possible to take corrective action to meet the quality assurance objectives (for example, if the analytical laboratory irrecoverably contaminates or loses a sample). Daily records of completeness will be maintained by the EER QA Coordinator for each test method. These daily records will be based on the validity of each run.

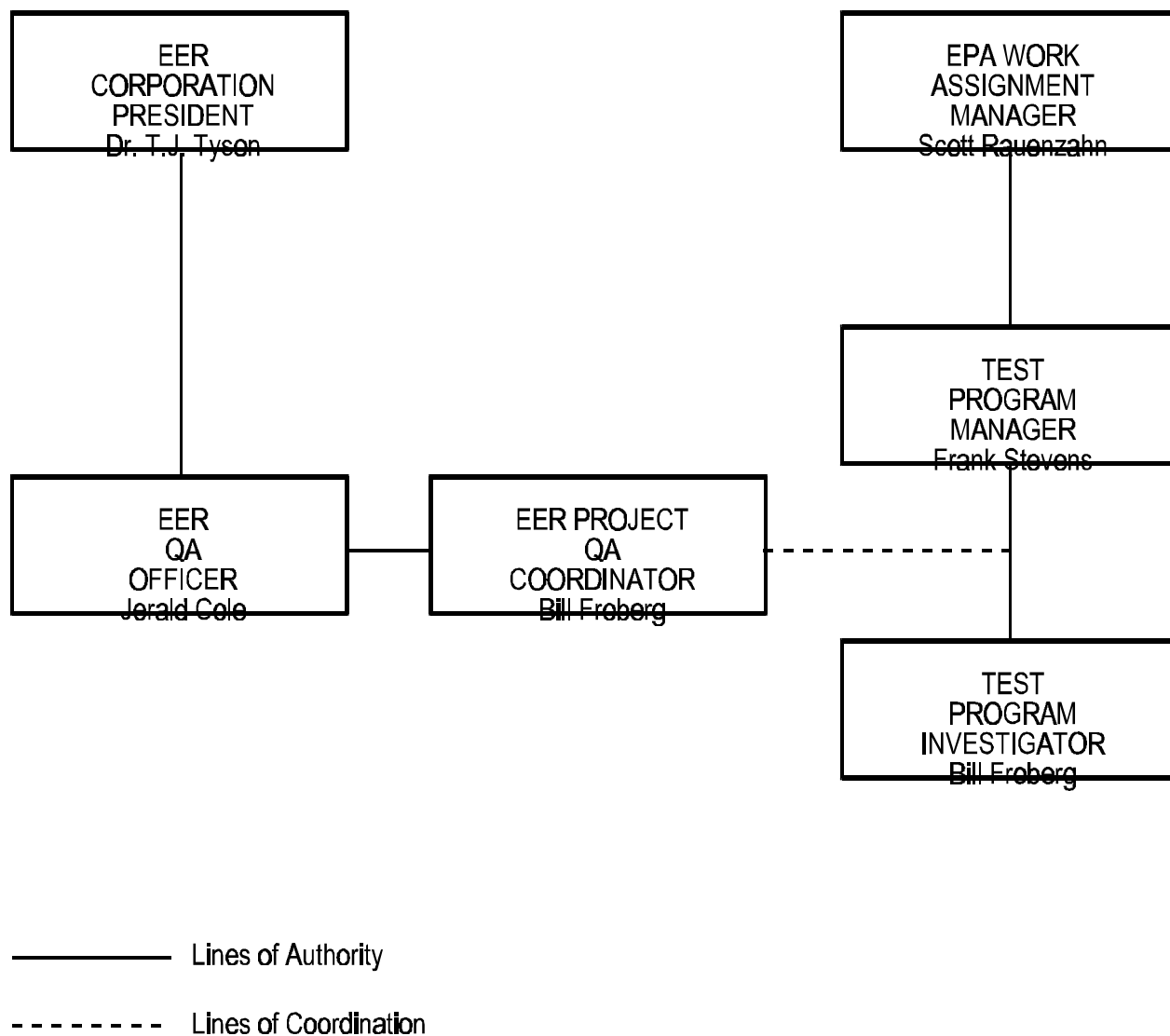


Figure 4-3. QA/QC organization for DuPont PM Demonstration.

4.3.4 *Calculation of Quality Assurance Objectives*

The quality assurance objectives for precision, accuracy, and completeness will support the integrity of the data generated for each source test. Precision will be a measure of mutual agreement among individual measurements of the same property. Precision will be generally determined for each of the key measurements through either the percentage agreement between duplicate measurements or by determining the relative percent standard deviation for three or more replicate measurements. For duplicate measurements, precision will be indicated as a percentage based on the ratio of the difference between the two values and the average of the two values expressed as the relative percent difference.

When three or more replicate measurements are available, then the relative standard deviation (RSD) from the mean of all the replicate values will be used to indicate precision, calculated using the equations below:

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n X_i \qquad RSD = \frac{S}{\bar{X}} * 100 \qquad S^2 = \frac{1}{n-1} \sum_{i=1}^n (X_i - \bar{X})^2$$

where:

RSD	=	relative standard deviation
S	=	standard deviation of the measurements, x
\bar{X}	=	mean of the measurements, x
n	=	number of replicate measurements

Accuracy, defined as the percent difference between a measurement and a reference or standard value, will be calculated by the following equation:

$$A (\%) = \frac{X - X_R}{X_R} * 100$$

where:

A	=	accuracy
X	=	measurement
XR	=	reference or standard value

Completeness will be a measure of the amount of valid data obtained compared to the amount which was expected to be obtained. Completeness will be calculated by the following equation:

$$C (\%) = \left(\frac{D_v}{D_p} \right) * 100$$

where:

C	=	Completeness
Dv	=	Quantity of valid data
Dp	=	Quantity of expected data

5.0 SAMPLING PROCEDURES

In order to achieve the project goals, a number of measurements will be performed for the facility. The test matrix is summarized in Table 5-1. Table 5-1 lists the sample location, the sampling or measurement method, and the total number of samples to be collected. The following sections discuss details of the sampling methods to be performed for this program.

5.1 Flue Gas Sampling Procedures

In order to achieve acceptable data from this test program, detection limits need to be established and achieved. For flue gas measurements, the detection limit is a function of the analytical detection limit and the total sample collected. Particulate sampling trains will be operated for one or two hours. Measurements will be made using various process conditions to vary the particulate levels over time. Details of the sample trains, sampling procedures, recovery procedures follow.

5.2 Sample Train Description and Sampling Procedures

EPA Methods 1, 2 - Traverse Point Determination, Stack Gas Temperature, Velocity, and Volumetric Flow Rate

EPA Method 1 will be used to determine the sample and velocity traverse points for velocity measurements and isokinetic sampling. With EPA Method 1, the duct or stack cross-section is divided into equal areas. A traverse point is located in each of the resulting areas.

The minimum number of equal areas and traverse points depends on the duct diameter and length in equivalent diameters directly upstream and downstream of the sample location. Schematic layouts of the sample locations and traverse points were shown earlier in the quality assurance project plan (QAPP).

EPA Method 2 is used to determine the stack gas temperature, velocity, and volumetric flow rate. The velocity of the stack gas is determined from the density of the gas and the measurement

TABLE 5-1. SUMMARY OF PROPOSED TESTING ACTIVITIES
WITH IONIZING WET SCRUBBER.

MEASUREMENT	COMBINED SAMPLING	EXHAUST GAS VOLUMETRIC FLOW RATE		
	PARTICULATE	VELOCITY	MW	MOISTURE*
Method	EPA 5	EPA 1A, 2A	EPA 3A	EPA 4
Isokinetic?	Yes	Yes	No	Yes
Analytical Principal	Gravimetric	Pitot/TC	ORSAT	Impingers
No. of Tests	2	2	2	2
QA/QC				
Leak Check	c	c	b	c
Stratification Check			a	
Bias Check (system integrity)			c	
Calibration (Zero)			b	
Calibration (Span)			b	
Linearity Check			b	
NO/NO ₂ Converter			n/a	
Efficiency Check				
Locations	1	1	1	1
Test Conditions	15	15	15	15
Total Samples	34	30	30	30

* Flue gas flow parameters determined during isokinetic sampling

a = Once during each run

b = Before and after each set of tests

c = Before and after each test

of the average velocity head. A stainless steel sheathed Type-K thermocouple (TC) is used to measure stack temperature, while a stainless steel Type-S pitot, and an incline manometer of applicable sensitivity is used to measure stack gas velocity. To minimize the mutual interference, the thermocouple (TC) and pitot are assembled according to the method specifications. Pre-test and post-test leak checks are conducted to ensure the accuracy of the velocity measurements.

