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FINAL

Osmose, Inc.

Buffalo, New York

OPERATION & MAINTENANCE MANUAL
Ozone Sparge/SVE Treatment System

Prepared for
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980 Ellicott Street
Buffalo, New York 14209

April 28, 2000

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OPERATION AND MAINTENANCE MANUAL FOR THE OZONE SPARGE TREATMENT SYSTEM OSMOSE, INC. BUFFALO, NEW YORK

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NYSDEC Site # 915143

April 28, 2000

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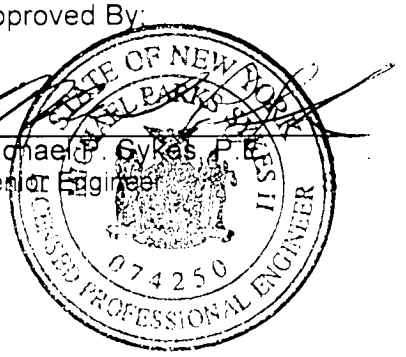

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1.0 INTRODUCTION

In December 1995, Osmose, Inc. (Osmose) submitted a *Feasibility Study* report for their Ellicott Street site in Buffalo, New York which recommended removal of Light Non-aqueous Phase Liquids (LNAPL), *in-situ* chemical treatment (ozone injection), monitoring of groundwater for compliance, monitoring of the sanitary sewer which is located beneath Ellicott Street, and institutional controls (deed restriction) as the preferred remediation strategy. In January 1997 the New York State Department of Environmental Conservation (NYSDEC) issued a Record of Decision (ROD) which formally concurred with the recommended remedial action.

Osmose subsequently entered into a formal Order on Consent (Index #B9-0314-90-01) which required preparation and implementation of a Remedial Design/Remedial Action at the site. In January 1999, the *Final Remedial Design* for the site was issued and subsequently approved by the NYSDEC. The components of the remedy are as follows:

- Recovery of Light Non-aqueous Phase Liquids (LNAPL)
- Treatment of impacted site soils with *in situ* injection of ozone
- Monitoring of groundwater for compliance
- Monitoring of the combined sewer which is located beneath Ellicott Street
- Monitoring of ambient air during treatment activities
- Acquisition of a deed restriction for the effected portion of the property

The installation of the Remedial Design treatment system was completed in August, 1999. Per Section I, Paragraph D of the Order, within 90 days after completion of construction activities, Osmose is required to submit a detailed Operation and Maintenance Plan (O&M Plan); as-built drawings; a final engineering report (including all changes made to the Remedial Design during construction); and a certification that the Remedial Design was completed in accordance with the Department-approved design plan. A final engineering report which certified that the installation was completed in accordance with the design plans and included as-built drawings (dated October 15, 1999), has been submitted to the NYSDEC.

IT Engineering of New York, P.C. (IT Engineering) has prepared this *Operation and Maintenance Manual* to describe the operation, maintenance, and monitoring requirements associated with the treatment system and also with monitoring the progress of the subsurface cleanup.

1.1 Document Purpose and Scope

This manual is a comprehensive guide for the startup, operation and maintenance (O&M), and monitoring of the remedial action treatment system. In addition, the manual presents the monitoring requirements to document the cleanup of the subsurface soils and groundwater during the remedial action. *This document is subject to revision and update during the remedial action activities, as required, to maintain an accurate description of the system equipment and optimal operational and maintenance requirements.*

Included in this document is:

- A description of the treatment system equipment (**Section 2.0**)
- A description of the start-up sequence, procedures, and requirements (**Section 3.0**)
- A description of the routine procedures for O&M and monitoring of the treatment system (**Section 4.0**)
- A description of the environmental monitoring requirements (**Section 5.0**)
- A description of the record keeping and reporting requirements (**Section 6.0**)
- A *Corrective Action Plan* to prevent undue hazards should a breakdown of the system occur **(Section 7.0)**

This manual has been designed to provide information needed to operate and monitor the treatment system by qualified persons familiar with the O&M of remediation systems and associated equipment. The manual will also provide:

- Field Maps and As-Built Drawings **(Figures** appendix)
- Wells Logs (**Appendix A**)
- Air discharge calculations supporting the request for authorization to operate the SVE system (**Appendix B**)
- Equipment manufacturers' information and literature (**Appendix C**)
- A *Corrective Action Plan* (**Appendix D**)
- Monitoring Forms for use at the site (**Appendix E**)
- An updated *Health and Safety Plan* (HASP) for the site (**Appendix F**)
- A revised *Sampling and Analysis Plan* (SAP) for the site (**Appendix G**)

Individuals who will be operating or maintaining the ozone generation equipment should obtain training from the equipment manufacturers.

1.2 System Overview

Based on specifications detailed in the *Final Remedial Design* dated January 19, 1999 the remedy for the site consists of an ozone injection/SVE treatment system. Partial dewatering of the aquifer is required to create an unsaturated zone from which potentially unreacted ozone can be recovered. The ozone injection/SVE system was installed between April and August, 1999.

A total of 23 vertical SVE wells and 20 vertical ozone injection wells comprise the ozone sparge/SVE system. Equipment associated with the ozone sparge system is located in one treatment compound (treatment compound TC-2); the equipment associated with the SVE system and the groundwater recovery and treatment systems are located in a second treatment compound (treatment compound TC-1) (**Drawing Y-1**). All wells associated with the treatment system are interconnected through piping networks that are manifolded to the respective treatment equipment. The locations of the ozone sparge and SVE wells are presented on **Drawing Y-2**; the locations of the trenches required to manifold the wells to the respective treatment compound is presented **Drawings Y3.** Four of the air sparge wells and 4 of the SVE wells are located inside the former soil treatment biocell. Well logs showing construction details of the ozone injection and SVE wells are included in **Appendix A;** the details are also summarized in **Table 1.0**

A total of **11** fiberglass reinforced epoxy (FRE) recovery wells fitted with top loading total fluids recovery pumps comprise the groundwater dewatering system which is required to create a dewatered zone below the existing clay layer. Potentially unreacted ozone will be collected from this dewatered zone.

For the purposes of this manual, the ozone injection/SVE treatment system consists of three primary systems. These systems include:

- groundwater dewatering and treatment
- soil vapor extraction and off-gas treatment
- ozone generation and injection

A brief description of each system is presented in **Section 2.0**.

1.3 Health and Safety

The previously approved site *Health and Safety Plan* (HASP) has been updated to include tasks associated with the O&M of the ozone injection/SVE treatment system. A copy of the revised HASP will remain on-site at all times. All individuals performing work at the site, and any visitors to the site, must read, understand, and sign the HASP. All work will be conducted in accordance with the requirements of the HASP.

A copy of the HASP is included as **Appendix F**

2.0 TREATMENT SYSTEM DESCRIPTION

A brief description of each primary system which collectively comprise the treatment system is presented below. A list of equipment and associated equipment specifications are included in **Table 3.0**. Additionally, a general overview of the electrical service and classification is presented.

The treatment system has been designed to operate in a fully automatic mode. In automatic mode, separate portions of the treatment system will shut down and automatically restart as alarm conditions are encountered, then cleared.

2.1 Groundwater Dewatering and Treatment System

The groundwater dewatering system consists of :

- 11 six-inch diameter fiberglass reinforced epoxy (FRE) recovery wells
- A groundwater pumping system
- A groundwater treatment system
- One discharge point to the combined municipal sewer (BSA Permit 97-02-TP002)

Each of these components is discussed below.

2.1.1 Recovery Wells

Eleven (11) 6-inch diameter FRE wells comprise the groundwater recovery well network. The locations of these wells are presented on **Drawing Y-3**. Well installation details are presented on the drilling logs (**Appendix A**) and summarized in **Table 2.0**.

2.1.2 Groundwater Pumping System

The groundwater pumping system consists of 11 down-well total fluids pneumatic pumps and associated piping and flowmeters. The 11 pneumatic pumps at the site consist of:

- five 4-inch diameter pumps manufactured by QED (Hammerhead model H45SET)
- three 2-inch diameter pumps manufactured by QED (Hammerhead model H25SET)
- three 4-inch diameter pumps manufactured by Brainard-Kilman (Evacuator II)

Manufacturer's specifications and literature are included in **Appendix C**.

The pumping system was designed to dewater the aquifer sufficiently to create an unsaturated zone below the clay layer that exists on site. An average of approximately 3.5 feet of water table depression across the site is required, except in the vicinity of the municipal sewer line which exists beneath Ellicott Street. At the sewer, the drawdown will be limited to 2.0 feet to insure that the water table is not lowered to a depth below the bottom of the sewer. The depth setting of each pump, the anticipataed drawdown at each recovery well, and the design flow rate of each recovery well are presented in **Table 2.0.** Based upon a groundwater flow model (MODFLOW), the pumps in the three westernmost wells are anticipated to extract groundwater at approximately 0.15 gallons per minute (gpm), and the remaining eight wells at 0.1 gpm (total flow rate of approximately 1.25 gpm). Records of each individual pump depth, along with the associated drawdown at each monitoring point, will be maintained and reported in the quarterly status report. The pumping system was designed to run continuously to maintain the required drawdown for the duration of the remedial action. Adjustments to the depth of the pumps and/or the pump flow rates may need to occur based upon monitoring data collected.

Conditioned (i.e. dried and filtered) air required to operate the down-well pumps is supplied from the Osmose pilot plant, with an alternate supply from the main plant.

The groundwater recovery wells were constructed with a 7/8-inch outside diameter teflon tube for groundwater recovery, and a 3/8 inch outside diameter polytube for pressurized air supply. The three recovery wells which were in use during the previous IRM system (RW-6, RW-7, and RW-9) are supplied with a 1 inch carbon steel pipe for groundwater recovery, and a ½-inch inside diameter rubber reinforced hose for pressurized air supply. **Drawing D-1** contains details on well and piping construction. Each down-well recovery pump has an associated in-line totalizing flow meter (FM-401 through FM-411) located inside treatment compound TC-1 to monitor and record the total flow from each well.

Flow from the groundwater recovery wells may be adjusted or stopped by several means. Each recovery well pump has an associated in-line ball valve and compressed air regulator. Flow from individual wells may be adjusted or shut off by closing the associated ball valve thus inhibiting water flow, or adjusting the compressed air regulator. Air supply to all wells may be shut off by closing the ball valve on the supply side of the solenoid valve.

2.1.3 Groundwater Treatment System

The groundwater treatment system consists of:

- a slant plate oil/water separator (tag #OWS-400)
- a 500-gallon equalization tank (tag #ET-400)
- a bag filter (tag #BF-400)

- three LGAC adsorbers (tag #s GC-1, GC-2, and GC-3) installed in series

The layout of the pumping and treatment system is shown of **Drawing S-2**. Equipment specifications are provided in **Table 3.0**, and manufacturers' literature is included in **Appendix C**.

Groundwater and LNAPL (if present) is pumped from the total fluids pumping system into the oil/water separator where separation and collection of LNAPL occurs. Water is gravity fed into the 500-gallon equalization tank prior to treatment. Three float-type switches (Low, High, High-high) installed within the equalization tank activate a transfer pump (TP-400) which pumps the water through a 100 micrometer (um) filter and three the high pressure, 200 pound LGAC contactors prior to discharge. The three LGAC adsorbers are capable of treating up to 10 gpm of water at up to 150 psi. The float-type switches are interlocked with the control panel for the down-well pumps. If a high-high alarm situation occurs within the equalization tank, a probe signal will close a solenoid actuated valve that will shut off air to the down-well pumps. The control logic will query the high-high alarm every ten minutes to determine if the high-high alarm conditions is cleared, at which time the down-well pumps will automatically re-start. A totalizing flowmeter (FM-400), sample port (SP-4) , and pressure indicator gauge (PI-400) are all installed immediately following the transfer pump.

Sampling points installed within the groundwater treatment system include:

- SP-4; influent to the first LGAC adsorber in series
- SP-5; between the first and second LGAC adsorbers
- SP-5A; between the second and third LGAC adsorbers
- SP-6; effluent from the third LGAC adsorber

One spare LGAC adsorber will be left on site to allow changeouts to occur, as they are needed. A carbon service company will perform the carbon changeouts. Changeouts include refilling the high-pressure units with reactivated carbon, and drumming the spent carbon. Spent carbon will be left in the hazardous waste storage area within the main plant for disposal by Osmose.

2.1.4 Treated Water Discharge

The treated groundwater is discharged to the Buffalo Sewer Authority's combined sewer system under the authority of a temporary discharge permit (ID 99-02-TP002). Semi-annual summary reports are submitted to Buffalo Sewer Authority, Industrial Waste Section (April and October). A copy of the discharge permit, and associated conditions and requirements, is on file at Osmose. Currently, an average maximum discharge of 5 gpm is allowed.

2.2 Soil Vapor Extraction System

The SVE system consists of:

- 23 4-inch diameter PVC extraction wells (tag #E-1 through E-23)
- a moisture separator (tag #F-300)
- an 18-inch diameter particulate filter (tag #PF-300)
- 1 regenerative vacuum blower with a 15 Hp motor (tag #K-300)
- 2 ozone reducing catalyst vessels (tag #R-300)

Construction details of the SVE wells are provided on the well logs (**Appendix A**) and are summarized in **Table 1.0**.

An AMETEK Rotron EN-909 explosion-proof regenerative vacuum blower powered by a 15 Hp, 460 volt, three phase motor provides the required vacuum. Manufacturer's literature and blower curves are included in **Appendix C**.

The blower is skid-mounted with a 30-gallon capacity moisture separator, inline particulate filter, bleed air valve, and vacuum relief valve. A condensate transfer pump (P-300) removes water from the moisture separator; low, high, and high-high level switches control the automatic operation of the pump.

A total design flow of 500-600 scfm at 30 inches of water column ("w.c.) extraction rate is anticipated to yield an area of influence (AOI) sufficient to contain and recover any potentially unreacted ozone. Based upon the preliminary design, each extraction point is anticipated to receive the flow rates indicated on **Table 1.0**. Field testing will be required to verify these flow rates (**Section 3.2**, below).

The effluent from the SVE system can potentially contain small concentrations of unreacted ozone. The effluent stream is therefore treated with Carulite 200 ozone reducing catalyst (tag #R-300) manufactured by Carus Chemical Company prior to discharge to the atmosphere. The catalyst material works by greatly increasing the rate at which the ozone (O_3) molecule naturally degrades into oxygen (O_2). The ozone catalyst unit has been sized to provide a residence time sufficient to achieve greater than 99 percent reduction of ozone. This reduction can be achievable at ambient temperatures, so no pre-heating is required. The efficiency of the ozone catalyst will be monitoried on a bi-weekly basis using Drager-type tubes as described in **Section 4.4.1** below. If required, the catalyst will be replaced to ensure compliance with Air Guide-1 maximum emission rates for ozone. Equipment specifications are presented in **Table 3.0**. The manufacturer's literature is provided in **Appendix C**.

2.2.1 Air Discharge

One point source discharge to the atmosphere is associated with the SVE treatment system. This includes:

- Off-gas from the SVE system after treatment with the ozone catalyst

As detailed in the *Final Remedial Design* the project is exempt from formal air permitting requirements. Monitoring of the SVE off-gas for the presence of ozone and VOCs, however, will occur during both startup and operation as detailed in **Section 4.4**.

2.3 Ozone Generation and Injection System

The ozone generation system is located within treatment compound TC-2 (**Drawing Y-3**). The ozone generation system consists of the following units:

- 15 Hp rotary screw air compressor (tag #K-100)
- Oxygen separation unit consisting of 2 molecular sieves (tag #F-100)
- Oxygen holding tank (tag #R-100)
- Ozone generator (tag #R-200)
- Ozone expansion chamber (tag #F-200)
- Recirculating chiller (tag #E-200)
- 20 1-inch diameter stainless steel injection points (tag#O-1 through O-20)

2.3.1 Oxygen Generation

An Atlas – Copco rotary screw air compressor (model GA-11) with a 120 gallon horizontal receiver tank is capable of providing 64 acfm of air at 125 psig to the oxygen separation unit. A pressure regulating valve (PV-100) located after the compressor tank, will be used to regulate air flow rates to the oxygen separator unit.

An AirSep; model AS-250 oxygen separation unit consists of two molecular sieves which will be run in alternating active/backflush modes. The molecular sieve separates the oxygen from the compressed air stream; the oxygen (at approximately 90-95% O_2) is sent to the pressurized oxygen receiver tank for storage; the nitrogen and other inert gasses are discharged to the atmosphere. From the oxygen storage cylinder, the oxygen will be fed to the ozone generation unit. A pressure regulating valve (PV-110) located after the oxygen receiver tank will regulate the oxygen supply to the ozone generator at a constant 45 psig.

The air compressor at the beginning of the system provides the pressure that creates flow through each unit, including discharge through the sparge points into the subsurface.

2.3.2 Ozone Generation

An Ozonia model OZAT CFS 6 ozone generator will receive 5-6 cubic meters per hour (m^3/hr) of 90-95 percent pure, dry oxygen, from the storage cylinder. The generator uses the corona discharge principle to produce ozone from the dry oxygen. From the ozone generator, ozone will pass through a 316 stainless steel expansion cylinder. This 0.6 ft^3 cylinder is provided to adsorb sudden changes in pressure when changing between ozone sparge points. A closed circuit recirculating chiller cools the ozone generator.

From the expansion cylinder, an ozone injection manifold, complete with ball valves, pressure gauges, and solenoid valves, will distribute the ozone to the subsurface. The ozone sparge system was installed with 20 vertical 2-inch-diameter stainless steel sparge wells. Each sparge well is piped independently from the sparge manifold located in treatment compound TC-2 (**Drawing S-1**). As described in the *Final Engineering Design*, the automatic timers will distribute ozone across all 20 sparge wells in 24 hours; spending approximately 72 minutes at each sparge point per day. The vertical sparge wells will be operated at approximately 6 - 10 acfm per point. Sparge wells nearest buildings or other sensitive structures will be operated during late-night hours when occupancy is lowest.

Equipment specifications are presented in **Table 3.0**. Manufacturers' manuals and specification sheets are included in **Appendix C**.

2.3.3 Air Discharge

One point source discharge to the atmosphere is associated with the ozone generation system. This includes

- Air from the oxygen concentrator (Sieve banks)

Off-gas from the sieve banks will consist primarily nitrogen and small quantities of inert gasses remaining in the ambient air stream after 90 – 95 percent of the oxygen has been removed. As detailed in the *Final Remedial Design*, monitoring of this discharge point is not required during either startup or operation.

2.3.4 Safety Interlocks

There are numerous safety interlocks that have been designed into the treatment system. A list of these interlocks is included in **Table 6.0**.

In all cases, when the ozone generator (Tag #R-200) is shut down, an autodialer will activate and send a facsimile message to the following individuals:

- Mr. David Kasprowicz
  Plant Manager
  Osmose, Inc.
  facsimile: (716) 882-2834

- Ms. Gina Senia
  Project Engineer
  IT Corporation
  facsimile: (716) 773-2285

In the event of a SVE system shut down, once the alarm condition is cleared, the SVE will automatically restart and restart the ozone generator. However, if oxygen or ozone is detected in the treatment compound (TC-2) ambient air above critical concentrations, the ozone generator will shut down permanently, until manually reset.

The safety interlock logic is included on **Drawing P-2**.

2.4 Electrical Service

The ozone treatment compound (TC-2) has one source of power to the building. A 277/480-volt service is installed on the utility pole to the west of the compound. From this service, a 277/480 volt feed enters the compound via a main disconnect panel located on the exterior west wall of the building (**Drawing E-2**). This 480-volt service powers a majority of the equipment inside the compound. A leg of the power is stepped down to provide 208/120 volt single phase power for the smaller equipment and utility outlets inside the building.

Treatment compound TC-1 has two sources of power to the building. A 277/408 volt service feed runs to treatment compound TC-1 via a below grade 2" conduit from treatment compound TC-2. In addition to this 277/408-volt service, treatment compound TC-1 is fed a separate 120-volt service from the Osmose pilot plant building.

All power to treatment compound TC-2 may be shut off from outside the compound by closing the main disconnect on the exterior west wall of the compound. Additionally, all power can be shut off from inside the compound at a main disconnect panel located on the interior west wall.

When power is shut off at either of these panels, the 460-volt power to TC-1 will also be shut off. The 460-volt power can also be shut off inside treatment compound TC-1 at the exterior of the motor control panel located on the SVE motor. The 120-volt power within treatment compound TC-1 (from Osmose's pilot plant) may be locked out at the panel located on the interior west wall of the compound.

A positive displacement ventilation fan installed on the east wall of treatment compound TC-2 provides greater than 1 cfm of ventilation air per square foot of floor space. Per NEC and NFPA code, both enclosures are rated as non-hazardous locations.

As-built electrical drawings are included in the **Figures** appendix.

Lock out/tag out procedures will be followed when working on equipment. Lock out/tag out requirements are included in the *Health and Safety Plan* (**Appendix F**).

3.0 STARTUP

This section provides a description of the startup sequence and procedures for each of the components of the ozone injection/SVE treatment system.

A phased startup sequence is required to insure that no unreacted ozone is released from the treatment zone and that all safety precautions are met. The startup sequence will consist of the following three phases:

- Phase I: Groundwater Dewatering and Treatment System
- Phase II: SVE System
- Phase III: Ozone Generation and Injection System

Field-testing associated with initial startup of each of the treatment systems will be required, therefore a total of approximately 2-3 months will be required for startup.

3.1 Groundwater Dewatering and Treatment System

Creation of an unsaturated zone beneath the clay layer that exists onsite is the first requirement of the startup sequence. The SVE system cannot be operated, and therefore no ozone can be injected into the subsurface without an unsaturated zone to recover potentially unreacted ozone.

Prior to startup of the dewatering system, groundwater gauging will be conducted to document static conditions. Gauging of the groundwater will be conducted periodically during startup to verify that the modeling data accurately predicted the actual response in the subsurface.

The initial depth that each of the 11 recovery pumps will be installed at, the anticipated drawdown at each well, and the design sustained flowrate is included in **Table 2.0.** Based upon actual field gauging results, the pump depths and flowrates may require adjustment to achieve the required drawdown of approximately 3.5 feet across the site.

In addition to the dewatering of the groundwater outside the soil treatment biocell, gauging of the static water levels within the biocell will be conducted. If required, water levels will be lowered inside the biocell to allow for vapor recovery.

It is anticipated that dewatering (outside the biocell) will require approximately 4 weeks until the dewatered zone has sufficiently drained to start the SVE.

3.1.1 System Startup

The following tasks will be conducted during startup of the groundwater dewatering system:

Step 1 Become familiar with this document and all manuals and documentation supplied by the manufacturers for the pumping and treatment equipment.

Step 2 Follow the process flow of the pumping and treatment system. Ensure that all valves, piping, connections, etc. are in proper (open/closed) position for system operation.

Step 3 Check the power supply. Ensure that all breakers have been labeled properly and that power is available to the equipment.

Step 4 Gauge the static groundwater elevation and the depth to water inside the Biocell record data on Gauging Form (**Appendix E**)

Step 5 Record the depths of the down-well pumps in each recovery well

Step 6 Begin pumping from the recovery wells

Step 7 Check system over-rides/interlocks (see **Section 3.2.4**)

Step 8 Check abovegrade piping for leaks

Step 9 Verify by gauging that the required groundwater table drawdown across the site has been achieved, and that the groundwater has not been lowered below the depth of the bottom of the sewer line which exists below Ellicott Street

Note: The NYSDEC must be notified prior to initial startup of the dewatering system.

3.2 SVE System

A description of the SVE system startup is provided below. In general, the following steps will be required:

- Perform a phased startup of the SVE system beginning with low flows from each vapor extraction point to limit moisture intake; incrementally increase the flow at each point until design flows have been achieved
- Perform air monitoring to confirm air discharge requirements are being achieved

- Verify the area of influence (AOI) the SVE system has in the subsurface
- Conduct a helium injection test to simulate ozone injection conditions

Each of these steps is described below.

3.2.1 System Startup

Step 1 Become familiar with this document and all manuals and documentation supplied by the manufacturers for the SVE and ozone catalyst equipment.

Step 2 Follow the process flow of the SVE system. Ensure that all valves, piping, connections, etc. are in proper (open/closed) position for system operation.

Step 3 Check the power supply. Ensure that all breakers have been labeled properly and that power is available to the equipment.

Step 4 Check the ventilation in the building. Make sure that the ventilation louvers are free of obstructions and ventilation system is operating. Operate for 10 minutes.

Step 5 Verify the depth to water within the biocell to insure sufficient unsaturated zone exists for proper SVE operation

Step 6 Check the SVE motor and blower (tag #K-300). Ensure that the blower fins rotate freely.

Step 7 Inspect the particulate filter (tag #PF-300). Ensure that air can freely enter the blower. Set bleed valve to 50 percent open.

Step 8 Open the 2-inch PVC ball valves (located on the SVE manifold) approximately 50 percent for each SVE point.

Step 9 Start the SVE motor. Check for air leaks at all fittings. Follow manufacturer's instructions and specifications for system checks.

Step 10 Perform integrated safety interlock checks (**Section 3.2.4**). Run shutdown scenarios to ensure interlocks engage as designed.

Step 11 Consult **Table 1.0** and design documents to confirm system design Settings (vacuum, flow, etc.)

Step 12 Record the pressure and air flow rates at each SVE point and at the Discharge stack on the Monitoring Form (**Appendix E**)

As stated above, low flows from each vapor extraction point are required to limit moisture intake at startup. Flow from each point will be incrementally increased over a 2-3 week period by opening the ball valve to each sparge point on the SVE manifold and closing the bleed air valve until design flows have been achieved.

3.2.2 Verification of Area of Influence

Once design flows have been achieved, subsurface testing will be performed to confirm that the actual AOI in the dewatered zone is consistent with the design AOI. Field personnel will verify the AOI using magnehelic gauges adapted to fit to the tops of temporarily installed small diameter vapor monitoring points. These points will be installed to a depth just below the clay layer, and into the dewatered zone. The stainless steel points will be installed using push technology, such as a Geoprobe-type rig, or similar. The quantity and location of the probes will be sufficient to confirm the AOI of the SVE system. It is anticipated that approximately 10-15 locations will be tested, as shown on **Figure 3-1**. A detail of a typical vapor monitoring point is included as **Figure 3-2**. The temporary wells will be left in place for use during the helium test (**section 3.2.4**).

Adjustments to the flowrates or modifications to the SVE system will be made until the required AOI is achieved. Results from the AOI test will be forwarded to the NYSDEC as part of the quarterly status reporting.

3.2.3 Helium Test

Once the SVE system is operating within the design parameters, and the AOI has been verified under "static" conditions, field verification of the AOI will be conducted under simulated ozone injection conditions. To accomplish this, a helium injection test will be conducted. Helium was selected because it is an inert gas that can simulate ozone movement in the subsurface. Helium will diffuse more than ozone in the subsurface, and additionally will not degrade like ozone, therefore; the test is considered very conservative.

For the helium injection test, the rotary screw air compressor (tag # K-100) will supply the carrier gas for the helium. The compressor will be operated, however, the oxygen separation unit (tag #F-100) and the ozone generator (tag # R-200) will not. A canister of helium will be delivered to the site and installed into the air stream prior to injection into the subsurface. Helium will be injected at a concentration of approximately 1 percent.

Helium will be sequentially injected through each ozone injection point for a period of approximately 60 minutes while the SVE system is operational. The small diameter monitoring

points installed during the AOI verification will be used to monitor for helium in the subsurface. Monitoring for helium will focus on sensitive areas such as around utilities, along the Osmose building foundation, and on the first floor of the building. The proposed locations of the monitoring points are presented on **Figure 3-1**.

A hand-held helium detector (MARK 9821 or 9822, or similar) will be used to perform the monitoring. Adjustments to the flowrates of individual SVE points may be required to ensure that the AOI is maintained. The results from the helium test will be forwarded to the NYSDEC as part of the quarterly status reporting.

3.3 Ozone Generation and Injection System

After completion of the helium injection test and verification of the AOI under operational conditions, startup of ozone injection will begin. A description of the startup of the ozone generation system is provided below. In general, the following steps will be required:

- Perform a phased startup of the ozone injection system beginning with low concentrations of ozone; incrementally increasing the concentration of ozone over a 2-4 week period until design flows have been reached
- Perform air monitoring at critical locations (around utilities, ambient air, inside first floor of Osmose facility, etc) to confirm no unreacted ozone is migrating out of the treatment zone (**section 5.1**)
- Perform air monitoring after the ozone catalyst to confirm air discharge requirements are being achieved

Each of these steps is described below.

3.3.1 System Startup

Step 1 Become familiar with this document and all manuals and documentation supplied by the manufacturers for the ozone generation equipment. The *Operating Instructions* manual supplied by the ozone generator manufacturer is included as **Appendix C**.

Step 2 Follow the process flow of the ozone generation system. Ensure that all valves, gauges, connections are in proper (open/closed) position for system operation.

Step 3 Check the power supply. Ensure that all breakers have been labeled properly and that power is available to the equipment.

Step 4 Check the ventilation in the building. Make sure that the ventilation louvers are free of obstructions and the ventilation system is operating. Operate for 10 minutes. Ensure that LEL is less than 10% in ambient air.

Step 5 Perform tightness check. Under operational pressure, treat all connections with leakage spray (SNOOP Liquid Leak Detector manufactured by Nupro Co., or similar). Any connections where bubbles form must be re-made.

Step 6 Test/verify that integrated system safety interlocks are operational. Run shutdown scenarios to ensure interlocks engage as designed.

Step 7 Adjust the timers on the ozone sparge manifold so that each sparge point will be opened for 72 minutes per 24-hour day. Timers on the sparge manifold will be adjusted such that sparge points next to the Osmose building will only be operational after normal working hours (6:00pm – 2:00am); sparge points outside the Osmose fence will be operational from approximately 2:00am – 7:00am.

Step 8 Start the ozone generation equipment. Before commissioning the ozone generator, ensure that there is no moisture in the gas lines. To dry out the system, the gas flow circuit must be purged for at least 24 hours with feedgas. Refer to the *Operating Instructions* manual for startup instructions/details.

Step 9 Adjust the ozone production rate and concentration to approximately 25% of the design criteria (design criteria = 26 lbs O_3/day total; 4 cfm of 10 percent O_3). Increase the ozone production rate and concentration by approximately 25% each week until the design criteria have been achieved.

4.0 MONITORING AND MAINTENANCE

The treatment system was designed to operate in a fully automatic mode. It is anticipated that a minimum of one site visit per week will be required during the first few months of treatment system operation. Once performance data has been documented, and the system shown to operate with minimal maintenance, it is anticipated that two to four site visits per month will be conducted.

Maintenance work may only be performed by personnel who have been trained, are authorized to perform the maintenance tasks, are familiar with the safety measures and regulations (including the site HASP), and have read and understood the equipment operating instructions.

Presented below is a discussion of the maintenance and monitoring requirements for each primary system, which collectively comprise the treatment system. As presented in **Section 1.2**, the three primary systems consist of:

- Groundwater Dewatering and Treatment System
- Soil Vapor Extraction and Treatment System
- Ozone Generation and Injection System

A discussion of the routine maintenance tasks required to maintain optimal operation of each of the treatment system components, and their frequency, is provided, followed by a discussion of the monitoring and sampling requirements to document the remediation process. All of the collected data will be recorded on the Monitoring Forms included in **Appendix E**. Photocopies of the Monitoring Form will be made at the completion of the site visit. One copy of the form will be kept on site, and one copy will be kept at both IT Corporation's Grand Island and Latham, New York offices.

Manufacturers' manuals and cut sheets have been included in **Appendix C** that includes additional maintenance and troubleshooting information.

4.1 Groundwater Dewatering and Treatment System

A list of the primary maintenance tasks that will be performed, and the required frequency of the tasks, is provided in **Table 4.0**. The primary objectives of the groundwater dewatering and treatment system maintenance tasks are to ensure that the equipment is operating within design specifications and that the system runs continuously. The maintenance tasks primarily include visual inspection of the process components, and their cleaning and changeout, as required.

Monitoring and sampling requirements, the parameters that will be monitored or sampled, and the frequency at which the data will be collected are shown on **Table 5.0**. Monitoring primarily consists of:

- recording the volume of water pumped
- recording line pressures at various critical points within the treatment process
- sampling the pumped water at various locations for laboratory analysis

4.2 Soil Vapor Extraction System

A list of the primary SVE maintenance tasks that will be performed, and the required frequency of the maintenance tasks, is provided in **Table 4.0**. The primary objectives of the SVE maintenance tasks are to ensure that the equipment is operating within design specifications and that the system runs continuously. When operating properly, little or no routine maintenance is required on the motor and blower. The maintenance tasks primarily include visual inspection of the process components and associated cleaning/changeout as required.

The SVE monitoring and sampling tasks which will be performed, the parameters which will be monitored, and the frequency at which the data will be collected, are shown on **Table 5.0**. Monitoring primarily consists of:

- recording air flow rates
- recording line pressures (vacuum) at critical points within the process
- sampling of the air stream at various locations

The monthly monitoring and sampling results will be used to calculate mass removal rates, the quantity of ozone removed from the subsurface, and the off-gas treatment efficiency to ensure compliance with air discharge regulations. Monthly laboratory samples (Tedlar bags) will be collected for VOC analysis until either:

- a database is developed which verifies that only low concentrations (below permit levels) of VOCs exist in the effluent stream
- asymptotic removal rates warrant monitoring with a field PID

As described above, all of the data collected will be recorded on the Monitoring Form included in **Appendix E**.

4.3 Ozone Generation and Injection System

The operating instructions and maintenance tasks associated with the ozone generation equipment are included in manufacturer's *Operating Instructions* and *Ozone System Shop Drawing Submittal* documents (**Appendix C**). The primary objectives of the maintenance tasks are to ensure that the equipment is operating within design specifications and that the system runs continuously. When operating properly, little routine maintenance is required.

The maintenance tasks recommended by the equipment manufacturer includes:

- periodic tightness testing
- periodic check of the ambient ozone monitoring devices
- periodic check of the breathing apparatus
- annual check of terminal/electrical connections
- periodic replacement of the filter mats

These tasks, and the minimum frequency at which the tasks will be performed, are summarized on **Table 4.0**.

The ozone sparge system monitoring and sampling tasks which will be performed, the parameters which will be monitored, and the frequency at which the data will be collected, are indicated on **Table 5.0**. This section describes the monitoring and sampling required on the treatment system to document its performance.

Monitoring of the ozone generation and injection system will primarily consist of collecting sufficient data to calculate the amount of ozone injected into each sparge point. The ozone production is primarily dependent upon the gas flow and the electrical power. To calculate the ozone production and concentration, the following information will be collected:

- the electrical real power (Pe)
- the gas flow into the ozone generator (Vn)

This information will be used, along with the setting curves provided by the equipment manufacturer, to calculate the quantity and concentration of ozone produced for injection. Additionally, at a minimum, the following information will be collected to evaluate the treatment process

- the ozone injection rate into the sparge wells
- the pressures in the injection points

- the total service hours the equipment has run
- the gas pressure within the ozone generator

As described above, all of the data collected will be recorded on the Monitoring Form included in **Appendix E**.

4.4 Air Discharge Monitoring

This section presents the monitoring requirements for the treatment system point source discharge associated with the SVE system. The SVE discharge will be sampled on a monthly basis for ozone and total VOCs

4.4.1 Ozone

The latest version of the NYSDEC's Air Guide-1 computer program was used to calculate the maximum emission rate that would not cause an annual or short-term guideline concentration exceedence of ozone. The calculations are provided in **Appendix B**.

According to the results of the Air Guide-1 program, the maximum emission rate of ozone at the site is 0.0078 lbs/hr. At the SVE blower's maximum design flow rate of 600 cfm, this corresponds to a maximum emission concentration of 1.62 ppm of ozone. For other flow rates, the maximum permissible concentration may be calculated as:

$$C = 971 / Q$$

where: C =concentration (ppm)
Q = flow rate (cfm)

The SVE discharge will be sampled before and after the ozone reducing catalyst (sampling point SP-7 and SP-8, respectively) on a bi-weekly basis using Dragger-type tubes. Sampling both before and after the ozone reducing catalyst will allow calculation of the efficiency of the catalyst, and provide information on the amount of unreacted ozone in the subsurface.

4.4.2 VOCs

Total VOCs will also be sampled after the ozone reducing catalyst (sample point SP-8) on a monthly basis. The maximum emission rate for total VOCs and benzene that would not cause an annual or short-term guideline exceedance was calculated. The calculation indicated the maximum emission rate of total VOCs at the site, conservatively assuming that benzene is 2 percent of the total volatiles, is 33.5 ppm-v as measured by a PID at the maximum design flow rate of 600 cfm. Calculations are included in **Appendix B**.

The SVE air discharge monitoring and sampling tasks which will be performed, the parameters which will be monitored, and the frequency at which the data will be collected, are included on **Table 5.0.** Data will be recorded on the Monitoring Forms included in **Appendix E**.

Tedlar bags will be used to collect monthly air samples for laboratory analysis until either:

- A database is developed which verifies that only low concentrations (below permit levels) of VOCs exist in the effluent stream, or
- Asymptotic removal rates warrant monitoring with a PID

Tedlar bag samples will be required for the first 2-3 months to establish a database; once the databse is established a PID will be used. The Tedlar bags will be sent to the contract laboratory for analysis of BTEX by TO3 methodology.

5.0 ENVIRONMENTAL MONITORING

This section provides a description of the media to be monitored and/or sampled during treatment system operation. Environmental monitoring includes:

- ambient air monitoring
- groundwater monitoring
- subsurface soils sampling
- monitoring of sewer sediments

5.1 Ambient Air

This section includes a description of the air monitoring requirements during treatment system operation. Ambient air monitoring will occur within both treatment compounds (TC-1 and TC-2), in the south parking lot area, and inside the Osmose facility. Monitoring will be conducted for VOCs and ozone gas. The objective of the air monitoring is to verify and document that no exposure to the general public, Osmose employees, or on-site maintenance workers, is occurring. Air monitoring requirements are also included in the site HASP (**Appendix F**). The locations designated for ambient air monitoring are shown on **Figure 5-1**.

A summary of the air monitoring tasks which will be performed and the frequencies at which the data will be collected, are also presented on **Table 5.0**.

Ambient air monitoring will be conducted until the remedial action objectives are attained and the active remediation (i.e. ozone injection/SVE system) is completed.

5.1.1 Ozone

An ozone monitor equipped with an audible alarm will be permanently placed inside the Osmose facility on the first floor. The monitor will be located adjacent to the treatment area and will be sensitive enough to detect 0.05 ppm of ozone above ambient levels (location AA-7 on **Figure 5-1).** A responsible Osmose employee will inspect the ozone monitor:

- in the morning just prior to normal office hours (7:30am – 8:00am)
- just prior to the lunch hour (11:30am – 12:00pm)
- just prior to the end of the normal working day (4:30pm – 5:00pm)

A form has been developed for recording the monitor readings, and the date and time of the reading collected by the Osmose employee. The Air Monitoring Form is included in **Appendix E**.

In addition to location AA-7, ambient ozone monitoring will be conducted using Drager-type tubes at the following locations, as shown on **Figure 5-1:**

- within the sewer manhole located south of treatment compound TC-1 (location AA-1)
- at three locations within the south parking area (locations AA-2, AA-3, and AA-4)
- at two locations in front of the Osmose facility (locations AA-5 and AA-6)

The ambient ozone monitoring will be conducted bi-weekly. Results will be recorded on the Site Monitoring Form included in **Appendix E.**

5.1.2 VOCs

A field PID will be used to monitor for the presence of VOCs. In addition to the monitoring required by the HASP, the following locations will require monitoring for VOCs:

- inside treatment compound TC-1
- within the sewer manhole located south of treatment compound TC-1

Monitoring results from the VOC monitoring will also be recorded on the Monitoring Form included in **Appendix E**.