EPA Methods 3A and 4 - Stack Gas Analysis and Moisture Content Determination

EPA Method 3 will be used to determine the stack gas oxygen (O₂) and carbon dioxide (CO₂) concentrations and the dry molecular weight. A stack gas sample is collected from the stack and examined using an Orsat analyzer to determine carbon dioxide and oxygen content. The dry molecular weight of the stack gas is calculated using the measured O₂ and CO₂ levels, assuming the remainder of the stack gas composition is nitrogen. Low levels (ppm range) of CO, SO₂, NO_x, hydrocarbons, and other compounds are not significant factors in the molecular weight determination. The molecular weight and excess O₂ levels are used in velocity, isokinetic sampling rate, and pollutant emission rate calculations.

EPA Method 4 is used to determine the moisture content of the stack gas. This method is applicable for a pre-test determination of moisture content. Moisture will be determined simultaneously from all sampling trains.

At some sample locations (such as the outlets of wet scrubbers), the moisture content determined using EPA Method 4 may exceed the saturation level at the measured stack gas temperature if there are droplets of moisture entrained in the gas stream. In this case, the measured moisture content should be reduced to the saturation level at that temperature and pressure.

EPA Method 5 - Determination of Particulate Emissions from Stationary Sources

As directed by the Code of Federal Regulations, Method 5 applies specifically to the gravimetric determination of the emission rate of particulate matter from stationary sources. For this to be achieved, the location of the sampling points must be determined (Method 1) and the volumetric flow rate (Method 2) calculated. To calculate the volumetric flow rate, the values for carbon dioxide and oxygen contents (Method 3), and moisture content (Method 4) must be determined, per the methods discussed in the previous section.

With EPA Method 5, a gas sample is withdrawn isokinetically from the stationary source and passed through a heated glass fiber filter. The filter collects any solid particulate matter contained in the effluent gas stream while allowing any uncombined water vapor to pass through for collection in the impinger train containing a known volume of water. The mass of the particulate is then determined by desiccating the filter and associated probe rinse. For this study, the recovery of the filter has been modified to accommodate a new light-weight filter housing. The housing is designed such that the filter and the fronthalf of the filter housing is one integral piece that can be tared as a single unit. The moisture content is determined by measuring the amount of water collected in the condenser. The volumetric flow rate of the gas stream is determined by the velocity and temperature traverse. These values are then used to calculate the particulate mass emission rate. Figure 5-1 gives a schematic of the Method 5 sampling train.

The largest area of significant error in Method 5 testing comes from sample recovery and analysis. For this study the standard Method 5 filter holder will be replaced with a modified holder that will minimize the recovery of the sampling train. The new filter assembly will allow the entire fronthalf and filter to be pre-tared, eliminating the need to remove the filter from the filter housing, thus simplifying the recovery for the sampling train. Filter assembly should be properly marked with non-reactive ink and tared; and the filters used for sampling will be immediately removed and carefully transferred to a dessicator.

After allowing the filter to cool and a successful post-test leak check (Figure 5-2), remove the filter holder from the sample box. Immediately cover the exposed ends of the probe, glass "L," and filter holder with double-sided duct tape or Teflon tape. The filter holder, probe and impinger train are taken to the recovery area. To recover the filter, loosen the rings of the filter holder and separate the filter halves. The fronthalf of the filter housing and the filter disassemble as one unit and can be placed directly into a dessicator to continue cooling and allow the weight to stabilize. The average weight of these units will be approximately 30 grams, allowing the pre-taring and final weighings to be performed on a micro balance with a resolution of ± 0.1 mg.

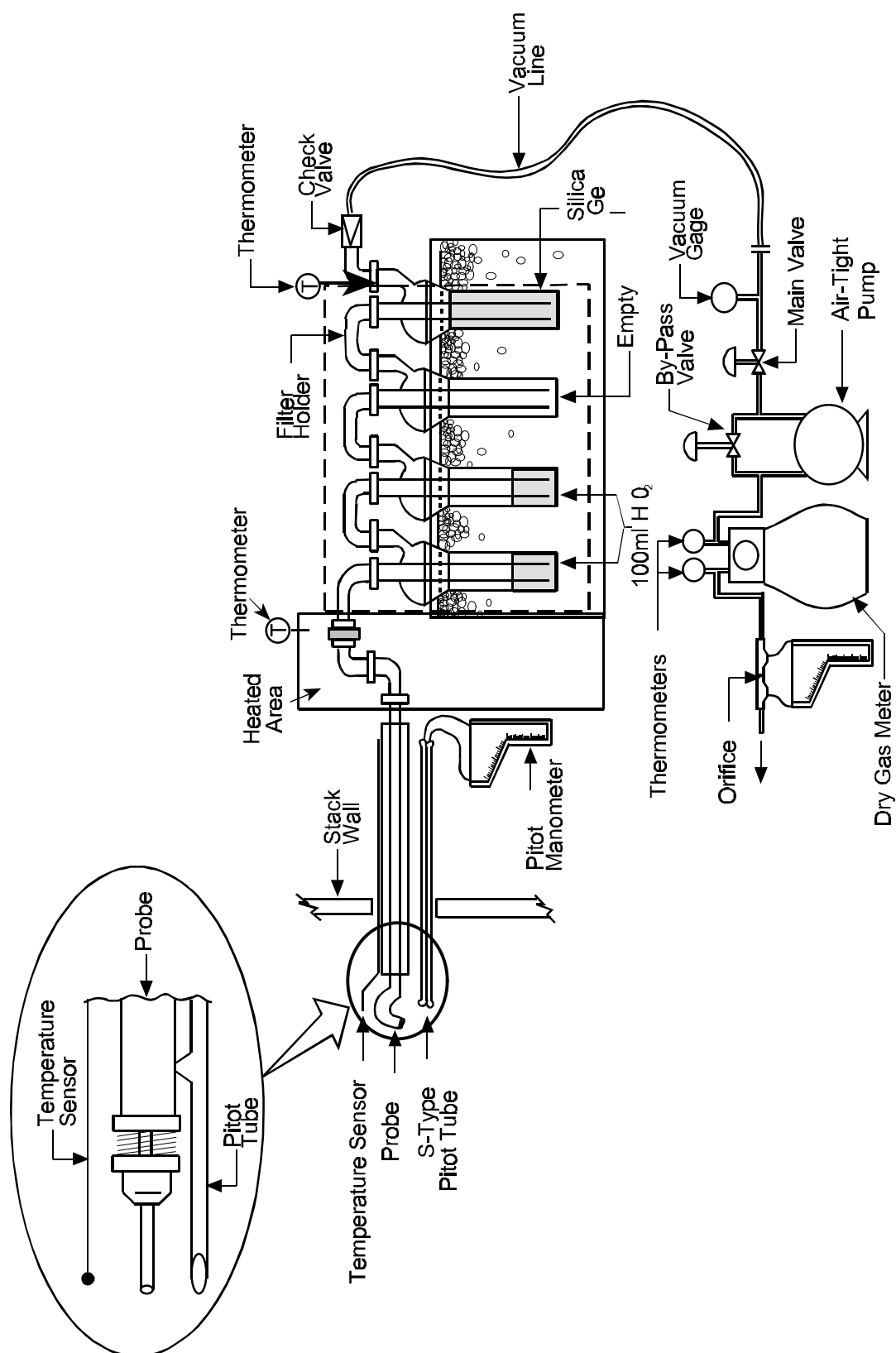


Figure 5-1. EPA Method 5 sampling train schematic.