Calibration of the PID will be performed at the beginning of each day of use with a standard calibration gas specified by the PID manufacturer. If the unit experiences abnormal perturbation or erratic readings, additional calibration will be required. All calibration data will be recorded in a field notebook or on a calibration log sheet that will be maintained on site.

5.2 Groundwater

Consistent with the ROD, gauging and sampling of a selected number of monitoring wells will be conducted. The objectives of the groundwater sampling are to:

- track the remedial action progress
- document groundwater quality at the designated compliance monitoring wells

Groundwater samples will be collected semiannually from the following six monitoring wells to document the progress of the remedial action treatment system:

MW-05	MW-16
MW-09	MW-17
MW-13	MW-24

The monitoring wells will be gauged prior to sampling as described in the site *Sampling and Analysis Plan* (**Appendix G**). The turbidity and dissolved oxygen (DO) content of the groundwater will be measured and recorded on the monitoring log. Groundwater samples will be sent to the contract laboratory for analysis of:

- PAHs by EPA Method 8310
- Aromatic Volatile Organics by EPA Method 8020

Additionally, as stated in **Section 3.3.4** of the *Feasibility Study* for the site, the following two monitoring wells will be designated compliance monitoring wells:

MW-11	MW-28

These two wells will be sampled on an annual basis to document groundwater quality. These samples will also be sent for analysis of:

- PAHs by EPA Method 8310
- Aromatic Volatile Organics by EPA Method 8020.

Gauging and sampling procedures and protocols included in the site SAP will be followed. The results from the sampling events will be tabulated and forwarded to the NYSDEC as part of the quarterly status reporting (refer to **section 6.0**).

Sampling of the compliance wells will continue after the site remedial action objectives have been met and the active remediation is discontinued. In accordance with the *Feasibility Study* for the site, compliance monitoring will continue for a period of 30-years.

5.3 Subsurface Soils

Subsurface soil samples will be collected and sent to the contract laboratory for analysis of PAHs by EPA Method 8310 to track the treatment progress. Soil samples will be collected semi-

annually using a Geoprobe-type drilling rig. It is anticipated that approximately 10 soil samples will be collected during each semi-annual event for analysis.

The proposed locations of the soil borings may change from sampling event to sampling event based upon the laboratory results from the previous event. Prior to the semi-annual sampling, the NYSDEC will be notified of the proposed locations.

Soil sampling and analysis will be conducted in accordance with the site SAP. For tracking the remediation progress, only standard laboratory QA/QC reporting protocols will be required.

The results from the sampling events will be tabulated and forwarded to the NYSDEC as part of the quarterly status reporting (refer to **section 6.0**).

A *Closure Sampling Plan* will be prepared and submitted to the NYSDEC, when appropriate, which defines the sampling requirements to close the active remediation portion of the remedial action. This sampling plan will describe the sampling requirements to adequately determine that the remedial action objectives for the site have been met.

5.4 Sewer

A concrete box section combined sewer exists in front of the Osmose facility beneath Ellicott Street. As required by the ROD, sediments from within the sewer will be collected and analyzed to determine if the Osmose site is impacting the sewer.

The sewer samples will be collected from manways at the following three locations:

- SWR-UP1: upgradient from the Osmose site near the intersection of Best Street and Main Street
- SWR-UP2: upgradient from the Osmose site in the intersection of Best Street and Ellicott Street
- SWR-OS1: (2 samples) downgradient from the treatment area at the intersection of Ellicott Street and Edna Street

The sampling locations are shown on **Figure 5-1**. These locations were chosen to document the environmental conditions of the sediments within the sewer upgradient- and downgradient from the Osmose site.

Sediment samples will be sent to the contract laboratory for analysis of:

- PAHs by EPA Method 8310.

The sewer will be sampled annually during the operation of the ozone injection system. At the completion of active soil treatment, and if the collected data indicates that the site has not impacted the sewer, additional sewer sampling will not be required.

6.0 RECORDKEEPING AND REPORTING

6.1 Recordkeeping

A copy of the HASP and a logbook will be kept on-site located inside the security guard office in Osmose's pilot plant. Anyone visiting the site to perform system O&M, system monitoring, or any other activities that require access to either of the equipment compounds must sign in, describe the activities conducted, and sign out. The field person will also take detailed notes and record all necessary operating data on the appropriate Monitoring Form(s) developed for the site. Photocopies of the Monitoring Form(s) will be made (at the Osmose facility) at the completion of the site visit. One copy (original) will be kept on file at the site, and one copy will be kept at both IT Corporation's Latham and Grand Island, New York offices for the duration of the project.

6.2 Reporting

As required by the Order on Consent, treatment system performance data and operational status will be documented in quarterly written progress reports. Operating data collected during the monthly site visits, and the results of any sampling events, will be compiled and evaluated.

Per the Order, the quarterly progress reports will include the following information:

- A summary of tasks completed during monitoring period
- The results of sampling and tests received or generated during the reporting period
- A list of all work plans, reports, or deliverables that were completed and submitted during the reporting period
- A description of tasks to be completed during the next reporting period
- Information regarding the percentage of completion, unresolved delays encountered or anticipated, and efforts to mitigate those delays
- Modifications to any Department-approved work plans
- A description of activities undertaken in support of the *Citizen Participation Plan* during the previous reporting period and those to be undertaken during the next reporting period

Laboratory reports will be included as attachments to the status report. Analytical data will be summarized in tables.

Draft copy of the quarterly status report will be sent to Osmose for review and comment. Osmose comments will be incorporated and copies of the final report will be submitted to the State as per the provisions of **Section XI**, **Paragraph A** of the Order.

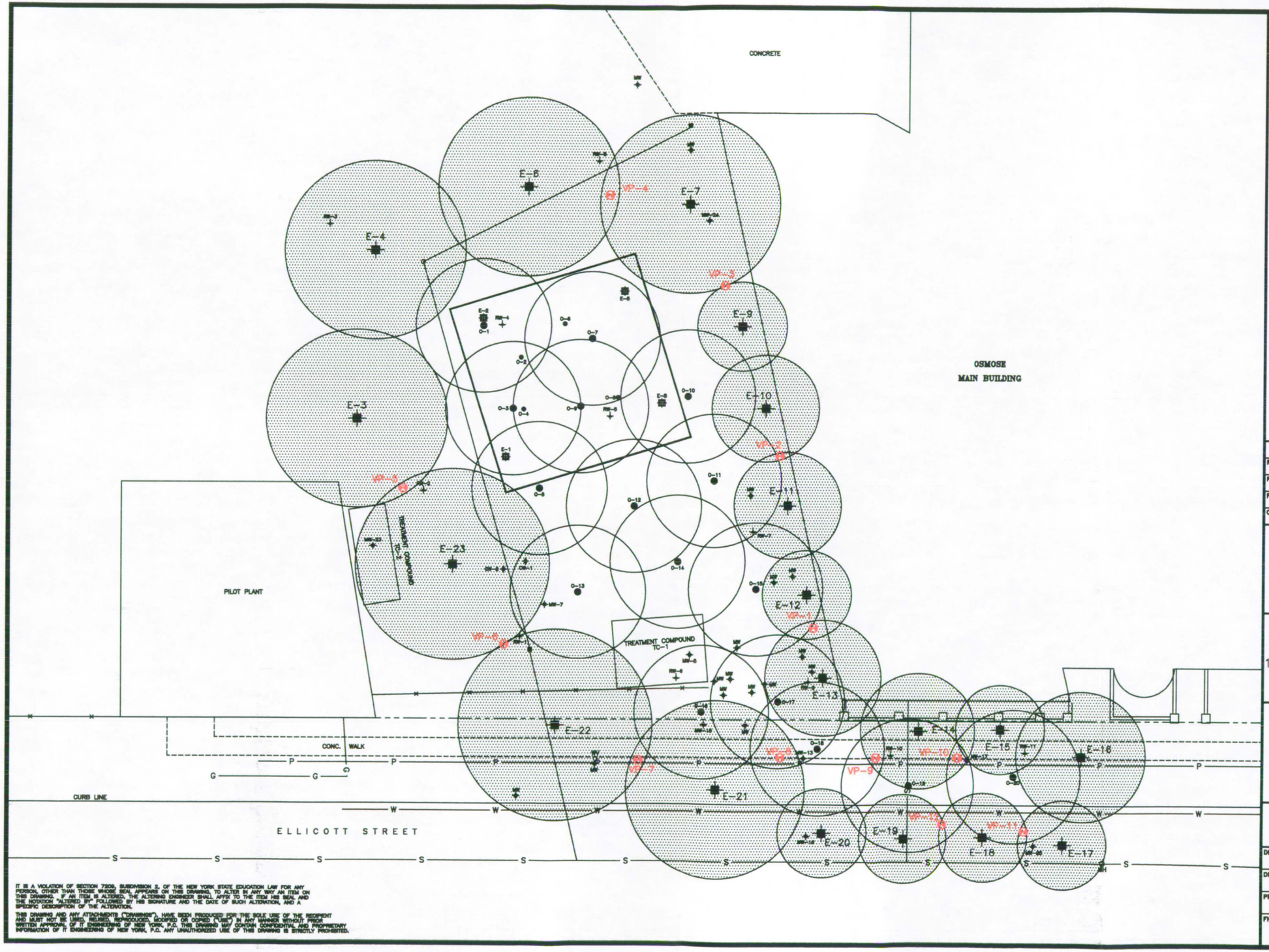
7.0 CORRECTIVE ACTION PLAN

To respond to shutdown, fault, or other situations that deviate from the design and routine operation and maintenance of the remediation system, a *Corrective Action Plan* has been prepared and is included as **Appendix D.** The *Corrective Action Plan* indicates responsibilities, actions, and documentation requirements in the event of emergency situations.

8.0 PROJECT TIMELINE

A project timeline is included as **Figure 8-1**.

FIGURES



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NO.	DATE	BY	REVISION

LEGEND

- MONITORING WELL
- RECOVERY WELL
- OZONE INJECTION WELL
- SVE EXTRACTION WELL
- OZONE INJECTION WELL WITHIN BIOCELL
- SVE EXTRACTION WELL WITHIN BIOCELL
- VAPOR MONITORING POINT LOCATION
- SEWER MANHOLE
- — S — SANITARY SEWER LOCATION (APPX.)
- — G — GAS LINE LOCATION (APPX.)
- — P — PHONE LINE LOCATION (APPX.)
- — W — WATER LINE LOCATION (APPX.)

N

10 0 10 20
SCALE FEET

SIGNATURE	DATE
REVIEW ENGR:	
PROJECT ENGR:	
PROJECT MGR:	
CLIENT:	

IT ENGINEERING
OF NEW YORK, P.C.
13 BRITISH AMERICAN BLVD.
ALBANY, NY 12110
(518) 783-1996

OSMOSE, INC.

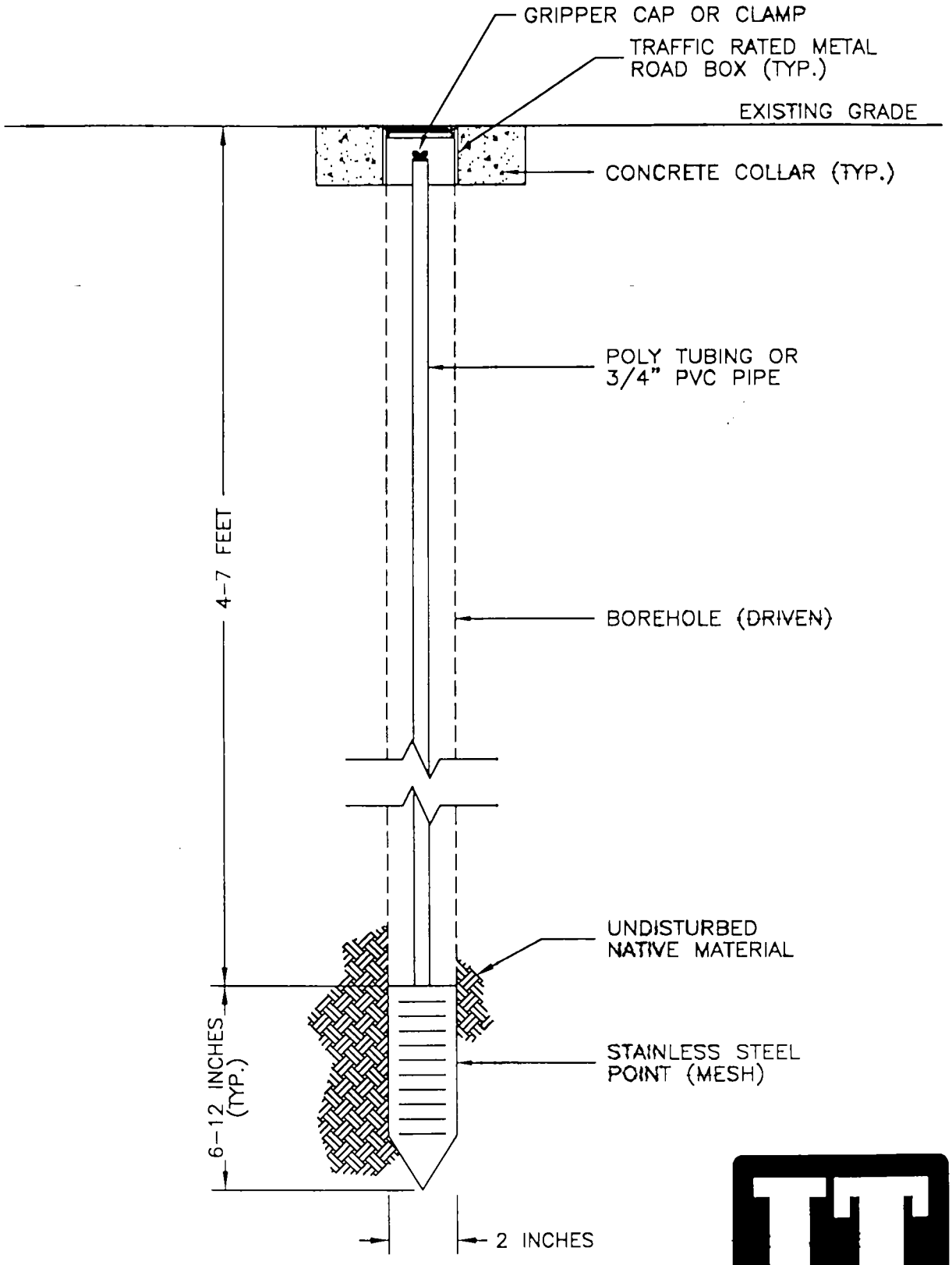
ELLICOTT STREET
BUFFALO, NEW YORK

VAPOR MONITORING POINT LOCATIONS

DESIGNED BY:	DETAILED BY:	CHECKED BY:
BWA	DEO	

DRAWING DATE:	ACAD FILE:
11/9/99	8061-VMP
PROJECT NO.: 11108061	CONTRACT:
FIGURE: 3-1	REVISION: -

FIGURE 3-2
TYPICAL VAPOR MONITORING POINT



NOT TO SCALE

IT CORPORATION
A Member of The IT Group

TYP-VMP

IMAGE	X-REF	OFFICE	DRAWING NUMBER
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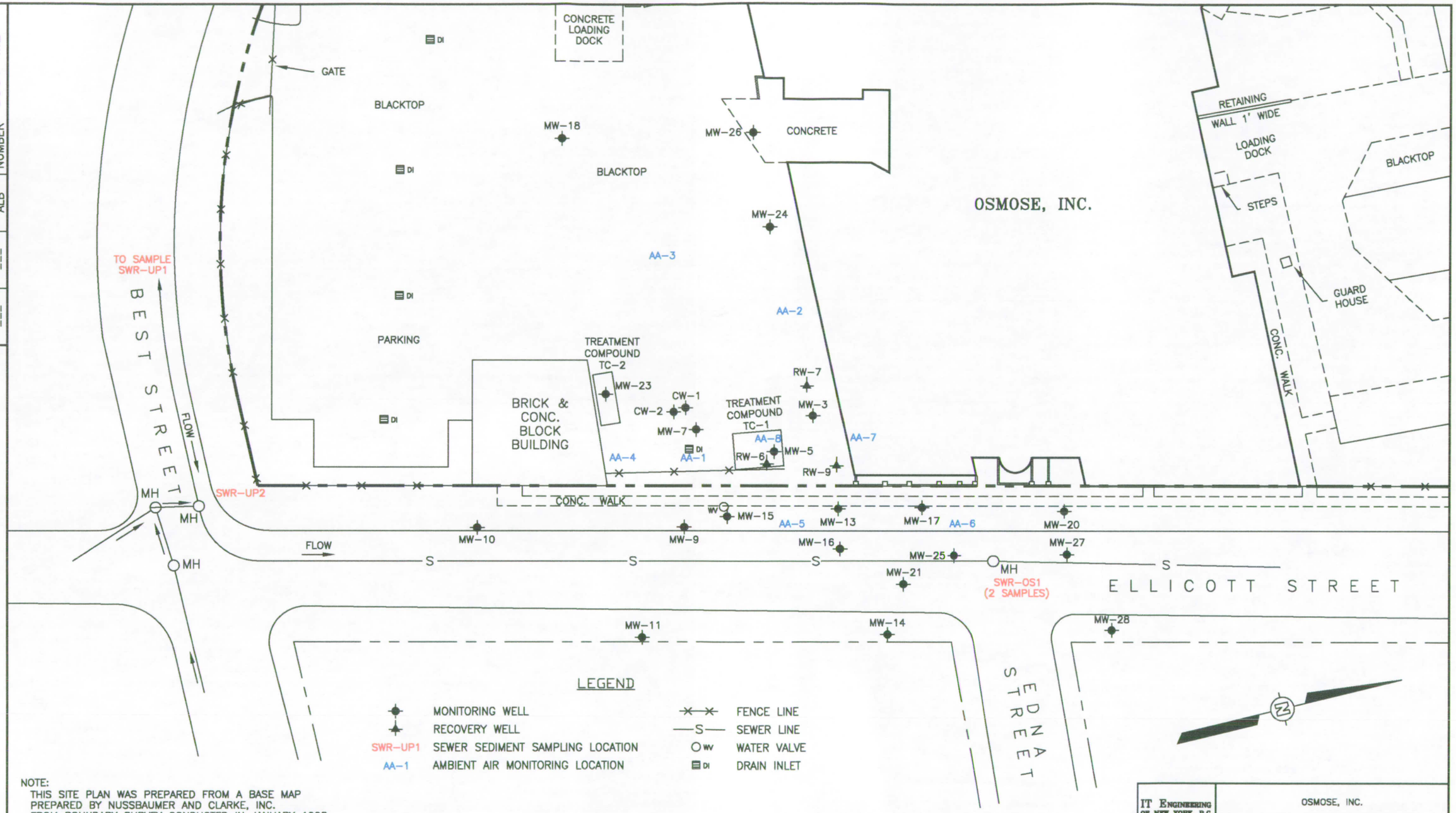

NOTE:
THIS SITE PLAN WAS PREPARED FROM A BASE MAP PREPARED BY NUSSBAUMER AND CLARKE, INC. FROM BOUNDARY SURVEY CONDUCTED IN JANUARY 1998.

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APPROXIMATE SCALE
SCALE
0 40 80 FEET

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE

IT ENGINEERING OF NEW YORK, P.C.
13 BRITISH AMERICAN BLVD.
ALBANY, NY 12110
(518) 783-1899

OSMOSE, INC.

MONITORING LOCATIONS

ELLICOTT STREET
BUFFALO, NEW YORK

DESIGNED BY	BWA	11/3/99	CHECKED BY		
DRAWN BY	DEO	11/4/99	APPROVED BY		

SCALE:	FIGURE	SHEET NO.	REVISION NO.
1" = 40'	5-1		

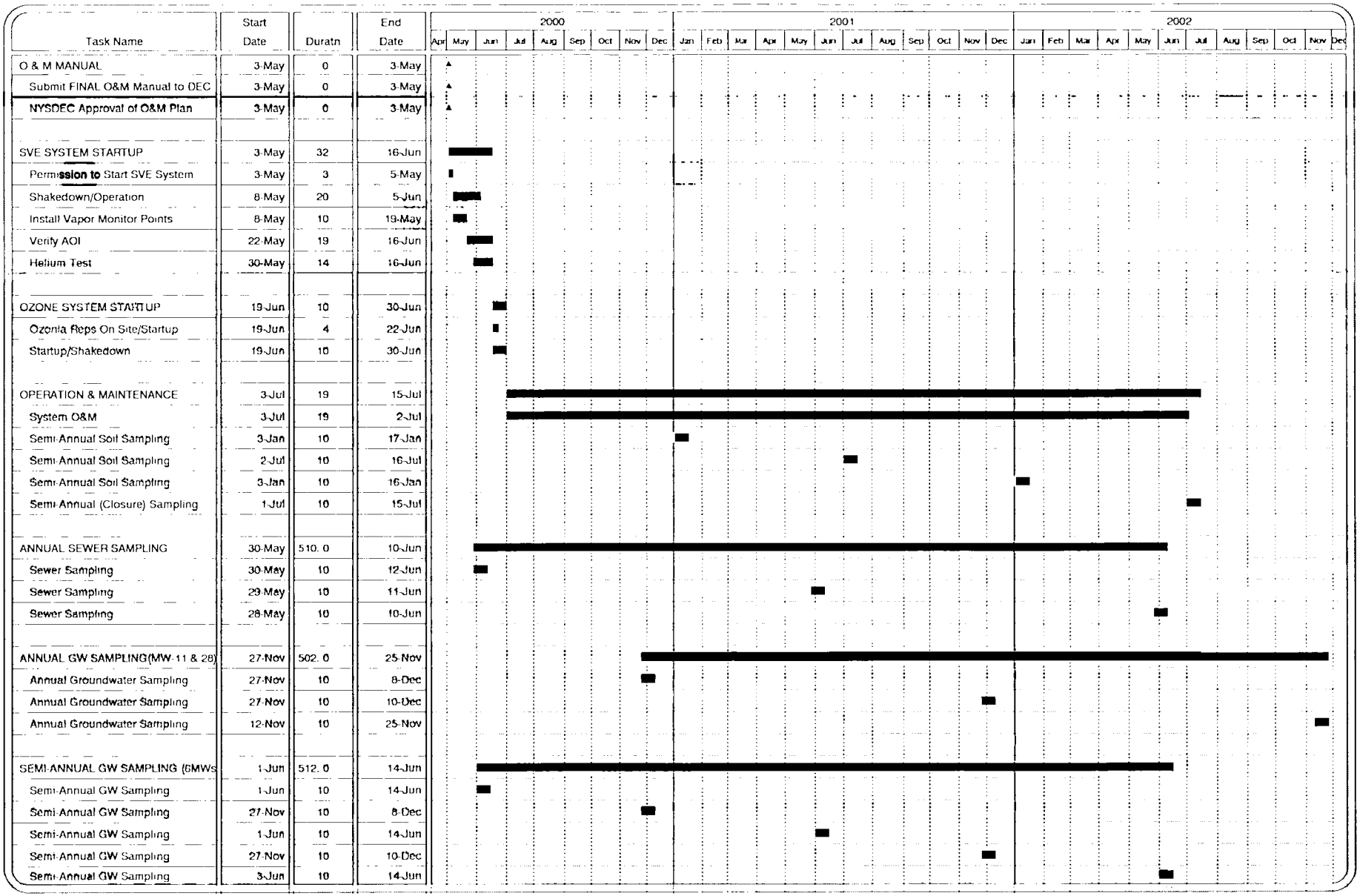
Figure 8-1
Revision R-1

Osmose, Inc

PROJECT TIMELINE

(2-Year)

April 27, 2000



Task Name	Start Date	Duratn	End Date
O & M MANUAL	3-May	0	3-May
Submit FINAL O&M Manual to DEC	3-May	0	3-May
NYSDEC Approval of O&M Plan	3-May	0	3-May
SVE SYSTEM STARTUP	3-May	32	16-Jun
Permission to Start SVE System	3-May	3	5-May
Shakedown/Operation	8-May	20	5-Jun
Install Vapor Monitor Points	8-May	10	19-May
Verify AOI	22-May	19	16-Jun
Helium Test	30-May	14	16-Jun
OZONE SYSTEM STARTUP	19-Jun	10	30-Jun
Ozonia Reps On Site/Startup	19-Jun	4	22-Jun
Startup/Shakedown	19-Jun	10	30-Jun
OPERATION & MAINTENANCE	3-Jul	19	15-Jul
System O&M	3-Jul	19	2-Jul
Semi-Annual Soil Sampling	3-Jan	10	17-Jan
Semi-Annual Soil Sampling	2-Jul	10	16-Jul
Semi-Annual Soil Sampling	3-Jan	10	16-Jan
Semi-Annual (Closure) Sampling	1-Jul	10	15-Jul
ANNUAL SEWER SAMPLING	30-May	510. 0	10-Jun
Sewer Sampling	30-May	10	12-Jun
Sewer Sampling	29-May	10	11-Jun
Sewer Sampling	28-May	10	10-Jun
ANNUAL GW SAMPLING(MW-11 & 28)	27-Nov	502. 0	25-Nov
Annual Groundwater Sampling	27-Nov	10	8-Dec
Annual Groundwater Sampling	27-Nov	10	10-Dec
Annual Groundwater Sampling	12-Nov	10	25-Nov
SEMI-ANNUAL GW SAMPLING (6MWs	1-Jun	512. 0	14-Jun
Semi-Annual GW Sampling	1-Jun	10	14-Jun
Semi-Annual GW Sampling	27-Nov	10	8-Dec
Semi-Annual GW Sampling	1-Jun	10	14-Jun
Semi-Annual GW Sampling	27-Nov	10	10-Dec
Semi-Annual GW Sampling	3-Jun	10	14-Jun

TABLES

TABLES

Table 1.0
Air Sparge and Vapor Extraction Well Construction Details

Well Type	Well I.D.	Diameter	Depth to Bottom (ft)	Screened Interval	Materials of Constrction	Slot Size (in)	Design Flow Rate (cfm)
Air Sparge Wells	O-1	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-2	2-inch	8.3	6.0 - 8.5	304 SS	0.010	6 - 10
	O-3	2-inch	25.1	22.5 – 25.1	304 SS	0.010	6 - 10
	O-4	2-inch	9.3	6.5 – 9.3	304 SS	0.010	6 - 10
	O-5	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-6	2-inch	8.4	6.0 – 8.0	304 SS	0.010	6 - 10
	O-7	2-inch	25.4	22.5 – 25.4	304 SS	0.010	6 - 10
	O-8	2-inch	9.3	6.8 – 9.3	304 SS	0.010	6 - 10
	O-9	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-10	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-11	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-12	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-13	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-14	2-inch	24.5	22.0 – 24.5	304 SS	0.010	6 - 10
	O-15	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-16	2-inch	24.8	22.3 – 24.8	304 SS	0.010	6 - 10
	O-17	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-18	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-19	2-inch	25.0	22.5 – 25.0	304 SS	0.010	6 - 10
	O-20	2-inch	25.5	23.0 – 25.5	304 SS	0.010	6 - 10
Soil Vapor Extraction Wells	E-1	4-inch	10.0	4.0 – 9.0	Sch 40 PVC	0.020	20
	E-2	4-inch	10.0	4.0 – 9.0	Sch 40 PVC	0.020	20
	E-3	4-inch	18.0	12.0 – 17.0	Sch 40 PVC	0.020	30
	E-4	4-inch	17.5	11.0 – 16.5	Sch 40 PVC	0.020	30
	E-5	4-inch	10.0	4.0 – 9.0	Sch 40 PVC	0.020	20
	E-6	4-inch	18.0	12.0 – 17.0	Sch 40 PVC	0.020	30
	E-7	4-inch	18.0	12.0 – 17.0	Sch 40 PVC	0.020	30
	E-8	4-inch	10.0	4.0 – 9.0	Sch 40 PVC	0.020	20
	E-9	4-inch	18.0	12.0 – 17.0	Sch 40 PVC	0.020	15
	E-10	4-inch	17.0	11.0 – 16.0	Sch 40 PVC	0.020	20
	E-11	4-inch	17.0	11.0 – 16.0	Sch 40 PVC	0.020	20
	E-12	4-inch	17.0	11.0 – 16.0	Sch 40 PVC	0.020	15
	E-13	4-inch	17.0	11.0 – 16.0	Sch 40 PVC	0.020	20
	E-14	4-inch	16.0	10.0 – 15.0	Sch 40 PVC	0.020	20
	E-15	4-inch	17.0	11.0 – 16.0	Sch 40 PVC	0.020	15
	E-16	4-inch	17.0	11.0 – 16.0	Sch 40 PVC	0.020	20
	E-17	4-inch	17.0	11.0 – 16.0	Sch 40 PVC	0.020	15
	E-18	4-inch	15.0	9.0 – 14.0	Sch 40 PVC	0.020	15
	E-19	4-inch	16.0	10.0 – 15.0	Sch 40 PVC	0.020	15
	E-20	4-inch	15.0	9.0 – 14.0	Sch 40 PVC	0.020	15
	E-21	4-inch	17.0	11.0 – 16.0	Sch 40 PVC	0.020	30
	E-22	4-inch	16.0	10.0 – 15.0	Sch 40 PVC	0.020	30
	E-23	4-inch	18.0	12.0 – 17.0	Sch 40 PVC	0.020	30

Table 2.0
Recovery Wells
Construction Details and Pump Settings

Well I.D.	Well Dia. (inches)	Material Of Constrctn	Depth to Bottom (ft below grade)	Top of Casing Elevation (ft)	Screened Interval (ft. below grade)	Pump Type	Pump Intake Setting (D.T.W, ft)	Anticipated Drawdown (ft)	Design Flowrate (gpm)
RW-1A	6	FRE	31.1'	Tbd	15' – 25'	4" QED	14	6	0.1
RW-2A	6	FRE	30.3'	Tbd	15' – 25'	4" QED	16	6	0.1
RW-3A	6	FRE	29.9'	Tbd	15' – 25'	4" QED	18	8	1.2
RW-4A	6	FRE	30.0'	Tbd	15' – 25'	4" QED	17	8	0.1
RW-5A	6	FRE	30.0'	Tbd	15' – 25'	4" BK	17	8	0.1
RW-6A	6	FRE	25.0'	Tbd	3' – 25'	2" QED	11	4	0.1
RW-7A	6	FRE	28.0'	Tbd	15' – 25'	4" BK	15	6	0.1
RW-8A	6	FRE	29.6'	Tbd	14.6' – 24'	4" QED	18	8	0.2
RW-9A	6	FRE	28.2'	Tbd	3' – 25'	4: BK	11	4	0.1
RW-10A	6	FRE	30.0'	Tbd	15' – 25'	2" QED	9.5	3.5	0.1
RW-11A	6	FRE	29.9'	Tbd	15' – 25'	2" QED	9.5	3.5	0.1

BK - Brainard Kilman
FRE - fiberglass reinforced epoxy
tbd - to be determined

A sump, approximately five feet in length was installed at the bottom of each recovery well.

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Table 3.0
Equipment Specifications

Tag #	Equipment Description	Quantity	Specifications	Supplier
K-100	Rotary Screw Compressor	1	**Capacity:** 61 cfm free air **Motor:** 15HP/480V/3 Phase **Controls:** Elektronikon panel **Filter:** Combination regulator/filter on discharge tank **Mfr.:** Atlas Copco **Model No.:** GA-11	Ozonia
FM-401 through FM-411	Flow Meters	11	**Capacity:** 1-50 gpm **Material:** Bronze **Connections:** 3/4" NPT, end connections **Mfr.:** Master Meter **Model No.:** MM4L-01	MSC
BF-400	Bag Filter	1	**Capacity:** 150 psi **Material:** Stainless Steel **Connections:** 1" Quick Disconnects **Mfr.:** Filtration Systems Mechanical Mfg. Co. **Model No.:** CF-8M	
K-300, F-300, PF-300	SVE Blower System	1	**Capacity:** 600 scfm at 25"WC **Motor:** 15HP/480V/3 Phase **Moisture Separator (F-300):** 30 gal capacity **Filter (PF-300):** inline particulate filter **Controls:** starter for blower, high level cut-off in separator, vacuum relief valve, discharge silencer, effluent flow meter **Model No.:** EN-909	Tri-Line Corp.
LS-400	Flow Switch	1	**Set Point:** Variable **Mfr.:** Columbus Electric **Model:** Grainger 2E462	Grainger
GC1, GC2, GC3	Granular Activated Carbon Contactors	3	**Nominal Flow Capacity:** 10 gpm **Media:** Regenerated liquid phase granular activated carbon (LGAC) **LGAC Capacity:** 200 pounds **Model No.:** 200 HP	Carbon Service Company
H-1	Heater	1	**Capacity:** 77,000 Btu/hr **Type:** Natural Gas **Mfr.:** Sterling **Model No.:** CF-100	
H-2	Heater	1	**Capacity:** 3 Kwh **Type:** Electric **Mfr.:** Q-Mark **Model No.:** MUH-0341	Grainger
VF-1	Ventilation Fan	1	**Dimensions:** 16" Diameter Venturi **Power:** 115V, 1 phase, 1.8 A, 1/20 Hp **Mfr.:** Dayton **Model No.:** 4C007D	Grainger
SP-1	Sump Pump	1	**Capacity:** 1020 gph @ 20' head **Power:** 120 V, 1 phase **Mfr.:** Goulds Pumps **Model No.:** SPO35MC	McMaster Carr 42945K21

Table 3.0 (Continued)
Equipment Specifications

Tag #	Equipment Description	Quantity	Specifications	Supplier
E-200	Recirculating Chiller	1	**Capacity:** 20,600 Btu/h **Comp. Power:** 1.5 Hp/14.5 A/230V/3 phase **Transfer Pump Power:** 1/3 Hp **Recirc. Rate:** 3 gpm **Mfr.:** Pioneer **Model No.:** C180A	Glauber Equipment Co.
M-200	Inline Ozone Gas Analyzer/Sensor	1	**Capacity:** 0-125 g/m^3 **Mfr.:** IN USA, Inc. **Model No.:** H1-X	Ozonia
A-102	Ambient Ozone Gas Monitor	1	**Capacity:** 0-2 ppm **Alarm:** ___% **Mfr.:** Analytical Technology, Inc. **Model No.:** 14	Ozonia
A-102	Ambient Oxygen Gas Monitor	1	**Capacity:** 0-25% **Alarm:** 22% **Mfr.:** Analytical Technology, Inc. **Model No.:** 19	Ozonia
M-210	Inline Dewpoint Sensor	1	**Capacity:** -80 to 20 degrees C **Mfr.:** Panametrics **Model No.:** Series 5	Ozonia
F-100	Oxygen Separator	1	**Capacity:** 180 scfh of 93% Oxygen at 70 psi **Power Req.:** 120 V/1.5 A **Feed Red.:** 90-150 psi air **Mfr.:** AirSep **Model No.:** AS-250	Ozonia
R-200	Ozone Generator	1	**Capacity:** 500 g O_3/h **Power Req.:** 4.3 kVA **Feed Red.:** 5.84 m^3/h **Mfr.:** Ozonia **Model No.:** OZAT CFS-6A	Ozonia
Multiple	Ozone Solenoid Valves	20	**Dimension:** 1/2" **Material:** Stainless Steel **Power Req.:** 120 V, 1 phase **Mfr.:** Asco **Model No.:** 8210G87E	Power Drives Inc.
WTDP-1, WTDP-2, WTDP-3, WTDP-4, WTDP-8	Water Table Depression Pump	5	**Capacity:** 10 gpm **Dimensions:** 4" diameter **Power:** 80 psi compressed air, 3.5 cfm **Mfr.:** QED **Model No.:** H45SET	QED
WTDP-6, WTDP-10, WTDP-11	Water Table Depression Pump	3	**Capacity:** 10 gpm **Dimensions:** 2" diameter **Power:** 80 psi compressed air, ~3 cfm **Mfr.:** QED **Model No.:** H25SET	QED
WTDP-5, WTDP-7, WTDP-8, WTDP-9	Water Table Depression Pump	4	**Capacity:** 10 gpm **Dimensions:** 4" diameter **Power:** 80 psi compressed air, 1 cfm **Mfr.:** Brainard Kilman **Model No.:** Evacuator II	Brainard-Kilman

Table 3.0 (Continued)
Equipment Specifications

Tag #	Equipment Description	Quantity	Specifications	Supplier
OWS-400	Oil/Water Separator	1	**Capacity**: 10 gpm **Supplier**: Hudson Industries **Model No.**: CS-10H	Hudson Ind.
ET-400	Equilization Tank	1	**Capacity**: 500 gallons **Dimensions**: 46" tall x 76" Dia. **Supplier**: Chemtainer	Corr-Tech
TP-400	Transfer Pump	1	**Capacity**: **Power**: 120v, 1 Phase **Model #**:	

List of Abbreviations:

A	=	amps
Cfm	=	cubic feet per minute
Dia	=	diameter
H	=	high
HP	=	horsepower
NPT	=	National Pipe Thread
NYSEG	=	New York State Electric & Gas
Psi	=	pounds per square inch
PVC	=	polyvinyl chloride
Scfm	=	standard cubic feet per minute
SVE	=	soil vapor extraction
V	=	volts
"WC	=	inches water column
rpm	=	rotations per minute

Table 4.0
Maintenance Tasks

Component	Designation	Maintenance Activity	Maintenance Schedule
I. Groundwater Dewatering and Treatment System			
Oil/Water Separator	OSW-400	Inspect contents- drain sediments or LNAPL as required; record vol. of LNAPL recovered	Monthly
Equalization Tank	ET-400	Inspect contents- have sediments pumped out as necessary Clean probes	Monthly Bi-weekly
Bag Filter	BF-400	Change bag filters as required	bi-weekly
Granular Activated Carbon Filters	GC-1, GC-2, GC-3	Inspect for leaks, back pressure; change as indicated by monthly removal efficiency data	Monthly
Groundwater Depression Pumps	WTDP-1 through WTDP-11	Verify operation of each pump; repair as required.	Monthly
II. Soil Vapor Extraction System			
Soil Vapor Extraction Blower	K-300	Verify impeller is rotating freely Verify maximum pressures at PI-312 & PI-314 are not exceeded	Monthly bi-weekly
Particulate Filter	PF-300	Check for silt, clean as necessary	bi-weekly
Ozone Reducing Catalyst	R-300	Inspect for leaks, back pressure; change as indicated by air quality data	bi-weekly
III. Ozone Sparging System			
Air Compressor	K-100	Check in-line filters Change oil in compressor	Monthly Bi-monthly
Flowmeter	FM-200	Check for moisture, clean as necessary	
System Piping/Connections	--	Tightness testing on complete installation	semi-annually
Ambient Ozone Monitor	--	Check ambient ozone monitor/calibrate as necessary	quarterly
Breathing Apparatus	--	Check for dust, change as required	monthly
Electrical Connections	--	Check/tighten all electrical connection screws	annually
IV. Interlocks/Overrides			
Safety Interlocks	I-1 through I-7	Test	Semi-annually

bi-weekly = every second week
bi-monthly = every second month

Table 5.0
Monitoring Tasks

Parameter	Sampling Location	Analysis	Activity	Schedule
I. Groundwater Dewatering and Treatment System				
PAHs/VOCs	SP-4, SP-5, SP-5A SP-6	Laboratory EPA 8310 EPA 602	Sample before, between, and after LGAC units to track removal efficiency	Monthly
PAHs/VOCs	SP-6	Laboratory EPA 602 EPA 625	Sample after LGAC units for semi-annual BSA reporting	Semi-annual (April & Oct)
Flowrate	FM-400 (Total flowrate) FM-401 through FM-411	Field	Record flow from each RW and total system	Monthly
Pressure	PI-400, PI-410, PI-420, PI-430	Field	Record line pressures along treatment process	Monthly
Depth to Groundwater	MW- 5, MW-7, MW-13, MW-15, MW-16, MW-17, MW-3, MW-24, MW-25	Field IP	Record depth to groundwater	quarterly
II. SVE System / Ozone Reducing Catalyst				
VOC Concentration	SP-E1 through SP-E23 Trunk Influent Line SP-7 Trunk Effluent Line SP-8	PID PID PID or Tedlar Bag*	Record VOCs in each leg Record VOCs in trunk VOCs in effluent (PID or Lab analysis by T03)	Quarterly Monthly Monthly
Ozone Concentration	Trunk Influent Line SP-7 Trunk Effluent Line SP-8	Dragger-type tube	Record O_3 in trunk line Record O_3 in effluent line	Bi-weekly Bi-weekly
Pressure / Vacuum	PI-E001 through PI-E023 PI-314 Trunk Influent Line PI-312 Trunk Effluent Line PI-314	Field Field Field Field	Record vacuum for each line Record influent pressure to catalyst Record Vacuum Record Vacuum	Monthly Bi-weekly Monthly Monthly
Air Flow	SP-E1 through SP-E23 Trunk Effluent Line SP-8	Flowmeter Flowmeter	Record flows, adjust to desired flow Measure and record flow	Monthly Monthly