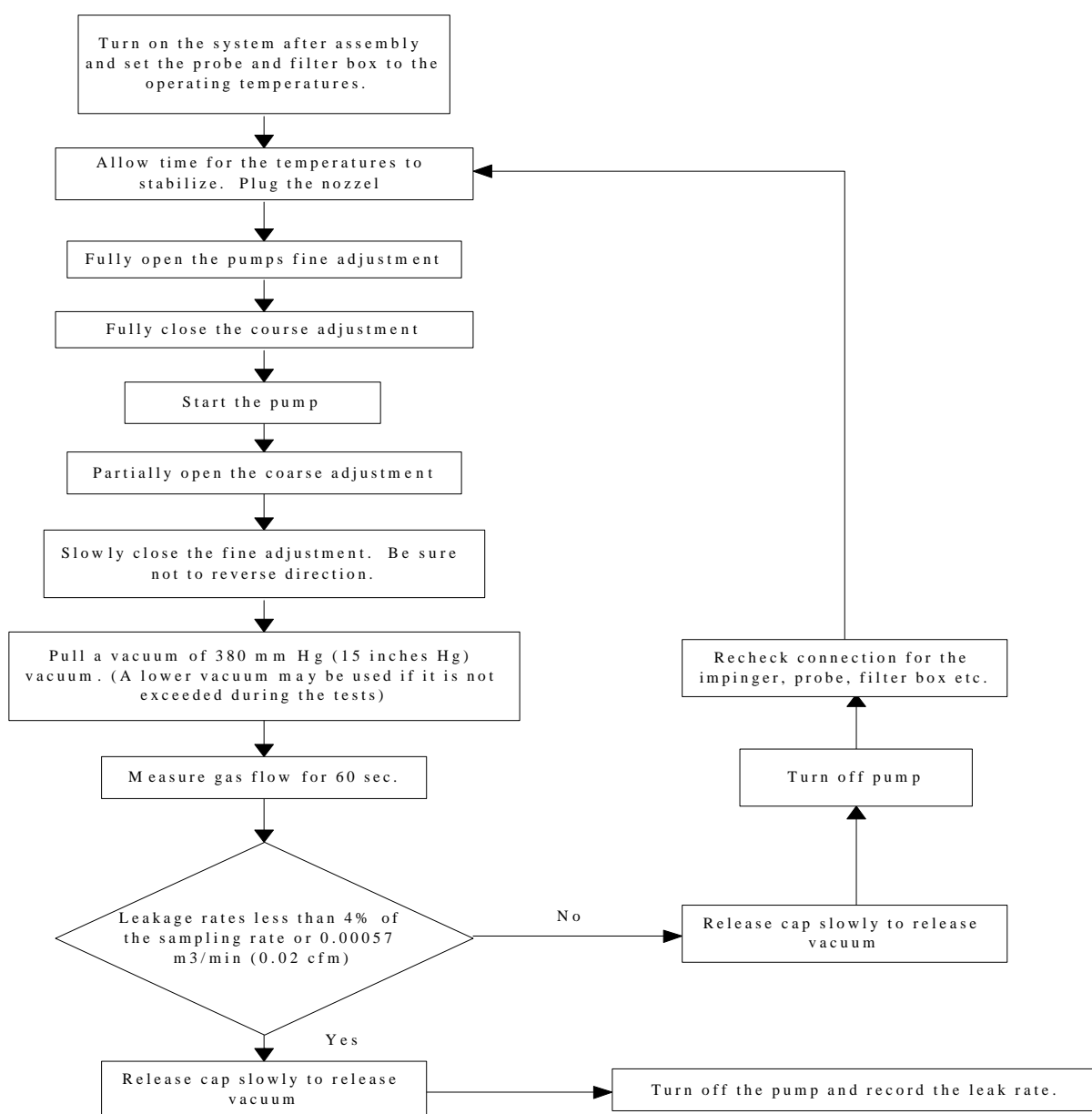


Figure 5-2. Leak check procedures for EPA Reference Method 5.

Recover the contents of the first three impingers into a glass sample container. Recover the silica gel from the fourth impinger into its original container.

Impingers 1-3 are emptied into a 1,000 ml graduated cylinder and the volume is recorded for determining the stack moisture concentrations. Alternatively each impinger can be weighed to the nearest 0.5g. Impinger 4 is weighed to nearest 0.5g to determine the moisture adsorbed by the silica gel. The two weight gain measurements combine to determine the moisture level of the stack gas.

Sample train fronthalf recovery is accomplished using a damp cloth or paper towel to remove any accumulated particulate from the exteriors of the nozzle and the probe. Then, remove the nozzle from the probe, taking care not to lose any particulate. If recovery cannot be immediately performed, cover the openings. Locate the recovery container marked "Fronthalf Rinse - Water." Hold the nozzle orifice within the open mouth of the container and, using a small brush and the wash bottle, rinse the nozzle with DI water three complete times or until particulate is no longer visible exiting the nozzle.

Remove the coverings from the sample probe. Locate the probe brush. Allow one technician to hold the base of the probe (the end previously attached to the filter) over the open mouth of the recovery container. Be sure to hold the probe liner in place so that it won't be dislodged by the action of the probe brush. Dispense DI water into the union at the end of the probe while collecting it in the container. Insert the probe brush into the union. Brush the full length of the probe three times, dispensing DI water each time and collecting the rinse in the container. Avoid breaking the glass liner. This procedure is repeated for the fronthalf of the sampling train using acetone, which is placed in a separate sample container for analysis. Figure 5-3 gives an outline of the recovery procedure.

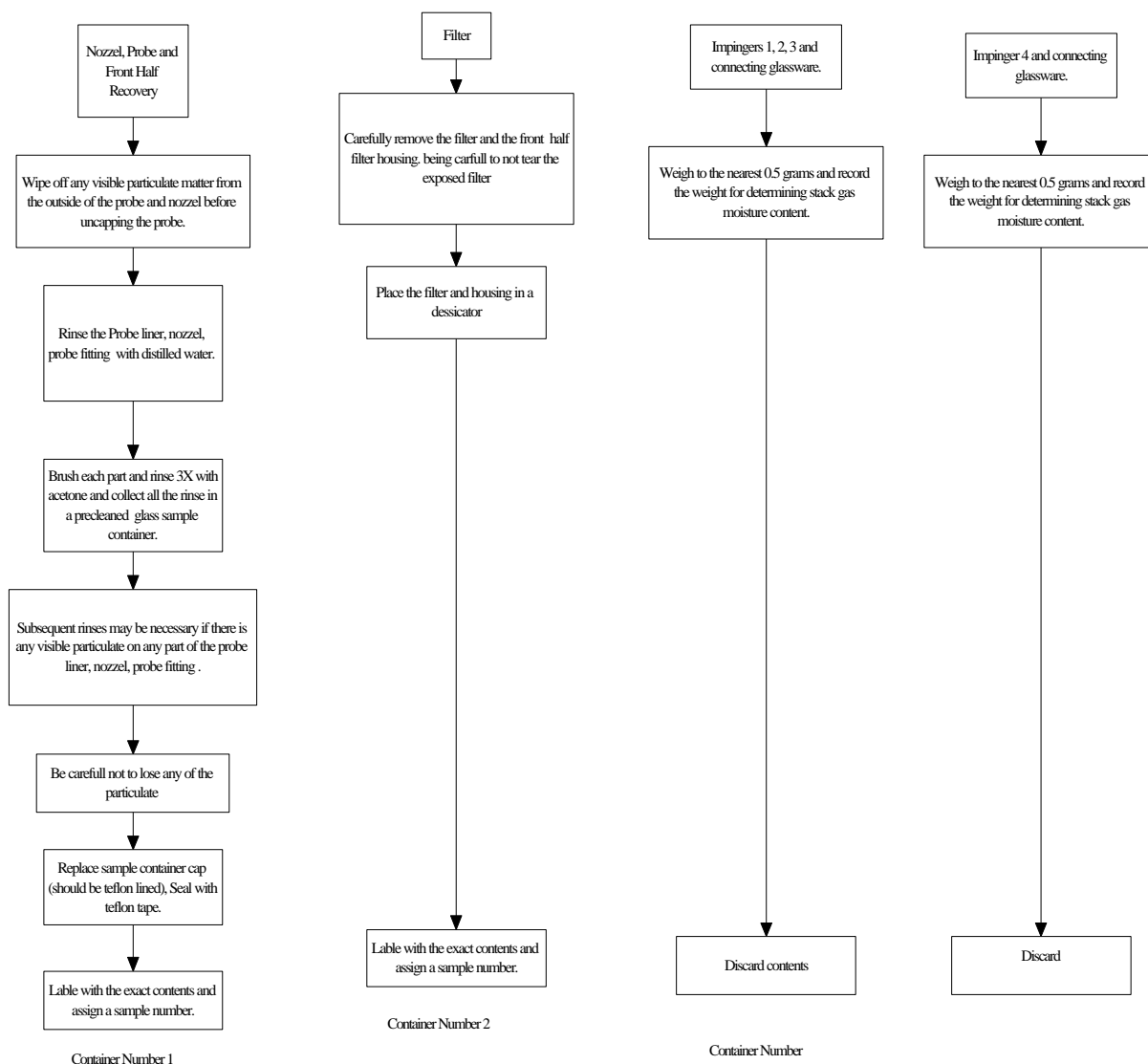


Figure5-3. Sample recovery Schematic for EPA Reference Method 5.

Analysis of the samples for particulate catch is accomplished using an a microbalance with a capability of 0.1 mg resolution. The filter and fronthalf are weighed after being desiccated for three hours. The acetone and water rinses are evaporated, desiccated and weighed separately. The samples must be evaporated at $20^{\circ} \pm 6^{\circ} \text{ C}$ ($68^{\circ} \pm 10^{\circ} \text{ F}$). The samples are weighed until three successive weighings are achieved that agree to $\pm 0.5 \text{ mg}$. Prior to analysis the balance will be calibrated using Class S weights that are traceable to a National Institute of Standards and Technology (NIST) standard.