* Tedlar bags will be used until a database has been developed

Table 5.0 (continued)

Parameter	Sampling Location	Analysis	Activity	Schedule
III. Ozone Sparging System				
Pressure	PI-O-1 through PI-O-20	Field	Record pressure; adjust as required	Bi-Weekly*
Ozone Injection Rate	FM-200	Field	Record flow, adjust needle valve at each sparge point to desired flow	Monthly
Dew Point	R-200; display panel	Field	Record dew point	Bi-weekly
DC-Power (Pe)	R-200; display panel	Field	Record DC rating Pe	Bi-weekly
Run Time	R-200; display panel	Field	Record Service Hour Counter readout	Bi-weekly
Pressure	R-200; display gauge	Field	Record gas pressure within the O_3 generator from Gas Pressure Gauge	Bi-weekly
Gas Flowrate (Vn)	R-200;gas flow meter	Field	Record gas flow (Vn) from flow meter	Bi-weekly
IV. Ambient Air Monitoring				
O_3	AA-1 (Sewer manhole South of TC-1), AA-2, AA-3, AA-4 (parking lot), AA-5, AA-6 (in front of Osmose facility)	Dragger-type tubes	Record O_3 levels	Bi-weekly
O_3	AA-7 (Indoor Air at Osmose facility)	Stationary Monitor	Record O_3 levels on log - prior to office hours - prior to lunch - prior to end of day	Daily (Mon- Fri)
VOCs	AA-1 (Sewer manhole) AA-8 (inside TC-1)	PID	Record VOC level on log	Bi-weekly

Table 6.0
Safety Interlocks

Interlock	Description
I-1	With ozone generator (R-200) and vapor extraction blower (K-300) operating, if blower K-300 shuts down, or gas alarms are registered, the ozone generator will shut down
I-2	If the ventilation fan (E-100) shuts off, the ozone generator (R-200) will shut down
I-3	If liquid level in the moisture separator (F-300) raises to the level of the high level switch (LSH-300), condensate pump (P-300) is started and will operate until liquid level drops below low level switch LSL-300.
I-4	With vapor extraction blower (K-300) operating, if water level in the moisture separator (F-300) raises to the high-high level switch (LSHH-300), blower K-33 will shut down.
I-5	When the liquid level in the 500 gal equilization tank (ET-400) raises to the level of the high level switch (LSH-400); transfer pump P-400 is started.
I-6	If the oxygen concentration exceeds 22%, and/or ozone is detected in the treatment compound air by the ambient air monitor (AE-102), the ozone generator will shut down, the solenoid valve (SV-100) controlling the oxygen flow to the generator will close, and the autodialer (UA-100) will send a facsimile notification message.
I-7	If the liquid level in the 500 gal equalization tank (ET-400) raises to the level of the high-high level switch (LSHH-400), the down well pumps will be shut off

APPENDIX A

APPENDIX A

WELL LOGS

Drilling Log

IT CORPORATION
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Monitoring Well **RW-1**

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *31.1 ft.* Diameter *14 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *6 in.* Length *10 ft.* Type/Size *0.010 Slot PRE in.*
Casing: Dia *6 in.* Length *5 ft.* Type *PRE*
Fill Material *Morie #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/SSP*
Driller *Bill Rice* Log By *KC/LKM* Date *3/29/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt
						0-2': No sampling; 3 1/4' HSA advanced.
2					SM	2-4': Very moist, loose silty sand, dark brown to black with little angular gravel (3") over very moist to moist brown firm silty clay, clayey silt with gray mottling, trace fine sand, fine gravel. No stains or odor.
4		ND	2/3/5/8			4-6': Moist firm to stiff, olive brown silty clay-clayey silt with occ gray mottling, trace fine gravel. Note: 0.1' brown loose very moist fine sand, no stain or odor.
6		ND	6/8/8/9		OH	6-8': Saturated, loose, brown fine sand with little silt, loose, fine sand with little silt, clay over damp stiff reddish brown silty clay, plastic, occ. gray mottling, no stain or odor.
8		ND	7/12/8/9		SM	8-10': Damp to moist reddish brown to brown silty clay, same as above to ~9' creosote odor detected below 8.5'. Wet, soft silty sand, odor and traces of product.
10		9.9 52	10/8/7/7		OH	10-12': Stiff brown mottled silty clay, no odor grading to wet brown soft fine sand with trace silt, creosote odor and traces of product, liquifies when disturbed.
12		15.2	4/3/4/8			12-14': Saturated brown fine sand, trace silt with occ. dark gray mottling. Creosote odor and traces of product throughout.
14		4.4	7/8/7/7			14-16': Saturated, compact brown fine sand, trace silt.
16		4.3	4/6/8/9			16-18': Same as above, wet, soft brown sandy clay, plastic with slight creosote odor, no product film.
18		1.3	15/8/5/5		SC	18-20': Very soft brown to olive brown, wet, clayey sand grading to sandy clay, trace silt, fine gravel, slight creosote odor.
20		0.9	WH/WH/1/1			20-22': Loose, wet, olive brown, fine sand with little clay, trace silt, grades to clayey sand-sandy clay with little silt, slight creosote odor.
22		0.8	3/2/3/5			22-24': Loose, wet olive brown clayey sand, loose wet fine sand, trace-little silt, faint odor.
24		0.8	4/5/3/3			

Drilling Log

IT CORPORATION
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Monitoring Well **RW-1**

Project: Osmose, Buffalo Owner: Osmose, Inc.
Location: 980 Ellicott Street, Buffalo, New York Proj. No. 111080681

Depth (Ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		ND	WH/WH/5/7			SC	24-26': Wet, loose, olive brown fine sand with some clay grades to fine sand, trace clayey silt, no odor.
26		ND	WH/WH/2/1				26-28': Wet to saturated, olive brown fine silty sand, trace clay, fine gravel, no odor.
28		ND	WH/WH/WH/1				28-31.1': Same as above with little clay, no odor.
30							
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

IT CORPORATION
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Monitoring Well RW-2

Project: Osmose, Buffalo — Owner: Osmose, Inc.
Location: 980 Ellicott Street, Buffalo, New York — Proj. No. 111108061
Surface Elev. ____ — Total Hole Depth 30.3 ft. — Diameter 14 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 6 in. — Length 10 ft. — Type/Size 0.010 Slot FRE in.
Casing: Dia 6 in. — Length 5 ft. — Type FRE
Fill Material ____ — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/SSP
Driller B.Rice/J.Percy — Log By KC/LKM — Date 04/01/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt
2						GC	0-7': Gravel backfill over clay, silt, sand w/slag, brick fragments over moist firm to stiff moist brown clay silt-silty clay w/little fine gravel fine sand, no staining or odor.
4							
6		ND		3/8/5/7			5-7': Moist stiff reddish brown silty clay-clayey silt w/trace fine gravel, fine sand, occ gray mottling, no stain or odor.
8		ND		7/8/10/11		CL	7-9': Same as above.
10		ND		3/4/4/3			9-11': Silty clay-clayey silt, same as above over moist to very moist brown fine silty sand, trace to little clay, trace fine gravel, no staining or odor.
12		ND		4/7/8/7			11-13': Wet, silty sand, same as above, no stain or odor.
14		ND		3/5/3/5		SC	13-15': Same as above, no stain or odor.
16		0.4		3/4/5/5			15-17': Same as above.
18		0.2		9/8/3/2			17-19': Wet, compact brown fine silty sand w/trace to little clay grades to wet loose fine sand w/little silt, trace clay, coarse gravel, no stain or odor.
20		ND		WH/2/3/2		SM	19-21': Wet very loose brown fine silty sand w/little to some clay trace fine gravel occ thin zones of fine sand w/little silty, clay, no stain or odor.
22		0.3		2/2/4/8			21-23': Same as above, no stain or odor.
24		0.1		WH/WH/1/1			23-25': Same as above, no stain or odor.

Drilling Log

IT CORPORATION
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Monitoring Well **RW-2**

Project: *Osmose, Buffalo* Owner: *Osmose, Inc.*
Location: *980 Ellicott Street, Buffalo, New York* Proj. No. *111080061*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		0.1		WH/WH/1/1			25–27': Wet very loose brown to grayish brown fine silty sand w/little to some clay, trace fine gravel, no stain or odor.
26		ND		WH/1/2/1		SM	27–30.3': Same as above.
28		ND		WH/WH/WH/WH			
30							
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

IT CORPORATION
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Monitoring Well **RW-3**

Project: Osmose, Buffalo Owner: Osmose, Inc.
Location: 980 Ellicott Street, Buffalo, New York Proj. No. 111080061
Surface Elev. ____ Total Hole Depth: 29.9 ft. Diameter ____
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia 6 in. Length 10 ft. Type/Size 0.010 Slot FRE in.
Casing: Dia 6 in. Length 5 ft. Type FRE
Fill Material: #0 Sand Rig/Core: CME 75
Drill Co.: Parratt Wolff Method: HSA/SSP
Driller: Joe Percy Log By: KC/LKM Date: 04/01/99 Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Installed 6" FRE well 4/20/99.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt
2					GC	0-4': Brown silt, clay, gravel fill over moist brown silty clay-clayey silt.
4		ND	9/11/6/8			4-6': Moist stiff brown silty clay-clayey silt w/trace fine sand, fine gravel, no stain or odor.
6		ND	11/11/15/10		CL	6-8': Same as above, no stain or odor.
8		ND	4/7/6/7			8-10': Same as above, somewhat softer where moisture content becoming very moist.
10		0.2	3/3/4/4		SC	10-12': Silty clay-clayey silt, same as above, grades to wet brown fine silty sand-sandy silt w/trace to little clay, fine gravel, no stain or odor.
12		0.2	4/8/5/8			12-14': Same as above, no stain or odor.
14		ND	4/4/7/8			14-16': Same as above, no stain or odor.
16		0.4	27/21/13/7			16-18': Same as above, fine to coarse black angular gravel, no stain or odor.
18		0.8	1/1/1/2		SM	18-20': wet very soft brown fine sandy s t-silty sand w/little to some clay, trace fine gravel, no stain or odor.
20		ND	WH/1/1/2			20-22': Same as above, very loose, no stain or odor.
22		0.4	2/3/2/3			22-24': Same as above, no stain or odor.
24					SC	

Drilling Log

IT CORPORATION
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Monitoring Well **RW-3**

Project: Osmose, Buffalo Owner: Osmose, Inc.
Location: 980 Ellicott Street, Buffalo, New York Proj. No. 111108061

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		ND	1/1/1/1			SC	24–26': Wet brown sand w/some silt and little clay, wet sandy clay w/ some silt, no stain or odor.
26		ND	3/4/3/2			SM	26–28': Saturated sand w/some silt, trace clay and trace gravel, no stain or odor.
28		ND	1/1/4/9			SC	28–29.9': Wet, soft silty clay–clayey silt w/some fine to coarse subangular to subround gravel, little fine sand, no stain or odor.
30							
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

IT CORPORATION
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Monitoring Well RW-4

Project: Osmose, Buffalo — Owner: Osmose, Inc.
Location: 980 Ellicott Street, Buffalo, New York — Proj. No. 111108061
Surface Elev. ____ — Total Hole Depth: 30 ft. — Diameter: 14 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 6 in. — Length: 10 ft. — Type/Size: 0.010 Slot FRE in.
Casing: Dia 6 in. — Length: 5 ft. — Type: FRE
Fill Material: Morie #0 — Rig/Core: CME 75
Drill Co.: Parratt Wolff — Method: HSA/SSP
Driller: B.Rice/J.Percy — Log By: KC/LKM — Date: 3/30/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

Installed 6" FRE on 4/19/99.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt
							0-6': No sampling; advanced 3 1/4"HSA to 6'BGS (Bicce'll).
2							
4							
6							6-8': Saturated, black to brown loose, sand, silt, clay with little fine to corase gravel, HDPE liner, creosote odor.
8		3.3		2/2/3/2			8-10': Same as above, fine, subround gravel (fill), creosote odor.
10		3.4		4/3/3/2		GC	10-12': Hit hard obstruction at 10.7', wet, loose fine subround gravel , loose brown fine sand with film and odor, little silty clay, black stained concrete/asphalt with creosote odor.
12		54		3-50/.2			12-14': Wet fine gravel (fill) over wet, loose brown fine silty sand, with creosote odor, sheen and occ. brown span of product/creosote.
14		1.0		2/3/4/4			14-16': Wet, compact fine silty sand with trace fine subround gravel, creosote odor.
16		3.2		4/7/7/10			16-18': Saturated brown fine sandy silt-silty sand, over saturated fine subangular to subround gravel and silty sand, over wet compact fine silty sand, creosote odor.
18		3.7		14/22/ 12/10			18-20': Wet soft silty clay little fine subround gravel grades to fine sandy silt, silty sand, very loose with creosote odor.
20		5.1		1/1/1/1			20-22': Wet, very soft brown fine sandy silt-silty sand with slight creosote odor.
22		0.5		1/7/2/1		SM	22-24': Wet, very loose brown fine silty sand-sancy silt with trace clay, faint creosote odor.
24		0.5		2/2/2/2		GC	

Drilling Log

IT CORPORATION
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Monitoring Well **RW-4**

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *111108061*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24						24–26': Wet, very dense fine silty sand–sandy silt with little clay fine subround gravel, faint creosote odor.
26		0.4	1/0/1/1			26–28': Same as above, trace fine to coarse subround gravel.
28		0.8	WH/1/1/1		GC	28–30': Wet, very soft brown fine sandy silt–silty sand with little clay, trace of subround gravel grades to very soft brown silt, clay sith trace to little fine subround gravel, faint creosote odor.
30		0.8	WH/WH/ /WH/WH			
32						
34						
36						
38						
40						
42						
44						
46						
48						
50						
52						
54						
56						

Drilling Log

IT CORPORATION
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Monitoring Well **RW-5**

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 111108061
Surface Elev. ____ — Total Hole Depth 30 ft. — Diameter 14 in.
Top of Casing ____ — Water Level: Initial ____ — Static ____
Screen: Dia 6 in. — Length 10 ft. — Type/Size 0.010 Slot FRE in.
Casing: Dia 6 in. — Length 5 ft. — Type FRE
Fill Material Morie #0 Sand — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/SSP
Driller B.Rice/J.Percy — Log By KC/LKM — Date 3/30/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

Install 5" well on 4/20/99.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt
							0-6': No sampling; advanced 3 1/4'HSA to 6'BGS (in Biocell).
2							
4							
6						GC	6-8': Wet, soft, brown silty-clay with some fine gravel/subround to subangular with creosote odor.
		4.7		WH/3/2/4			
8							8-10': Saturated grayish brown fine sand overlaying a black HDPE liner, fine loose subround gravel fill, firm wet silty clay, grayish brown creosote, sheen.
		8.9		2/2/2/1			
10							10-12': Wet, loose brown silt fine sand, with creosote odor.
		4.1		2/2/2/3			
12						SM	12-14': Wet, loose brown silt fine sand, trace clay with creosote odor.
		5.4		4/5/3/7			
14							14-16': Wet compact brown fine sand, trace silt, subround fine gravel, creosote odor.
		1.1		5/7/15/10			
16						GC	16-18': Same as above, loose over firm brown clayey silt-silty clay with occ. gray mottling, faint creosote odor.
		2.0		5/4/1/2			
18							18-20': Wet loose brown fine sand trace to little clay, silt, trace subround fine grave., faint creosote odor.
		0.8		1/3/2/8			
20						SM	20-22': Same as above grades to wet loose brown fine sand, trace silt.
		1.5		5/4/4/7			
22							22-24': Wet compact brown silty sand with trace clay, coarse subangular gravel grades to wet loose brown fine sand trace silt odor.
		1.1		8/11/5/4		GC	
24						SC	

Drilling Log

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Monitoring Well **RW-5**

Project: *Osmose, Buffalo* Owner: *Osmose, Inc.*
Location: *980 Ellicott Street, Buffalo, New York* Proj. No. *111108061*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		0.3	3/1/1/2		SC	24-26': Wet, very loose brown fine silty sand trace clay, creosote odor.
26		0.1	WH/WH/1/2			26-28': Wet, very loose brown fine silty sand to clayey sand, faint creosote odor.
28		ND8	WH/WH/ /WH/1			28-30': Wet, very loose brown fine clayey sand-sandy clay, faint creosote odor.
30						
32						
34						
36						
38						
40						
42						
44						
46						
48						
50						
52						
54						
56						

Drilling Log

IT CORPORATION
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Monitoring Well **RW-8**

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *29.6 ft.* Diameter *14 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *6 in.* Length *10 ft.* Type/Size *0.010 FRE in.*
Casing: Dia *6 in.* Length ____ Type *FRE*
Fill Material: *Morie #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA*
Driller *Bill Rice* Log By *KC/LKM* Date *3/30/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Installed 6" well 4/13/99.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt
						0-2': No sampling.
2					GC	2-4': Moist stiff brown to reddish brown silty clay, occ. gray mottling, trace fine gravel, no stain or odor.
		ND	4/4/7/8			
4						4-6': Silty clay, same as above, wet, loose fine grained sand, moist reddish brown stiff silty clay, no stain or odor.
		ND	6/8/10/11			
6					OH	6-8': Wet, loose brown silty fine sand, no stain or odor, moist stiff reddish brown silty clay with occ. gray mottling, no stain or odor.
		ND	13/13/15/12			
8						8-10': Silty clay, same as above, over very moist brown compact silty sand, little clay, slight solvent odor, silty clay.
		74	5/7/7/8			
10						10-12': Moist becoming wet, loose silty sand, little to some clay with slight solvent odor.
		0.8	3/3/3/4			
12						12-14': wet, loose brown fine silty sand, trace clay, no stain or odor.
		0.3	3/4/3/2		SM	
14						14-16': Wet compact brown fine silty sand, trace fine to coarse subround gravel, clay, no stain or odor.
		0.3	8/11/19/17			
16						16-18': Wet, very loose brown to grayish brown fine silty sand, no stain or odor.
		0.2	3/1/2/1			
18						18-20': Very soft wet grayish brown sandy clay little silt, trace fine gravel plastic grades to very loose wet grayish fine silty sand with trace clay, fine gravel, no odor or stain.
		ND	WH/2/1/1			
20						20-22': Very loose, wet fine silty sand, grayish brown trace clay, fine gravel, no stain or odor.
		ND	1/0/1/0		SC	
22						22-24': Same as above, very soft, wet sandy clay-clayey sand, little silt fine gravel, no stain or odor.
		ND	WOH/WOH/WOH/WOH			
24						

Drilling Log

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Monitoring Well **RW-8**

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *111108061*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							24–26': Wet, very soft grayish brown sandy clay–clayey sand, same as above over wet, very stiff (no stain or odor) sandy silt clay with some fine to coarse gravel (subangular).
26		0.1	WOH/3/7/9			SC	26–28': Soft grayish brown silty sand with little clay, trace fine gravel, grades to wet loose silt, fine sand, grayish brown, no stain or odor.
28		0.1	5/13/8/ 8/9/10			SM	28–30': Reddish brown, wet firm silty clay–clayey silt with some fine gravel (subround) over loose, fine to coarse subround gravel and fine to coarse grained sand, little silt, trace clay, no stain or odor.
30		0.1	5/14/3/ 4/5/4				
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

IT CORPORATION
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Monitoring Well RW-10

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 111108061
Surface Elev. ____ — Total Hole Depth 30 ft. — Diameter 14 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 6 in. — Length 10 ft. — Type/Size 0.020 Slot FRE in.
Casing: Dia 6 in. — Length 5 ft. — Type FRE
Fill Material ____ — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/SSP
Driller Bill Rice — Log By KC/LKM — Date 04/02/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

ND=Due to high humidity (fog) HNu readings unreliable.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Concrete
2						0-6': Moist, stiff reddish brown silty clay-clayey silt w/gray mottling, trace fine sand, fine gravel, no staining or odor.
4					CL	
6		ND	4/7/8/12			6-8': Moist, very stiff, same as above grades to moist, firm brown fine silty sand w/some clay, trace fine gravel, no stain or odor.
8		ND	8/11/11/9			8-10': Wet very loose fine silty sand w/little clay, trace fine gravel w/ creosote odor throughout and slight sheen noted.
10		ND	3/2/2/3			10-12': Same as above.
12		ND	1/1/2/3			12-14': Same as above, odor lessens w/depth.
14		ND	2/3/6/4		SC	14-16': Wet, compact, brown fine sand w/little silt, trace clay, fine subround gravel, faint creosote odor throughout.
16		ND	5/7/5/2			16-18': Same as above.
18		ND	2/7/9/12			18-20': Wet very loose brown fine silty sand w/trace clay, fine gravel, no staining, creosote odor lessens w/depth.
20		ND	1/2/2/1			20-22': Same as above, very faint creosote odor.
22		ND	WH/1/1/1		SM	22-24': Same as above, loose.
24		ND	1/2/3/4		SC	

Drilling Log

IT CORPORATION
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Monitoring Well **RW-10**

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							24-26': Same as above grades to wet very soft fine sandy clay w/little silt, trace fine gravel creosote odor very faint, no odor or staining.
26		ND		8/2/1/1		SC	26-28': Wet very loose brown fine silty sand w/little clay, trace fine gravel, no odor or staining.
28		ND		1/1/1/1		SM	28-30': Same as above.
30		ND		WH/WH/1/1			
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

IT CORPORATION
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Monitoring well **RW-11**

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 29.9 ft. — Diameter 14 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 6 in. — Length 10 ft. — Type/Size 0.010 Slot FRE in.
Casing: Dia 6 in. — Length 5 ft. — Type FRE
Fill Material #0 Sand — Rig/Core CME 75
Drill Co. Perratt Wolff — Method HSA/SSP
Driller Bill Rice — Log By KC/LKM — Date 04/02/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

ND=Due to high humidity (fog) HNu readings unreliable.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Concrete
2						0-6': Moist, stiff, reddish brown to brown silty clay-clayey silt w/ occ gray mottling, trace fine sand, fine gravel, no stain or odor.
4		ND	4/5/7/7		CL	
6		ND	10/12/12/9			6-8': Same as above, no stain or odor.
8		ND	4/5/5/5		SC	8-10': Silty clay-clayey silt, same as above, grades to moist, compact brown fine silty sand w/little clay, no stain or odor.
10		ND	4/2/3/2			10-12': Moist, becoming wet below ~11'; loose brown fine silty sand w/ little to some clay grades to fine silty sand w/little clay, trace fine gravel, no stain or odor.
12		ND	4/5/5/8			12-14': Wet, loose brown fine silty sand w/trace clay, fine gravel, no stain or odor.
14		ND	8/8/14/14			14-16': Wet, grayish brown fine silty sand w/trace clay, fine to coarse subround gravel, no stain or odor.
16		ND	8/8/3/3		SM	16-18': Saturated to wet, loose fine silty sand to fine sand, trace clay fine gravel, no stain or odor above ~17.5'; faint creosote odor noted.
18		ND	WH/WH/1/1			18-20': Wet very loose to very soft fine silty sand-clayey sand, trace gravel, faint to very faint creosote odor, no staining.
20		ND	WH/WH/2/2			20-22': Same as above, very faint creosote odor, no staining.
22		ND	WH/2/2/5			22-24': Same as above, very faint odor, lessens w/depth, no staining.
24						

Drilling Log

IT CORPORATION
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Monitoring Well **RW-11**

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		ND	4/2/2/1			SM	24-26': Saturated to wet, very loose grayish brown fine silty sand- sandy silt w/little clay, trace fine gravel, no odor or staining.
26		ND	WH/2/2/2				26-28': Wet to saturated, same as above w/trace fine to coarse gravel, no stain or odor.
28		ND	WH/WH/WH/2				28-30': Wet to saturated, same as above.
30							
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

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Monitoring Well O-1

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. _____ Total Hole Depth *25 ft.* Diameter *3 in.*
Top of Casing _____ Water Level Initial _____ Static _____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length _____ Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC* Date *04/08/99* Permit # _____
Checked By _____ License No. _____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt (In Biocell)
2	Temp Sand Cover					
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						

Drilling Log

IT CORPORATION
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Monitoring Well O-2

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *8.3 ft.* Diameter *6.5 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *3.7 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA*
Driller *Bill Rice* Log By *KC/LM* Date *04/15/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt Parking Lot (In Biocell)
2						
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						

Drilling Log

IT CORPORATION
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Monitoring Well O-3

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *25.1 ft.* Diameter *3 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *20 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC/LM* Date *04/08/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt
2		Temp Sand Cover					
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							
26							
28							
30							

Drilling Log

IT CORPORATION
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Monitoring Well O-4

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *111108061*
Surface Elev. _____ Total Hole Depth *8.3 ft.* Diameter *3 in.*
Top of Casing _____ Water Level Initial _____ Static _____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *4.2 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC* Date *04/06/99* Permit # _____
Checked By _____ License No. _____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt in Parking Lot (In Biocell)
2		Temp Sand Cover				
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						

Drilling Log

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Monitoring Well O-5

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *25 ft.* Diameter *3 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length ____ Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC* Date *04/06/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt Parking Lot
2	Temp Sand Cover					
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well O-6

Project Osmose, Buffalo Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York Proj. No. 111108061
Surface Elev. ____ Total Hole Depth 8.4 ft. Diameter 6.5 in.
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia 2 in. Length 2.5 ft. Type/Size 0.010 Slot in.
Casing: Dia 0.5 in. Length 3.8 ft. Type Type 304 SS
Fill Material Sand #0 Rig/Core CME 75
Drill Co. Parratt Wolff Method HSA
Driller Bill Rice Log By KC Date 04/15/99 Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt Parking Lot (In Biocell)
2						
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						

Drilling Log

IT CORPORATION
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Monitoring Well O-7

Project Osmose, Buffalo Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York Proj. No. 111108061
Surface Elev. ____ Total Hole Depth 25.4 ft. Diameter 3 in.
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia 2 in. Length 2.5 ft. Type/Size 0.010 Slot in.
Casing: Dia 0.5 in. Length 20 ft. Type Type 304 SS
Fill Material Sand #0 Rig/Core CME 75
Drill Co. Parratt Wolff Method HSA/BW Casing
Driller Joe Percy Log By KC/LM Date 04/08/99 Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt
2		Temp Sand Cover					
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							
26							
28							
30							

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well O-8

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. _____ Total Hole Depth *9.3 ft.* Diameter *3 in.*
Top of Casing _____ Water Level Initial _____ Static _____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *6.6 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC/LM* Date *04/06/99* Permit # _____
Checked By _____ License No. _____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt Parking Lot (In Biocell)
2		Temp Sand Cover				
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						

Drilling Log

IT CORPORATION
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Monitoring Well O-9

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 25 ft. — Diameter 3 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 2 in. — Length 2.5 ft. — Type/Size 0.010 Slot in.
Casing: Dia 0.5 in. — Length 20 ft. — Type Type 304 SS
Fill Material Sand #0 — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/BW Casing
Driller Joe Percy — Log By KC — Date 04/09/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt
2	Temp Sand Cover						
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							
26							
28							
30							

Drilling Log

IT CORPORATION
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Monitoring Well O-10

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *25 ft.* Diameter *3 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *20 ft.* Type *Type 304 SS*
Fil Material *Sand #0* Rig/Core *CME 75*
Dril Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC/LM* Date *04/08/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt
2	Temp Sand Cover					
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						
32						
34						
36						

Drilling Log

IT CORPORATION
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Monitoring Well O-11

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 111108061
Surface Elev. ____ — Total Hole Depth 25 ft. — Diameter 3 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 2 in. — Length 2.5 ft. — Type/Size 0.010 Slot in.
Casing: Dia 0.5 in. — Length 20 ft. — Type Type 304 SS
Fill Material Sand #0 — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/BW Casing
Driller Joe Percy — Log By KC — Date 04/07/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2 to 36	Temp Sand Cover					0: Asphalt

Drilling Log

IT CORPORATION
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Monitoring Well O-12

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 25 ft. — Diameter 3 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 2 in. — Length 2.5 ft. — Type/Size 0.010 Slot in.
Casing: Dia 0.5 in. — Length 20 ft. — Type Type 304 SS
Fill Material Sand #0 — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/BW Casing
Driller Joe Percy — Log By KC — Date 04/07/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge Note: There is a temporary SS stick up to 1'BGL, but there is a threaded connector at 2.5'BGL.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt Parking Lot
2	Temp Sand Cover					
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						

Drilling Log

IT CORPORATION
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Monitoring Well O-13

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 25 ft. — Diameter 3 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 2 in. — Length 2.5 ft. — Type/Size 0.010 Slot in.
Casing: Dia 0.5 in. — Length 20 ft. — Type Type 304 SS
Fill Material Sand #0 — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/BW Casing
Driller Joe Percy — Log By KC — Date 04/07/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt
2	Temp Sand Cover					
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						

Drilling Log

IT CORPORATION
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Monitoring Well O-14

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 24.5 ft. — Diameter 3 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 2 in. — Length 2.5 ft. — Type/Size 0.010 Slot in.
Casing: Dia 0.5 in. — Length 19.5 ft. — Type Type 304 SS
Fill Material Sand #0 — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/BW Casing
Driller Joe Percy — Log By KC — Date 04/07/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt
2	Temp Sand Cover					
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						

Drilling Log

IT CORPORATION
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Monitoring Well O-15

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. _____ Total Hole Depth *25 ft.* Diameter *3 in.*
Top of Casing _____ Water Level Initial _____ Static _____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *20 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC* Date *04/07/99* Permit # _____
Checked By _____ License No. _____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt
2		Temp Sand Cover					
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							
26							
28							
30							

Drilling Log

IT CORPORATION
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Monitoring Well O-16

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. _____ Total Hole Depth *24.8 ft.* Diameter *3 in.*
Top of Casing _____ Water Level Initial _____ Static _____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *19.8 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC* Date *04/05/99* Permit # _____
Checked By _____ License No. _____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						
2	Temp Sand Cover					
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						
32						
34						
36						

Drilling Log

IT CORPORATION
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Monitoring Well **O-17**

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. _____ Total Hole Depth *25 ft.* Diameter *3 in.*
Top of Casing _____ Water Level Initial _____ Static _____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *20 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC* Date *04/06/89* Permit # _____
Checked By _____ License No. _____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						
2		Temp Sand Cover				
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						

Drilling Log

IT CORPORATION
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Monitoring Well O-18

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *25 ft.* Diameter *3 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *20 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC* Date *04/08/89* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Sidewal
2	Temp Sand Cover					
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						

Drilling Log

IT CORPORATION
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Monitoring Well O-19

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *25 ft.* Diameter *3 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *20 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/BW Casing*
Driller *Joe Percy* Log By *KC/LM* Date *04/08/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Sidewalk
2		Temp Sand Cover				
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well O-20

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. _____ Total Hole Depth *25.5 ft.* Diameter *3 in.*
Top of Casing _____ Water Level Initial _____ Static _____
Screen: Dia *2 in.* Length *2.5 ft.* Type/Size *0.010 Slot in.*
Casing: Dia *0.5 in.* Length *20.5 ft.* Type *Type 304 SS*
Fill Material *Sand #0* Rig/Core *IRA-200*
Drill Co. *Parratt Wolff* Method *Casing*
Driller *Bill Rice* Log By *KC* Date *04/05/99* Permit # _____
Checked By _____ License No. _____

See Site Map For Boring Location

COMMENTS:

Ozone Sparge

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Concrete Sidewalk
2	Temp Sand Cover						
4							
6							
8							
10							
12							
14							
16							
18							
20							
22							
24							
26							
28							
30							

Drilling Log

IT CORPORATION
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Monitoring Well E-1

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *111108061*
Surface Elev. ____ Total Hole Depth *10 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *4 ft.* Type *PVC*
Fil Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *LKM* Date *04/01/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

SVE Well

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Pavement
					GW	0-1': Coarse gravel.
					GC	1-2': Sand and clay with some fine gravel.
2					SW	2-2.5': Sand; HDPE liner at 2.5'.
		5				2.5-5': Saturated sand and clay with some fine gravel.
4						
		100				5-7': Saturated sand with clay and fine gravel.
6					SC	
		55				7-10': Same as above; liner at 9.5'.
8						
		60				
10						
12						
14						
16						
18						
20						
22						
24						

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well E-2

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 10 ft. — Diameter 6 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 4 in. — Length 5 ft. — Type/Size PVC in.
Casing: Dia 4 in. — Length 4 ft. — Type PVC
Fill Material Morie #0 — Rig/Core ____
Drill Co. Parratt Wolff — Method HSA
Driller ____ — Log By LKM — Date 04/01/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

SVE well

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Pavement
2		0.2				GW	0-2': Gravel with little sand (Fill).
4		100				GC	2-4': Liner at 2.5'; saturated gray sand and gravel with some clay (Fill).
6		80				SC	4-6': Saturated gray sandy clay with some silt and fine gravel; has sheen.
8		80					6-8': Same as above.
10							8-10': Saturated gray clayey sand with some silt and fine gravel.
12							
14							
16							
18							
20							
22							
24							

Drilling Log

IT CORPORATION
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Monitoring Well E-3

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *18 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *Sched40PVC;0.020 Slot in.*
Casing: Dia *4 in.* Length *12 ft.* Type *Sched 40PVC*
Fill Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *LKM* Date *3/30/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:
SVE Well

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Pavement
2		0.4			SW	0-3': Dark-medium brown sand and gravel-dry, no odor.
4		0.4			SM	3-5': Medium brown sand with little gravel and some silt, moist.
6		0.3			OH	5-9': Dark brown and gray mottled clay; relatively dry, stiff. Sand lens 1" thick at 6.8'.
8		0.3				
10		0.4				9-10': Dense dark brown clay; moist, stiff.
12		5			ML	10-12': Silt with some clay and sand.
14		10				12-14': Silt with little clay and some sand.
16		10				14-16': Silt with some sand, and trace clay, wet.
18		8			SM	16-18': Sand with some silt and little clay, wet.
20						
22						
24						

Drilling Log

IT CORPORATION
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Monitoring Well E-4

Project: Osmose, Buffalo — Owner: Osmose, Inc.
Location: 980 Ellicott Street, Buffalo, New York — Proj. No. 111080061
Surface Elev. ____ — Total Hole Depth: 17.5 ft. — Diameter: 6 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 4 in. — Length: 5 ft. — Type/Size: SCH40-0.020Sloted in.
Casing: Dia 4 in. — Length: 11 ft. — Type: SCH40
Fill Material: Morie #1 — Rig/Core: CME 75
Drill Co.: Parratt Wolff — Method: HSA w/SSP
Driller ____ — Log By: KC/LKM — Date: 04/01/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

SVE Well

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2 to 0							Asphalt
0 to 6						GC	0-5': Hand dig w/post hole digger; brown clay, silt, sand, gravel (Fill) w/brick fragments over.
6		0.6	6/8/11/13				5-7': Moist to wet, stiff reddish brown silty clay-clayey silt little sand, trace fine to coarse gravel, subangular to subround, no stain or odor.
8		1.5	8/11/11/12			CL	7-9': Moist, stiff reddish brown silty clay-clayey silt w/trace fine sand, fine gravel, occ gray mottling, no stain or odor.
10		1.5	3/4/5/5				9-11': Moist, becoming wet below ~10.5', stiff to firm reddish brown to brown silty clay-clayey silt w/trace fine sand, fine gravel grades to fine silty sand w/little clay below ~10.7', no stain or odor.
12 to 24							

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well E-5

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *10 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *4 ft.* Type *PVC*
Fill Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *KC/LKM* Date *03/31/89* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Third Attempt of E-5.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2 to 0						Asphalt
0 to 10		5.0	3/3/2/1		CL	2-4': Wet, firm grayish brown silt, clay, gravel w/stain and odor (creosote). Liner in auger cutting.
		0.8	1/1/1/1			4-6': Same as above.
		1.0	4/7/7/4			6-8': Saturated, compact, silt, gravel, clay w/creosote odor.
		8.8	2/1/1/WH			8-10': Same as above. Note: liner in shoe of spoon.

Drilling Log

IT CORPORATION
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Monitoring Well E-5a

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *10 ft.* Diameter ____
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia ____ Length ____ Type/Size ____
Casing: Dia ____ Length ____ Type ____
Fill Material ____ Rig/Core ____
Drill Co. *Parratt Wolff* Method ____
Driller ____ Log By *KC/LKM* Date *03/31/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

First Attempt of E-5.

Depth (ft.)	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2					
0					
2					2-4': Loose silt, sand, clay (Fill) over damp firm grayish black to brown silty clay-clayey silt w/occ gray mottling, no discenible odors.
	0.8	4/3/5/7			
4					4-6': Moist, stiff brown silty clay-clayey silt w/occ gray mottling.
	88	3/5/8/8		CL	
6					6-8': Same as above, appears soil are all native, location is outside Biocell.
	28	8/11/15/14			
8					8-10': Abandon bore hole: plug with concrete.
10					
12					
14					
16					
18					
20					
22					
24					

Drilling Log

IT CORPORATION
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Monitoring Well **E-5b**

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *8 ft.* Diameter ____
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia ____ Length ____ Type/Size ____
Casing: Dia ____ Length ____ Type ____
Fill Material ____ Rig/Core ____
Drill Co. *Parratt Wolff* Method ____
Driller ____ Log By *KC/LKM* Date *03/31/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

Second Attempt of E-5.