5.3 Calibration Procedures

All equipment used in this source test program will be maintained and calibrated using approved procedures and EPA, American Standards Testing Material (ASTM), and/or National Institute of Standards and Technology (NIST) traceable reference equipment, where applicable. Calibrations will be routinely performed on all key equipment so that required pre-test calibrations are performed prior to equipment mobilization. During equipment preparation, the calibration records will be reviewed to ensure that specified calibrations are up-to-date. The applicable equipment will also be checked in the field to assure that handling and use has not affected the calibrations. Following the test program, the equipment will again be routinely calibrated in order to verify continuous calibration status throughout the on-site testing. If at any time during testing the operator has reason to believe a piece of equipment may no longer be in calibration due to unusual change in readings or possible damage, a recalibration will be performed to verify accuracy. Equipment which requires calibration includes meter boxes, thermocouples, nozzles, and pitot tubes. Reference calibration procedures will be followed when available, and the results properly documented and retained in a calibration log book.

A discussion of the techniques used to calibrate this equipment is presented below.

Type-S Pitot Tube Calibration

The EPA has specified guidelines concerning the construction and geometry of an acceptable Type-S pitot tube. If the specified design and construction guidelines are met, a pitot tube coefficient of 0.84 can be used. Information related to the design and construction of the Type-S pitot tube is presented in detail in Section 3.1.1 of EPA Document 700/4-77/027b. Only Type-S pitot tubes meeting the required EPA specifications will be used during this project. Pitot tubes will be inspected and documented as meeting EPA specifications prior to the field sampling.

Sampling Nozzle Calibration

EPA Method 5 prescribes the use of stainless steel buttonhook nozzles for isokinetic particulate sampling. However, for this study glass nozzles will be used. Calculation of the isokinetic sampling rate requires that the cross-sectional area of sampling nozzle be accurately and precisely known. All nozzles used for Methods 5 sampling will be thoroughly cleaned, visually inspected, and calibrated according to the procedure outlined in Section 3.4.2 of EPA Document 600/4-77-027b.

Temperature Measuring Device Calibration

Accurate temperature measurements are required during source sampling. Bimetallic stem thermometers and thermocouple temperature sensors will be calibrated using the procedure described in Section 3.4.2 of EPA Document 600/4-77-027b. Each temperature sensor will be calibrated at a minimum of three points over the anticipated range of use against an NIST-traceable mercury-in-glass thermometer. All sensors will be calibrated prior to field sampling.

Dry Gas Meter Calibration

Dry gas meters (DGMs) will be used in the Method 5 trains to monitor the sampling rate and to measure the sample volume. All dry gas meters will be calibrated (documented correction factor) just prior to the departure of the equipment to the field. A post-test calibration check will be performed as soon as possible after the equipment is returned to EER's shop. Pre- and post-test calibrations should agree to within 5%.

Dry gas meters will be calibrated using the calibration system. Prior to calibration, a positive pressure leak-check of the system will be performed using the procedure outlined in Sections 3.3.2 of

EPA Document 600/4-77-27b. The system is placed under approximately 10 inches of water pressure and a gauge oil manometer is used to determine if a pressure decrease can be detected over a one-minute period. If leaks are detected, they will be eliminated before actual calibrations are performed.

After the sampling console is assembled and leak-checked, the pump will be allowed to run for 15 minutes. This will allow the pump and dry gas meter to warm up. The valve is then adjusted to obtain the desired flow rate. For the pre-test calibrations, data are collected at orifice manometer settings (ΔH) of 0.5, 1.0, 1.5, 2.0, 3.0, and 4.0 inches of H_2O . Gas volumes of 5 ft^3 are used for the two lower orifice settings and volumes of 10 ft^3 for the higher settings. The individual gas meter correction factors (Y_i) are calculated for each orifice setting and averaged. The method requires that each of the individual correction factors must fall within 2% of the average correction factor or the meter must be cleaned, adjusted, and recalibrated. For the post-test calibration, the meter is calibrated three times at the average orifice setting and highest vacuum used during the actual test.

Analytical Balance Calibration

Analytical balances will be calibrated over the expected range of use with standard weights (NIST Class S). Measured values must agree within ± 0.1 mg, and 1.0 mg for moisture, respectively. The balances will be calibrated prior to the field measurement program.

Field checks of balance accuracy will be made daily using a set of quality control weights which have previously been weighed side-by-side with the NIST traceable weights.

5.4 On-Site Facilities and Communications

Sampling and analysis will be supported from the laboratory trailer to be located on-site at DuPont during the test program. These facilities will be located inside the plant boundary. The trailer has the following amenities:

- A fume hood for recovery and glassware cleaning;
- A separate room for office work; and
- Additional counter space and storage facilities.

Personnel traffic through the recovery areas will be restricted to only those persons directly involved with recovery activities. This will generally include two persons plus a quality assurance observer (from either the internal or external QA team). Smoking will be prohibited inside the trailer or in the immediately surrounding areas. Signs will be posted to this effect.

Off-Site Communications: Communications between the sampling and analysis team will be facilitated by telephone. A telephone line will be installed in the trailer once on site. The phone number will be: TBA

On-Site Communications: Communications among the EER Field Manager, On-Site QA Coordinator, and Team Leaders will be facilitated by wireless FM two-way radios. These will ensure that the personnel assigned to each station can be in immediate contact with the EER Field Manager or with each other if problems arise.

5.5 Summary of Plant Requirements

Electrical Power: A total of six 110V-15 Amp circuits need to be supplied to the inlet and outlet flue gas locations. EER will require lighting at the sampling ports for any night testing.

Sampling Ports: Unobstructed sampling ports and sampling locations must meet at least the minimum requirements for sampling locations as stated in 40 CFR, Part 60, Appendix A, EPA Reference Method 1. Sample ports should be at least three inches in diameter, with caps and eyebolts installed approximately three feet above each port on the stack.

Platforms and Access: Safe working conditions for EER personnel are required in accordance with OSHA General Industry and Construction Standards. This includes, but is not limited to:

- Secured ladders, stairways, and/or other approved means to gain access to working platforms;
- Approved rigid working platforms capable of supporting twice the intended loading of 800 lbs. Working platforms, rooftops, and access routes will be cleared of foreign

debris (ice, snow, dust, etc.) that can cause unsafe conditions. Platforms must be long enough to hold equipment and test personnel;

- Fall protection devices (i.e., guard rails, cages for ladders, safety harnesses, etc.); and
- Safety information on hazardous substances and/or conditions that exist in the working area. EER reserves the right to postpone testing when conditions differ significantly from any information given prior to testing to obtain the appropriate safety equipment.

Other Plant Requirements: Additional plant requirements are listed below:

- Prompt clearance for EER personnel and vehicles through plant security for ingress and egress;
- Consistent process operation for the duration of each test; and
- Work area environment is not hazardous to EER employees' health due to excessive heat and/or fumes from various processes. Excessive heat may require additional on-site staff to meet OSHA and General Safety Standards for safe working conditions; hazardous fumes may require special safety equipment, slowing work performance and increasing project costs.

5.6 Sample Tracking, Shipping, Storage, and Custody Procedures

The execution of this program includes the acquisition and compilation of field data and the physical collection, handling, storage, shipping, and analysis of various types of field samples. Both acquired data and physical samples require rigorous documentation and safeguarding to maintain data and sample integrity and to ensure against loss of valuable test results. Field data, such as computer files, operator logs, and data sheets, must be filled out and checked for completeness, and then copied and stored or maintained in systematic fashion. In addition, physical samples must be promptly labeled and tracked. Physical samples must be handled, stored, and/or shipped using methods and observing procedure, according to the specific methodologies. These steps are critical for samples since the number of physical samples is large and many of the samples must be shipped or change hands between operations in order to conduct sample analysis.

The Field Manager is responsible for proper data and sample logging and custody. Run sheets, data sheets, files, and sample tracking forms will be completed by each of the respective team members responsible for data acquisition, equipment operation, sample recovery, and manual data logging. The Test Team Leader, or an alternate, will check off the completion of logging, documentation, and storage tasks lists on a daily basis. The sample recovery specialist, or an alternate, will be responsible for signing sample custody forms and shipping samples.

5.6.1 *Sample Tracking*

The team member(s) responsible for sample acquisition will maintain a detailed log of testing activities, including the details of sample acquisition. Field and laboratory data sheets will be completed in ink, dated and signed by the operator, and then checked later by the Team Leader or designate. At a minimum, the log will itemize the following for each sample:

1. Sample identification number;
2. Location and time of sample collection;
3. Test conditions and all other factors defining the test conditions;
4. Sampling method and procedures and reference; and
5. Method of processing or preserving of samples collected in the field.