Depth (ft.)	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2					
0					Asphalt
2	1.4	3/2/3		CL	0-2': Encountered top HDPE liner at ~2.3'. 2-4': Wet to moist dark brown clay, silt, gravel, over loose moist brown fine to medium sand, 2 liners over moist stiff silty clay-clayey silt w/gray mottling.
4					
6					6-8': Silty clay-clayey silt. Boring ended at ~8'.
8					
10					
12					
14					
16					
18					
20					
22					
24					

Drilling Log

IT CORPORATION
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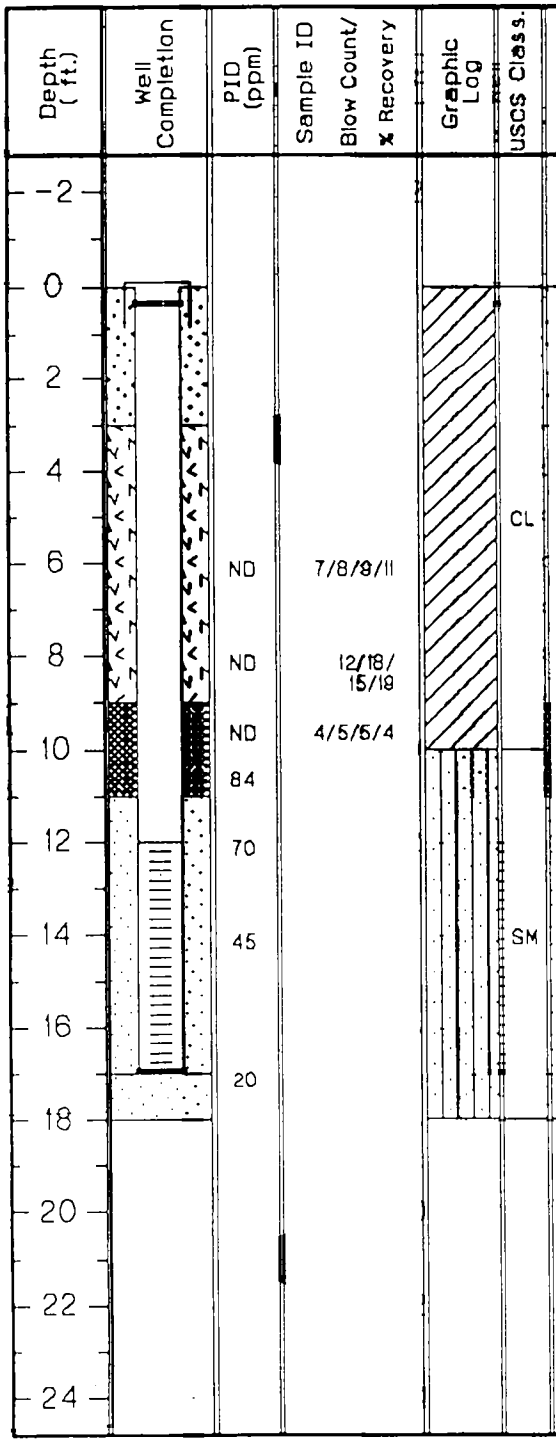
Monitoring Well E-6

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 18 ft. — Diameter 6 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 4 in. — Length 5 ft. — Type/Size PVC in.
Casing: Dia 4 in. — Length 12 ft. — Type PVC
Fill Material Morie #0 — Rig/Core ____
Drill Co. Parratt Wolff — Method HSA
Driller ____ — Log By KC/LKM — Date 03/31/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:
SVE Well.



Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
						Asphalt
					CL	5–7': Moist stiff brown silty clay–clayey silt, trace fine sand, fine gravel occ gray mottling, no apparent odor.
	ND		7/8/9/11			7–9': Same as above.
	ND		12/18/ 15/19			9–11': Silty clay–clayey silt, same as above over very moist to wet brown loose fine silty sand w/trace clay, noted odor in sand.
	ND		4/5/5/4			11–13': Brown–moist to wet sandy silt w/trace clay, strong odor.
	84					13–15': Brown–moist to wet silty sand w/trace clay and trace fine gravel (strong odor).
	70				SM	15–18': Same as above.
	45					
	20					

Drilling Log

IT CORPORATION
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Monitoring Well E-7

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *18 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *12 ft.* Type *PVC*
Fill Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *KC/LKM* Date *03/31/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

SVE well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							Pavement
0						GM	0-5': Dark brown sand and gravel w/some silt.
2		0.2					
4		0.2				OH	5-7': Brown-gray mottled clay, stiff, moist.
6		0.3				SM	7-8': Wet-saturated sand w/some silt and clay.
8		5.0				OH	8-9': Dense gray, brown clay-moist, grading into sandy clay. 9-11': Dense stiff gray-brown clay, grading to silty clay w/little sand, odor, sandy silt w/come clay, odor.
10		80					11-13': Silt w/some sand and little clay; moist to wet.
12		50				SM	13-15': Same as above, faint odor.
14		35					15-17': Sand w/some silt and little clay.
16		5					17-18': Same as above.
18							
20							
22							
24							

Drilling Log

IT CORPORATION
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Monitoring Well E-8

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *10 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *4 ft.* Type *PVC*
Fill Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *LKM* Date *04/01/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

SVE Well

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Pavement
2		0			GM	0-2': Coarse gravel-dry.
4		5			SC	2-5': Sand and fine gravel-fill, wet sandy clay w/fine gravel.
6		30			SM	5-10': Saturated sandy silt w/fine gravel, finer at 9.5'.
8		20				
10						
12						
14						
16						
18						
20						
22						
24						

Drilling Log

IT CORPORATION
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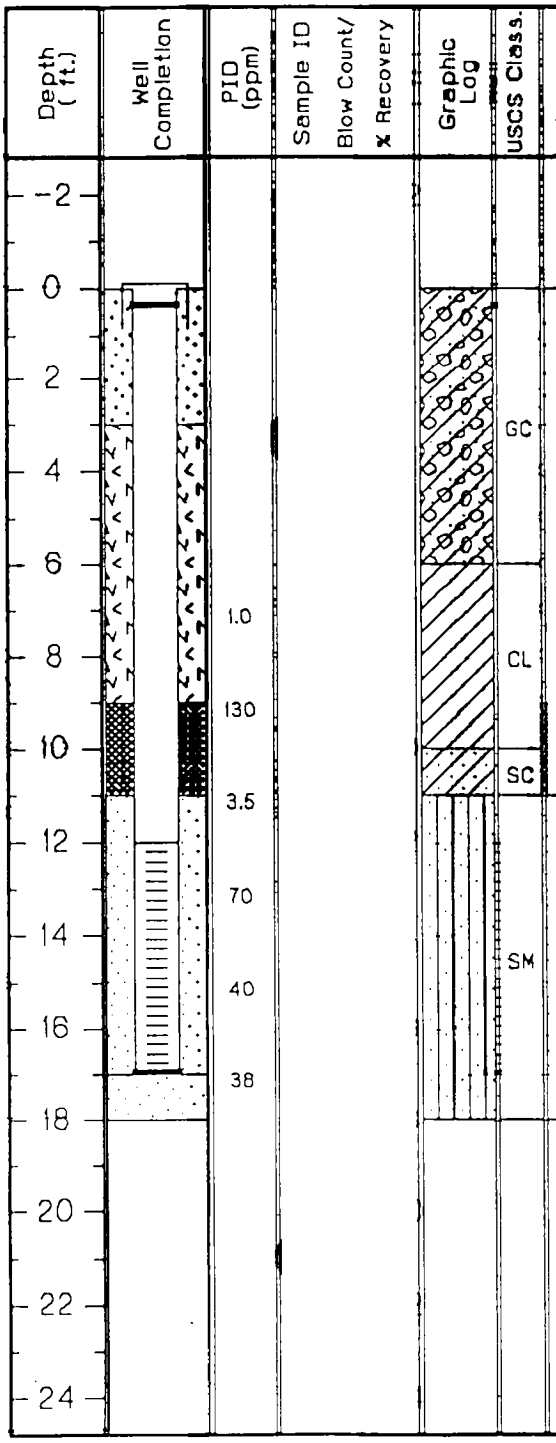
Monitoring Well E-9

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. _____ Total Hole Depth *18 ft.* Diameter *6 in.*
Top of Casing _____ Water Level Initial _____ Static _____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *12 ft.* Type *PVC*
Fill Material *Morie #0* Rig/Core _____
Drill Co. *Parratt Wolff* Method *HSA*
Driller _____ Log By *KC/LKM* Date *03/31/99* Permit # _____
Checked By _____ License No. _____

See Site Map For Boring Location

COMMENTS:

SVE Well.



Description

(Color, Texture, Structure)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%

Asphalt

0-6': Brown to grayish black sand, silt, clay w/fine to clay gravel, cobbles.

6-8': Moist, brown stiff silty caly w/little to some fine gravel, very faint creosote smell, poor recovery due to gravel in shoe.

8-10': Moist brown stiff silty clay w/little fine gravel grades to moist, very stiff reddish brown silty clay, trace fine gravel. Note: slight solvent odor in siltier zones.

10-11': Poor recovery, wet, very stiff, brown clayey silt w/little fine sand, gravel.

11-15': Moist brown sand w/some silt and trace fine gravel and trace clay (strong odor).

15-18': Moist brown sand w/some silt and trace fine gravel (strong odor).

Drilling Log

IT CORPORATION
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Monitoring Well E-10

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 17 ft. — Diameter 6 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 4 in. — Length 5 ft. — Type/Size PVC in.
Casing: Dia 4 in. — Length 11 ft. — Type PVC
Fill Material Morie #0 — Rig/Core ____
Drill Co. Parratt Wolff — Method HSA
Driller ____ — Log By KC/LKM — Date 03/31/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:
SVE well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt
2							0-7': Wet, loose brown gravely silty sand-sandy silt w/little clay, slight odor (mothballs) over moist firm brown silty clay-clayey silt w/trace fine sand, fine gravel, odor noted in siltier-sandier partings in clay.
4							
6		88		5/6/7/8		CL	
8		72		5/8/8/8			7-9': Moist, firm brown silty clay-clayey silt w/trace fine sand, fine gravel w/odor, same as above, occ gray mottling.
10		200		2/2/3/2			9-11': Silty clay-clayey silt, same as above over very moist to wet loose brown fine grained silty sand w/little clay, w/odor throughout in silty sand.
12		170					11-13': Brown moist sandy silt w/little clay and trace fine gravel (strong odor).
14		80				SM	13-15': Brown, moist, wet silty sand w/little clay (strong odor).
16		40					15-17': Same as above.
18							
20							
22							
24							

Drilling Log

IT CORPORATION
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Monitoring Well E-11

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *17 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *11 ft.* Type *PVC*
Fill Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *KC/LKM* Date *03/31/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:
SVE well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt
2					SM	0-7': Moist, firm brown sandy silt w/little gravel grades to moist stiff brown silty clay-clayey silt w/occ gray mottling, trace fine gravel, fine sand, odor.
4						
6		48	6/7/8/12			
8		180	6/11/10/12		CL	7-9': Moist, very stiff brown silty clay-clayey silt w/occ gray mottling, trace fine gravel, fine sand, odor.
10		210	4/4/4/5			9-11': Sandier moist to very moist, silty clay grades to wet loose brown, silty sand-sandy silt w/little clay, trace fine to coarse gravel, odor.
12		80				11-13': Silt w/some sand and clay, moist to wet, trace fine gravel (strong odor).
14		80			SM	13-15': Silt w/some sand and trace clay, wet, odor.
16		80				15-17': Sand w/some silt and trace clay, wet, odor.
18						
20						
22						
24						

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well E-12

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *17 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *11 ft.* Type *PVC*
Fill Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *KC/LKM* Date *03/31/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

SVE Well

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							Asphalt
0						CL	0-7': Moist, stiff brown silty clay-clayey silt w/gray mottling, trace fine sand, fine gravel, no odors.
2							
4							
6		1.2		3/5/7/8			
8		8.4		5/8/8/10			7-9': Same as above, sandy.
10		120		2/3/4/3		OH	9-11': Silty clay-Clayey silt, same as above over very moist to wet, loose brown silty fine sand w/odor, trace clay.
12							11-13': Brown, wet, sandy silt w/trace clay, strong odor.
14						SM	13-15': Brown, wet silty sand w/trace clay.
16							15-17': Brown, wet silty sand.
18							
20							
22							
24							

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well E-13

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *111080061*
Surface Elev. ____ Total Hole Depth *17 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *11 ft.* Type *PVC*
Fill Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *KC/LKM* Date *03/31/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

SVE Well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Pavement
2							0-7': Dense gray-brown, moist mottled clay with some silt.
4						OH	
6		0.5		3/6/6/8			
8		50		5/7/10/10			7-9': Dense gray-brown, moist mottled clay w/trace silt, grading to sandy silt, strong odor, sandy silt.
10		200		2/2/2/2			9-11': Brown moist to wet sandy silt grading to silty sand w/trace clay, strong odor.
12		170					11-13': Brown-moist to wet, silty sand w/trace clay, strong odor.
14		100				SM	13-15': Brown, wet silty sand w/trace clay and trace fine gravel, strong odor.
16		50					15-17': Same as above.
18							
20							
22							
24							

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well E-14

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 16 ft. — Diameter 6 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 4 in. — Length 5 ft. — Type/Size PVC in.
Casing: Dia 4 in. — Length 10 ft. — Type PVC
Fill Material Morie #1 — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/SSP
Driller ____ — Log By KC — Date 04/06/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

SVE well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2 to 0						Concrete Sidewalk
0 to 10		0.3	3/4/7/10		OH	5-7': Damp to moist, stiff brown silty clay-clayey silt w/gray mottling, trace fine sand, fine gravel, no staining or odor.
		0.7	7/8/5/5			7-9': Same as above, grades to moist, loose brown fine silty sand w/ little to some clay, no stain or odor.
		8.0	2/2/2/4		SM	9-11': Very moist to wet brown very loose fine silty sand, w/trace to little clay, trace fine gravel w/faint creosote odor in fine silty sand, no staining.
12 to 24						

Drilling Log

IT CORPORATION
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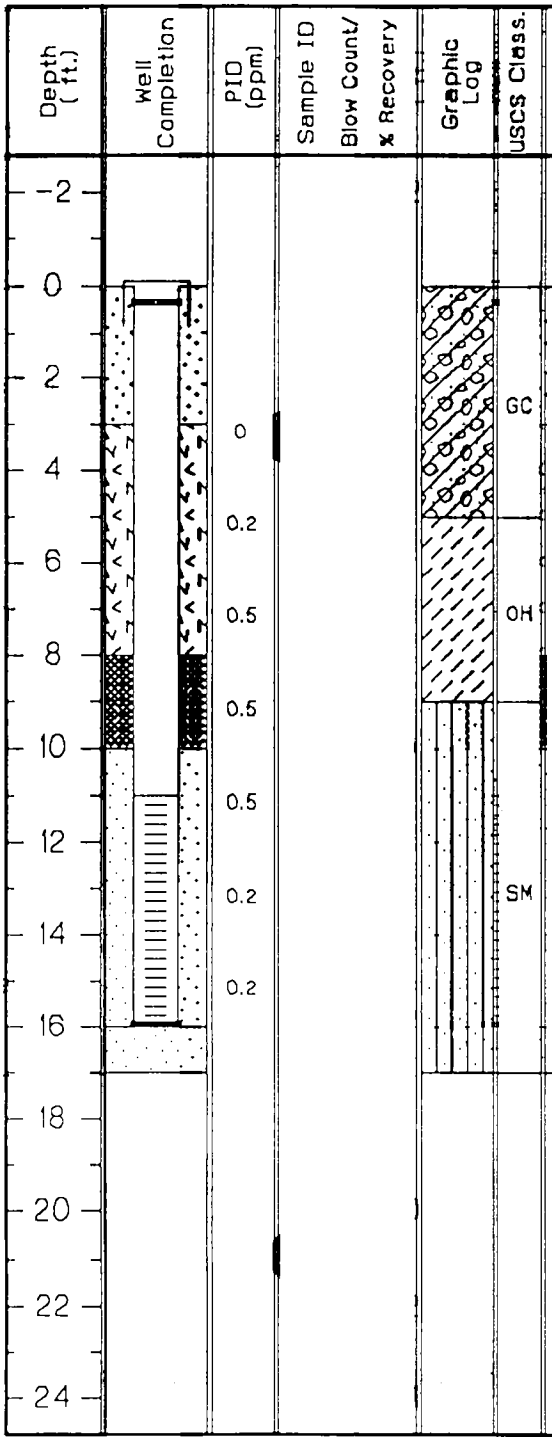
Monitoring Well E-15

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. _____ Total Hole Depth *17 ft.* Diameter *6 in.*
Top of Casing _____ Water Level Initial _____ Static _____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *11 ft.* Type *PVC*
Fill Material *Morie #0* Rig/Core _____
Drill Co. *Parratt Wolff* Method *HSA*
Driller _____ Log By *KC/LKM* Date *04/01/99* Permit # _____
Checked By _____ License No. _____

See Site Map For Boring Location

COMMENTS:

SVE Well.



Description

(Color, Texture, Structure)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%

Concrete

0-2': Dry, brown sand and gravel w/some clay.

2-5': Moist brown sand and fine gravel w/some clay, grading into clay.

5-7': Dense-gray-brown clay w/little silt, no odor.

7-9': Dense brown clay, clay w/some silt and sand, brown and moist.

9-11': Grades to sand w/some silt and little clay.

11-13': Wet sand w/some silt and little clay.

13-15': Same as above.

15-17': Wet sand w/some silt, trace clay and trace fine gravel.

Drilling Log

IT CORPORATION
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Monitoring Well E-16

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *17 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *Sched 40 PVC in.*
Casing: Dia *4 in.* Length *11 ft.* Type *Sched 40 PVC*
Fill Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *LKM* Date *04/02/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

SVE Well

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Concrete
2						0-1': Relatively dry sand and coarse gravel. 1-2': Moist sandy clay w/fine gravel.
4					GC	
6						5-7': Wet sand w/fine to coarse gravel, stiff brown clay w/some gravel.
8					OH	7-8.5': Stiff gray-brown clay w/little silt, no odor. 8.5-9': Silt w/some clay and little sand, no odor.
10						9-11': Fine to coarse sand, grading into fine to medium sand, wet and brown w/some silt and little clay, no odor. 11-13': Wet brown fine sand w/some silty and little clay.
12					SM	
14						13-15': Wet brown fine sand w/some silt and trace clay.
16						15-17': Wet brown fine sand w/some silt, trace clay and trace fine gravel, no odor.
18						
20						
22						
24						

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well E-17

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *17 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial *11 ft.* Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *Sched 40 PVC in.*
Casing: Dia *4 in.* Length *11 ft.* Type *Sched 40 PVC*
Fill Material *Morie #0* Rig/Core ____
Drill Co. *Parratt Wolff* Method *HSA*
Driller ____ Log By *LKM* Date *04/02/89* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

SVE well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Pavement
2					GC	0-1': Pavement and fill. 1-2': Moist to wet sand and gravel with some clay. 2-5': Moist to wet sand and fine gravel w/some clay, no odor.
4						
6					OH	5-6': Saturated gray-green clay w/some gravel and silt, strong creosote odor. 6-7': Stiff wet clay w/some silt and little fine sand, strong creosote odor, some wood fragments. 7-9': No recovery.
8						
10					SC	9-11': Wet brown sand w/some clay and silt, strong creosote odor and sheen.
12						11-13': Same as above.
14					SM	13-15': Wet brown sand w/some silty and little clay (odor). 15-17': Wet brown sand w/some silt, little clay and trace fine gravel.
16						
18						
20						
22						
24						

Drilling Log

IT CORPORATION
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Monitoring Well E-18

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 111108061
Surface Elev. ____ — Total Hole Depth 15 ft. — Diameter 6 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 4 in. — Length 5 ft. — Type/Size PVC in.
Casing: Dia 4 in. — Length 9 ft. — Type PVC
Fill Material Morie #1 — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/SSP
Driller ____ — Log By KC — Date 04/05/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

SVE well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt (Ellicott Street)
2							
4							
6		ND	4/8/10/15			OH	5-7': Moist, very stiff reddish brown silty clay clayey silt w/trace fine sand, fine gravel w/occ gray mottling, slight creosote odor.
8		ND	5/6/7/7				7-9': Moist, wet brown firm silty clay-clayey silt, grading to loose brown fine silty sand w/some clay, trace fine gravel, faint creosote odor.
10		ND	2/2/3/2			SM	9-11': Wet, loose brown fine silty sand w/some to little clay, trace fine gravel.
12							
14							
16							
18							
20							
22							
24							

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well E-19

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *16 ft.* Diameter *6 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *PVC in.*
Casing: Dia *4 in.* Length *10 ft.* Type *PVC*
Fill Material *Morie #1* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/SSP*
Driller ____ Log By *KC/LM* Date *04/06/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

SVE well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						Asphalt (Ellicott Street)
2						
4						
6		3.2	18/18/18/10		OH	5-7': Damp to moist, hard, brown silty clay-clayey silt w/occ gray mottling, trace fine sand, fine gravel w/napthalene like odor becoming like creosote.
8		7.8	8/5/6/8			7-9': Firm moist silty clay-clayey silt, same as above, grades to very moist to wet loose fine silty sand, little clay, trace fine gravel w/creosote odor.
10		350	2/2/2/4		SM	9-11': Stiff silty clay-clayey silt over wet, very loose brown fine silty sand w/trace to little clay, creosote odor.
12						
14						
16						
18						
20						
22						
24						

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well E-20

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 11108061
Surface Elev. ____ — Total Hole Depth 15 ft. — Diameter 6 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 4 in. — Length 5 ft. — Type/Size PVC in.
Casing: Dia 4 in. — Length 9 ft. — Type PVC
Fill Material Morie #0 — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/SSP
Driller ____ — Log By KC — Date 04/05/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

SVE Well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2 to 0						
0 to 6						5-7': Moist, stiff brown to reddish brown silty clay-clayey silt w/occ gray mottling, trace fine sand, fine gravel faint creosote odor.
6		ND	3/8/7/8		OH	
8		ND	2/8/5/5			7-9': Moist becoming wet, stiff becoming soft brown silty clay, grades to wet loose brown fine silty sand w/creosote odor, little clay, trace fine gravel.
10		ND	2/2/2/3		SM	9-11': Wet very loose brown fine silty sand, little clay, trace fine gravel w/faint creosote odor.
12 to 24						

Drilling Log

IT CORPORATION
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Monitoring Well E-21

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 111108061
Surface Elev. ____ — Total Hole Depth 17 ft. — Diameter 6 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 4 in. — Length 5 ft. — Type/Size PVC in.
Casing: Dia 4 in. — Length 11 ft. — Type PVC
Fill Material Morie #0 — Rig/Core CME 75
Drill Co. Parratt Wolff — Method HSA/SSP
Driller ____ — Log By KC — Date 04/05/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

SVE well.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / Blow Count / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2 to 0						Grass/Topsoil
0 to 10			3/7/10/10 8/10/13/12 2/2/3/4		OH SM	5-7': Damp to moist, very stiff reddish brown to brown silty clay-clayey silt w/trace fine sand, fine gravel. Note: very faint creosote odor. 7-9': Same as above, becoming sandier. Note: naphalene like odor in sample. 9-11': Same as above, moist to wet, brown fine silty sand w/trace to little clay, creosote odor.
12 to 24						

Drilling Log

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Monitoring Well E-22

Project *Osmose, Buffalo* Owner *Osmose, Inc.*
Location *980 Ellicott Street, Buffalo, New York* Proj. No. *11108061*
Surface Elev. ____ Total Hole Depth *16 ft.* Diameter *10.5 in.*
Top of Casing ____ Water Level Initial ____ Static ____
Screen: Dia *4 in.* Length *5 ft.* Type/Size *Sched 40 PVC in.*
Casing: Dia *4 in.* Length *9.5 ft.* Type *Sched 40 PVC*
Fill Material *Morie #0* Rig/Core *CME 75*
Drill Co. *Parratt Wolff* Method *HSA/SSP*
Driller ____ Log By *KC/LKM* Date *04/01/99* Permit # ____
Checked By ____ License No. ____

See Site Map For Boring Location

COMMENTS:

SVE Well

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Asphalt
2						GC	0-5': Clay, silt, sand, gravel (Fill) grades to moist firm to stiff reddish brown to brown silty clay-clayey silt, trace fine sand, fine gravel, no stain or odor.
4							
6		ND	3/5/5/8			CL	5-7': Moist stiff reddish brown silty clay-clayey silt w/trace fine sand, fine gravel occ gray mottling, no stain or odor.
8		ND	7/8/8/8			OH	7-9': Same as above, grades to moist soft reddish brown clay silt-sandy silt w/creosote odor.
10		ND	3/3/3/8			SM	9-11': Wet, loose brown fine silty sand-sandy silt w/little clay, trace fine gravel w/napthalene type odor.
12							
14							
16							
18							
20							
22							
24							

Drilling Log

IT CORPORATION
A Member of the IT Group

Monitoring Well E-23

Project Osmose, Buffalo — Owner Osmose, Inc.
Location 980 Ellicott Street, Buffalo, New York — Proj. No. 111108061
Surface Elev. ____ — Total Hole Depth 18 ft. — Diameter 6 in.
Top of Casing ____ — Water Level Initial ____ — Static ____
Screen: Dia 4 in. — Length 5 ft. — Type/Size Sched40PVC;0.020Slot in.
Casing: Dia 4 in. — Length 12 ft. — Type Sched 40PVC
Fill Material Morie #0 — Rig/Core ____
Drill Co. Parratt Wolff — Method HSA
Driller ____ — Log By LKM — Date 3/30/99 — Permit # ____
Checked By ____ — License No. ____

See Site Map For Boring Location

COMMENTS:

SVE Well

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ x Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2							
0							Pavement
2		0.3				SW	0-2': Dark brown-dry sand and gravel with little silt.
		0.5					2-4': Same as above.
4							4-6': Dense gray-brown mottled clay with trace silt, brick fragments at 5', no odor.
6		0.4				OH	6-9': Dense gray-brown clay; no odor.
8		0.3					
10		0.4					9-10': Gray-brown clay with some silt and little sand; moist.
		0.5					10-11': Silt with some clay and sand; moist.
12							11-12': Silt with little clay and some sand; moist.
		18				ML	12-14': Silt wih clay and some sand; wet.
14							14-16': Silt with some sand; wet, brown.
		12					
16							16-18': Sand with some silt; wet, brown.
		10				SM	
18							
20							
22							
24							

APPENDIX
B

APPENDIX B

AIR DISCHARGE CALCULATIONS

Appendix B

1.0 OZONE DISCHARGE CALCULATIONS

The maximum emission rate which would not cause an annual or short-term guideline concentration exceedence of ozone was calculated using the following data and assumptions:

- Stack height: 18 feet
- Stack ht. above structures: 6 feet
- Building height: 12 feet
- Building width: 15 feet
- Building length: 20 feet
- Stack diameter: 3 inches
- Maximum flow rate: 600 cfm
- Maximum emission rate: 0.078 lbs/hr

Printouts from the Air Guide – 1 run file are included as attachments.

2.0 SVE AIR DISCHARGE CALCULATIONS

Assumptions: 1. 15 ft stack height (for conservative estimate)
2. @15 ft benzene emission limit is 0.00494 lbs/hr per the SVES STIP
3. Maximum flow rate- 600 cfm

0.00494lbs/hr * 1hr/60min * 1min/60sec * 1g/0.0022lbs = 0.000624g/s

0.000624g/s * 60s/min * 1ug/10-6g * 35.1cf/1cm * 1min/600cf = 2190.24ug/cm

2190.24ug/cm * 10-6g/1ug * 1mg/10-3g = 2.19mg/cm

ppm-v = mg/cm * R / $MW_{benzene}$

ppm-v = 2.19mg/cm * 24.05 / 78.11 = **0.67 ppm-v benzene limit** (Drager-type tube reading @ 600 cfm)

If using a PID; assuming benzene makes up 2% of the VOCs detected on-site by a PID, the action limit per the PID is:

0.02 * x = 0.67 ppm-v therefore: **x = 33.5 ppm-v** (@ 600 cfm)

LOC	FAC	E.P.	SOURCE TYPE	MO DAY YR	HA, or h(AREA) FEET	hs FEET	D IN.	T F	V FPS	Q AFCM	DPL, or D(AREA) FEET	BW, or S(AREA) FEET	BL FEET	NUMB OF CONTAM.
Facility Name & Address: Osmose Ozone Injection System 980 Ellicott St Buffalo														
SIC Code: 0			Source Code:		Application: PC		UTME: 0.		UTMN: 0.		BL FACING DIRECTION: 45.0			
000001	0001	STACK	POINT	9 3 99	6.	18.	3.	80.	204.00	600.00	15.	15.	20.	1

	(CAS NUMBER)	(EMISSIONS - LBS/HOUR)	(EMISSIONS - LBS/YEAR)	(RATING)	(%CONTROL)
(1)	10028-15-6	0.007800000000000	68.330000000000000		0.0000

********** AIR GUIDE 1 - ANALYSIS **********

********** INPUT DATA **********

LOC	FAC	E.P.	CAS #	SOURCE TYPE	HA, or h(AREA) FEET	hs FEET	D IN.	T F	V FPS	Q ACFM	EMISSIONS #/HOUR	EMISSIONS #/YEAR	DPL, or D(AREA) FT	BW, or S(AREA) FT	BL FT
Facility Name & Address: Osmose Ozone Injection System 980 Ellicott St Buffalo															
SIC Code: 0			Application: PC		UTME: 0.		UTMN: 0.			BL FACING DIRECTION: 45.0			%CONTROL: 0.0000		
000001	0001	STACK	10028-15-6	POINT	6.	18.	3.	80.	204.00	600.00	0.00780		68.	15.	15.	20.

CONTAMINANT TOXICITY PROFILE FOR AIR GUIDE 1 ANALYSIS

CONTAMINANT NAME	CAS NUMBER	SGC ug/m3	HOW SGC ASSIGNED	AGC ug/m3	HOW AGC ASSIGNED	DAR TOXICITY	COMMENTS
OZONE	10028-15-6	240.00000	FED/NYS STANDARD	0.240000000	PROPOSED ACGIH TLV		

EMISSION POINT AND CONTAMINANT IMPACT SUMMARY OF AIR GUIDE 1 ANALYSIS

LOC	FAC	E.P.	CAS NUMBER	EMISSIONS #/HOUR	EMISSIONS #/YEAR	ANNUAL EMISSIONS #/HOUR	SHORT-TERM IMPACT MAXIMUM (Cav,Pt,Area) ug/m3	CAVITY IMPACT ACTUAL ANNUAL ug/m3	POINT or AREA SOURCE IMPACT POTENTIAL ANNUAL ug/m3	POINT or AREA SOURCE IMPACT ACTUAL ANNUAL ug/m3
000001	0001	STACK	10028-15-6	0.007800	68.3300	0.007800	10.817528	0.000000	0.239349	0.239630
SUMMARY TOTALS				0.007800	68.3300	0.007800	10.817528	0.000000	0.239349	0.239630

EMISSION POINT AND CONTAMINANT ASSESSMENT OF AIR GUIDE 1 ANALYSIS

LOC	FAC	E.P.	CAS NUMBER	AGC ug/m3	SGC ug/m3	SHORT-TERM IMPACT MAXIMUM (Cav,Pt,Area) % OF SGC	CAVITY IMPACT ACTUAL ANNUAL % OF AGC	POINT or AREA SOURCE IMPACT POTENTIAL ANNUAL % OF AGC	POINT or AREA SOURCE IMPACT ACTUAL ANNUAL % OF AGC
000001	0001	STACK	10028-15-6	0.240000000	240.0000	4.5073	0.0000	99.7288	99.8457
SUMMARY TOTALS						4.5073	0.0000	99.7288	99.8457

CONTAMINANT IMPACT SUMMARY OF AIR GUIDE 1 ANALYSIS

CAS-NUMBER	EMISSIONS #/HOUR	EMISSIONS #/YEAR	ANNUAL EMISSIONS #/HOUR	SUMMATION OF SHORT-TERM IMPACTS, MAXIMUM (Cav,Pt,Area) - ug/m3	SUMMATION OF CAVITY IMPACTS ACTUAL ANNUAL ug/m3	SUMMATION OF POINT or AREA SOURCE IMPACTS POTENTIAL ANNUAL ug/m3	SUMMATION OF POINT or AREA SOURCE IMPACTS ACTUAL ANNUAL ug/m3
10028-15-6	0.007800	68.3300	0.007800	10.817528	0.000000	0.239349	0.239630
SUMMARY TOTALS	0.007800	68.3300	0.007800	10.817528	0.000000	0.239349	0.239630

CONTAMINANT ASSESSMENT SUMMARY OF AIR GUIDE 1 ANALYSIS

CAS NUMBER	AGC ug/m3	SGC ug/m3	SUMMATION OF SHORT-TERM IMPACTS, MAXIMUM (Cav,Pt,Area) % OF SGC	SUMMATION OF CAVITY IMPACTS ACTUAL ANNUAL % OF AGC	SUMMATION OF POINT or AREA SOURCE IMPACTS POTENTIAL ANNUAL % OF AGC	SUMMATION OF POINT or AREA SOURCE IMPACTS ACTUAL ANNUAL % OF AGC
10028-15-6	0.240000000	240.0000	4.5073	0.0000	99.7288	99.8457
SUMMARY TOTALS			4.5073	0.0000	99.7288	99.8457

APPENDIX C

APPENDIX C

EQUIPMENT SPECIFICATION SHEETS AND LITERATURE

Analytical Technology, Inc.
680 Hollow Rd., Box 879, Oaks, PA 19456
Phone: (800) 959-0299 or (610) 917-0991 FAX: (610) 917-0992

GasSens

Oxygen Gas Monitor

This manual contains information critical to the proper operation and maintenance of your gas detection system. The reliability of this important piece of safety equipment depends upon operational personnel performing routine operational checks outlined in this manual. It is important that the information contained in this manual be read and understood by those responsible for the operation and maintenance of this gas detector.

TABLE OF CONTENTS

INTRODUCTION

GasSens is an on-line monitoring system for the detection of hazardous gases in ambient air. It is designed to detect and alarm gas leaks from storage cylinders, process piping, or gas feed equipment in virtually any type of industrial plant environment. Systems are available for monitoring a variety of gases as shown in Table 1-1.

TABLE 1-1

GAS	CODE NO.	STD. RANGE	MIN. RANGE	MAX. RANGE
		GENERAL GASES		
Ammonia	15*	0-100 PPM	0-50 PPM	0-500 PPM
Carbon Monoxide	16*	0-100 PPM	0-50 PPM	0-500 PPM
Hydrogen	18	0-2 %	0-200 PPM	0-10 %
Nitric Oxide	25	0-100 PPM	0-25 PPM	0-500 PPM
Oxygen	19	0-25 %	0-10 %	0-100 %
Phosgene	20	0-2 PPM	0-1 PPM	0-100 PPM
		OXIDANT GASES		
Bromine	10	0-2 PPM	0-1 PPM	0-100 PPM
Chlorine	11*	0-10 PPM	0-1 PPM	0-100 PPM
Chlorine Dioxide	12	0-2 PPM	0-1 PPM	0-100 PPM
Fluorine	13*	0-2 PPM	0-1 PPM	0-100 PPM
Hydrogen Peroxide	24	0-10 PPM	0-5 PPM	0-100 PPM
Ozone	14*	0-2 PPM	0-1 PPM	0-100 PPM
Iodine	35	0-2 PPM	0-1 PPM	0-100 PPM
		ACID GASES		
Hydrogen Chloride	21*	0-20 PPM	0-10 PPM	0-200 PPM
Hydrogen Cyanide	22	0-20 PPM	0-10 PPM	0-200 PPM
Hydrogen Fluoride	23*	0-20 PPM	0-10 PPM	0-200 PPM
Hydrogen Sulfide	27	0-50 PPM	0-10 PPM	0-200 PPM
Nitrogen Dioxide	26*	0-20 PPM	0-5 PPM	0-200 PPM
Sulfur Dioxide	17	0-20 PPM	0-5 PPM	0-200 PPM
		HYDRIDE GASES		
Arsine	28	0-1000 PPB	0-1000 PPB	0-100 PPM
Diborane	29	0-1000 PPB	0-1000 PPB	0-100 PPM
Germane	30	0-1000 PPB	0-1000 PPB	0-100 PPM
Hydrogen Selenide	39	0-500 PPB	0-1000 PPB	0-100 PPM
Phosphine	32	0-1000 PPB	0-1000 PPB	0-100 PPM
Silane	33	0-10 PPM	0-1000 PPB	0-100 PPM

* Auto-Test is available in these gases.

The *GasSens* system consists of modular components that can be used in a variety of configurations to fit specific application requirements. A description of the major system components follows:

A11 Sensor/Transmitter

Consists of an electrochemical gas sensor closely coupled to a NEMA 4X transmitter. This component measures gas concentration and converts the measurement to a digital signal for transmission to a receiver module. It must be mounted in the area where gas leakage or buildup is expected, and can either be wall mounted or supported by electrical conduit carrying interconnecting wiring. Sensor/transmitters are available with optional Auto-Test, an electrochemical gas generator which automatically tests sensor response daily and alarms any sensor problems. For hazardous areas, explosion-proof sensor/transmitters are available.

A14 Receiver Module

Receives digital data from the sensor/transmitter and provides an LED display of gas concentration, two gas alarm setpoints, three gas alarm relays, an isolated 4-20 mA output, and a trouble alarm and relay. The receiver is packaged in a compact DIN rail mount housing, and fits easily into NEMA 4X enclosures suitable for one, two, three, or six modules. Each module is switch programmable for full scale range, alarm setpoints, relay latch/non-latch operation, and relay normal/fail-safe operation. A single switch (marked A/R) on the front panel provides alarm acknowledge and reset functions, and can also be used to test front panel LED indicators and to inhibit alarm relays. LED bars on the front panel provide visual indication of alarm status.

A17 Power Supply Module

Provides 12 VDC power to one or two receiver modules plus power for an audible horn and for charging an external battery. Packaged in the same compact DIN rail mount module used for the receiver, the power supply is designed for use throughout the world. Input to this module may be any AC (50 or 60 Hz.) or DC voltage between 85 and 270 volts. The supply is self-regulating, meaning no jumper changes, no changes in switch settings, and no variation in wiring pattern. A power failure alarm relay is included in the module to signal the loss of input power.

NEMA 4X Enclosures

Four standard enclosures are available for housing receiver and power supply modules. Polystyrene enclosures are suitable for outdoor environments, and digital displays and alarm indicators are clearly visible through a clear polycarbonate window on the front. The window hinges open to gain access to the receiver A/R control switch, and the entire front section of the enclosure can be removed for ease of mounting and wiring. Enclosures are provided with knockouts on all four sides to facilitate wiring, and 1/2" FNPT conduit hubs are provided with each enclosure.

Explosion-proof Enclosures

Two versions are available to allow use of the receiver and power supply modules in hazardous areas. One version is suitable for a single receiver module, while the second is large enough to contain both a power supply and a receiver. Enclosures are rated for Class 1, Division 1, Groups C & D. Group B enclosures are also available if required. All explosion-proof enclosures can be supplied with an external acknowledge and reset switch.

Audible Horn

A 12 VDC piezoelectric alarm horn is available for mounting into any of the NEMA 4X enclosures. The horn is wired to the receiver module and will sound intermittently when the warning setpoint is reached, and continuously when the alarm setpoint is reached. The horn can be silenced by pushing the A/R switch on the receiver front panel. A single horn can be wired through multiple receivers and will sound if any receiver goes into alarm.

Strobe Lamp

Provides a bright visual indication of an alarm condition. The strobe uses a xenon flash lamp to give a high intensity flash approximately 70 times a minute. The strobe is wired to one of the alarm relays, with power for the strobe supplied from the power supply module. Mounting is by 1/2" MNPT nipple, making it convenient to mount directly to a NEMA enclosure.