The responsible team member will also prepare the following documents:

- Sample Label: The sample label is to be completely filled out and attached to each sample promptly upon collection by the team member who took the sample. This label has a pre-printed number for the sample, and it is the unique identification number for that sample.
- Sample Tracking and Custody Report: The responsible team member will maintain an up-to-date Sample Tracking and Custody Report. This document includes a brief description of each sample and lists where each sample was sent or stored. It specifies the analytical procedures to be conducted by the laboratory. Separate field tracking report pages will be maintained for the organics, particulate and condensable particulate trains. This form is a special "cradle-to-grave" document which accompanies all samples, tared containers and filters, sample trains, and other specialized sample

collection apparatus. The chain of custody form, a critical component of EER's QC procedures, is essential in satisfying the legal "rules of evidence" in the event of legal challenge and satisfies the requirements specified in EPA/600/4-77/027a2.0.6 and EPA/600/4-77/077b3.0.3.

5.6.2 *Sample Shipping*

Samples will be shipped at the completion of the test program using Fed Ex next-day services to the laboratory performing the analysis. Fed Ex has a special next-day handling service for hazardous goods, which includes flammable and/or toxic materials. Until they are packaged and shipped, organic samples will be kept under refrigeration at the respective test sites.

The same attentive care must be applied in shipping samples as in the sample collection and recovery. Experience has shown that samples are damaged most often during shipping under two conditions:

1. Sample containers are packed too tightly and bang together during transit.
2. Samples are too loosely packed and are free to move when package is jostled.

Therefore, care will be taken to ensure that all samples are tightly packed so that they will not bang against other containers. Shipping boxes will be filled completely with packing peanuts, taking care not to leave any spaces for contents to settle. The boxes will be properly labeled and marked with "fragile" and "this side up" stickers. Each shipment will be insured. Lab tracking sheets and other pertinent sheets, such as weigh sheets, will be included in each box. Copies will be retained by the responsible team member.

The sample labels will be double-checked for accuracy and completeness against custody and tracking sheets. Any labels that appear to be peeling will be taped down. Each glass container will be placed inside a zipped bag, completely enclosed with bubble wrap, and taped tightly. All parts of the container will be covered. The wrapped container will be labeled with the sample number inside a zipped bag (labeled with sample number) and then placed upright in the shipping box and completely surrounded by styrofoam peanuts. Petri dishes, resin modules, and liquid samples will be shipped in separate containers.

Petri dishes will be tightly sealed with Teflon tape such that top and bottom plates will not separate and then sealed in zipped bags. A set of dishes will then be stacked with cardboard in between each. The entire stack will then be completely enclosed with bubble wrap and taped tightly. The stack should be compressed so there will be no separation between petri dishes and cardboard inserts if package is jostled. The entire assembly will be placed upright (filters facing up) in a shipping container completely surrounded by styrofoam packing peanuts. As many as 25 petri dishes may be shipped. These can be stacked five to ten high in several stacks and be enclosed in a 1-2 cubic foot box.

Sample bottles of 500 ml and 1 liter sizes. Liquid and ash samples will be contained in these bottles. Levels will be marked on the outside of these containers. Lids will be closed tightly and sealed with Teflon tape. Bottles will be shipped with cardboard, paper, or foam rubber dividers. In a week there may be 500 or more sample bottles. Around 10-15 sample bottles can be shipped in a two cubic foot box.

5.6.3 *Sample Storage*

Samples should be handled and shipped in order for sample analysis to be performed within specified time limits. Samples which require a shorter holding time prior to analysis are to be shipped/couriered more frequently. For Method 5, there is no real hold-time, however, the initial analysis will be performed on site.

All reagent chemicals, filters, and materials which will become parts of samples will be properly stored in compliance with safety regulations. Prepared solutions will be labeled with identification lot number, the concentration of the solution, date of preparation (and the expiration date if appropriate, etc.), and name of technician who prepared the stock solution. Blank samples will be labeled with sample identification numbers and tracked just like a regular sample.

5.6.4 *Sample Custody*

The execution of source test programs includes the collection of field data and the collection, handling, storage, shipping, and analysis of physical samples. Both field data and physical samples require proper documentation and safeguarding to maintain data and sample integrity and to ensure against loss of valuable test results. Field data such as computer files, operator logs, and data sheets

will be filled out, checked for completeness, and copied and stored or maintained in systematic fashion. Physical samples will be promptly labeled and tracked. They will be handled, stored, and/or shipped using methods and observing procedures specified by the applicable sample collection and analysis methodologies.

The Field Manager will be responsible for proper logging and custody of samples and field data. Run sheets, data sheets, files, and sample tracking forms will be completed by each assigned team member. Upon receipt of samples, the laboratory will observe procedures consistent with previous handling of the samples.

6.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data gathered during this program falls into the following categories:

1. Manual methods sampling operations data and sample analysis data; and
2. Process data.

Manual methods operations data will be input onto computer spreadsheets each day following receipt from testing. Results of samples analysis will be input onto the computer system upon receipt from analytical labs. Process data will consist of logs and continuously monitored data. Data will be reduced and analyzed using hand-held calculator programs, computer spreadsheets, and other computer programs. The actual equations and nomenclature are shown on the calculator program data sheets and on the spreadsheets. This feature enables operator and analyst familiarity with the programmed computations, gives facilities separate spot-checking of computed results by hand, and eliminates the need to show equations separately in the text.

6.1 Manual Methods Data Reduction

Standardized run data forms will be used for each method. All run sheets are to be reviewed daily by the Field Manager for evaluation of progress, completeness, and problems. Standardized computer spreadsheets will be used to reduce and analyze field data. At the end of each test day, test data will be input onto these spreadsheets. Lab analytical results will not be available at the end of each test day. However, results will be input as they become available. A standard data set, which has been verified by hand, will be used to demonstrate the accuracy of the spreadsheet calculations before and after the test program at each site.

For each manual method, the field data will be reduced manually at the end of each test. An isokinetic ratio will then be estimated at the end of each day using an average or typical moisture value. The estimated moisture value, estimated isokinetic ratio, and all intermediate calculations will be noted on the run sheet. Upon entry into the computer spreadsheet program, both the data and the program will be validated by checking the estimated isokinetic ratio against the manually determined

value. Verification of the spreadsheet program will be conducted using a standard data set which has been manually calculated.

Spreadsheet calculations for the various runs will observe the following guidelines:

1. Isokinetic calculations for each train will be conducted using the input run data from that specific run rather than from the average or other values from previous runs. Stack gas moisture content will be determined using the condensed water measured in that train;
2. Stack temperature, moisture content, velocity, and flow rate values for each of the inlet and outlet locations will be average values from all of the combined applicable runs for that test condition. The exception to this rule would be the exclusion of any data from a single run which may deviate more than 20% from the average of the data from the other runs. This exception may occur if one particular sample port location is unavoidably in a location which does not meet EPA Method 1 criteria and has less than ideal flow conditions. In addition, this exception may occur if there is questionable data for a specific run due to operator error, process failure, equipment failure, or other circumstances;
3. In the case of questionable data due to operator error, the average results of the other runs will be used to correct the results of this run where applicable. For example, if the velocity readings for a specific run are thought to be erroneous due to moisture condensation in the pitot lines, the average velocity measurements from the other simultaneous runs at that location will be used to determine isokinetic rate for that run; and
4. There may be other cases of questionable data, such as measured moisture content, which exceeds the saturation value under the existing stack pressure and temperature conditions. These values will be corrected for actual stack pressure using the equation below:

$$C_{H_2O, P_s} = \left(\frac{C_{H_2O, 29.92}}{29.92} \right) * P_s$$

where: $C_{H_2O,Ps}$ = Moisture content at stack pressure
 $C_{H_2O,29.92}$ = Moisture content measured
 Ps = Stack static pressure

The accepted range for the isokinetic rate is 90 to 110%. A sample rate below the isokinetic rate can result in a greater proportionate capture of large particles relative to gas volume collected. Some of the large particles, due to their momentum, may enter the nozzle even though gas streamlines curve around the nozzle. On the other hand, a sample rate above the isokinetic rate may result in a smaller proportionate capture of large particles relative to the gas collected. Both the particulate concentration and mass emission rate may be erroneously high in the case of a low sampling rate, or low in the case of a high sampling rate.

If sampling occurs outside the 90-110% isokinetic sampling range, the concentration and mass emission rate will be corrected according to the sampling rate. From Shigehara, the culate concentration C_t may be biased proportionally to the degree of sampling rate deviation from the isokinetic rate. Since the mass emission rate (m_s) is calculated from C_t (using the concentration method), then m_s is equally biased. The actual values for C_t and m_s would be between the measured values and the adjusted values as follows:

$$C_{t,adj} = C_{t,meas} * \frac{I}{100}$$

$$C_t = \frac{C_{t,meas} + C_{t,adj}}{2}$$

$$m_{s,adj} = m_{s,meas} * \frac{I}{100}$$

When the sampling rate is outside the 90-110% range, then the actual C_t and m_s for that run will be approximated by taking the average of the measured values and the adjusted values:

$$m_s = \frac{m_{s,meas} + m_{s,adj}}{2}$$

Upon daily completion of testing, the Field Manager will be responsible for preparation of a data summary which will include:

- Raw data sheets;
- Calculation of isokinetic ratio for each run;

- Traverse start and stop times for each run;
- Calculation of sample volume for each run;
- Calculation of stack gas flow rate; and
- Problems encountered during sampling and/or deviations from standard procedure.