A19 Battery Back-up

Provides a 12 VDC, 4 AH battery and charging control circuitry in a separate NEMA 4X enclosure. The battery backup connects directly to the A17 power supply module to provide standby power to the detection system. If AC power is lost, the battery insures that detection continues uninterrupted.

GasSens components allow simple assembly of either single or multipoint detection systems. Each point of detection requires one sensor/transmitter and one receiver. The sensor/transmitter is mounted in the hazard area, and the receiver is located anywhere within 1000 feet. If the user has a regulated 12 VDC power supply and an enclosure to house the receiver, nothing else is required. If not, one power supply for every two receivers is needed for power, and an enclosure of a size to contain the modules is needed for environmental protection. An optional horn and strobe may be added if desired.

MECHANICAL INSTALLATION

System enclosures, battery back-up units, and sensor transmitters are all designed for surface mounting using screws or bolts inserted through the recessed mounting holes at each corner of the enclosures. Included with each system enclosure is a template with mounting hole dimensions for two and three module system enclosures, battery back-up enclosure, and sensor/transmitter enclosure. The template can be used to mark hole centers on walls or mounting panels.

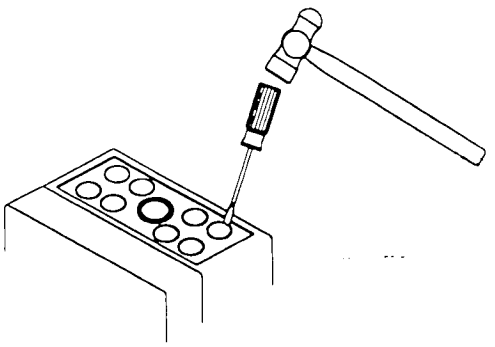
Mounting recesses are suitable for #6 or #8 machine screws or wood screws. Screw length will vary with specific site conditions.

Two and three module system enclosures provide knockouts on all four sides to allow wiring conduit to be connected in the most convenient way. Enclosures are shipped with all knockouts in place except for the larger knockout on the bottom, where the audible horn is installed if ordered. See pages 1-6 through 1-9 for dimensional drawings of the one, two, three and six module enclosures.

Each enclosure is supplied with conduit hubs for connection of 1/2" NPT threaded conduit. Also included is a seal ring for each hub. **Seal rings are required to provide a water tight conduit hub connection to the enclosure.** The following lists the number of hubs that should be included with each enclosure type.

Two module Enclosure - 4 hubs
Three module Enclosure - 6 hubs
Six Module Enclosures - 6 hubs
Battery back-up Enclosure - 2 hubs
Sensor/Transmitter Enclosure - 1 hub

Conduit hubs are installed in any enclosure knockout labeled PG16. Note that some knockouts have more than one designation, such as PG11/16. Those with two designations will have concentric circles for knockouts. The inner circle marks the lower PG number while the outer circle marks the higher number. Place a thin bladed screwdriver into the circular slot or the desired knockout size and tap firmly with a hammer. To install the hub, place the seal ring over the threaded part of the hub. Locate the hub nut on the inside of the enclosure and screw the hub into the hub nut from the outside. Tighten firmly to insure that the seal ring provides a good seal between the hub and the outside of the enclosure.



For installations where conduit will not be used, cable gland seal fittings must be installed in the conduit hubs. Plastic cable glands are available from most electrical supply stores. Gland seals with 1/2" NPT threads will screw directly into the conduit hub. Gland seals are also available from ATI for installation directly into the enclosures in place of the conduit hubs. Refer to the parts list for the correct part number of the cable gland seals.

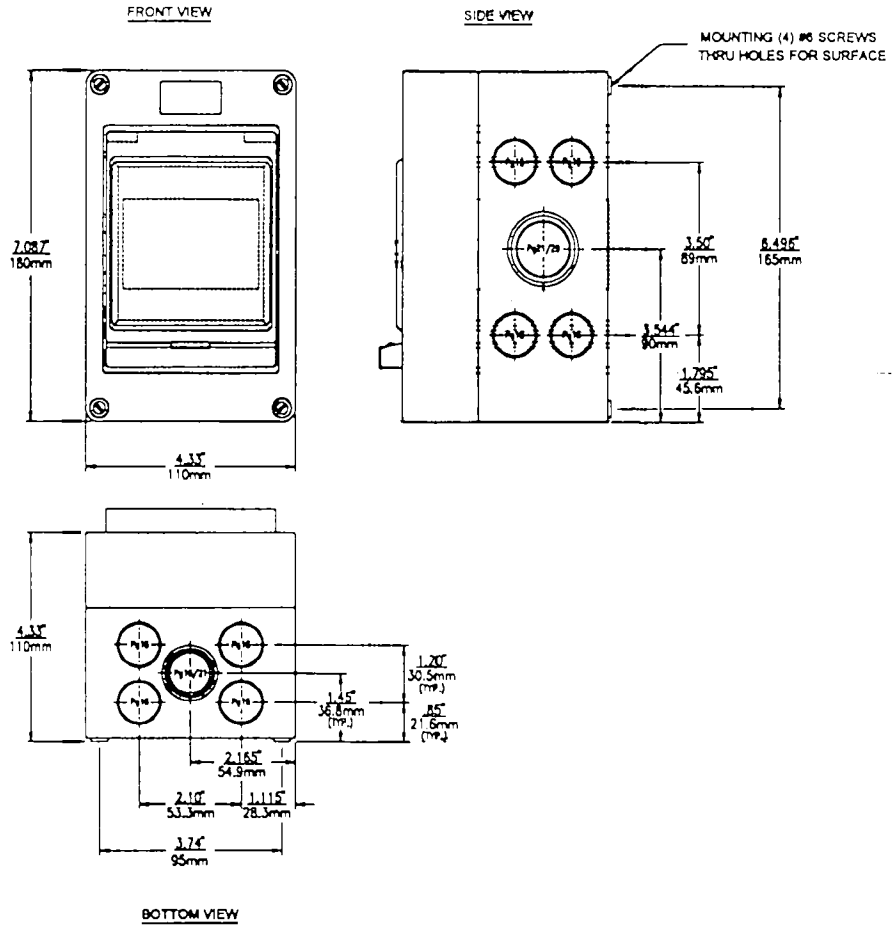


Figure 1-1: Single Module System Enclosure Dimensions (80-0005R, Rev-A)

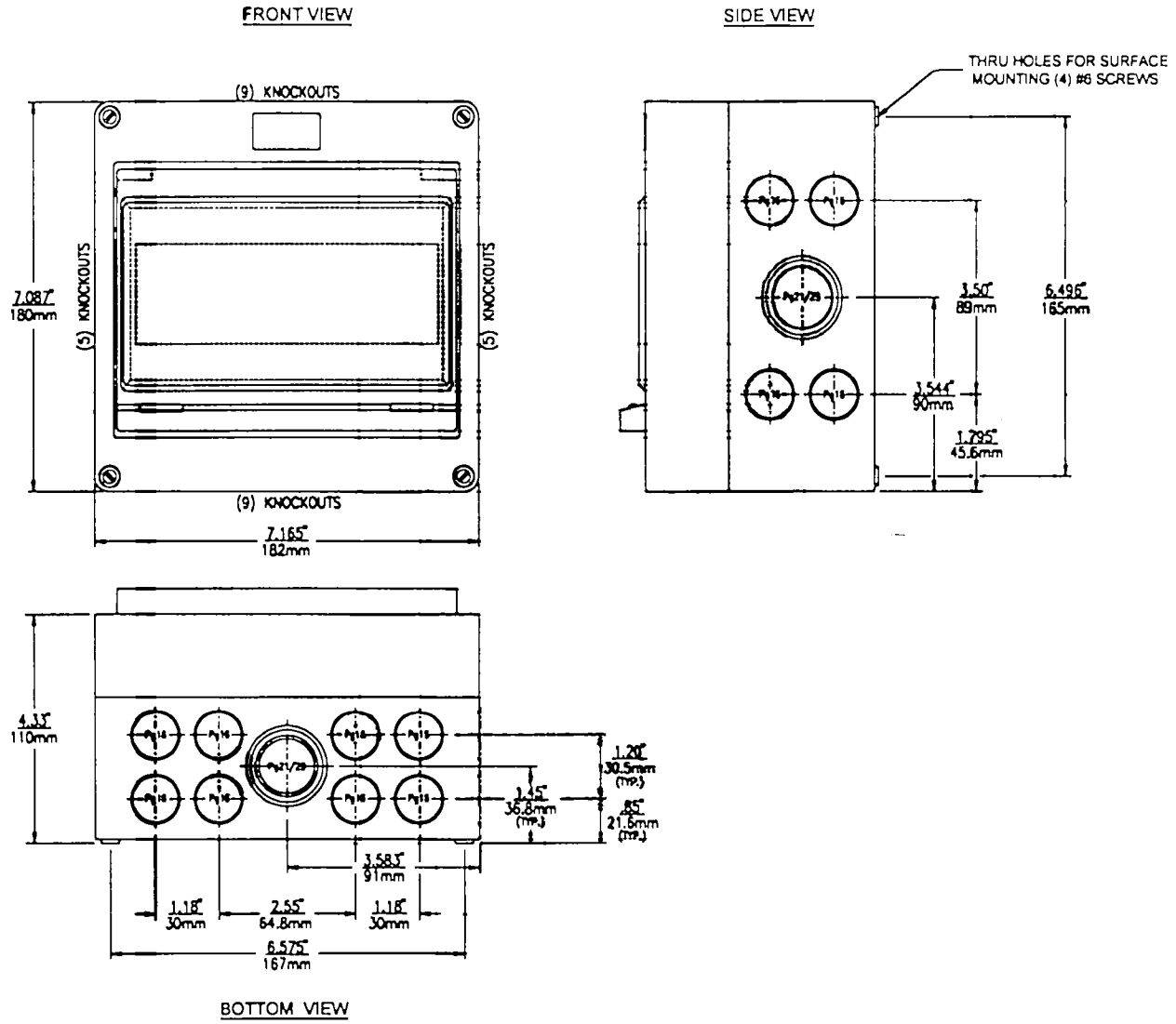


Figure 1-2: Two Module System Enclosure Dimensions (80-0006R, Rev-A)

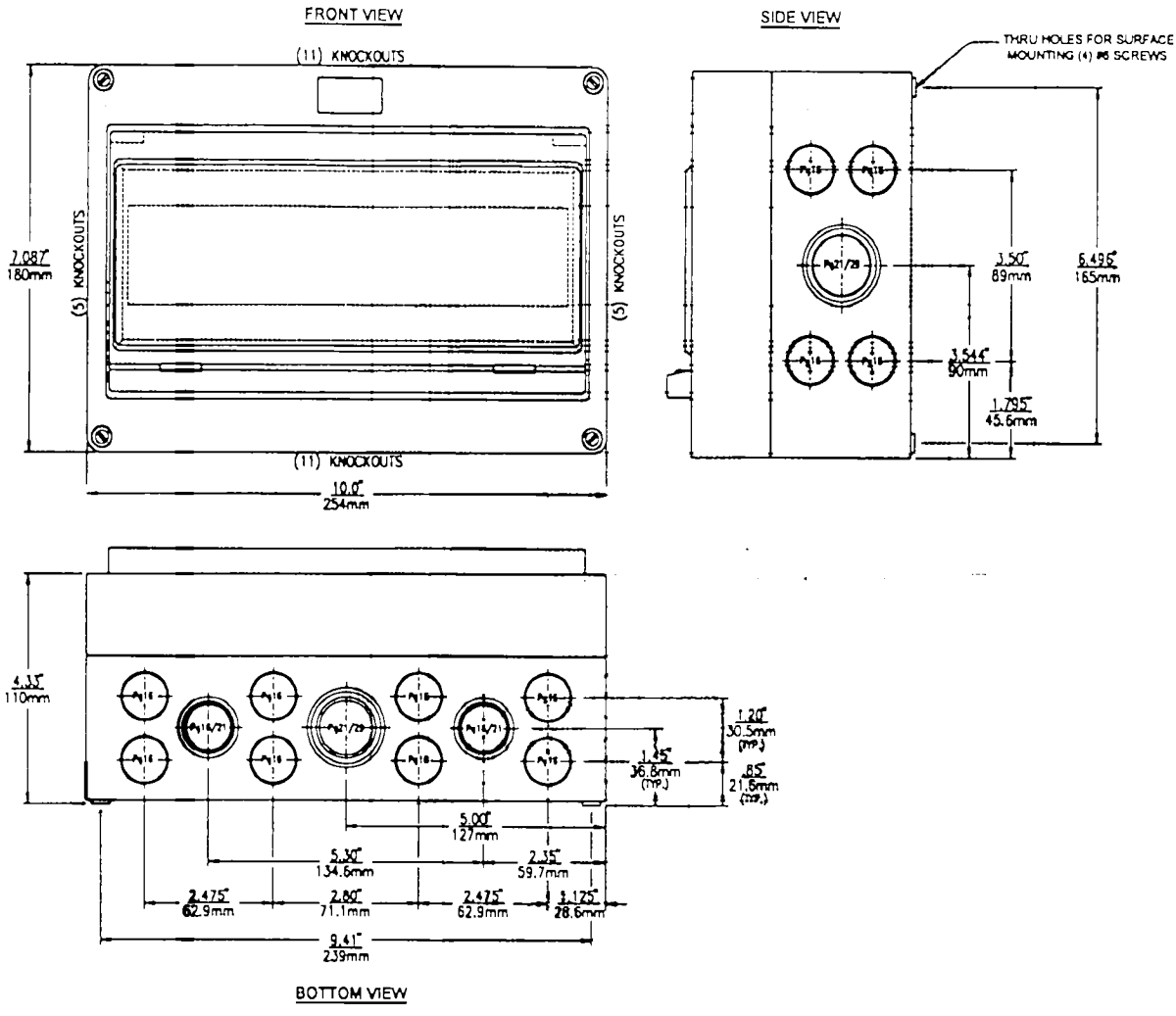


Figure 1-3: Three Module System Enclosure Dimensions (80-0007R, Rev-A)

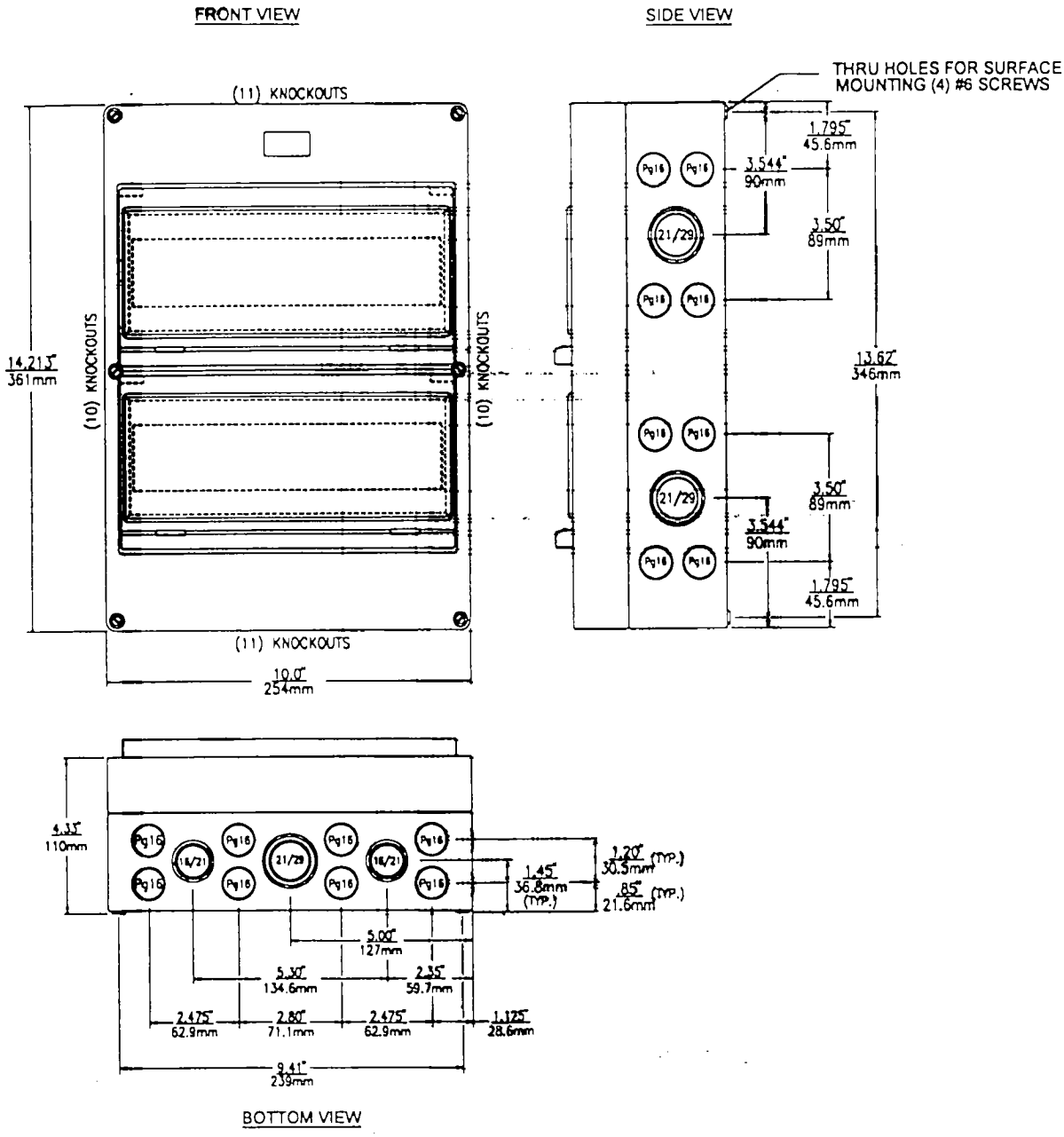


Figure 1-4: Six Module System Enclosure Dimensions (80-0008R, Rev-A)

ELECTRICAL INSTALLATION

Field wiring required for a detection system includes connection of AC power, connection of two conductor cable between the receiver and the sensor/transmitter, and connection of the battery back-up unit if it was purchased with the system. ATI does not supply an AC power cord with the system. A 25 foot length of 2 conductor interconnect cable is supplied for connection of the sensor/transmitter to the receiver. Longer lengths up to 1000 feet may be used when required.

Single point detection systems are supplied with the power supply, receiver, and optional horn factory wired as shown in Figure 1-5 below.

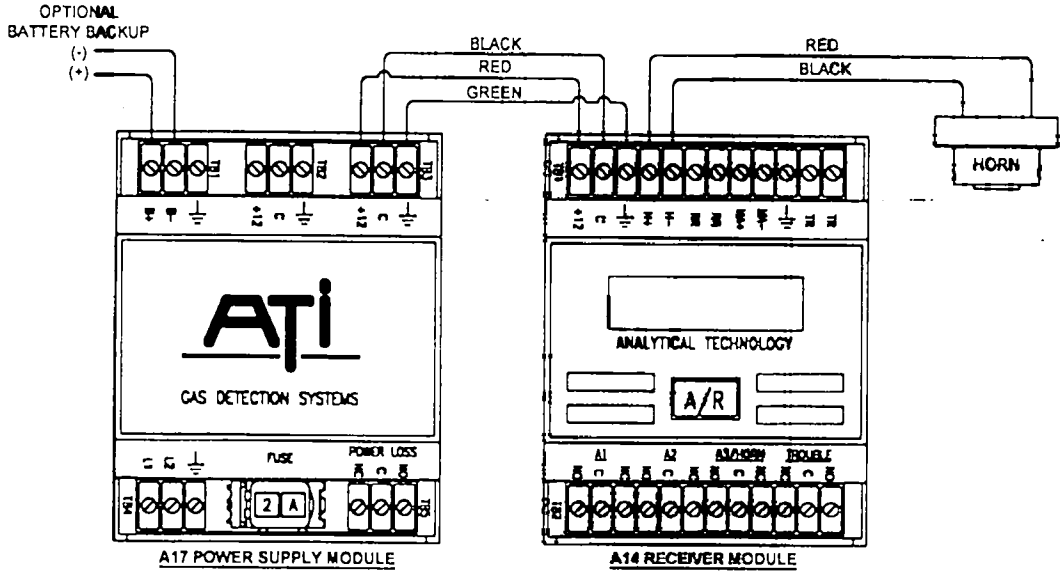


Figure 1-5: Single Point Receiver Internal Wiring (ATI-032, Rev-C)

Figure 2-2 in section 2 of this manual shows a detailed terminal wiring drawing for the Receiver module. Figure 3-1 in section 3 shows a detailed terminal wiring drawing for the power supply module.

A *GasSens* gas detection system will always contain an A14 Receiver and an A11 Sensor/transmitter. Normally, an A17 Power Supply module will also be included, and an A19 Battery Back-up Unit will often be used to provide standby power for the system. Figures 1-8 and 1-9 provide interconnect wiring diagrams for typical single channel systems.

Two point detectors include one power supply and two receivers. These systems are shipped factory wired as shown in Figure 1-6 below.

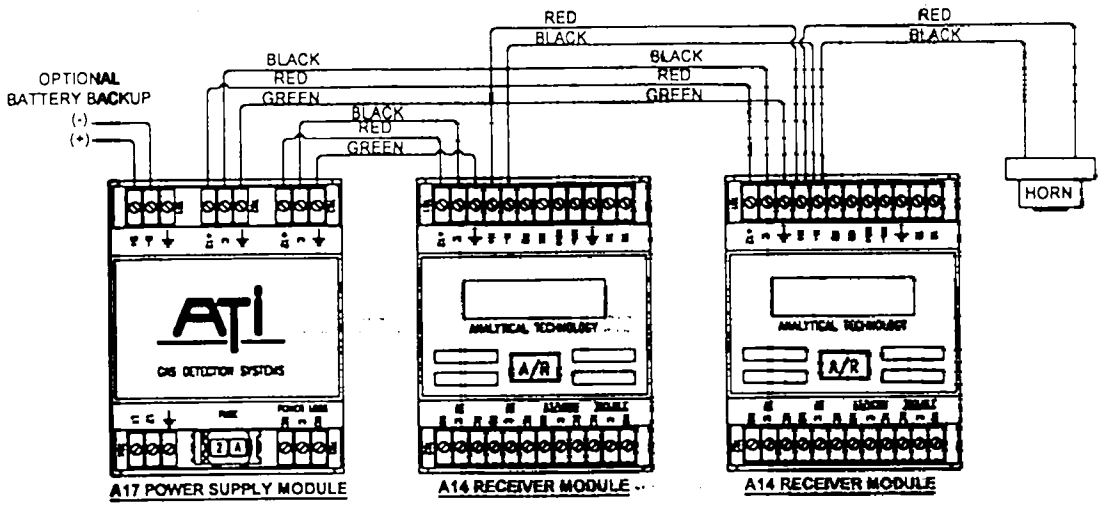


Figure 1-6: Dual Point Receiver Internal Wiring, (ATI-033, Rev-C)

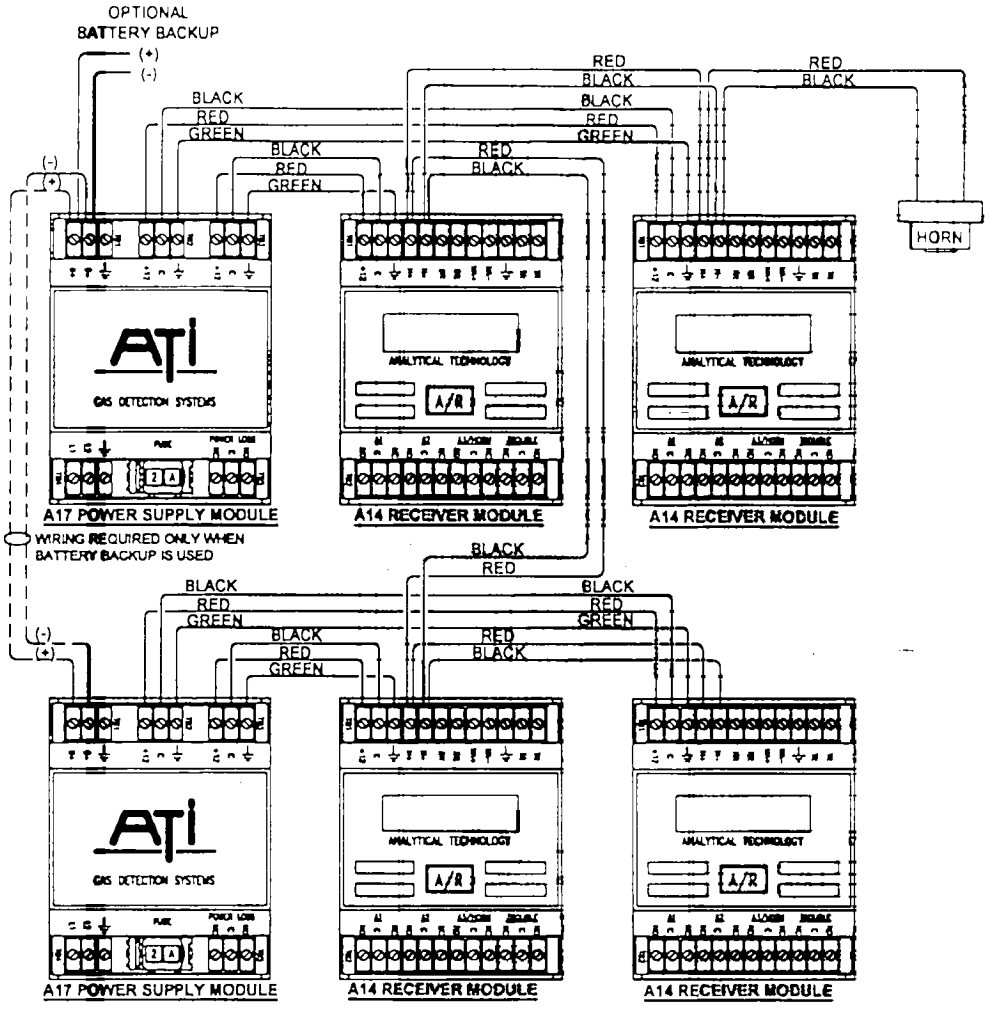


Figure 1-7: Four Point Receiver Internal Wiring (ATI-075, Rev-A)

Sensor/transmitters contain two 2-position terminal blocks, one for receiver connection and one for connection of the Auto-Test generator. Connection of the two wires from the receiver are not polarity sensitive. These wires can be hooked up without regard to terminal position. **Connection of the generator is polarity sensitive.** The generator will not function unless connected properly. Sensor/transmitters supplied with the generator from the factory will be factory wired. Adding a generator to an existing unit requires the installer to be sure that generator wiring follows the diagram in Figure 1-8 below.

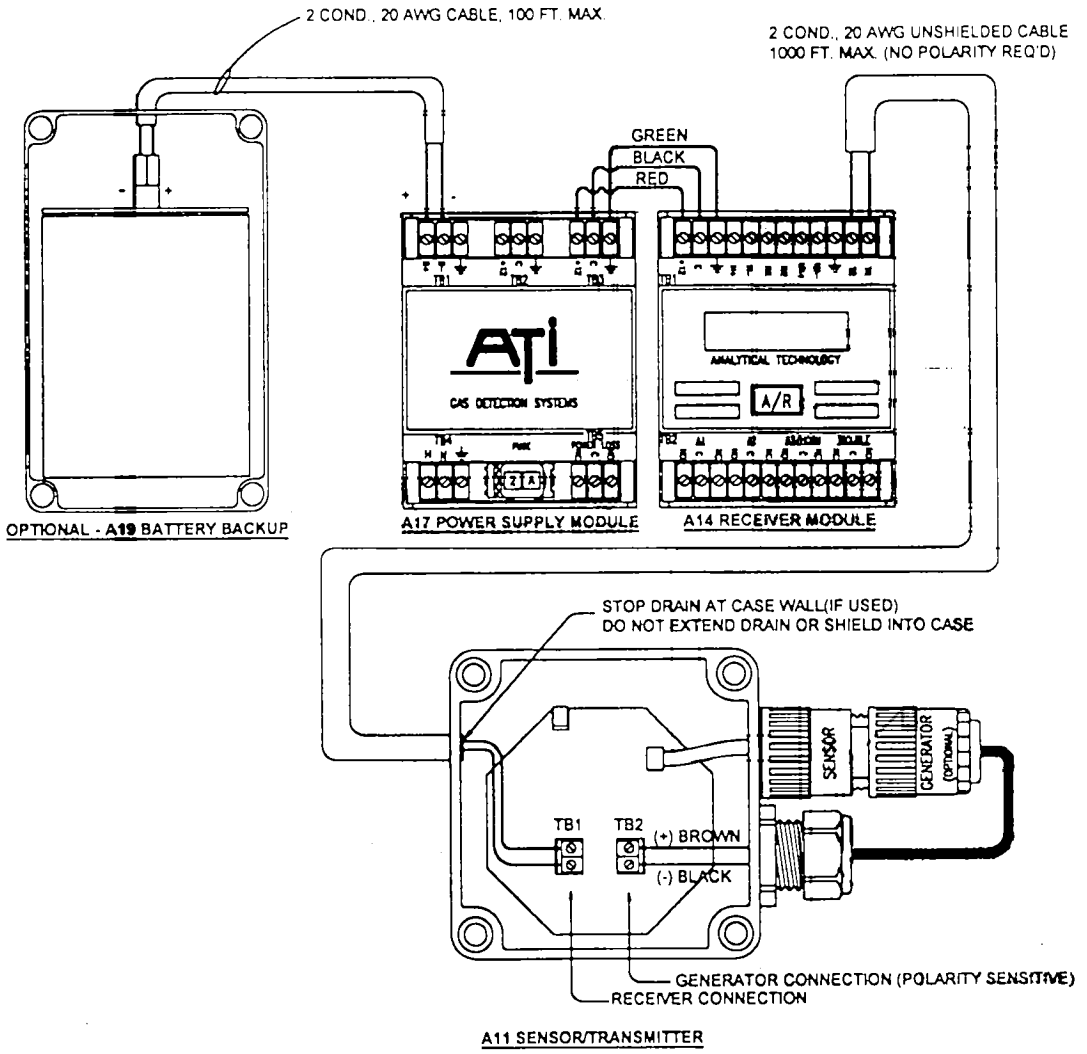


Figure 1-8: Typical System Wiring, Nema-4 Transmitter Version (ATI-034, Rev-B)

CAUTION: **Be very careful when removing the knockouts on the sensor/transmitter enclosure. A small bladed screwdriver tapped firmly in the knockout recess is all that is necessary. Do not drive the screwdriver blade into the transmitter enclosure or it may strike the circuit board and cause component damage.**

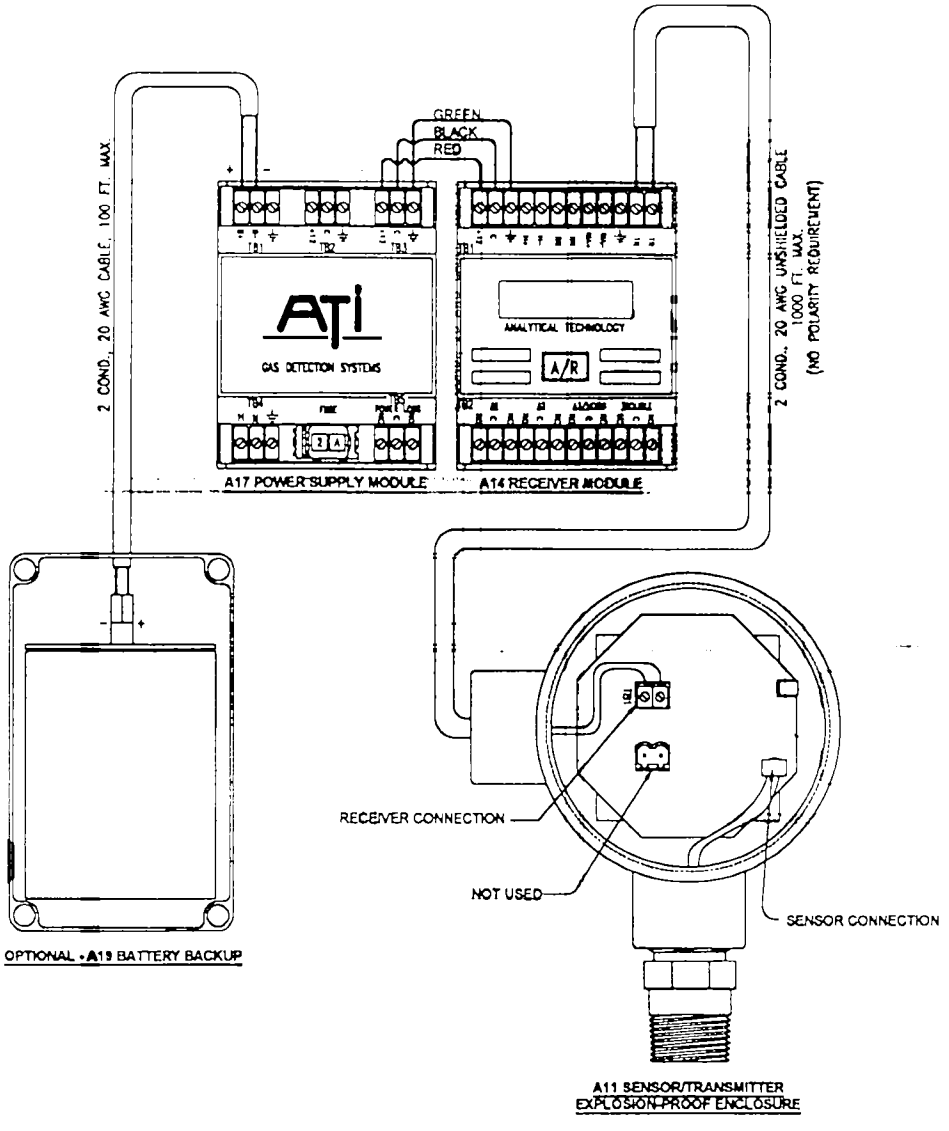


*Figure 1-9: Typical System **Wiring, Explosion-proof Transmitter Version (ATI-076, Rev-A)***

The remainder of this manual is divided into sections that describe each component of the system. Mechanical and electrical installation are the only requirements to provide a workable system. Power supply modules and battery back-up units require no adjustments. Receiver modules are factory set to the range specified on the order, and alarm setpoints will be set to default values unless otherwise specified on the order. Sensor/transmitters are factory calibrated, and should require no adjustments when placed in service. Calibration can be checked if desired according to the instructions in the Sensor/transmitter section of this manual.

Normal operation of the system is done using the switch on the Receiver module. The "Operation" portion of the Receiver section (section 2) should be read and understood before placing the detection system into operation.

RECEIVER MODULE

Introduction

Series A14 Receivers provide the user interface to the gas detection system. Each receiver is connected to a series A11 sensor/transmitter with a 2 conductor cable, and displays information on the gas concentration in the sensor area. Receivers are powered by a separate 12 VDC power supply (part no. 00-0055) supplied as part of the system, or by a power supply furnished by the user (12 VDC only).

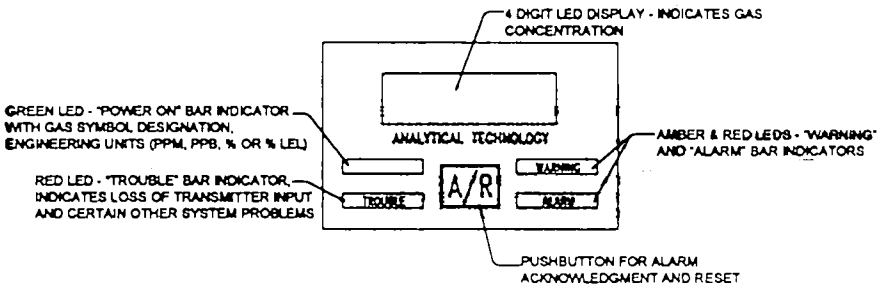


*Figure 2-1: **Front Panel Controls & LEDs (0109PM)***

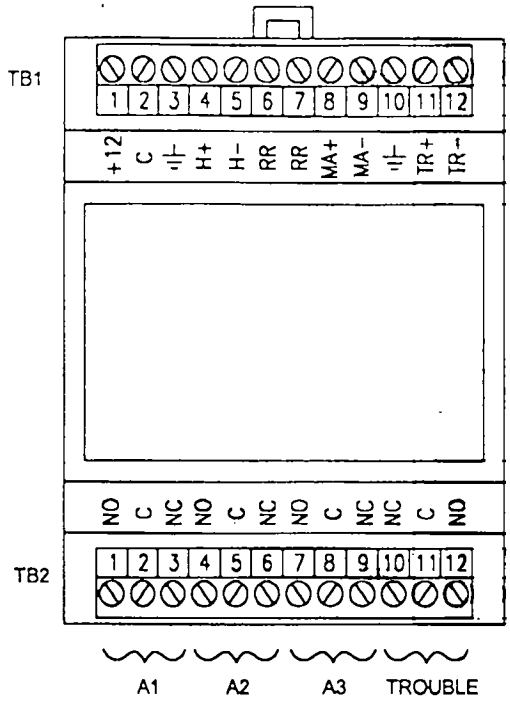
Receiver modules also include the following standard features:

1. Three SPDT alarm relays, switch programmable for operating configuration.
2. One SPDT trouble relay, for remotely indicating that the TROUBLE alarm is activated.
3. Isolated 4-20 mA output signal proportional to gas concentration.
4. Isolated remote reset input terminals for remote alarm acknowledgment.
5. Power for operation of an A11 sensor/transmitter located up to 1000 feet away.

Receivers are housed in a compact noryl case designed for mounting to a 35 x 7.5 mm DIN rail. The rails are supplied in standard ATI system enclosures, or can be supplied by a system integrator as part of a custom panel arrangement. A spring clip on the back of the enclosure holds the module to the rail. To remove from a rail, slide a thin bladed screwdriver through the black loop at the top of the module and pull outward until the module releases from the rail. To mount to the rail, reverse the procedure. When mounting, slide the bottom of the module against the bottom of the rail before extending the spring clip.

Electrical Connection

Electrical connections to the receiver are made to two pluggable terminal blocks as shown in Figure 2-2. Transmitter connections must be made at the time of installation, while power and horn connections are factory wired when the receiver is part of a complete system. Connections should be made and checked before power is applied to the module. Never connect or alter connections while power is on.



TB1	TB2
1: +12 Module Power positive (12 VDC)	1: A1 NO Alarm 1 normally open contact
2: C Module Power Common	2: A1 C Alarm 1 common
3: Earth Ground (REQUIRED)	3: A1 NC Alarm 1 normally closed contact
4: H+ Audible Horn positive	4: A2 NO Alarm 2 normally open contact
5: H- Audible Horn negative	5: A2 C Alarm 2 common
6: RR Remote Reset	6: A2 NC Alarm 2 normally closed contact
7: RR Remote Reset	7: A3 NO Alarm 3 normally open contact
8: MA+ 4-20 mA output positive	8: A3 C Alarm 3 common
9: MA- 4-20 ma output negative	9: A3 NC Alarm 3 normally closed contact
10: Earth Ground	10: TROUBLE NC trouble normally closed contact
11: TR Transmitter Input	11: TROUBLE C Trouble common
12: TR Transmitter Input	12: TROUBLE NO Trouble normally open contact

NOTE: Relay contact designation is shown for relays in normal mode of operation for relays A1, A2 and A3. If fail-safe relay operation is selected, NO and NC designations are reversed for that relay. The TROUBLE relay is set to fail-safe operation at the factory, and the designation shown above is for the trouble relay in fail-safe mode.