The daily data summary will be submitted to the QA Coordinator. The final project report will include a separate QA/QC section which summarizes any audit results from manual sampling procedures, as well as QC data collected throughout the duration of the program. The EER QA/QC Officer will review the manual methods QC data and provide data quality input for the final report.

6.2 Process Data Reduction

Critical process data will be collected using existing plant instrumentation, supplemented whenever necessary with manual tabulation of process parameters. The need to manually record operating data will be assessed early in the program, and a standard reporting format will be developed by the Field Manager. Process data reduction consists of developing average, minimum, maximum, and standard deviation values for each process parameter. These will be developed for start-up (pre-test), test run, and post-test stages of operation. Summary tables will be prepared showing:

- Average values of each process parameter for the average of three test runs;
- Average and maximum deviation from target operating conditions during each run;
- Flagging of suspect data; and
- Average, maximum, and minimum value for each process parameter and for each stage of operation.

6.3 Data Validation

Data validation is a systematic procedure of reviewing data against a set of established criteria to provide a level of assurance of its validity prior to intended use. Data will be validated internally by QC personnel. All measurement data will be validated based upon process conditions during sampling or testing, acceptable sample collection/testing procedures as outlined in Section 5, consistency with expected and/or other results, adherence to prescribed QC procedures, and the specific acceptance criteria. The data will be coded as valid or invalid based on its adherence to these criteria. Data validation will be conducted at several critical stages of data reduction:

- Field checks of raw and reduced field data by the Field Manager and Crew Leaders;
- Analytical laboratory QC Checks by a lab QA Supervisor;
- Spot checks of reduced raw data by the Project QA Coordinator;
- Review of summary tables for consistency with reduced raw data by the Project QA Coordinator;
- Draft final report review by the QA Manager, Program Manager, Principal Investigator and Project Manager; and
- Final report review by the Program Manager, Principal Investigator, and Project Manager.

Data validation consists of verification of calculation methodology, consistency of raw, reduced and summarized data tables, comparison of expected results, and consistency of results among multiple measurements at the same location.

Field data will be initially validated by the EER Field Manager and the internal QC Coordinator based on their judgement of the representativeness of the sample, maintenance and cleanliness of sampling equipment, and the adherence to the sample collection procedures defined in Section 5. They will also validate the data on a daily basis based on :

- Process conditions during sampling;
- Adherence to acceptance criteria; and
- Acceptable external performance evaluation and technical system audit results conducted by the external audit team.

When the data set is complete, the EER field QA Officer and the external QA/QC team will perform an overall review of the data. This review will consider:

- The previously listed criteria; and
- The reasonableness and consistency of the data based on a knowledge of the site characteristics and the specific location of the samples.

The review will also contain an evaluation of the data in terms of meeting the quality assurance objectives of the program discussed in Section 7 of this plan. The QC criteria for data validation

contains consistency, duplicate sample calibration, tests for outliers, transmittal error, and uncertainty analysis.

Outliers will be identified by comparison with other measurements in a set of observations using the standard student T-Test procedures for outliers. This test will flag specific data points as potential outliers; however, it will not automatically disqualify any data. Corrective action will be initiated immediately to determine the outlier cause. If possible, the associated sample will be reanalyzed. The acceptance rejection of the data will be in a uniform and consistent manner based on the established validation criteria. Data will be rejected only if a validated and documentable reason is identified.

Validation of spreadsheet calculations used for data reduction will be conducted by entering a QA data set which has been verified by hand. This will be done at the beginning and end of the test program.

Data flags will be added to all tables to identify special handling procedures or unusual data results. These flags will include:

- Quantities including analytical results which are at or below method minimum detection limits;
- Any results where contamination is suspected;
- Any average results which exclude any individual test run results;
- Any test data which was corrected for moisture content or isokinetic sampling rate;
- Any CEM data where drift exceeded acceptance criteria;
- Calculation of polychlorinated dibenzo-p-dioxins/polychlorinated dibenzo furans (PCDD/PCDF) results using confirmation analysis; and
- Other special data handling procedures or qualifications.

6.4 Reporting

Upon completion of testing, the Field Manager will be responsible for preparation of a complete data summary, including calculation of results and raw data sheets. The Field Manager will be assisted in this effort by other field team members. In addition, the Field Manager will be responsible for providing the QA/QC Coordinator with a summary of all QC data collected and

preparation of an overall data summary. The QA/QC Coordinator will review and tabulate the QC data and provide input for the final report. The data summary will include:

- Raw data sheets;
- Summary of the actual operating conditions compared to target operating conditions;
- Calculation of isokinetic ratio for each run;
- Traverse start and stop point;
- Calculation of sample volume for each point;
- Calculation of stack gas flow rate;
- Summary of process samples collected; and
- Problems and delays encountered during sampling, including any deviations from standard procedures.

The daily summary will be compiled into a site document by the EER Field Manager. All information in the Daily Test Summary will be marked "Preliminary, Do Not Quote or Cite." The final project data summary will include a separate QA/QC section which will summarize any audit results from manual sampling procedures and QA/QC procedures collected throughout the duration of the program.

Weekly progress summaries of the testing will be prepared by the EER Field Manager at the completion of each calendar week on site. All information in the weekly test summary will be marked "Preliminary, Do Not Quote or Cite." This report will supplement the daily summaries by including a preliminary analysis of the quality of each triplicate data set. In particular, any QA/QC concerns that may disqualify any of the data will be identified, as well as any corrective actions taken. The weekly report will also present a brief summary of the remaining test schedule and testing status.

Final Report

The results of the test program will be evaluated for completeness and representativeness and will include all collected data. A report will be submitted to the EPA Project Officer within 60 days after completion of sampling. Data and result interpretations will be presented, as necessary, in the report. The final report, at a minimum, will contain the following sections:

SECTION 1.0, INTRODUCTION

- Overall goals of the test;
- Specific objectives of the test;
- Names and locations of all businesses, contractors, and agencies;
- Inclusive dates and duration of the test period;
- Overview of process, sampling locations, types of samples, pollutants, or characteristics measured;
- Modifications, work conditions, sampling conditions, sampling results, or process changes resulting in major sampling program changes; and
- Brief outline of contents of the rest of report.

SECTION 2.0, SUMMARY AND DISCUSSION OF RESULTS

2.1 Summary

- Tabular summary of process operating data during sampling periods;
- Tabular summary of averaged data for all locations including test methods;
- Tabular summary of data for each location including data from each run, average data form;
- All tests, notes regarding validity of data, process production rate (test conditions), emission; and
- Rates, emission factors.

2.2 Discussion

- Difficulties in sampling or analysis;
- Factors which may affect results e.g. weather, ambient conditions, condition of sampling or analytical equipment and possible connection to test results;
- Unusual occurrences and possible connection to results;
- Unusual process conditions and estimated relation to test (process upsets, variations between tests, etc.); and
- Rationalization of discrepancies(e.g. variations between runs, possible causes, etc.) to identify possible weaknesses in the test program.

SECTION 3, PROCESS DESCRIPTION AND OPERATION

3.1 Process Description

- Process flow diagram and description (continuous vs. batch fuels, feed materials, production rates, etc.);
- Unusual or unique aspects of the system or equipment, and possible effect on sampling program;
- References on standard process equipment; and
- Sizes and capacities of individual pieces of equipment.

3.2 Process Operation

- Normal plant operating schedule (not actual during sampling);
- Overall design capacity and average operating rates (product, byproduct, fuels, raw materials);
- Possible peak operating capacity;
- Scheduled maintenance shutdowns; and
- Average yearly on-stream times.

SECTION 4, SAMPLING LOCATIONS

- Table of sample locations, numbering scheme, physical dimensions, etc.
- Discussion of each location (e.g., location relative to overall system, modifications for test program, geometry, dimensions, exact size, type, and location of sampling ports);
- Orthogonal sketch with sufficient views to show adjacent equipment and the exact location of ports;
- Cross-sectional sketch of location illustrating location of traverse points, probe locations, or other significant locations or restrictions; and
- Additional sketches and descriptions as needed.