Figure 2-2: Receiver Module Terminals (ATI-029, Rev-A)

CAUTION: **Receiver modules MUST be connected to a secure earth ground. Terminal 3 of TB1 in Figure 2-2 above must be connected to the earth ground terminal of ATI's power supply module as shown in the connection diagram in Figure 1-3. If the user is providing another 12 VDC supply, be sure that the receiver is properly grounded.**

Factory Configuration

All receivers are identical except for the gas symbol attached to the green power LED. Operating range, alarm relay configuration, display intensity, and Auto-Test activation are selectable using 4 banks of DIP switches located on the configuration circuit board inside the module.

Receivers are factory configured for the operating range specified on the customer order. If the system is ordered with the Auto-Test option, this is also factory configured. Factory configuration of the relays is as follows:

Relay 1 - Configured to trip at the Warning setpoint and set for normal, non-latching operation.
Relay 2 - Configured to trip at the Alarm setpoint and set for normal, latching operation.
Relay 3 - Configured to trip at the Alarm setpoint and set for normal, latching operation.
Alarm Delay - Configured for 2 second delay.

Warning and Alarm setpoints are factory set to standard values depending on the operating range. Except for oxygen systems, alarms are set to activate above the setpoints. Oxygen alarms are set to activate below the setpoints.

The LED display will operate in either normal or high intensity mode. Normal mode is the factory default setting, and is used when receivers are located indoors or in shaded areas. High intensity mode is selected when receivers will be mounted outdoors. In high intensity mode, the LED display can be read in direct sunlight.

Configuration Switches

Figure 2-3 indicates the location of each bank of DIP switches on the configuration P.C. board and Figure 2-4 provides a description of the function of each switch on each bank.

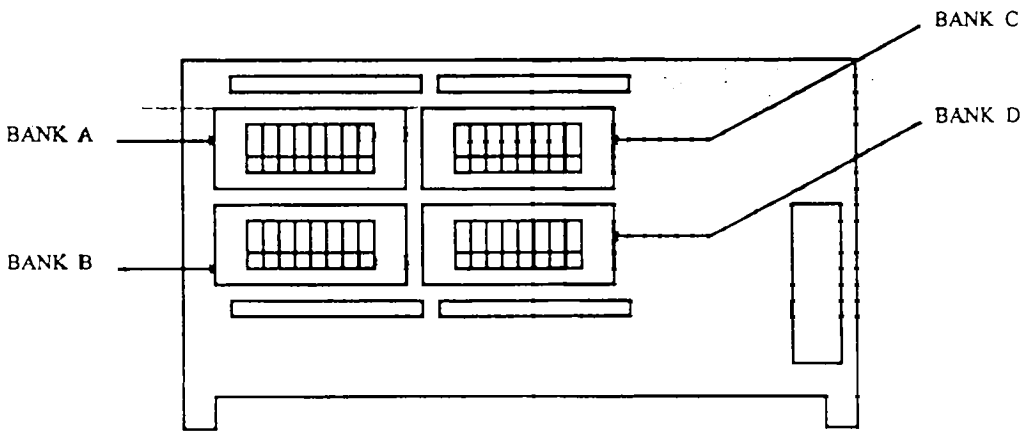


Figure 2-3: Configuration Board Switch Location

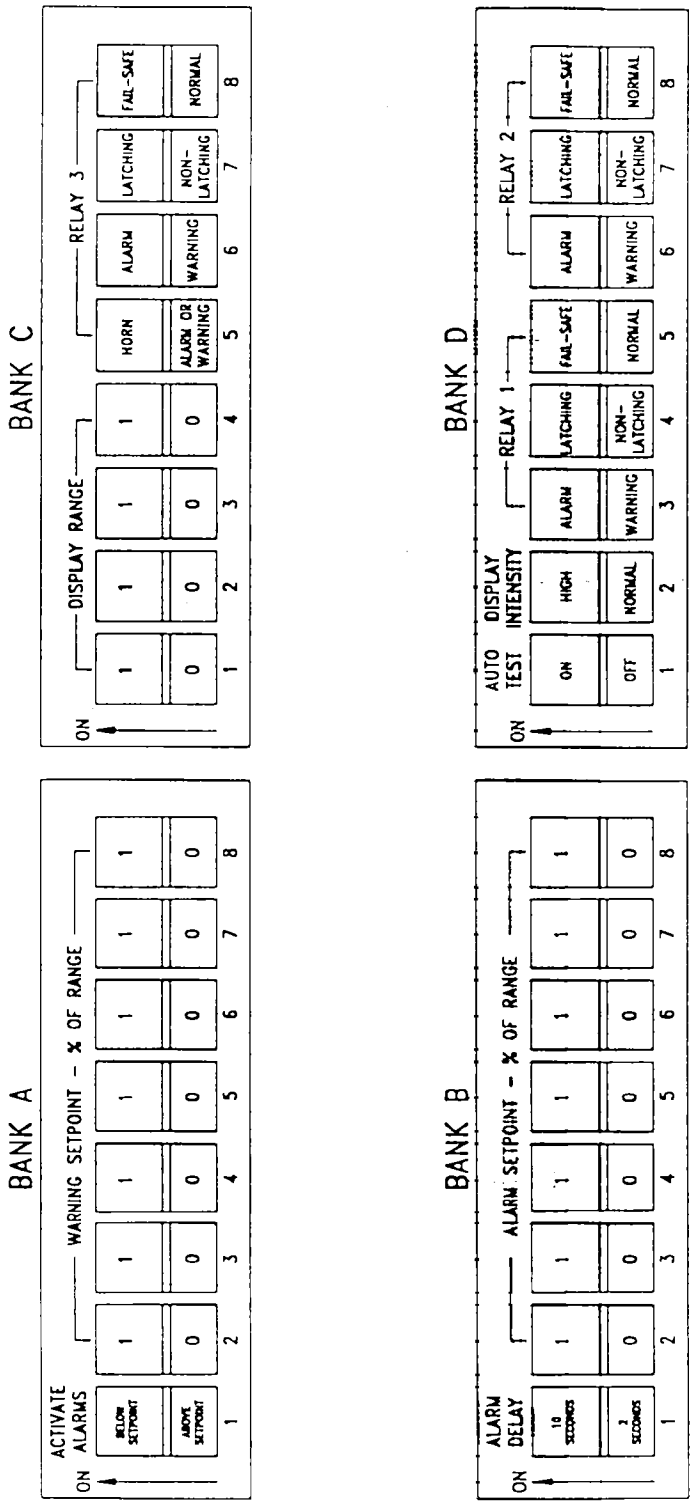


Figure 2-4: Configuration Switch Functions (0110PM)

Setpoint Selection

The operating range and the Warning and Alarm setpoints can be changed, if desired, by using the configuration switches identified in Figure 2-4. The Warning setpoint is set using switches A2-A8 and the Alarm setpoint is set using switches B2-B8. A binary number is used to select setpoints as a percent of operating range. For example, if you have a receiver range of 0-10 PPM and want to adjust a setpoint for 3 PPM, set the appropriate DIP switches to the binary number for 30% from Table 2-1 below. Switches can be set using the tip of a ball point pen or other tool with a small point on one end. Switch are two position, up indicating 'on' or a value of '1' and down indicating 'off' or a value of '0'.

TABLE 2-1

%	SWITCH POS.	%	SWITCH POS.	%	SWITCH POS.
6	0000110	38	0100110	70	1000110
8	0001000	40	0101000	72	1001000
10	0001010	42	0101010	74	1001010
12	0001100	44	0101100	76	1001100
14	0001110	46	0101110	78	1001110
16	0010000	48	0110000	80	1010000
18	0010010	50	0110010	82	1010010
20	0010100	52	0110100	84	1010100
22	0010110	54	0110110	86	1010110
24	0011000	56	0111000	88	1011000
26	0011010	58	0111010	90	1011010
28	0011100	60	0111100	92	1011100
30	0011110	62	0111110	94	1011110
32	0100000	64	1000000	96	1100000
34	0100010	66	1000010	98	1100010
36	0100100	68	1000100	100	1100100

Range Selection

Display range selection is made using binary numbers to represent the full scale operating range for the receiver. Table 2-2 provides the proper switch settings for the ranges available on each receiver. Range selection is made using switches C1-C4. The 4-20 mA output signal is proportional to the selected range.

Ranges marked with 'LSD Fixed' indicate that the least significant digit on the display always reads zero.

TABLE 2-2

DISPLAY RANGE	SWITCH SETTINGS		DISPLAY RANGE	SWITCH SETTINGS
0-1.00	0000		0-50	1000
0-2.00	0001		0-100	1001
0-3.00	0010		0-200	1010
0-4.0	0011		0-500	1011
0-5.0	0100		0-1000	1100
0-10.0	0101		0-1000 LSD Fixed	1101
0-20.0	0110		0-2000 LSD Fixed	1110
0-25.0	0111		0-5000 LSD Fixed	1111

Relay Configuration

Receivers contain 3 SPDT relays that actuate based on gas concentration. Relays can be set to actuate when the gas concentration either goes above or falls below the setpoint. Most gas leak detection applications require alarms to activate above a specific setpoint, but alarms for oxygen deficiency require relay actuation below the setpoints. Switch A1 selects relay operation either above or below setpoints and applies to all relays.

Each relay can be assigned to either the warning or alarm setpoint. As shown in Figure 2-4, switches D3, D6, and C6 configure each relay . When warning is selected, the relay will activate when the warning lamp on the front panel lights. When alarm is selected, the relay will activate with the alarm lamp on the front panel.

Relays may be either Latching or Non-latching. A latching relay activates when gas concentration exceeds the setpoint, but will only deactivate when the A/R button is pressed, and then only if the gas concentration has fallen below the setpoint. A non-latching relay will automatically deactivate when the gas concentration falls below the setpoint without A/R button being pressed. Selection of the latch/non-latch function uses switches D4, D7, and C7.

Relays may be configured for either Fail-safe or Normal operation. The designation of normal or fail-safe refers to the operation of the relay coil during normal operation. A relay configured for Normal operation will have the relay coil energized when an alarm occurs and de-energized during normal operation. A relay configured for Fail-safe operation has the relay coil energized when conditions are normal and de-energizes when an event occurs. A fail-safe relay will change state if power to the receiver is interrupted.

A short time delay precedes the activation of warning and alarm relays when a setpoint is exceeded. This brief delay of 2 seconds eliminates false alarms due to transients that might be encountered in a particular installation. The 2 second delay is the factory default and is selected with switch B1. A 10 second delay may be selected if required in a specific application. The delay time of either 2 or 10 seconds affects both the warning and alarm indicator lamps and the associated relays.

External Horn Relay

Relay 3 provides an additional configuration option not available on relays 1 or 2. Switch C5 allows relay 3 to be configured for use in activating an external audible horn. When switch C5 is on, relay 3 will operate in parallel with the internal horn. This means that any external horn tied to that relay will sound intermittently when the warning setpoint is exceeded and will go to steady on when the alarm setpoint is exceeded. The relay will deactivate when the A/R switch is pressed, silencing the external horn.

Using relay 3 in the horn configuration eliminates the need for additional relay logic to silence an external horn. This can provide significant cost savings in the installation of a complete alarm system.

Display Intensity

The LED display on the receiver will operate in either normal or high intensity mode. The factory setting is normal mode. Switch D2 is used to select high intensity mode for outdoor installations.

OPERATION

Startup

Receiver front panels contain four LED bar indicators and a 4 digit LED display. The digital display indicates gas concentration in either PPM, PPB, or percent. The green LED bar is marked with the gas symbol and units of measurement (PPM, PPB, or %) specified on the customer order. LED bars also indicate WARNING, ALARM, and TROUBLE conditions.

12 VDC power for the receiver is supplied from the power supply module. When power is first applied, the LED display will turn on and will step through three information displays. The first number displayed is the full scale range. A 0-10 PPM unit will be indicated by "10.0" on the display. After 3 seconds, the display will indicate the warning setpoint, the concentration at which the warning relay will activate, with the WARNING lamp illuminated. After 3 seconds, the display will indicate the alarm setpoint, with the ALARM lamp illuminated. At the end of this sequence, the display will begin to indicate gas concentration. However, all alarm functions will be inhibited for 5 minutes while the system is allowed to stabilize. This is indicated by WARNING and ALARM lamps flashing in an alternating pattern. During this period, alarms will not function, but the display will indicate the presence of any gas that might be in the area of the sensor. Normally, the display will spike when power first comes on, and will slowly recover to zero over the 5 minute period in which alarms are inhibited.

Alarm Acknowledge and Reset

The front panel of the receiver contains one button, marked A/R, which is used for a number of different functions. When the receiver is in normal operation, a gas leak that exceeds the warning setpoint will cause the WARNING indicator to flash and the internal horn to sound intermittently. If the alarm setpoint is exceeded, the ALARM indicator will flash and the horn will sound steadily. Pressing the A/R button the first time will silence the audible horn, and will change the WARNING and ALARM indicators from flash to steady on. The indicator lamps will remain lit until the gas condition has cleared. The WARNING indicator will automatically shut off when gas concentration falls below the setpoint, but the ALARM indicator will remain lit. Pressing the button after the alarm condition has cleared will reset the ALARM indicator.

Operation of the individual relays depends on the configuration selected for each one. As shipped from the factory, relay 1 will energize when the WARNING indicator lights and will automatically reset when the gas condition clears and the WARNING indicator shuts off. Relays 2 and 3 are configured to energize and latch when the ALARM indicator lights. These relays will reset when the A/R button is pressed to reset the ALARM indicator. Changes in the relay configuration switches will alter this operational sequence.

Trouble Alarm and Relay

Receivers contain a TROUBLE indicator and an associated SPDT relay. The trouble alarm will be activated if the transmitter cable is broken or shorted, or if electronic component failure in either the transmitter or receiver causes a loss of digital input. If these conditions occur, the TROUBLE indicator will light, the horn will sound intermittently, and the trouble relay will change state. Note that the trouble relay is a fail-safe relay. Under normal conditions, the coil of this relay is energized, and it de-energizes when a trouble alarm occurs. The trouble relay will also change state if power fails.

For systems supplied with the Auto-Test option, the TROUBLE lamp will also indicate the failure of a sensor to respond to the gas test that occurs automatically every 24 hours. Should this type of failure occur, the TROUBLE indicator will flash, the trouble relay will change state, and the audible horn will activate. Pressing the A/R switch will silence the horn, but the lamp and relay cannot be reset for at least 10 minutes. The flashing TROUBLE light indicates that the sensor and gas generator should be tested for proper operation using the manual Auto-Test. If the sensor does not respond, the system should be tested using calibration or test gas as described in the sensor/transmitter instructions. Pressing the A/R button resets the trouble relay and indicator.

Auto-Test Function (Optional)

While an Auto-Test is in progress, the alarm relays are inhibited. This is indicated by the alternating flash pattern on the WARNING and ALARM indicators used during the 5 minute power on delay. Typically, an Auto-Test will progress only a few minutes before the sensor begins to respond. The actual time varies depending on the gas. A chlorine test normally takes less than 30 seconds while a sulfur dioxide test can take as long as four minutes. Alarm relays will remain inhibited for 10 minutes after completion of the test to allow the sensor to recover. The alternating flash pattern will continue during this time.

ATI's optional Auto-Test feature is a valuable tool for verifying the proper operation of a gas detection system while saving manpower normally required for routine testing. Auto-Test is an electrochemical gas generator fixed to the gas sensor and controlled from the receiver. Every 24 hours, the receiver automatically activates the gas generator and monitors the output of the gas sensor. When the sensor responds normally, the generator is shut off and the system returns to normal operation. With this feature in place, operation of every gas sensor is verified daily. Manual testing is reduced to periodic calibration every 3-12 months, or when the receiver indicates that a sensor has not passed its normal test.

During the first two minutes of the 10 minute inhibit period, alarms are completely inhibited. The warning and alarm relays will not activate during this period. During the second 8 minute period, the alarms are only partially inhibited. The inhibit flash pattern will continue during the 8 minute period, but the inhibit will be superseded by an alarm should the measured gas concentration exceed 50% of range. This means that alarm protection is partially restored to protect against any major leak during this period. At the end of the 10 minute inhibit period, the alternating flash will end and the unit will return to normal operation.

When the Auto-Test is activated, the generator will turn on for a maximum of 5 minutes. If no sensor response is detected during this time, the generator will turn off and the receiver will wait for 15 minutes before initiating another Auto-Test. If no sensor response is detected after the second test, the trouble indicator will flash, trouble relay will change state, and the horn will sound. The test sequence will be repeated twice more at one hour intervals. If the system passes, alarms will automatically shut off. If it fails, the alarms will continue to be energized. If the trouble alarm has been manually acknowledged and reset between tests, a failure will reactivate the trouble alarm.

NOTE: No Auto-Test will be initiated if the measured gas concentration is above either of the two setpoints. If this condition exists, the receiver will wait for another 24 hours before initiating another Auto-Test sequence.

Lamp and Horn Test

Verification that all digital display segments and alarm indicator bars are functional is done using the A/R button to initiate a lamp test. If the detection system includes an internal horn, the horn is also tested as part of the lamp test.

To activate the lamp test, press and hold the A/R button for 2 seconds and all front panel indicators will light. The horn will also sound briefly. Immediately release the button and the indicators will return to normal. During this test, alarm relays will not be activated.

Relay Inhibit

Alarm relays in the receiver can be inhibited for up to 4 hours to allow calibration or testing of sensor/transmitters without activating external alarm or control devices. Inhibit is activated through the use of the A/R button.

Press and hold the button for approximately 5 seconds. The lamp test will occur first, but continue to hold the button down. Once the lamps have shut off, release the button. The WARNING and ALARM lamps will begin an alternating flash pattern, and, if the receiver is configured for Auto-Test, the flash will switch to the trouble lamp. If you do nothing, the flash will switch between the WARNING/ALARM lamps and TROUBLE lamp twice and then revert to normal operation.

If the A/R button is pressed and released while the WARNING and ALARM lamps are in alternating flash, the receiver will go into the relay inhibit mode (if a horn is connected, a quick beep will sound when the inhibit is selected). The WARNING and ALARM lamps will continue their alternating flash for 4 hours or until the A/R button is pressed again. During this period, the display will indicate gas concentration, but the relays will not. Transmitters may be calibrated while the inhibit is on without activating external alarms.

Manual Auto-Test

Gas detection systems purchased with the optional Auto-Test generator may be tested by manual activation of the generator from the receiver module. This function will operate only if the Auto-Test configuration switch D1 is 'on'. As with the lamp test and alarm inhibit, access to manual operation of the generator is through the A/R button.

Press and hold the button for approximately 5 seconds. The lamp test will occur first but continue to hold the button down. When the lamps have shut off, release the button. The number of hours since the last successful auto-test (automatic or manual) will appear on the display. When the WARNING/ALARM flash is alternating with the TROUBLE flash, you can select manual activation of the generator rather than relay inhibit. Press the A/R button when the TROUBLE lamp is flashing (if a horn is connected, a quick beep will sound when the Auto-Test is selected). The green gas indicator will begin to flash, indicating that the generator is activated. The system will go through a normal Auto-Test sequence, exactly the same as the sequence used every 24 hours. If you observe the display, you will see increasing gas values as the sensor begins to respond. Upon completion of a successful test, the horn will sound a single beep. The inhibit will remain on for an additional 10 minutes while the sensor recovers to zero. Should the test be unsuccessful, the TROUBLE lamp will light and the alarm relay and horn will activate. Pressing the A/R button will silence the horn, but the alarm cannot be reset for at least 10 minutes after a failure of the manually activated Auto-Test. This period will allow time to manually inspect the sensor to determine the reason for the failure

If the manual Auto-Test sequence results in a trouble alarm, check the sensor/transmitter. Either the sensor or generator has failed, or the diffusion path between the two is physically blocked. Methods for testing individual gas sensors can be found in specific sensor/transmitter instructions.

Remote Reset

Receivers are provided with input terminals for connection of a remote reset switch. The remote reset input provides horn silence and alarm reset functions using a switch located at a remote point. When receivers are located at sites with telemetry equipment, the remote reset input may be connected to a relay contact in the telemetry system.

The remote reset input accomplishes the same acknowledge and reset functions as the A/R button on the front panel. When a switch closure is detected across the remote reset terminals, the detector horn will silence and any latching relays will reset, provided that the gas condition has cleared. The remote reset input will not activate any of the testing or inhibit functions of the receiver.

Analog Output

Receivers provide an isolated 4-20 mA output signal for interface with recorders, data loggers, or computer systems. The span of the 4-20 mA signal is the same as the range of the receiver selected during the receiver configuration. The output will drive loads up to 1200 ohms.

TROUBLESHOOTING

Receiver modules will normally provide trouble free operation over many years of service. However, should problems arise, a few simple tests can be done to determine if the receiver is functioning properly.

LED display and green gas indicator do not light when power is applied to the system.

1. Check polarity of the power connection at terminals 1 and 2 of TB1. Terminal 1 must be positive and terminal 2 must be negative.

2. With a voltmeter, check the power supply at terminals 1 and 2 of TB1. Input power supply must be 11 to 15 VDC.

Receiver module powers up correctly, but does not respond when test gas is applied to sensor/transmitter.

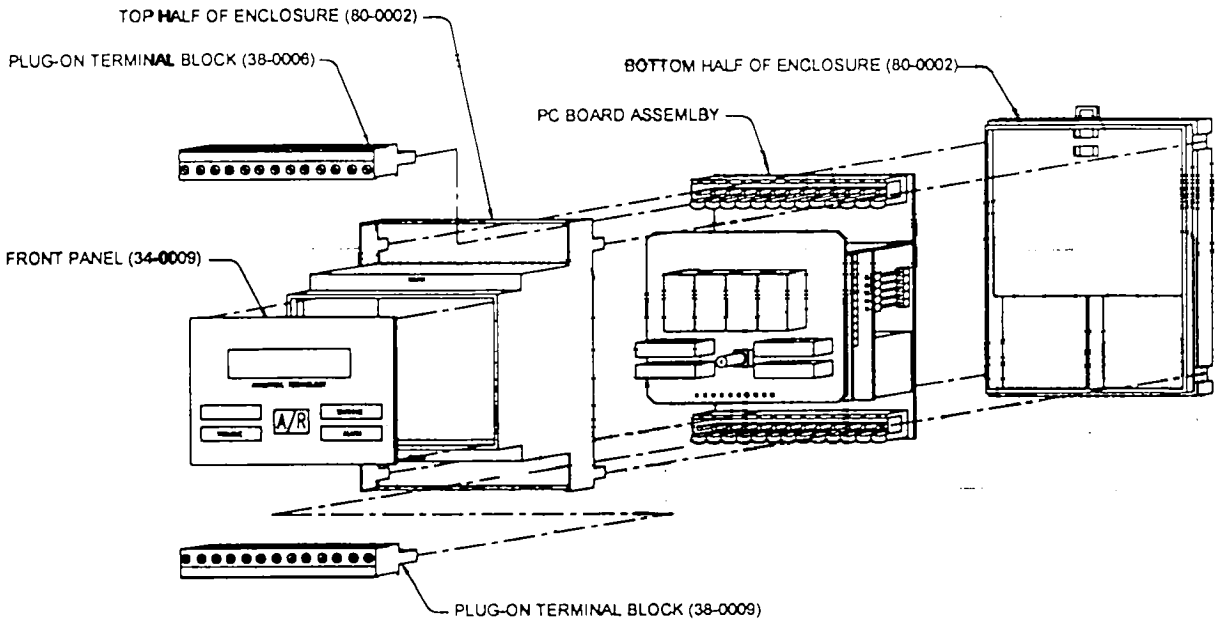
1. Disconnect transmitter connections at terminals 11 and 12 of TB1. Check the voltage on the terminals with a voltmeter. The voltage should be about 12 VDC.

2. Connect a milliamp meter between terminal 11 and 12 of TB1. The current should measure about 20 mA.

Problems in the receiver module can only be caused by an electronic component failure. In most cases, the simplest solution is to remove the module and install a replacement. Troubleshooting the electronic circuit boards is best handled by trained technician familiar with the circuits. As modules are small and easily shipped, it is best to return defective modules to ATI for service.

Modules failing during the warranty period will be exchanged by ATI with replacement units. Contact the ATI service department for assistance.

RECEIVER MODULE PARTS LIST



Part Number	Description
00-0056	Complete receiver module (Specify Gas)
80-0002	Module enclosure (top and bottom)
34-0009	Front panel
38-0009	Relay terminal block plug, 12 position
38-0006	DC terminal block plug, 12 position

UNIVERSAL POWER SUPPLY

The power supply module used in the *GasSens* system (part #00-0055) is a self-adjusting supply that will accept the AC power provided in virtually every country in the world. Any AC (50-60 Hz.) or DC voltage from 85 volts to 270 volts can be connected to the power input terminals on TB4. There are no adjustments of any kind required.

The output of the power supply is a regulated 13.7 VDC. There are 3 sets of DC terminals at the top of the module for connection to receivers and external battery back-up units. This voltage permits float charging of a separate 12 volt lead acid battery for detector system back-up.

Power supply modules are rated for 1 ampere output, and will deliver higher current for periods. Each receiver module draws a maximum of approximately 300 mA, and will normally draw about 125 mA. An external battery back-up unit can draw up to 750 mA for a few hours if the battery is deeply discharged, but the current draw drops sharply as the battery approaches full charge. The audible horn draws less than 10 mA average current, and an optional strobe will draw approximately 400 mA when activated.

The power supply contains a 2 amp. slow-blow fuse located in a removable holder between TB4 and TB5. The fuse can be removed by pulling the black fuse holder out of the orange housing. A clip on the bottom of the holder can be released to open the holder and replace the fuse. Removing the fuse also serves as a simple way to remove AC power to the detector if necessary.

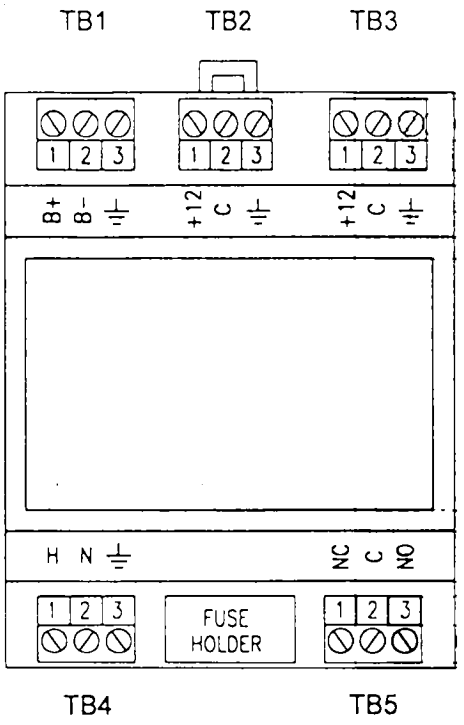
The power supply provides a SPDT relay to indicate power failure. The relay coil is energized by power from the input power terminals and will de-energize if power is lost. This relay is convenient for input to telemetry systems to indicate loss of power at a remote site.

Mounting of power supply modules is done by clipping them to a standard 35 x 7.5 mm DIN rail. A spring loaded clip holds the module to the rail and is used for mounting and removal. From the front, the clip is seen as a black loop at the top rear of the module. To remove from a rail, place a small screwdriver into the opening in the black loop and pull outward until the module releases from the rail. Reverse the procedure to mount the module.

CAUTION

The power supply module is sealed, and the seal should not be broken. Never attempt to disassemble or service the power supply module. Service on this module should only be done only by a qualified service technician familiar with the circuit design and equipped with the proper service equipment. Severe electrical shock may result from touching internal components with input power applied.

Figure 3-1 provides detailed information on the terminals provided on the power supply. All terminal blocks are plug-in type, and can be easily unplugged should removal of the module be necessary.



TB1
(12V Battery only)

1: B+ External Battery (+)
2: B- External Battery (-)
3: Earth Ground

TB2

1: +12 Receiver Module (+)
2: C Receiver Module Common
3: Earth Ground

TB3

1: +12 Receiver Module (+)
2: C Receiver Module Common
3: Earth Ground

TB4

1: H AC power hot (85-255 VAC)
2: N AC power neutral
3: AC power ground (earth ground REQUIRED)

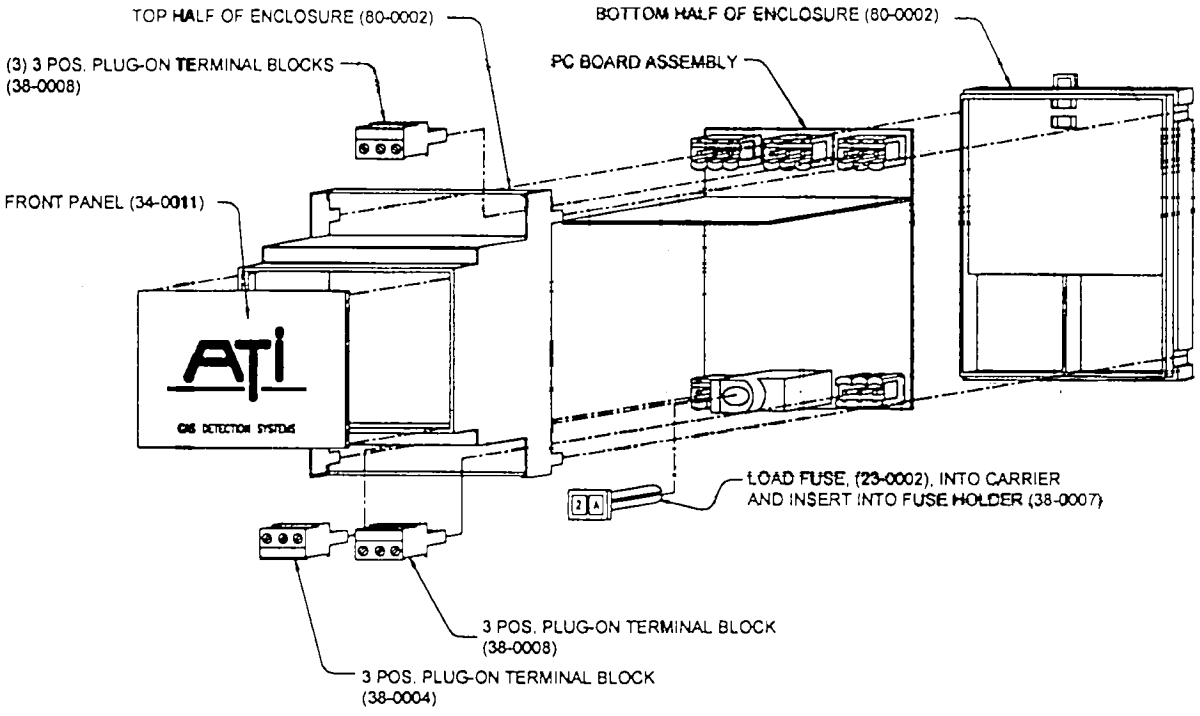
TB5

1: NC Power failure normally closed contact
1: C Power failure common
1: NO Power failure normally open contact

NOTE: AC power input must be properly earth grounded for safe operation. 220 VAC power without a neutral line may not be used with this power supply.

Figure 3-1: Power Supply Terminal Connections (ATI-030 Rev-A)

POWER SUPPLY PARTS LIST



Part Number	Description
00-0055	Complete power supply module
80-0002	Module enclosure (top and bottom)
34-0011	Front panel
23-0002 *	Fuse - 2 A slow blow, 25 mm
38-0007	Fuse holder
38-0004	AC power terminal block plug, 3 position
38-0008	Power failure relay & DC terminal block plug, 3 position

Items marked with an asterisk (*) are recommended spares.

OPTIONAL EQUIPMENT

Battery back-up units for *GasSens* detection systems (part #00-0057) are separate components housed in a NEMA 4X wall mount enclosure. Back-up units include a 4 ampere-hour sealed lead acid battery with a control circuit attached to the battery terminals. The battery is held in place on an aluminum bracket fixed to the plastic enclosure.

Installation

Figure 4-1 shows the dimensions of the battery back-up unit and the mounting hole centers. Two conduit hubs are supplied with the unit, one for use on the battery back-up enclosure and one for use on the receiver enclosure. **When mounting the battery back-up unit, be careful to hold the module securely when screwing the enclosure in place. The battery is heavy and could cause injury to feet if it should fall directly on them.** The battery and attached circuit board are held in place with a wire tie. Should you wish to remove the battery, the wire tie must be cut. When replacing the battery, secure with a new wire tie. Replacement batteries from ATI are supplied with the proper wire tie.

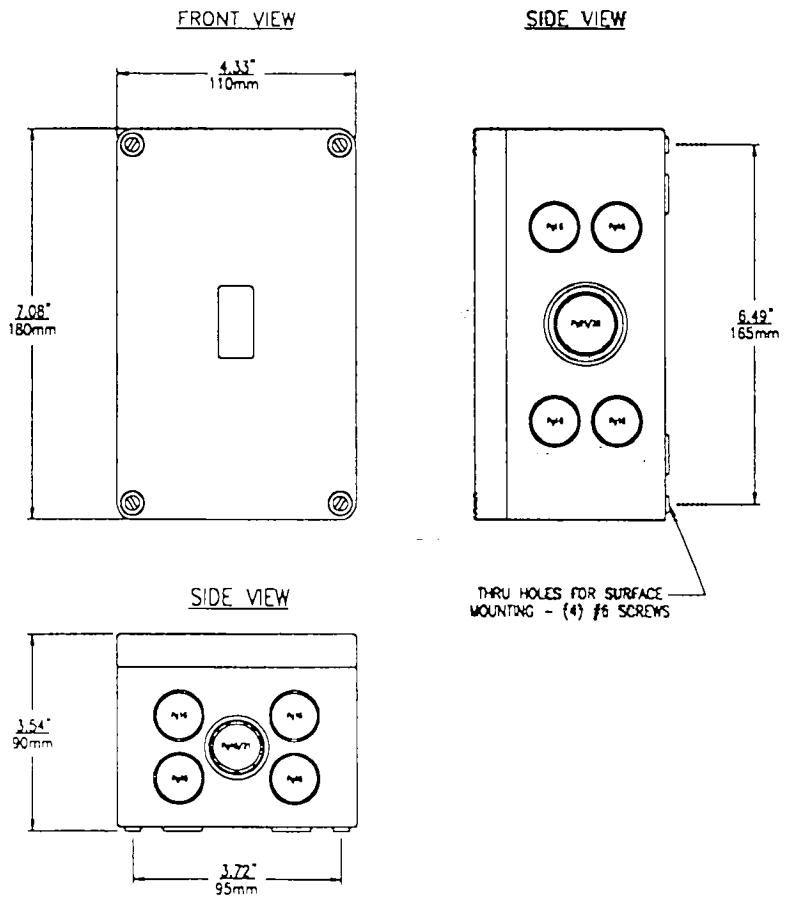


Figure 4-1: Battery Backup Enclosure Dimensions (80-0008R Rev-A)

Electrical connection is made between the battery back-up unit and the power supply module. The circuit board mounted on the battery contains a 2 position plug-in terminal block marked plus and minus. The plus terminal is connected to terminal B+ of the power supply and the minus terminal is connected to B- of the power supply.

Operation

When power is applied to the power supply module, a relay on the battery back-up circuit board energizes and places the battery back-up into operation. There are no user adjustments in the battery back-up unit. If the battery is not fully charged, the power supply will begin supplying charge current to the battery, and will float charge the battery as long as the power supply is on.

Should the power supply loose its input power, the battery back-up will immediately supply power to receiver modules to maintain detection system operation without interruption. The back-up period will vary depending on whether the detector is single channel or two channel, on whether displays are in normal or high intensity mode, and on how many relays are configured for fail-safe operation. The minimum period expected for a single channel system is 12 hours and for a two channel system is 6 hours. Normally, the back-up period is twice as long as the minimums.

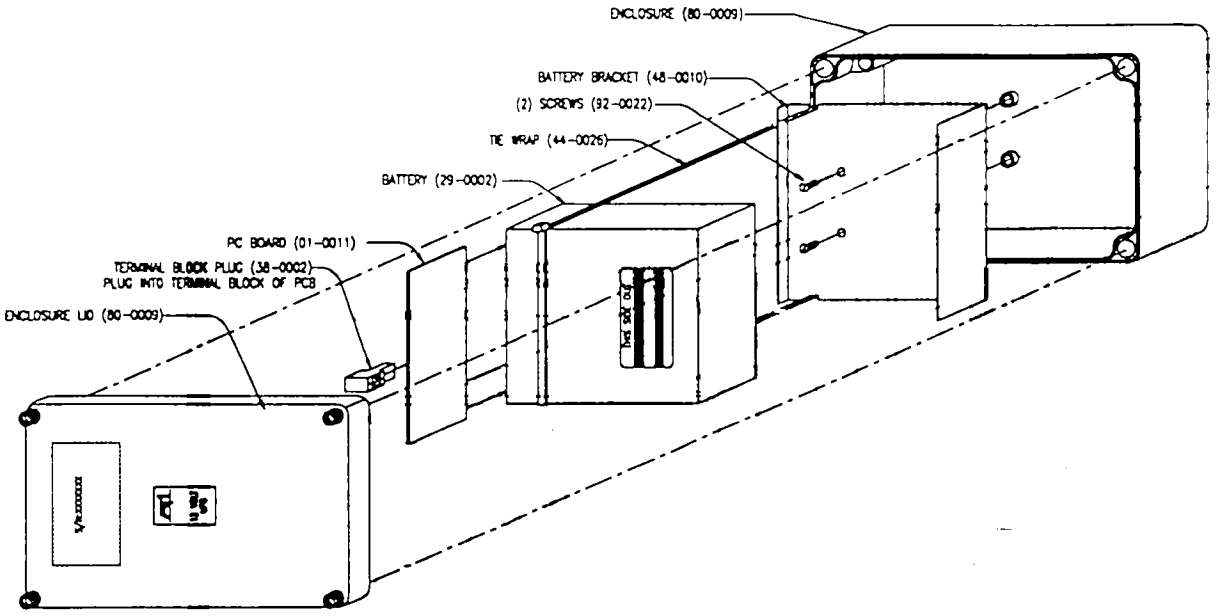
The circuit board attached to the battery serves two functions. First, it regulates the charging current to the battery to a maximum of 0.75 amps. This prevents possible damage to the battery due to an excessively high charge current. Second, it isolates the battery from the detection system when the battery voltage falls below 10 volts. This is done through a relay, and protects the battery against damage caused by very deep discharge.

The isolation relay that protects against deep discharge will also protect the battery against an external short circuit of the wires connected to the battery. If a short occurs, the relay will immediately open, protecting the battery and limiting the current that the battery will deliver.

Removal from Service

The relay that isolates the battery when the 10 volt level is reached is energized as soon as power is applied to the power supply module. Once energized, the coil current is supplied from the battery if needed. If the gas detection system supported by the battery back-up is started up for testing and then shut down, the battery back-up relay should be de-energized manually. Otherwise, the relay coil will continue to draw power from the battery until the 10 volt level is reached. While this will not cause damage, it means that the battery will be discharged when the detection system is started up again.

To de-energize the relay, slide the control circuit board off the battery terminals briefly and then slide it back on. As soon as the battery connection is broken, the relay coil will drop out, and will not energize until power is applied to the power supply module in the system. This procedure is recommended any time the detection system is to be shut down for more that a few days.



BATTERY BACKUP PARTS LIST

Part Number	Description
00-0057	Complete battery back-up unit
01-0011	Battery back-up circuit board
80-0009	NEMA 4X enclosure (top and bottom)
48-0010	Battery bracket
29-0002	Battery, 12 V, 4 A-H
92-0022	Self-tapping screws, (Pkg. Of 2)
44-0017	Pg 16 to 1/2" NPT conduit hub
44-0018	Pg 16 Seal Ring (required for NEMA-4X rating on hub)

STROBE PARTS LIST

Part Number	Description
35-0002	Red Strobe, 12-80 VDC
35-0005	Red Strobe, 120 VAC
35-0004	Amber Strobe, 12-48 VDC
35-0006	Amber Strobe, 120 VAC

STROBE LIGHT

The accessory alarm indicating strobe light (part number 35-0002) available for use with the *GasSens* alarm system is a weatherproof high-intensity strobe operating from a 12 VDC power source. The strobe can be conveniently mounted on the top or either side of the alarm enclosure using one of the 1/2" NPT hubs supplied with the unit. The bottom of the strobe also contains a 1/2" NPT mounting adapter, so that only a 1/2" pipe nipple is needed to complete the assembly. The necessary nipple is available from most hardware stores or plumbing supply outlets.

For remote applications, the strobe should be mounted to 1/2" conduit, with a junction box nearby for splicing the strobe wires to the interconnect wiring running to the alarm unit. This wiring should be kept separate from AC power wiring to avoid accidental connection of AC power to the strobe, which will damage the lamp.

The 12 VDC power to operate the strobe can be picked up from the power supply module which is part of the alarm unit. Figure 4-2 shows the typical wiring diagram for connection of the strobe. The wiring diagram shows the plus side of the 12 VDC supply brought to the common of the alarm contact, one side of the strobe wired to the normally open (NO) contact, and the other side of the strobe connected to the minus side of the 12 VDC supply. Connection of the strobe lamp directly across the alarm relay will not operate the strobe because alarm contacts are unpowered.

CAUTION: **Strobe light connection is polarity sensitive. Check wiring to be sure that the +12 is connected to the red strobe wire.**

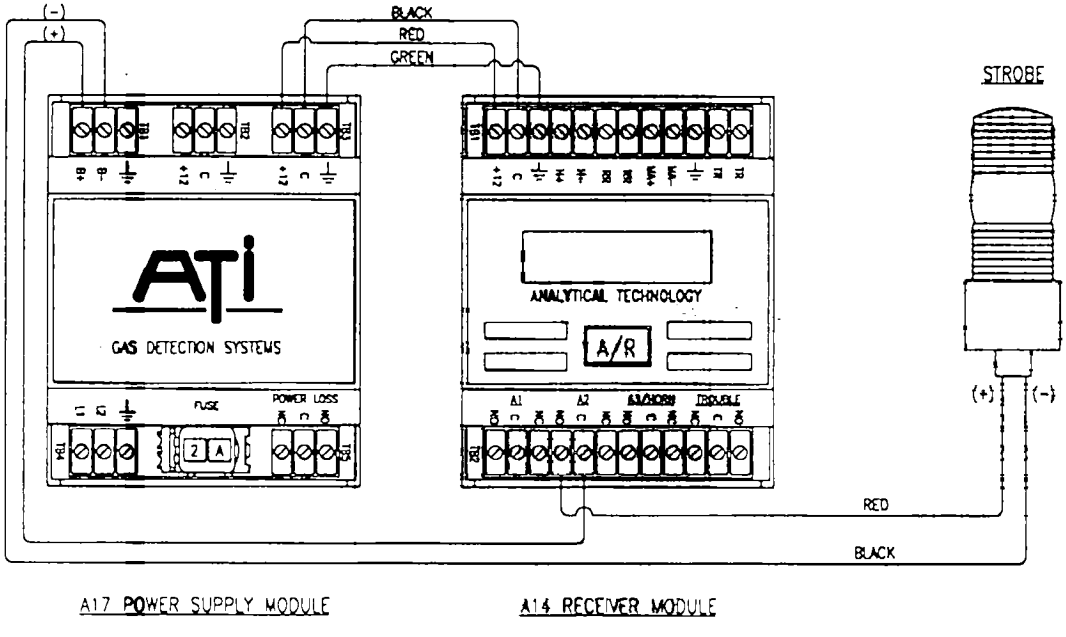


Figure 4-2: External Strobe Light Connections (ATI-0240 Rev-A)

INTRODUCTION

Series A11 sensor/transmitters combine electrochemical gas sensors and an electronic amplifier that transmits gas concentration using a current pulse position technique. When ordered as an option, sensor/transmitters are also supplied with a gas generator that provides the Auto-Test automatic sensor testing system.

NOTE: **An Auto-Test generator is not required to verify operation of an Oxygen Sensor/Transmitter. Oxygen sensors inherently provide an alarm if the sensor fails because sensor failure results in low oxygen readings.**

Gas sensors are housed in a corrosion resistant plastic housing connected to the transmitter enclosure through a knockout. A short sensor cable with a three pin socket connects the sensor to the transmitter circuit board. For hazardous area applications, sensor/transmitters are housed in a cast iron explosion-proof enclosure and the sensor is contained in a stainless steel shell with explosion-proof cable seal.

Sensors/transmitters are powered from a current limited 12 volt supply provided by the receiver. **Do not attempt to operate the transmitter from another 12 volt power supply or the transmitter will be damaged.** If you wish to perform a calibration on the bench, use a spare receiver module to power the transmitter. A separate 12 volt supply can be used if the current is limited to a maximum of 20mA.

INSTALLATION

Sensor/transmitters are surface mounted using screws or bolts as required. Figure 5-1 provides the dimensions for the NEMA-4X transmitter. NEMA-4X enclosures will accommodate #6 or #8 screws which are not supplied. For NEMA-4X transmitters not equipped with Auto-Test, the sensor may be oriented either horizontally as shown in Figure 5-1 or facing downward. For pipe mounting, special 2" pipe mounting brackets are available.

Explosion-proof transmitters mount directly to the conduit system and are supported by the conduit. The sensor orientation may be either horizontal or facing downward, as shown in Figure 5-2. To maintain the explosion-proof integrity of the transmitter, a suitable cable entry seal must be used in accordance with the applicable electrical code.

NOTE: **Gas sensors are shipped with a protective plastic cap over the end. This cap should be left in place to avoid damage to the sensor during installation. If the detection system is to be activated within a few days of installation, the cap should be removed when installation is complete. Otherwise, leave the cap in place until the system is to be activated. Be sure to leave the protective cap on the sensor if painting is to be done in the area of the sensor.**

Installation wiring requires connection of a 2 conductor cable from the receiver. Connection is made at the terminals marked TB1 on Figure 5-3. This connection is not polarity sensitive so you can connect either conductor to either terminal. The cable supplied with the system in unshielded #20 gauge stranded.

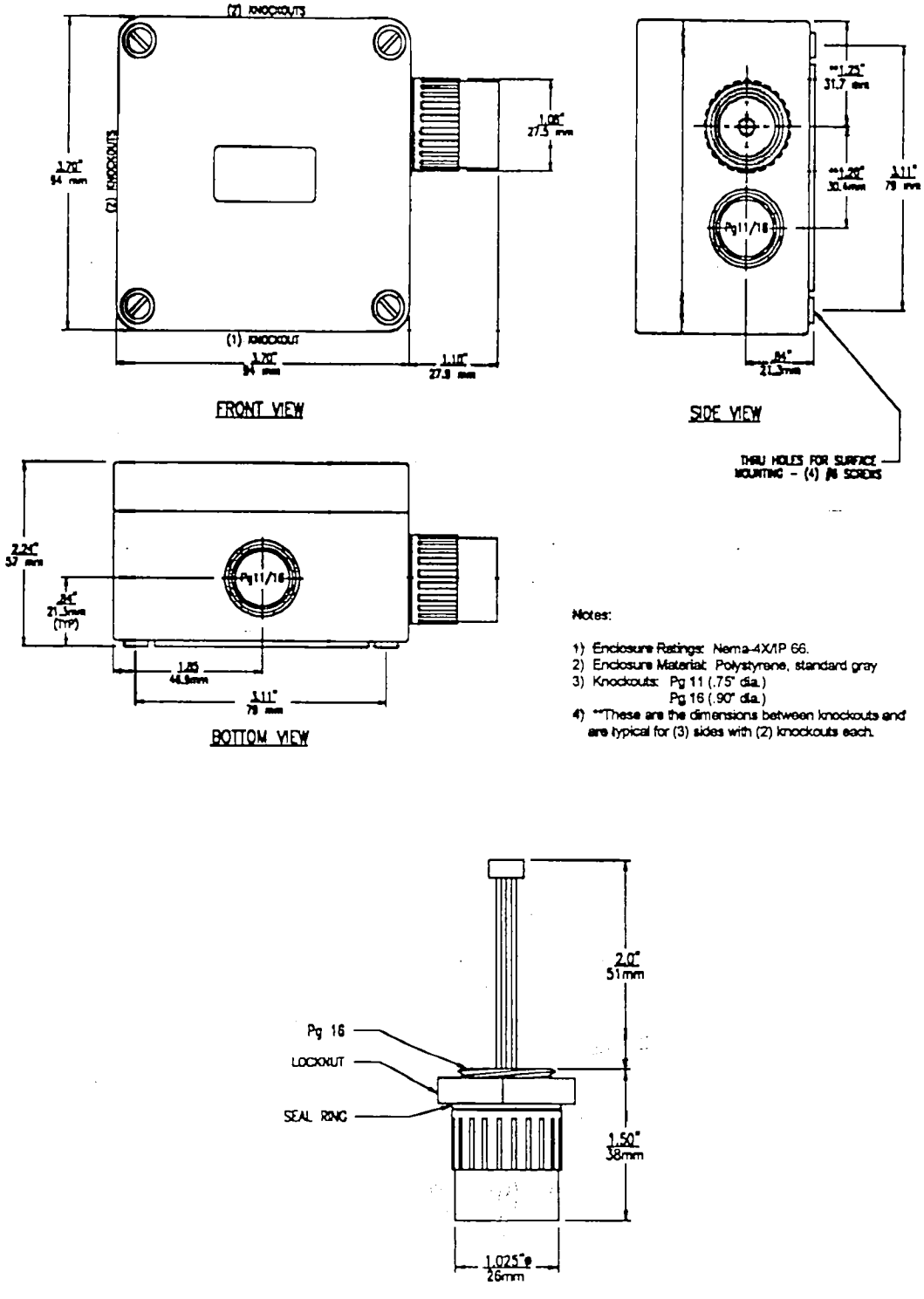


Figure 5-1: Nema-4X Sensor/Transmitter Dimensions (ATI-017, ATI-0169)

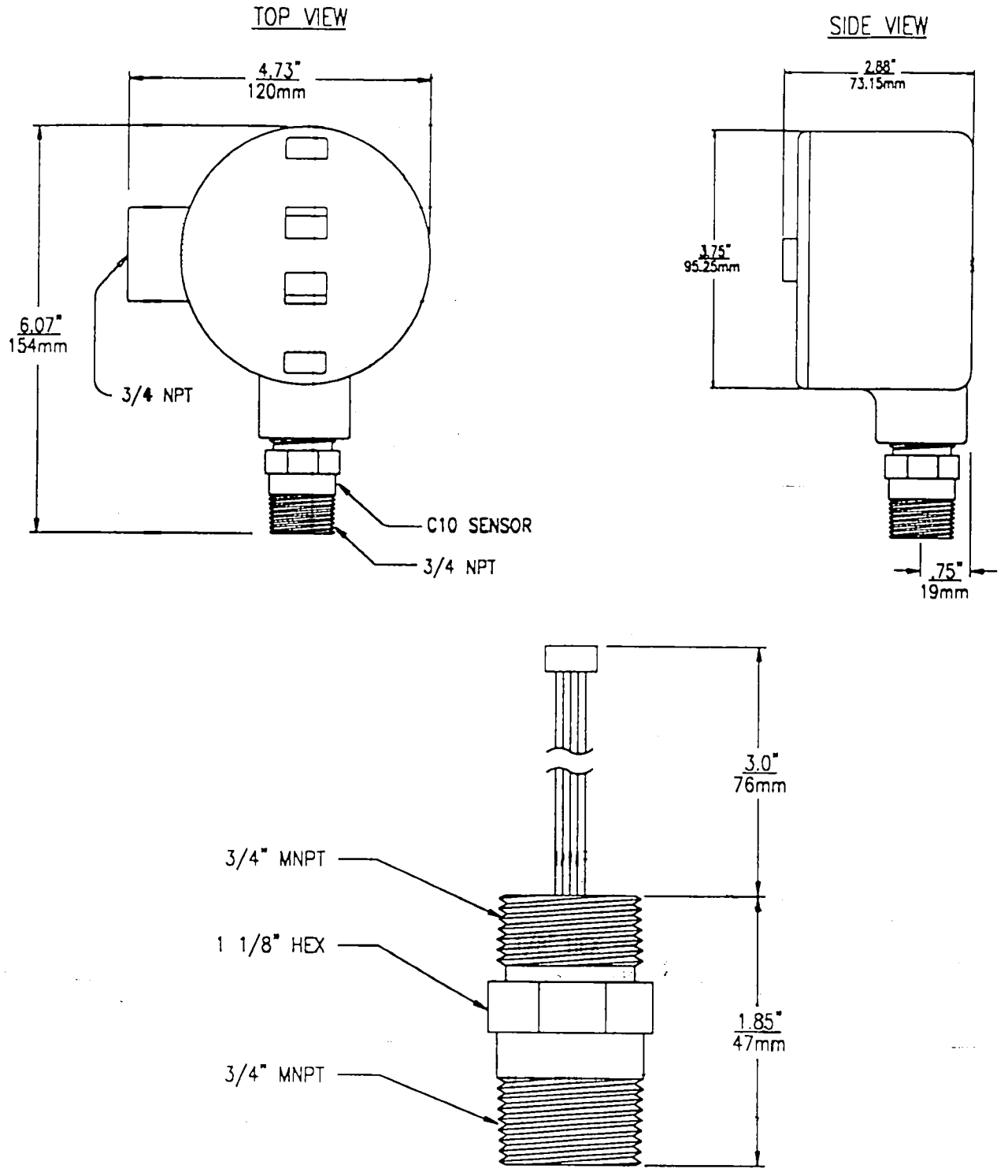


*Figure 5-2: **Explosion-Proof Sensor/Transmitter Dimensions (ATI-046, ATI-0170)***

SENSOR LOCATION

Oxygen gas mixes uniformly throughout most enclosed spaces. However, oxygen sensors are normally used to detect oxygen deficiency, caused by the displacement of oxygen by another gas such as carbon dioxide or nitrogen. When locating an oxygen sensor in an enclosed space, the user should evaluate the hazard associated with the space. Normally, the oxygen sensor would be located about 5 feet from the floor, but a higher or lower elevation may be better in applications where a gas that is either heavier or lighter than air is the source of the hazard.

INTERFERENCES

The A11-19 sensor/transmitter uses an electrochemical sensor manufactured by ATI. It is designed to measure oxygen gas concentration in air with a maximum of sensitivity and a minimum of interference from other gases.

Oxygen sensors are affected by only two possible interferences. The first and least likely, is percent levels of oxidant gases such as chlorine, bromine, or ozone. Oxygen sensors will respond to these gases as if they were oxygen, indicating higher oxygen levels than really exist. However, storage areas containing these types of gases should always be equipped with separate oxidant gas leak detectors.

The second possible interference is high concentrations of Carbon Dioxide. CO_2 can slightly enhance the oxygen sensor signal at levels above 10% CO_2. This effect will generally result in slightly higher oxygen measurements, but the effect is relatively small and will not offset the large signal change caused by the exclusion of oxygen by high CO_2 levels.

CALIBRATION

Oxygen sensor/transmitters are factory calibrated for the operating range specified on the order, with the calibrated range shown on the calibration tag attached inside the lid of the transmitter enclosure. The typical operating range for oxygen deficiency applications is 0-25%, with a WARNING setpoint of 19.5% and an ALARM setpoint of 16%. Recalibration of an oxygen system should be done every 3-6 months.

Calibration of an O_2 sensor/transmitter can be done in the field using fresh air or calibration kits available from ATI. A small kit (Part no. 00-0193) provides enough gas for about 7 calibrations, while a larger kit (Part no. 00-0185) provides gas for about 25 calibrations. Calibration kits include a cylinder of nitrogen, a cylinder of 18.0% oxygen span gas, a fixed flow regulator, a sensor calibration adapter, tubing, and a carrying case. The calibration procedure requires a digital volt meter (DVM) to read the output of the transmitter if the receiver is located remote from the transmitter. If the receiver is nearby, the LED display on the receiver may be used for calibration. If calibration is to be done using compressed gas from calibration kits, a calibration adapter is needed, and is supplied as part of the calibration kit mentioned previously.

NOTE: **If using the receiver display when adjusting the transmitter zero, place the receiver in the "Inhibit" mode as described in Section 2 of this manual. When in the inhibit mode, the blanking around zero is disabled so that the zero can be set accurately.**

Prior to calibration, remove the cover from the sensor/transmitter enclosure and connect a DVM to the test points shown in Figure 5-3. The same octagonal transmitter circuit board shown in Figure 5-3 will be found in the explosion-proof transmitter. The test points will provide a 0-1.00 VDC signal proportional to transmitter range. For a standard 0-25% unit, 0% is 0.00 volts and 25% is 1.00 volt.

TRANSMITTER ZERO

Oxygen sensors normally have a very stable zero, which is precisely set at the factory prior to shipment. The zero should be checked and verified at the time a sensor/transmitter is recalibrated. Transmitter zero is adjusted when the sensor is exposed to nitrogen gas supplied as part of a calibration kit.

To check zero using nitrogen gas, attach the calibration adapter to the sensor as shown in Figure 5-3. Attach the outlet of the nitrogen cylinder to the calibration adapter and turn on the gas flow. Observe the DVM reading while allowing gas to flow for 3-5 minutes. The test point voltage should drop to 0.00 volts over the 5 minute period. If the voltage drops to 0.00 ± 0.02 volts, no adjustment is necessary. If not, adjust the zero to 0.00 volts using the ZERO potentiometer identified in Figure 5-3.

TRANSMITTER SPAN

Using ambient fresh air as a standard is the easiest way for setting the oxygen transmitter span. This assumes that the ambient air is not depleted of oxygen, and has a value of 20.9%. This would normally be true in any well ventilated room. If this is the case, the oxygen sensor/transmitter may be calibrated while the sensor is exposed to fresh air. To do so, simply adjust the test point voltage to 0.84 VDC when the room is well ventilated.

To span the sensor/transmitter using 18.0% oxygen gas from a calibration kit, connect tubing from your span gas cylinder to the sensor calibration adapter. Turn on the gas flow and adjust to approximately 500 cc/min. (ATI calibration kits contain fixed flow regulators that automatically provide 500 cc/min. flow). The reading on the DVM attached to the transmitter test points will display the output voltage corresponding to 18.0% O_2, or 0.72 VDC. Allow the gas to flow to the sensor for 5 minutes and observe the reading on the DVM. The reading should be relatively stable ± 0.02 VDC. If necessary, use the SPAN potentiometer to adjust the DVM to read 0.72 ± 0.02 VDC. If using the Receiver module display for calibration, adjust the span until the receiver reads 18.0.

If a oxygen standard of another value is being used, calculate the calibration voltage using the following formula.

V = 1.00 X (Span Gas Concentration ÷ Transmitter Range)

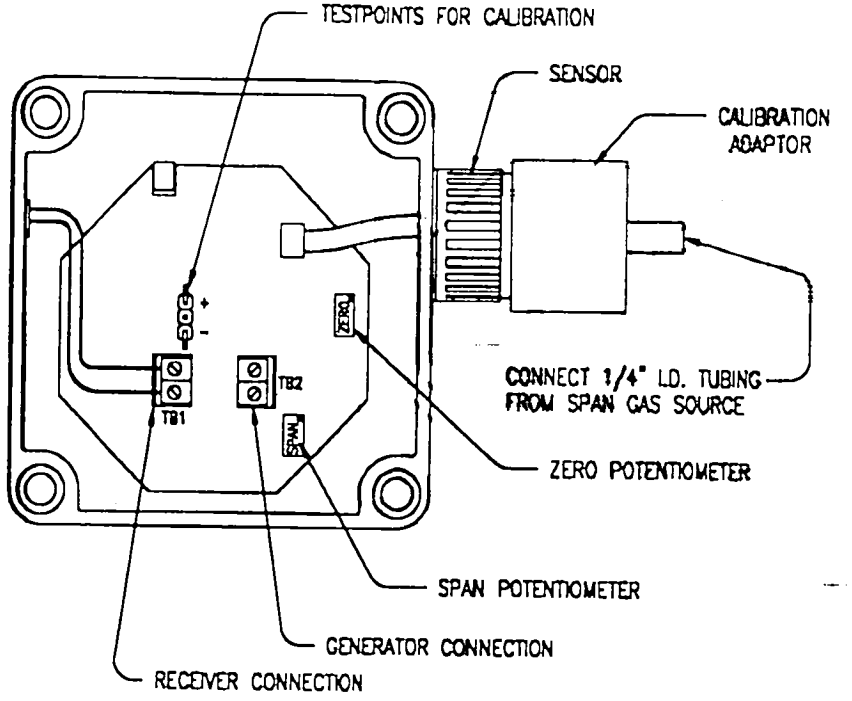


Figure 5-3: Sensor/Transmitter Controls & Test points (ATI-096)

SENSOR RESPONSE TEST

While zero and span adjustments are required only periodically, gas sensors should be checked regularly for proper response. The response check can be done quickly by simply aiming the outlet tube from a nitrogen gas cylinder at the face of the sensor and turning on the gas flow for 10-20 seconds. The sensor output will begin to drop quickly as oxygen is excluded from the sensor.

The sensor response test will create a condition where alarm relays will be activated unless they are inhibited as described in the receiver section. To observe the response at the transmitter, it is necessary to connect a DVM to the test points indicated in Figure 5-3. If the receiver is nearby, you may simply observe the digital display on the receiver. If the sensor does not respond, it should be replaced.

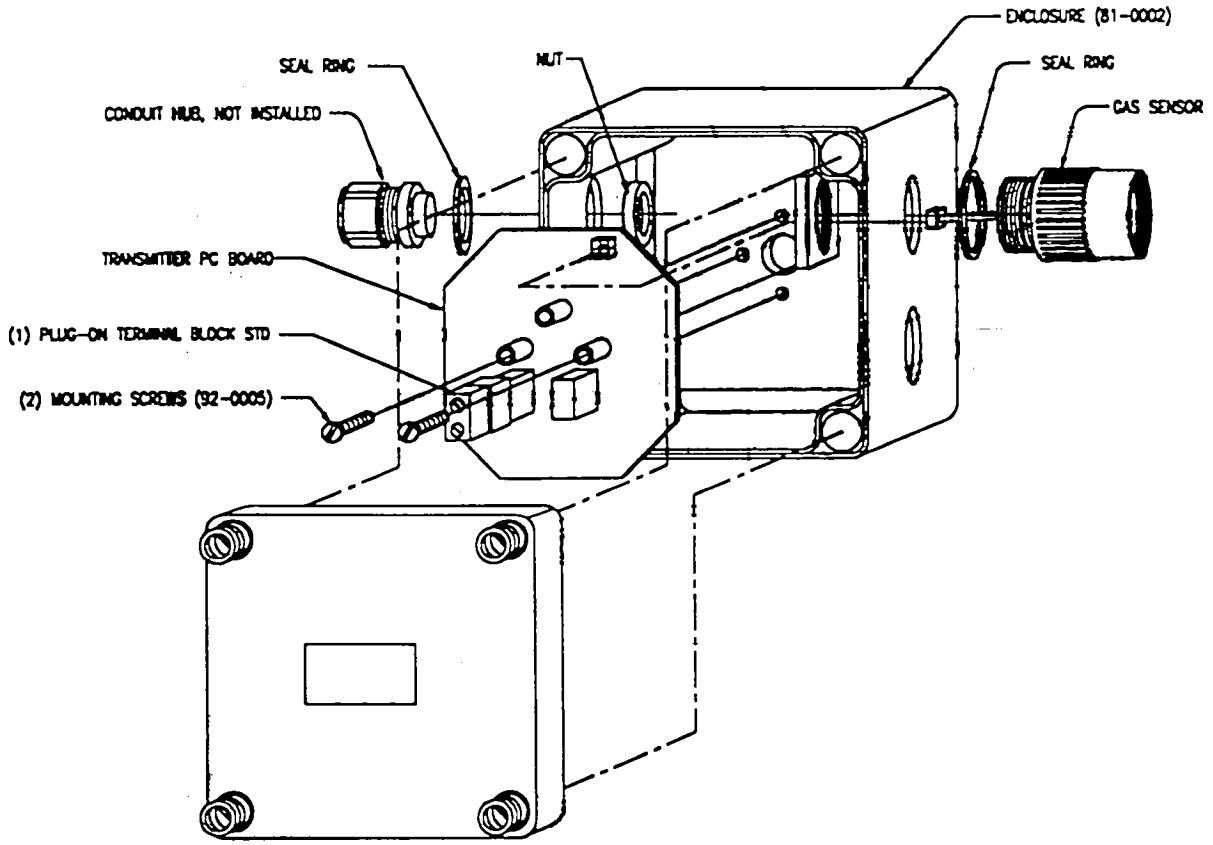
SENSOR REPLACEMENT

Electrochemical sensors used in the A11 are warranted for 12 months and generally last 18-24 months or more. When sensor replacement is required, it can be done easily and quickly. Open the transmitter and unplug the sensor cable from the transmitter circuit board. Unscrew the sensor from the nut on the inside of the enclosure and screw in the replacement sensor. For explosion-proof transmitters, there is no nut, since the stainless steel sensor housing threads directly into the enclosure.

Connect the new sensor to the pins on the transmitter board and replace the transmitter cover. After a new sensor has been connected, allow 12 hours for the new sensor to completely stabilize. Then perform a zero and span as described on page 5-5 and 5-6.

O_2 NEMA-4X SENSOR/TRANSMITTER

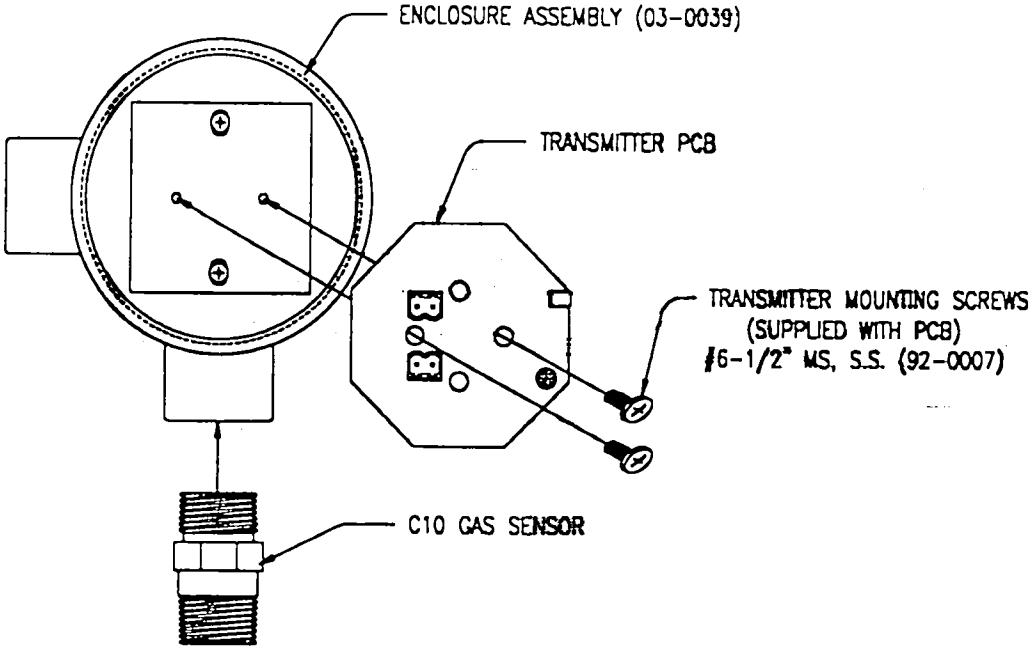
PARTS LIST



Part Number	Description
00-0125	Complete oxygen sensor/transmitter assembly
00-0089	A10-19 Gas sensor
01-0025	A11-19 Transmitter circuit board
81-0002	NEMA 4X enclosure (top and bottom)
92-0005	Self-tapping screw (Pkg. Of 4)
38-0002	Terminal block plug, 2 position
44-0017	Pg 16 to ½" NPT conduit hub with nut
44-0018	Seal ring (required for NEMA 4X rating on hub)
44-0019	Pg 11 Cord grip
44-0043	Pg 11 Seal ring (required for NEMA-4X rating on cord grip)
44-0044	Pg 11 Nut

O_2 EXPLOSION-PROOF SENSOR/TRANSMITTER

PARTS LIST

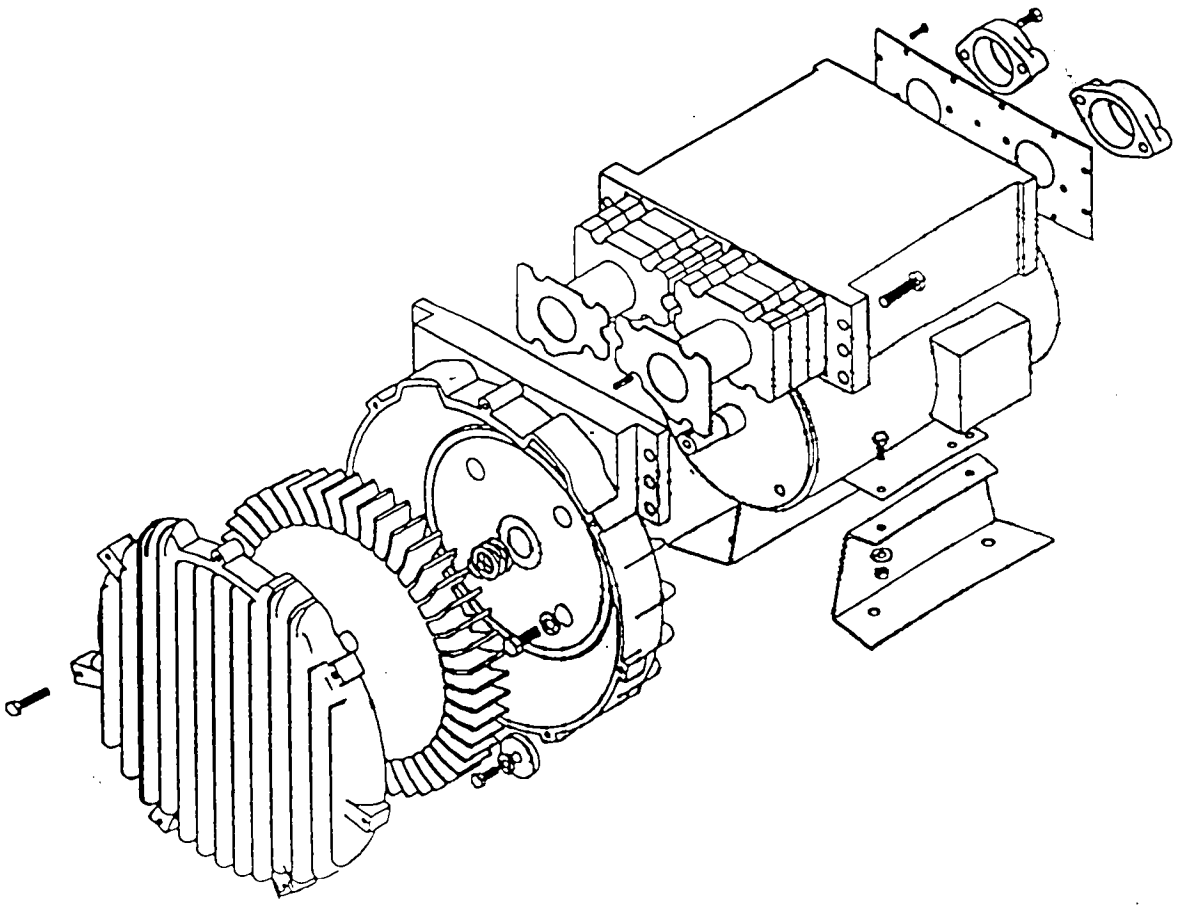


Part Number	Description
00-0312	Complete oxygen sensor/transmitter assembly-explosion-proof
00-0107	C10-19 oxygen gas sensor
03-0039	Explosion-proof enclosure assembly
92-0007	Self-tapping screws (Pkg. Of 4)
38-0002	Terminal block plug, 2 position

GENERAL INFORMATION:

for Blower Model

EN ~~6, 858,~~ 909, ~~14~~



AMETEK®

ROTRON TECHNICAL MOTOR DIVISION
REGENERATIVE BLOWER GROUP
SAUGERTIES NEW YORK 12477
TEL (914) 246-3401 FAX (914) 246-3501

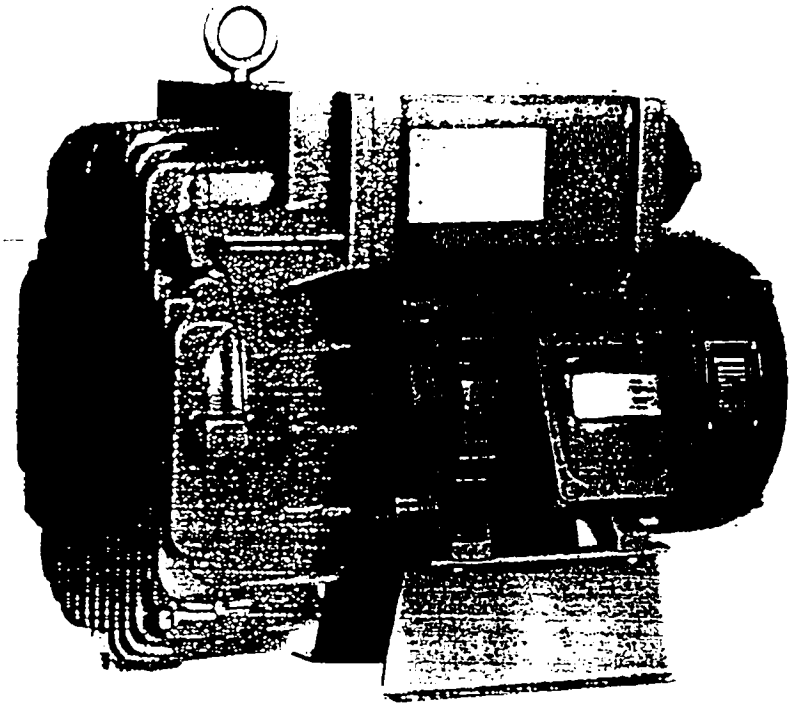
TRI-LINE CORPORATION
6820 ELLICOTT DR.
E. SYRACUSE, NEW YORK 13057
315-437-7205

EN 909 & CP 909
Explosion-Proof Regenerative Blower

TRI-LINE CORPORATION
P.O. BOX 2096
EAST SYRACUSE, NY 13220

FEATURES

- Manufactured in the USA – ISO 9001 compliant
- Maximum flow: 600 SCFM
- Maximum pressure: 120 IWG
- Maximum vacuum: 100 IWG
- Standard motor: 15 HP, explosion-proof
- Cast aluminum blower housing, cover, impeller & manifold; cast iron flanges (threaded); teflon lip seal
- UL & CSA approved motor with permanently sealed ball bearings for explosive gas atmospheres Class I Group D minimum
- Sealed blower assembly
- Quiet operation within OSHA standards



MOTOR OPTIONS

- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

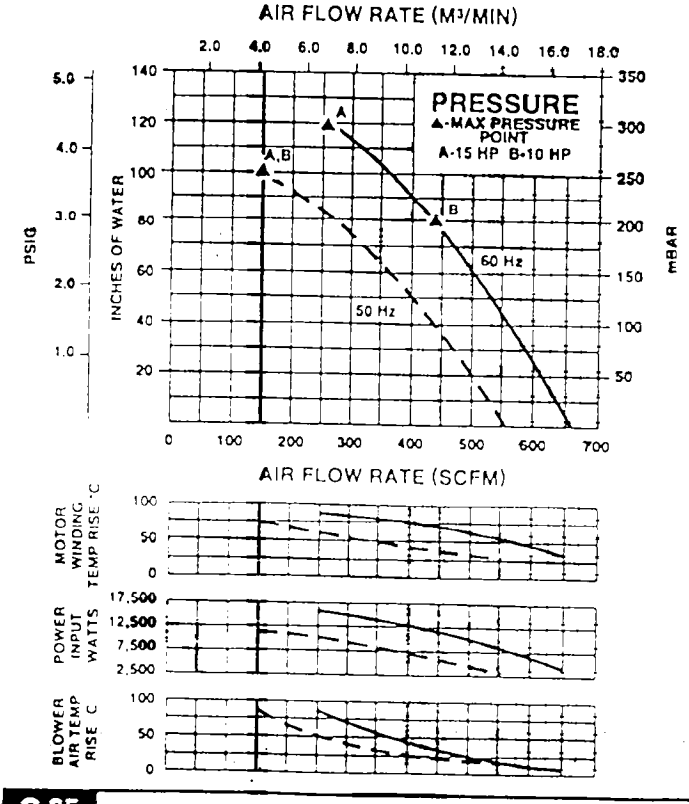
BLOWER OPTIONS

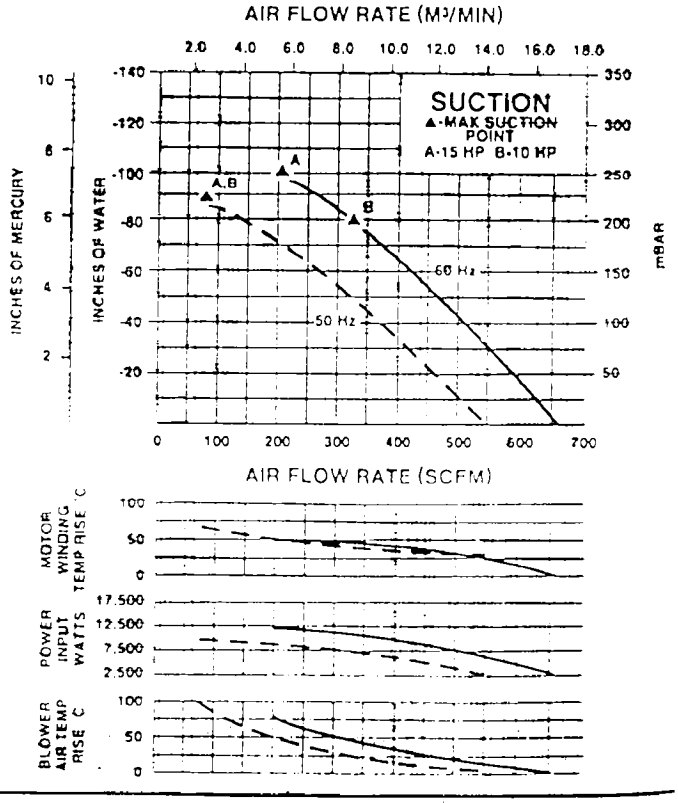
- Corrosion resistant surface treatments & sealing options
- Remote drive (motorless) models
- Slip-on or face flanges for application-specific needs

ACCESSORIES (See Catalog Accessory Section)

- Flowmeters reading in SCFM
- Filters & moisture separators
- Pressure gauges, vacuum gauges & relief valves
- Switches – air flow, pressure, vacuum or temperature
- External mufflers for additional silencing
- Air knives (used on blow-off applications)
- Variable frequency drive package

BLOWER PERFORMANCE AT STANDARD CONDITIONS

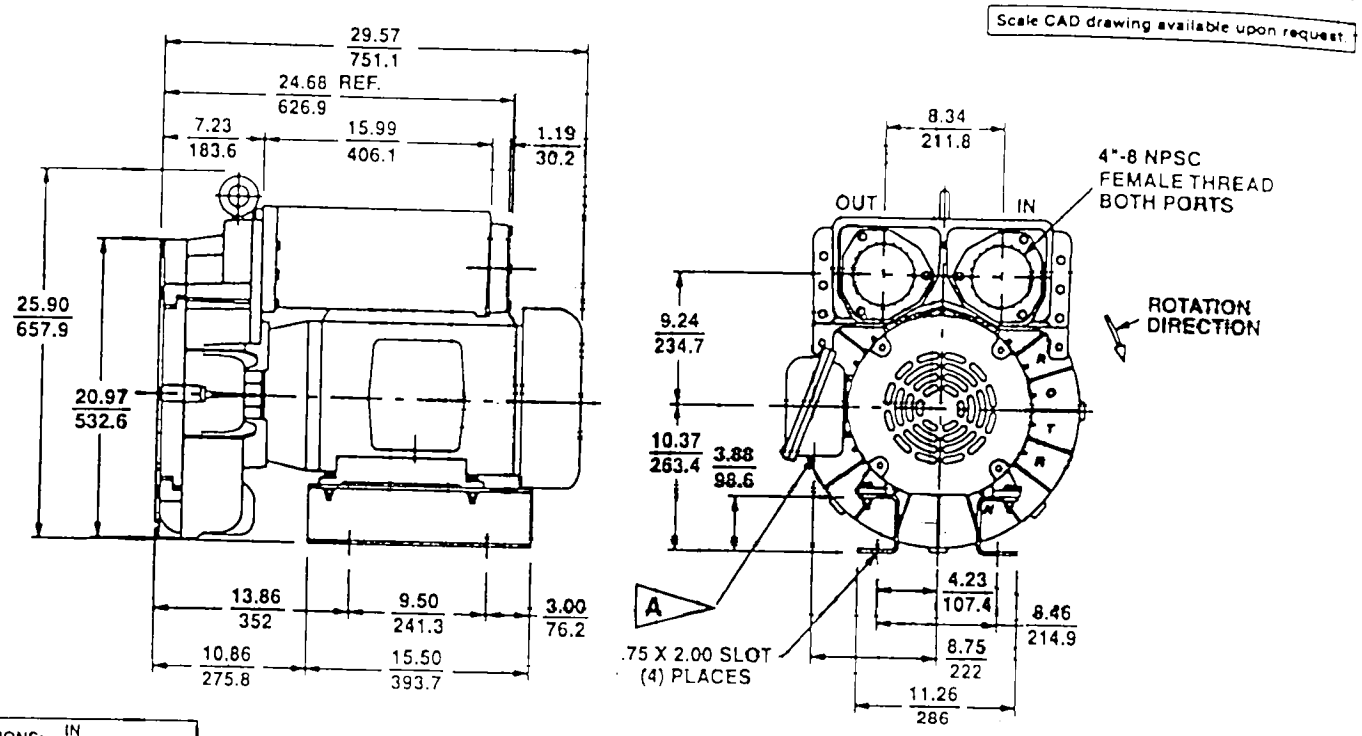




TRI-LINE CORPORATION
P.O. BOX 2096
EAST SYRACUSE, NY 13220

EN 909 & CP 909 Explosion-Proof Regenerative Blower

Scale CAD drawing available upon request.