SECTION 5, SAMPLING AND ANALYTICAL PROCEDURES

5.1 Sampling Procedures

- Tabular summary of methods for each location with description referencing standard published methods and/or appendix of new methods;
- Conditions encountered during test beyond normal operating parameters of standard methods;
- Adverse sampling conditions (weather, ambient conditions, etc.);
- Abnormal sampling conditions (e.g. widely fluctuating flows, temperatures, pressures, etc.);
- Unusual operation on sampling equipment and possible causes;
- Detailed description of deviations from standard or listed methods and reasons for the deviation (deliberate or otherwise); and
- Documentation of which exact samples were subject to any of the above.

5.2 Analytical Procedures

- Tabular summary of methods for each location with description referencing standard published methods and/or appendix of new methods;
- Detailed description of deviations from standard or listed methods and reasons for deviation (deliberate or otherwise);
- Adverse conditions encountered during analysis;
- Location of the analysis;
- Condition of all samples upon arrival to the analyst;
- Comments on unexpected or widely deviating results; and
- Document which exact samples were subject to any of the above.

SECTION 6, INTERNAL QUALITY ASSURANCE AND QUALITY CONTROL RESULTS

- Summary of items in the QA plan which were completed during the field sampling and analysis;
- Any changes to the procedures in the QA Plan and discussion of reasons;
- Results of audits, blind or spiked samples, calibrations; and
- Any problems with quality control results (impact on data in Section 2).

APPENDICES

- A - Emissions Testing Data Sheets
- B - Process Data Sheets
- C - Sample Parameter Calculations
- D - Analytical Data
- E - Calibration Data
- F - Example Equations and Calculations
- G - Project Participants
- H - Sampling and Analytical Protocols
- I - Field Sampling Log
- J - Chain-Of-Custody Records
- K - Additional Information

7.0 INTERNAL QUALITY CONTROL CHECKS

The quality assurance (QA) objectives provide a standard of quality for the various measurements to be made in this program. These objectives include criteria for precision, accuracy, and completeness. In order to quantify how well the measurements have satisfied these objectives, comprehensive internal QA/QC activities will be implemented. The efforts of the internal QA coordinator are designed to assure that the specific goals for precision, accuracy, and completeness are achieved. The specific system of internal quality control (QC) procedures to establish the performance of the measurement systems is presented in this section. This system of internal checks is an integral part of the emissions characterization program.

For each key measurement area, there are specific QC activities and checks, which ensure that written procedures are followed during all preparation, validation, sampling, and recovery activities. There are also criteria used to quantify and judge the performance of the measurements and corrective action procedures for correcting deficiencies.

Quality control is the overall system of activities whose purpose is to provide a quality product or service: for example, the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process. Quality assurance, on the other hand, is a system of activities whose purpose is to provide assurance that the QC system is adequate to ensure that the program goals will be achieved and that it is being implemented effectively. The program quality control system includes these features:

- Calibration procedures and schedules;
- Specific checklists and procedures for pre-test, test operation, and post-test activities for each measurement system;
- Standard pre-programmed calculation routines using hand-held calculators and computer spreadsheets;
- Blanks, spikes, duplicates, QC audit samples, and other analytical quality control procedures for each measurement system; and

- Organization and documentation of all calibration records, run sheets, data sheets, process logs, calculation sheets and spreadsheet files and printouts.

In order to ensure that the above QC activities are effectively implemented, QA audits will also be conducted. The following sub-sections discuss QC activities to ensure data validity.

Quality control samples are used to determine QA objectives and to provide data which supports the generated data. Quality control samples include field blanks, matrix spikes, matrix spike duplicates, and laboratory control spikes.

7.1 Quality Control Procedures

This program will involve sampling and analysis of a number of different process streams. These streams will include air pollution control device (APCD) inlet and APCD outlet flue gas, APCD collected transport stream. This section describes the QA/QC activities and criteria to be accomplished during the sampling, as well as the analytical phases of this test program.

7.1.1 *QC for Flue Gas Sampling and Analysis*

The following section discusses the QA/QC activities that will be utilized for this program's flue gas sampling and analytical procedure.

EPA Method 1, 2, and 4 - Sample point determination, flue gas velocity, and moisture content

Sampling: The S-type pitot tube will be visually inspected before sampling. Both legs of the pitot tube are to be leak checked before and after sampling. Proper orientation of the S-type pitot tube will be maintained while making measurements. The roll and pitch axis of the S-type pitot tube is maintained at 90° to the flow. The oil manometer will be leveled and zeroed before each run. The pitot tube/manometer umbilical lines will be inspected before and after sampling for moisture condensate (lines will be cleared if found). Cyclonic or turbulent flow checks are to be performed prior to testing the source. An average velocity pressure reading will be recorded at each point instead of recording extreme high or low values. Reported duct dimensions will be checked by measurements to determine cross-sectional duct area. If a negative gas static

pressure is present, checks will be made for air in leakage at ports resulting in possible flow and temperature errors (leaks are sealed if found). The stack gas temperature measuring system will be checked by observing ambient temperatures prior to placement in the stack. Duplicate readings of temperature and differential pressure taken at each traverse point must agree to within $\pm 1.6\%$ and $\pm 6\%$, respectively, to be considered acceptable. The balance zero is checked, and rezeroed if necessary, before each weighing. Pre-test liquid volumes of impinger solutions are recorded as a check on tare weights. The balance is leveled and placed in a clean, motionless environment for weighing. The indicating silica gel is fresh for each run and periodically inspected and replaced during runs if necessary. The silica gel impinger gas temperature is maintained below 68°F . The dry gas meter is fully calibrated every six months using an EPA-approved intermediate standard. Pre-test, port change, and post-test leak checks are completed (must be less than 0.02 cfm or 4% of the average sample rate). The gas meter is read to the thousandth of a cubic foot for the initial and final readings. The meter thermocouples are compared with ambient prior to the test run as a check on operation. Readings of the dry gas meter, meter orifice pressure (ΔH) and meter temperatures are taken at every sampling point.

Accurate barometric pressures are recorded at least once a day. Post-test dry gas meter checks are completed to verify the accuracy of the meter full calibration constant (Y).

Analysis: Prior to daily use, the balance will be calibrated with NIST-traceable weights. The impinger will be weighted to the nearest 0.5 g.

EPA Draft Method 5

Sampling: All sampling equipment will be thoroughly checked to ensure clean and operable components. The oil manometer or Magnehelic gauge used to measure pressure across the S-type pitot tube will be leveled and zeroed. The pitot tubes and connecting tubing are to be leak checked. The temperature measurement system will be visually checked for damage and operability by measuring the ambient temperature prior to each traverse. All train components will be sealed with Teflon tape before train is leaked checked. Vacuum grease will not be used on any part of the train. The

permanganate solution will be kept on ice until sampling commences and will be used within 24 hours of preparation.

During Test: Duplicate readings of temperature and differential pressure will be taken at each traverse point. Isokineticity will be maintained at each traverse point. The sample train is to be leak-checked between port changes.

The probe and filter temperature will be maintained at $248 (\pm 25)^\circ\text{F}$. The impinger out will be maintained at $< 68^\circ\text{F}$. Any unusual occurrences will be noted during each run on the appropriate data form.

Post-test: The Field Team Leader will review sampling data sheets daily during testing; record final gas meter readings; perform a final leak-check at the highest observed vacuum; ensure that the Field Task Manager has the data sheets; and transport samples to recovery area. The recovery train uses specified procedures, and all equipment used for recovery will be cleaned accordingly.

Analysis: Method 5 QC samples collected in the field will include a field train blank and field reagent blanks. Sample results will be corrected for field reagent blanks only as described in Method 5. The field train blank results will be reported with the sample results.

Analysis of particulate in Method 5 samples will be conducted by a microbalance with resolution of ± 0.1 mg. The balance will be calibrated prior to analysis using NIST-traceable Class S weights. The calibration will be checked using one of the Class S weights every 10 sample weighings. Table 7-1 lists the QA/QC criteria for the stack gas sampling procedure.

7.1.2 *Quality Control for Process Samples*

The process sampling will include a check on the following procedures:

- Cleaning of the sampling equipment;

TABLE 7-1. SUMMARY OF QA/QC FOR STACK GAS SAMPLES

STACK GAS PARAMETER	QUALITY PARAMETER	METHOD OF DETERMINATION	FREQUENCY	CRITERIA
Gas Flow	Pitot tube angle & dimensions	Measurements with vernier micrometer and angle indicator	Post-test	Specifications in EPA Method 2
	Barometer	Calibrated against lab Hg-in-glass barometer	Pre-test	Within 0.1 in. Hg
	Stack thermocouple	Calibrated against ASTM Hg-in-glass thermometer	Pre- and post-test	Within 1.5% as deg. R
Isokinetic sampling trains	Dry gas meter	Calibrated against a reference test meter	Pre- and post-test	Y within 0.05 of pre- test Y; delta H@ within 0.15 of pre-test
	Probe nozzle	Measurements with vernier micrometer to 0.001 in.	Post-test	Maximum difference in any two dimensions within 0.004 inches
	Dry gas meter thermocouples	Calibrated against ASTM Hg-in-glass thermometer	Post-test	Within 5°F
	Trip balance	Calibrated against 10 LM weights	Post-test	Within 0.5 g
Particulate matter	Electronic balance	Calibrated against Class S weights	Post-test	Within 1.0 mg
	Constant filter weight	Documentation	Each sample	Difference of no more than 0.5 or 1 % of total weight
	Accuracy	Documentation of train component and analytical calibrations	N/A	N/A
	Precision	Not possible to assess	N/A	N/A
	Blanks	One filter and reagent blank carried through sample prep & analysis	One per test	Reagent blank less than 0.01 mg/g; filter less than 5 mg or 2% of sample weight

Figure 16

- Sample collection procedures;
- Techniques for sample mixing and aliquotting; and
- Recording observations on pre-formatted data sheets.

Process samples will be collected for the fuel and waste input streams, as well as the APCD collected ash. The same QA/QC criteria for the flue gas samples will be applicable to these samples.

7.2 Preventative Maintenance

The primary objective of a comprehensive preventive maintenance program is to help ensure the timely and effective completion of a measurement effort. EER's preventive maintenance program is designed to minimize the downtime of crucial sampling and/or analytical equipment due to component failure. Details of the preventive maintenance efforts for this project are discussed below.

Prior to this field program, all sampling and analytical systems will be assembled and checked for proper operation. At this time, any worn or inoperative components will be identified and replaced.

The maintenance activities described above and an adequate inventory of spare parts will be required to minimize equipment downtime. This inventory will emphasize those parts (and supplies) which:

- are subject to frequent failure;
- have limited useful lifetimes; or
- cannot be obtained in a timely manner should failure occur.

Also, the Field Task Manager will be responsible for maintaining a contact at the EER office to support unforeseen requirements and to expedite shipment of materials to the field site. Major replacement items, such as meter boxes and probes, will be kept ready at the sampling location.

8.0 SAFETY RESPONSIBILITIES AND AUTHORITY

EER's Vice President of Performance Evaluations has the overall responsibility for ensuring compliance with plant entry, health, and safety requirements. The Plant Manager has the authority to impose or waive facility restrictions. The Project Director has the authority to negotiate with the Plant Manager and determine any deviations from the facility restrictions. The Field Team Manager is responsible for the entire team's compliance with all plant safety regulations and entry guidelines. Each member of the test team will take responsibility for personnel safety, as well as the team safety, immediately notifying the Field Team Manager of any safety hazard either real or perceived.

8.1 Plant Requirements

Upon arrival at the site, all crew members will be required to attend a plant safety orientation. Each day, the EER Field Manager will inform DuPont of the team's arrival on-site. He will also inform the plant's representatives upon departure. All team members must be 40 hr Hazwopper trained, and all personnel must use the following personnel protective equipment:

- Steel-toed shoes;
- Safety glasses with side shields; and
- Hard hats.

8.2 EER Corporate Safety Program

EER has a comprehensive Health and Safety Program, which satisfies Federal OSHA requirements. The basic elements include the following:

- Written policies and procedures;
- Routine training of employees and supervisors;
- Medical monitoring;
- Use of personal protective equipment;
- Hazard communication;
- Pre-mobilization meetings with facility personnel and EER test team personnel; and

- Routine surveillance of on-going test work.

The Safety and Health Program is in compliance with SB-198-Injury and Illness Prevention Program. EER maintains a Health and Safety Program for all of the employees located in California, Ohio, New Jersey, and North Carolina.

The engineering and technical staff design safety into every project to ensure maximum control over existing safety hazards, and they also participate in an extensive, mandatory safety program.

The nature of this type of work presents numerous hazards. Since some hazards are unique to areas of research, EER must have a Safety and Training Program, which encompasses a large area through training, hazard awareness, experience, and adherence to OSHA standards. Safety training is the base of EER's safety program. The objectives of the safety training is to make the employee aware of the surrounding environment and the potential hazards and to accomplish the job in the safest possible way.

All employees of EER receive training about the Injury and Illness Prevention Program, and as a result, they are able to recognize a hazard identification and the code of safe practices as a means of ensuring their safety.

The Fire Prevention and Emergency Action Plans were developed in compliance with 29 CFR 1910.38. The fire prevention training instructs employees on identification and elimination of possible fire hazards, inspection and use of fire extinguisher, and emergency escape and evacuation procedures.

A Hazardous Communication Program was developed in compliance with 29 CFR 1910.1200. This plan is designed to ensure that the hazards of chemicals used by employees of EER and the employees of EER's contractors and customers are communicated to those employees who may be exposed to them. This program consists of a comprehensive labeling program, material safety data sheets, and employee training. For labeling purposes, EER has adopted the Hazardous Material Identification Guide (HMIG) labeling system.

A Respiratory Protection Program was developed conforming to 29 CFR 1910.134. This program consists of employee instruction and training in the use and limitations of the respirator, and proper cleaning, disinfecting, storage, and inspection intervals. There is an annual testing of employees

who are, or who potentially may be, exposed to respiratory hazards on the job. Employees must attend the training, including the part on recognition of respiratory hazards likely to be found on the job site, and pass the performance test to be authorized to use the respirator.

A Compressed Gas Cylinder Handling and Regulator Use Training is conducted for those employees who work with and handle compressed gas cylinders and regulators.

An Equipment Qualification Program has been implemented to promote safety procedures when using power tools. To be qualified, an employee must demonstrate the proper procedures for inspection and use, following all safety guidelines, including use of safety equipment.

A Hearing Conservation Program was developed conforming to 29 CFR 1910.95. This program consists of annual testing of all employees who are exposed to noise levels exceeding those permitted under 29 CFR 1910.95 and who must use hearing protection on the job.

A Pre-Project Safety Report is primarily used to identify potential hazards and develop a code of safe practices for a specific project. This report will list the type of materials to be used, names of the personnel involved with the project, and documentation of training. The project engineer is responsible for the training and safety education associated with the project.

8.3 On-Site Safety Procedures

On the job site, it is the responsibility of the Project Leader to ensure the safety of the team. Before conducting any test, the Project Leader must conduct an initial job survey. This survey consists of identifying safety hazards, developing safe practices, and gathering specific data for the test. The Project Leader determines the procedures and the minimum amount of equipment needed to accomplish the testing. Any hazards that can be corrected will be reported to the plant personnel for immediate correction prior to the testing operation.

Before beginning the test program at DuPont Experimental Station in Wilmington, Delaware, on-site test team members will be required to attend a safety orientation meeting at the facility. The orientation will cover the safety requirements necessary by subcontractors on the premises. They are as follows:

- Wear only long sleeve shirts or garments;
- Wear hard hats at all times on-site except inside sample recovery trailers and mobile CEM laboratory;
- Wear protective shoes or boots in test areas;
- Wear protective glasses and goggles, if available, at the test location;
- Wear ear protection where designated;
- Be familiar with location of safety shower and eye wash stations;
- Know where facility wind direction sock is located;
- Know where upwind meeting location is in the event of an episode;
- Employ wall belts (safety belts) in all cases where working above ground elevation;
- Know when Type I or explosion proof type electrical equipment is needed;
- Keep control room personnel aware of both arrival and departing in the area;
- Comply with plant traffic rules;
- Smoke only in designated areas; and
- Receive MSDS on all compounds which team members may be exposed to.

On the first on-site day, the Test Director will fill out the Emergency Response Procedure Form and provide copies to be posted at each test site. An example of this form is provided in Figure 8-1.

Project Health & Safety Information

=====

Project No: _____

Client: _____

Project Description: _____

Plant Contact: _____

Name Phone Number

EMERGENCY PLANT NUMBER: _____

EMERGENCY PLANT EVACUATION PROCEDURE

PLANT EVACUATION SIGNAL: _____

Nearest Medical Facility: _____

Fire Department: _____ Police: _____

Project Manager's Home #: _____ (919) 644-1617

=====

REQUIRED SAFETY EQUIPMENT

- Hard Hat
- Chemical Splash Goggles
- Safety Shoes
- Safety Glasses
- Coveralls

Safety Considerations:

Chemical Exposures:

(All known chemical hazards must be listed. This includes all chemicals used for analysis and sample collection, as well as potential exposure to hazardous chemicals at the project site. Consult with the Division of Safety Officer to obtain Occupational Health Guidelines and/or Material Safety Data Sheets for all chemicals that the field team may be expected to encounter)

=====

Physical Hazards:

(List all known or expected physical hazards, such as elevated work requiring safety belt/harness, high temperatures, High Winds, excessive heat or cold, etc. Consult with the Division Safety Officer in order to provide the field team with instructions for handling these known physical hazards)

=====

Figure 8-1. On-site emergency response procedures.