DIMENSIONS: IN / MM
TOLERANCES: .XX ± .1 / 2.5
(UNLESS OTHERWISE NOTED)

A 1.25" NPT CONDUIT CONNECTION AT 6 O'CLOCK POSITION

SPECIFICATIONS

MODEL	EN909BG72WL		EN909BG86WL	EN909BD72WL		CP909GA72WLR
Part No.	038629		038634	080071		038982
Motor Enclosure – Shaft Material	Explosion-proof – CS		Explosion-proof – CS	Explosion-proof – CS		Chem XP – SS
Horsepower	15		15	10		Same as EN909BG72WL – 038629 except add Chemical Processing (CP) features from catalog inside front cover
Phase – Frequency [1]	Three - 60 Hz		Three - 60 Hz	Three - 60 Hz		
Voltage [1]	230	460	575	230	460	
Motor Nameplate Amps	36	18	14.4	22.2	11.1	
Max. Blower Amps [3]	44	22	18	26	13	
Inrush Amps	240	120	100	162	81	
Starter Size	2	2	2	2	1	
Service Factor	1.0		1.0	1.0		
Thermal Protection [2]	Class B - Pilot Duty		Class B - Pilot Duty	Class B - Pilot Duty		
XP Motor Class – Group	I-D, II-F&G		I-D, II-F&G	I-D, II-F&G		
Shipping Weight	584 lb (265 kg)		584 lb (265 kg)	564 lb (256 kg)		

[1] Rotron motors are designed to handle a broad range of world voltages and power supply variations. Our dual voltage 3 phase motors are factory tested and certified to operate on both: 208-230/415-460 VAC-3 ph-60 Hz and 190-208/380-415 VAC-3 ph-50 Hz. Our dual voltage 1 phase motors are factory tested and certified to operate on both: 104-115/208-230 VAC-1 ph-60 Hz and 100-110/200-220 VAC-1 ph-50 Hz. All voltages above can handle a ±10% voltage fluctuation. Special wound motors can be ordered for voltages outside our certified range.

[2] Maximum operating temperature: Motor winding temperature (winding rise plus ambient) should not exceed 140°C for Class F rated motors or 120°C for Class B rated motors. Blower outlet air temperature should not exceed 140°C (air temperature rise plus inlet temperature). Performance curve maximum pressure and suction points are based on a 40°C inlet and ambient temperature. Consult factory for inlet or ambient temperatures above 40°C.

Maximum blower amps corresponds to the performance point at which the motor or blower temperature rise with a 40°C inlet and/or ambient temperature reaches the maximum operating temperature.

Specifications subject to change without notice. Please consult your Local Field Sales Engineer for specification updates.

Warranty Information

1. **No-Fault Policy.** AMETEK Rotron regenerative direct drive blowers are guaranteed up to one full year from the date of purchase to the original purchaser only. Should the blower fail, regardless of the cause of failure, we will at our option repair or replace the blower.

2. **Standard Policy.** AMETEK Rotron remote drives, Nasty Gas™ models and special built (EO) products are guaranteed up to one full year from date of purchase for workmanship and material defect to the original purchaser only. Should the blower fail, we will evaluate the failure. If determined to be workmanship or material defect, we will at our option repair or replace the blower.

3. **Modified Policy.** AMETEK Rotron packaged units, Vacu-Master models and moisture separators are guaranteed up to one full year from date of purchase for workmanship and material defect to the original purchaser only on all parts excluding maintenance/wear items such as belts and bags. Should the blower fail, we will evaluate the failure. If determined to be workmanship or material defect, we will at our option repair or replace the blower.

4. **Parts Policy.** AMETEK Rotron spare parts and accessories are guaranteed up to three months from date of purchase for workmanship and material defect to the original purchaser only. Should the part fail, we will at our option repair or replace the part.

Corrective Action. A written report will be provided indicating reason(s) for failure, with suggestions for corrective action. If the failure is determined to be a defect in material or workmanship, Rotron will institute a corrective action. Subsequent customer failures due to abuse, misuse, misapplication or repeat offense will not be covered. AMETEK Rotron will then notify you of your options. Any failed unit that is tampered with by attempting repair or diagnosis will void the warranty, unless authorized by the factory.

Terms and Conditions. Our warranty covers repairs or replacement of regenerative blowers only, and will not cover labor for installation, shipping costs, accessories or other items not considered integral blower parts. Charges may be incurred on products returned for reasons other than failures covered by their appropriate warranty. Maximum liability will in no case exceed the value of the product purchased. Other terms and conditions of sale are stated on the back of the order acknowledgment.

Installation

1. **Bolt It Down.** Any blower must be secured against movement prior to starting or testing to prevent injury or damage. The blower does not vibrate much more than a standard electric motor.

2. **Filtration.** All blowers should be filtered prior to starting. Care must be taken so that no foreign material enters the blower. If foreign material does enter the blower, it could cause internal damage or may exit at extremely high velocity.

   Should excessive amounts of material pass through the blower, it is suggested that the cover(s) and impeller(s) be removed periodically and cleaned to avoid impeller imbalance. Impeller imbalance greatly speeds bearing wear, thus reducing blower life. Disassembling the blower will void warranty, so contact the factory for cleaning authorization.

3. Support the Piping. The blower flanges and nozzles are designed as connection points only and are not designed to be support members.

   Caution: Plastic piping should not be used on blowers larger than 1 HP that are operating near their maximum pressure or suction point. Blower housing and nearby piping temperatures can exceed 200° Fahrenheit. Access by personnel to the housing or nearby piping should be limited, guarded, or marked, to prevent danger of burns.

4. Wiring. Blowers must be wired and protected/fused in accordance with local and national electrical codes. All blowers must be grounded to prevent electrical shock. Slo-Blo or time delay fuses should be used to bypass the first second of start-up amperage.

5. **Pressure/Suction Maximums.** The maximum pressure and/or suction listed on the model label should not be exceeded. This can be monitored by means of a pressure or suction gage (available from Rotron), installed in the piping at the blower outlet or inlet. Also, if problems do arise, the Rotron Application Engineering staff will need to know the operating pressure/suction to properly diagnose the problem.

6. Excess Air. Bleed excess air off. DO NOT throttle to reduce flow. When bleeding off excess air, the blower draws less power and runs cooler.

Note: Remote Drive (Motorless) Blowers - Properly designed and installed guards should be used on all belts, pulleys, couplings, etc. Observe maximum remote drive speed allowable. Due to the range of uses, drive guards are the responsibility of the customer or user. Belts should be tensioned using belt gauge.

Maintenance Procedure

When properly piped, filtered, and applied, little or no routine maintenance is required. Keep the filter clean. Also, all models in the DR, EN, CP, and HiE series have sealed bearings which require no maintenance. Bearings should be changed after 15,000 to 20,000 hours, on average. Shell Dolium R grease is used at the factory. Replacement bearings should contain Shell Dolium R or its equivalent.

Troubleshooting

		POSSIBLE CAUSE	OUT OF WARRANTY REMEDY ***
IMPELLER DOES NOT TURN	Humming Sound	1. * One phase of power line not connected 2. * One phase of stator winding open 3. Bearings defective 4. Impeller jammed by foreign material 5. Impeller jammed against housing or cover 6. ** Capacitor open	1. Connect 2. Rewind or buy new motor 3. Change bearings 4. Clean and add filter 5. Adjust 6. Change capacitor
	No Sound	1. * Two phases of power line not connected 2. * Two phases of stator winding open	1. Connect 2. Rewind or buy new motor
IMPELLER TURNS	Blown Fuse	1. Insufficient fuse capacity 2. Short circuit	1. Use time delay fuse of proper rating 2. Repair
	Motor Overheated Or Protector Trips	1. High or low voltage 2. * Operating in single phase condition 3. Bearings defective 4. Impeller rubbing against housing or cover 5. Impeller or air passage clogged by foreign material 6. Unit operating beyond performance range 7. Capacitor shorted 8. * One phase of stator winding short circuited	1. Check input voltage 2. Check connections 3. Change bearings 4. Adjust 5. Clean and add filter 6. Reduce system pressure/vacuum 7. Change capacitor 8. Rewind or buy new motor
	Abnormal Sound	1. Impeller rubbing against housing or cover 2. Impeller or air passages clogged by foreign material 3. Bearings defective	1. Adjust 2. Clean and add filter 3. Change bearings
	Performance Below Standard	1. Leak in piping 2. Piping and air passages clogged 3. Impeller rotation reversed 4. Leak in blower 5. Low voltage	1. Tighten 2. Clean 3. Check wiring 4. Tighten cover, flange 5. Check input voltage

* 3 phase units
** 1 phase units
*** Disassembly and repair of new blowers or motors will void the Rotron warranty. Factory should be contacted prior to any attempt to field repair an in-warranty unit.

Blower Disassembly

WARNING: Attempting to repair or diagnose blower may void Rotron's warranty. This unit can be difficult to successfully disassemble and reassemble.

Refer to assembly diagram (Appendix 2) for referenced part designations. CAUTION: Be sure power is disconnected before doing any work on units.

1. Disconnect power leads.
2. Remove or separate piping and/or mufflers from unit.
3. Remove cover bolts (B14) and then cover (B13). Note: This unit has seals on it. Opening unit will require mandatory replacement of these seals.
4. Remove impeller bolt (B10) and washers and then remove impeller. Note: Never pry on the edges of the impeller. Use puller, if necessary.
5. Carefully note number and location of shims (B8). Remove and set aside. Note: If disassembly was for inspection or cleaning purposes, unit may now be reassembled by reversing the above steps. If motor servicing, replacement, or impeller replacement is required, the same shims may not be re-used. It will be necessary to re-shim according to the procedure shown under Assembly.
6. Remove housing bolts (B5) and remove motor assembly.

Muffler Material Replacement

1. Remove manifold cover bolts (B19).
2. Muffler assembly can now be removed and replaced if necessary.
3. Reassemble by reversing procedure.

Bearing Selection

All bearings used in AMETEK Rotron blowers are of the double sealed variety. In addition, high temperature greases are used to prevent loss of lubrication under severe operating conditions. Select the appropriate bearings by referencing the parts list if ordering from AMETEK Rotron, or the parts list and the accompanying chart.

BEARING TYPES AND LUBRICANTS

All Rotron regenerative blowers supplied with direct fitted motors are designed with ABEC1 quality double sealed ball bearings in the motor. The bearing design in all cases is a C3 fit. Below is our recommended chart by bearing part number.

Part No.	Size	Seal Material	Grease	Heat Stabilized
510217 510218 510219	205 206 207	Polyacrylic	Nye Rheotemp 500 30% ± 5% fill	Yes - 325°F
510449 516440 516648	203 202 307	(Buna N)	Shell Dolium "R" 25-40% fill	No
516840 516841 516842 516843 516844 516845 516846 516847	206 207 208 210 309 310 311 313	(Buna N)	Shell Dolium "R" 30% ± 5% fill	No

Blower Reassembly

1. Place assembled motor against rear of housing (B4) and fasten with bolts (B5) and washer (B17).
2. To ensure impeller is centered within housing cavity, reshim impeller according to the procedure outlined below.
3. Replace seal (B27) (if used).
4. Place impeller onto shaft (be sure key is in place (M3)) and fasten with bolt (B10), washer (B11 & B12), and spacer (B16) if applicable. TORQUE impeller bolt per table below. Once fastened, carefully rotate impeller to be sure it turns freely.
5. Replace cover and fasten with bolts (B14, B14B).
6. Reconnect power leads per motor nameplate.

Bolt Size	Torque
1/4 - 20	6.25 +/- .25
5/16 - 18	11.50 +/- .25
3/8 - 16	20.0 +/- .5
1/2 - 13	49.0 +/- 1
5/8 - 11	90.0 +/- 2

Impeller Shimming Procedure

WARNING: This unit is difficult to shim. Care must be exercised.

Tools needed: Machinist's Parallel Bar
Vernier Caliper with depth measuring capability
Feeler Gauges or Depth Gauge

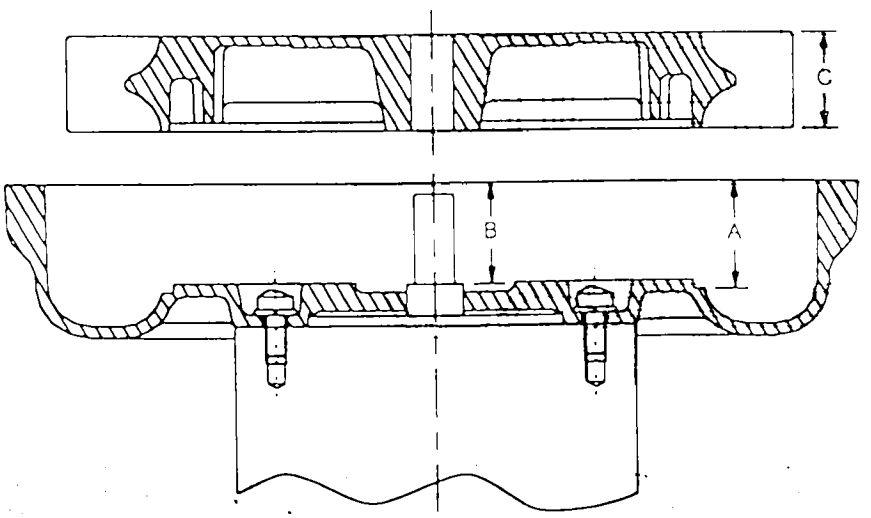
Measure the following:

- Distance from the flange face to the housing (A)
- Distance from the flange face to the motor shaft shoulder (B)
- Impeller thickness (C)

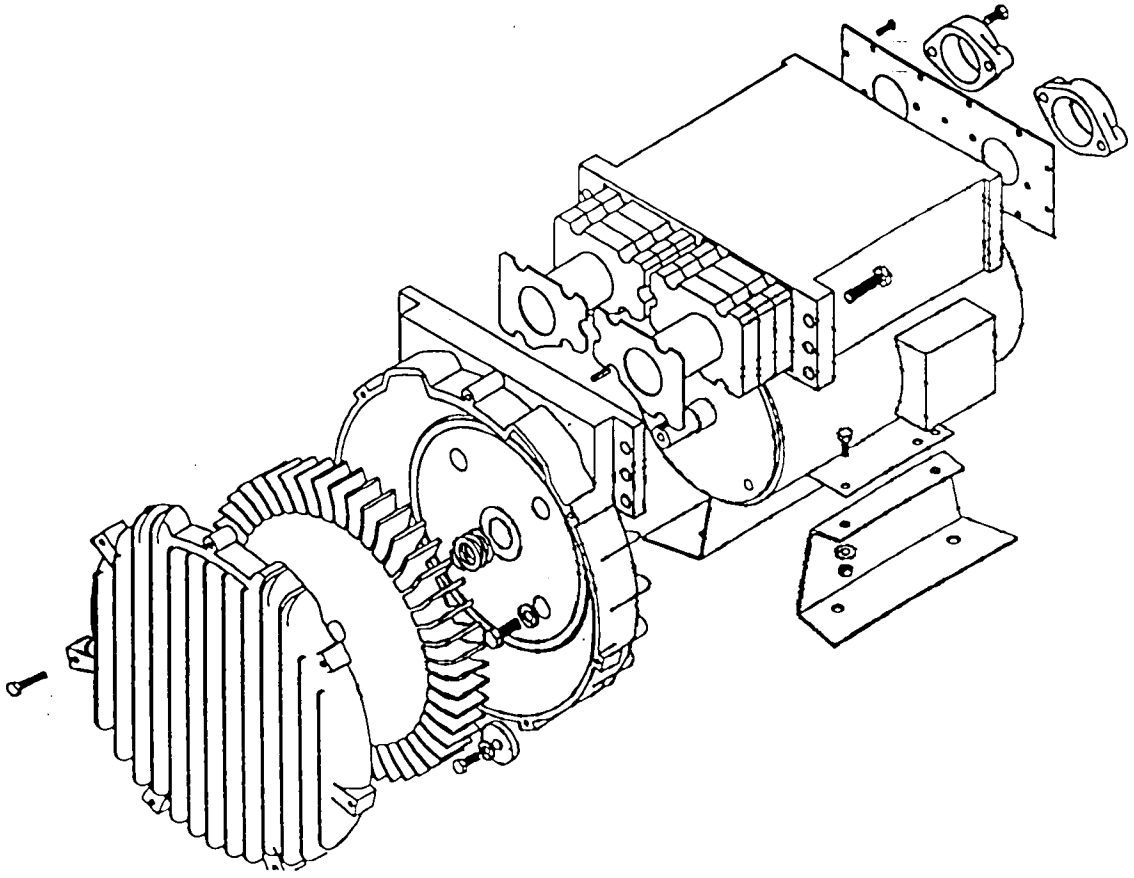
Measurements (A) and (B) are made by laying the parallel bar across the housing flange face and measuring to the proper points. Each measurement should be made at three points, and the average of the readings used.

$$Shim\ Thickness = B - \left(\frac{A+C}{2}\right)$$

After impeller installation (step 3 above), the impeller/cover clearance can be checked with feeler gauges, laying the parallel bar across the housing flange face. This clearance should nominally be $\left(\frac{A-C}{2}\right)$.



Service and Parts Manual for Blower Model EN ~~6, 858,~~ 909, ~~14~~

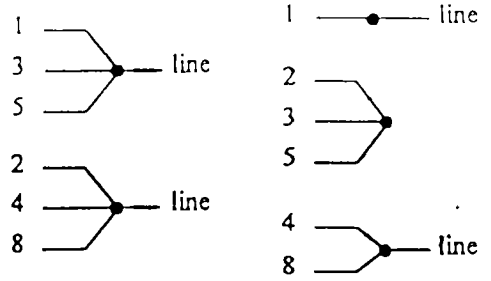


AMETEK®
ROTRON TECHNICAL MOTOR DIVISION
REGENERATIVE BLOWER GROUP
SAUGERTIES, NEW YORK 12477

TRI-LINE CORPORATION
6820 ELLICOTT DR.
E. SYRACUSE, NEW YORK 13057
315-437-7205

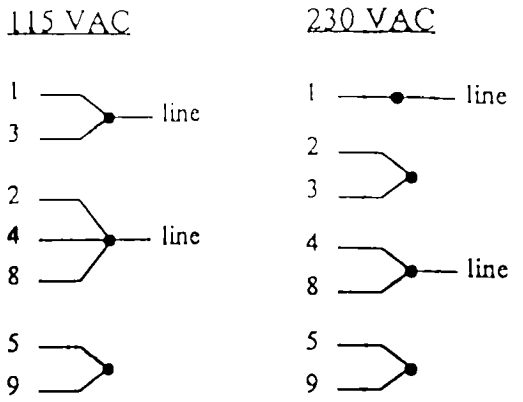
Wiring Diagrams, XP Motors

H. 1ø, 6 wire



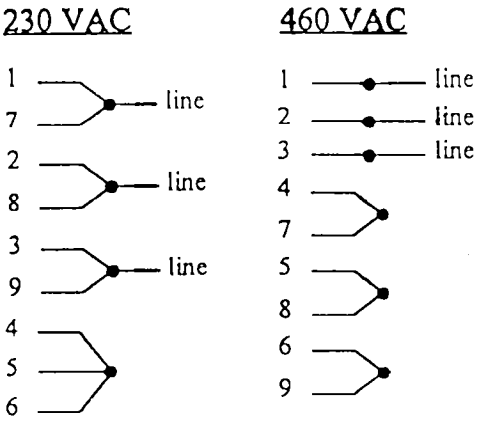
Interchange leadwires 5 & 8 to reverse rotation

I. 1ø, 7 wire



Interchange leadwires 5 & 8 to reverse rotation

K. 3ø, 9 wire

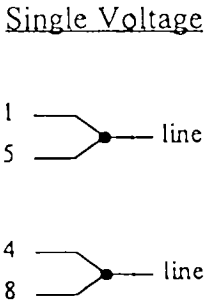


Interchange any two line leads to reverse rotation

L. Pilot Duty Thermal Overload Leads

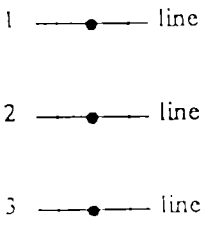
Hook J leads to control circuitry

M. 1ø, 230 VAC



Interchange leadwires 5 & 8 to reverse rotation

N. 3ø, 575 VAC

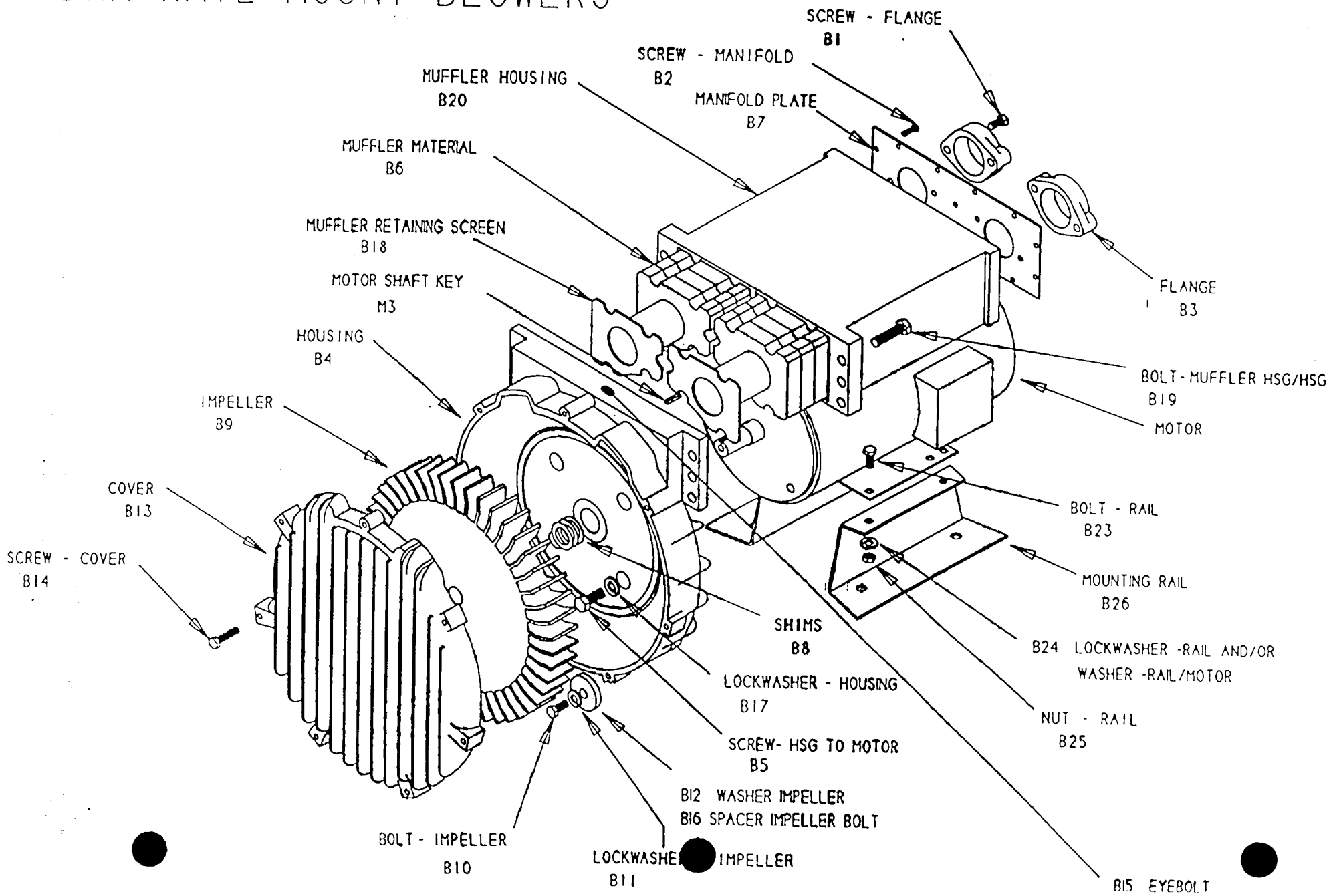


Interchange any two line leads to reverse rotation

NOTE: Wiring diagram on motor takes precedence over those printed here. Wiring diagram typically found under T-box cover.

2/28/96 Rev.

ASSEMBLY DIAGRAM
DRX RAIL MOUNT BLOWERS



Parts Breakdown

Item No.	Qty Req'd	Description	Model: EN6 / Part No.: 038361, 038180, 038438	EN858 / 038744, 038745	EN909 / 038629, 038634	EN14 / 038762, 038761	EN14 / 038760
M3	1	Key Motor Shaft	510212	511532	511532	155066	511532
B1	6	Screw, Flange	(4 pcs) 120255	(4 pcs) 155067	140016	140016	140016
B2		Screw, Manifold	Not Used	Not Used	Not Used	Not Used	Not Used
B3	2	Flange	See Next Page	511614	529912	529912	529912
	2	O-ring	Not Used	Not Used	155377	155377	155377
		Elbow 90°	See Next Page	Not Used	Not Used	Not Used	Not Used
B4	1	Housing	516747	516764	515356	516799	516797
B5	4	Screw, Hsg /Motor	251792	155034	140014	120205	120205
B6	54	Muffler Material	Not Used	(28) 550020	(40 pcs) 529943	550073	550073
	2	Matting, Fiberglass	Not Used	550075	550077	550116	550116
B7		Manifold Plate	Not Used	Not Used	Not Used	Not Used	Not Used
B8	*	Shim .002"	272703	511547	511547	515991	511547
	*	Shim .005"	272704	511548	511548	515992	511548
	*	Shim .010"	272705	511549	511549	515993	511549
	*	Shim .020"	272706	511550	511550	515994	511550
	*	Shim .030"	Not Used	Not Used	Not Used	Not Used	Not Used
B9	1	Impeller	515484	515249	515270	515509	515683
B10	1	Bolt, Impeller	251791	120210	140015	155068	120251
B11	1	Lockwasher, Impeller	251787	251788	251788	251788	251788
B12	1	Washer, Impeller	Not Used	511529	Not Used	Not Used	Not Used
B13	1	Cover	515488	515247	515359	515910	515910
B14	8	Screw, Cover	251790	140016	140016	155069	155069
B15	1	Eye Bolt	Not Used	140019	140019	140019	140019
B16	1	Spacer, Impeller Bolt	478336	515555	511529	515990	515990
		Shaft Sleeve	Not Used	Not Used	Not Used	Not Used	Not Used
B17		Lockwasher, Housing	Not Used	Not Used	Not Used	Not Used	Not Used
B18	1	Screen, Muffler Retaining, Right (**)	Not Used	515407	529939	550040	550040
	1	Screen, Muffler Retaining, Left (**)	Not Used	515408	529940	550042	550042
B19	6	Bolt, Muffler Hsg/Hsg	Not Used	155025	155025	155067	155067
B19A	4	Bolt, Muffler/Housing	Not Used	120214	120214	120214	120214

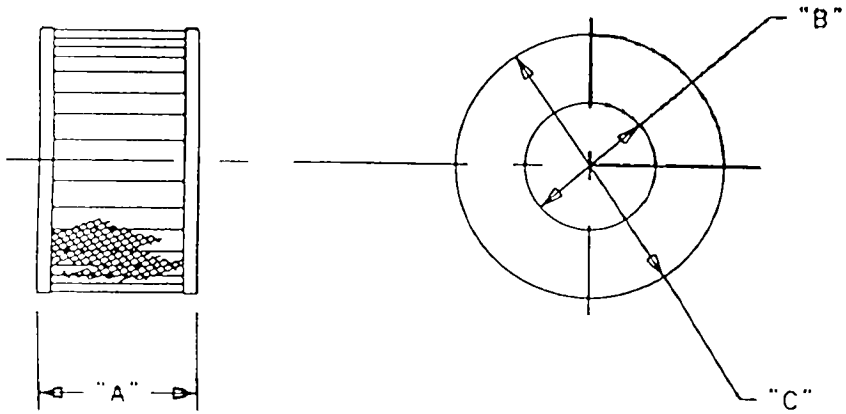
Item No.	Qty Req'd	Description	Model: EN6 Part No.: 038361 038180 038438	EN858 038744 038745	EN909 038629 038634	EN14 038762 038761	EN14 038760
B20	1	Muffler Housing	Not Used	550019	529932	550039	550039
	1	Muffler Discrete	522948	Not Used	Not Used	Not Used	Not Used
		Bolt, Motor/Muffler	Not Used	Not Used	Not Used	Not Used	Not Used
		Lockwasher, Motor/Muffler	Not Used	Not Used	Not Used	Not Used	Not Used
		Washer, Motor/Muffler	Not Used	Not Used	Not Used	Not Used	Not Used
		Spacer, Motor/Muffler	Not Used	Not Used	Not Used	Not Used	Not Used
B21		Heat Slinger	Not Used	Not Used	Not Used	Not Used	Not Used
B22		Guard Heat slinger	Not Used	Not Used	Not Used	Not Used	Not Used
B23	4	Bolt, Rail	251791	120007	155095	120256	155025
B24	4	Lockwasher Rail	251787	251787	251787	251788	251788
B24A	8	Washer, Rail/Motor	Not Used	Not Used	155091	Not Used	Not Used
B25	4	Nut, Rail	251789	251789	251789	155070	155070
B26	2	Rail Mounting	478338	595301	515286	516242	516242
	1	Lip Seal	516691	516693	516693	516694	516693

Model	Part #	Motor	Wiring Diagram	Specific Parts	Bearing, Rear (M1)	Bearing, Impeller End (M2)
EN6F5L	038361	529475	M + L	B3 Flange 511480 (2 pcs) Elbow 120153 (2 pcs)		
EN6F72L	**038180**	**500297**	**K + L**	**B3 Flange 478341 (2 pcs)** Elbow Not Used Screen Guard, Flange 511479 (2 pcs)	**510217**	**510218**
EN6F86L	038438	529634	N + L	B3 Flange 478341 (2 pcs) Elbow Not Used Screen Guard, Flange 511479 (2 pcs)		
EN858BD72WL	038744	515556	K + L		516840	516844
EN858BD86WL	038745	529627	N + L			
EN909BG72WL	038629	511512	K + L		516842	516844
EN909BG86WL	038634	529631	N + L			
EN14DX86MWL	038762	529632	N + L		516844	516846
EN14DX72MWL	038761	516095	K + L			
EN14BK72MWL	038760	511513	K + L		**516842**	**516844**

REPLACEMENT HEPA ELEMENT P/N	REPLACEMENT "Z" MEDIA ELEMENT P/N	REPLACEMENT POLYESTER ELEMENT P/N	"A"	"B"	"C"
528919	517894	516435	8.75	3.50	5.875
528917	517893	516434	4.75	2.562	5.00
		517613	**2.75**	**2.375**	**3.875**
528923		517348	14.50	9.00	14.625
528925	517877	516515	9.625	8.00	11.75
528921	517876	515135	9.625	4.75	7.875
	517875	515134	9.50	4.625	5.875
	517874	515133	4.75	3.625	5.875
	517873	515132	4.75	3.00	4.375
		517612	2.25	1.125	2.25

FILTER ELEMENT									
516465	515135	517351	517348	517878	517873	517891	517876		
516463	515135	517347	517348	517872	517877	517890	517876		
516461	516434	516513	516515	517871	517876	517889	517894		
515256	516435	516511	516515	517870	517875	517888	517894		
515255	516435	516501	515135	517869	517875	517887	517893	528916	528923
515254	516434	516499	515135	517868	517875	517886	517893	528915	528921
515151	515135	516497	515134	517867	517874	517885	517877	528914	528925
515145	515134	516495	515134	517866	517873	517884	517876	528913	528919
515126	515135	516493	515134	517865	517873	517883	517875	528912	528919
515125	515134	516491	515133	517611	516515	517882	517875	528911	528917
515124	515134	516489	515132	517610	517613	517881	517875	528845	528917
515123	515133	516487	515132	517609	517612	517880	517874	528843	528921
515122	515132	516466	515132	517355	517348	517879	517873	517892	517877

REPLACEMENT FILTER ELEMENT CROSS REFERENCE TABLE



TRI-LINE CORPORATION
P.O. BOX 2096
EAST SYRACUSE, NY 13220

DRAFTING STD. PER ROTRON STD. NO.1 UNLESS OTHERWISE SPECIFIED

NO BURRS ALLOWED INSIDE AND OUTSIDE CORNERS UNLESS SPECIFIED MAY HAVE .010 MAX BREAK

TOLERANCE UNLESS SPECIFIED
2 PL.DEC. ±
3 PL.DEC. ±
ANGULAR ±

EG&G ROTRON
INDUSTRIAL DIV. ROTRON INC. SAUGERTIES, NY 12477

ELEMENT SHEET

MC- 515122

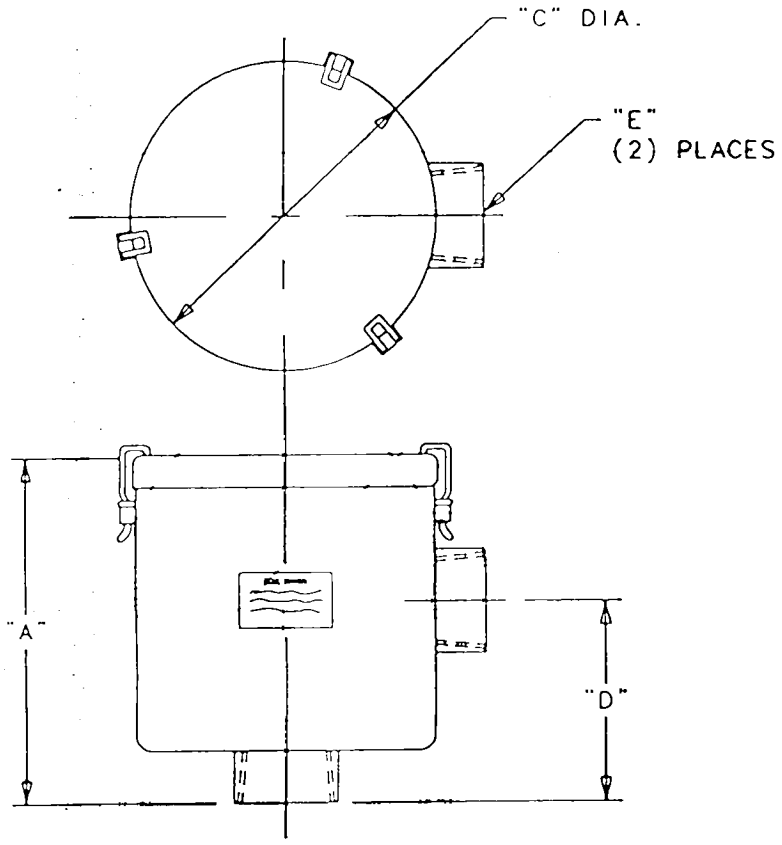
F REV

SCALE NONE

SHEET 3 OF 3

NOTES:

1. FILTER ELEMENTS ARE PLEATED POLYESTER 97% EFFICENT AT 10 MICRON RETENTION, CLEANABLE AND/OR REPLACEABLE.
2. FINISH: BLUE GLOSS PAINT, DURABLE ALL WEATHER.



FILTER HEPA P/N	FILTER "Z" MEDIA P/N	FILTER P/N	"A"	"C" DIA.	"D"	"E"
528916		517353	38.00	22.00	25.50	8.00 FLANGE
528914	517892	517611	28.00	18.00	19.50	6.00 NPSC
		517610	4.375	5.50	2.625	.75 NPSC
528915	517891	516465	27.00	14.00	18.50	4.00 NPSC
528843	517890	516463	26.50	14.00	18.00	3.00 NPSC
528911			6.50	7.25	4.50	1.50 NPSC
528845	517886	516461	6.50	7.25	4.50	1.00 NPSC
528913	517889	515256	10.25	8.00	5.50	2.50 NPSC
528912	517888	515255	10.25	8.00	5.50	2.00 NPSC
	517887	515254	6.50	7.00	4.50	1.50 NPSC

TRI-LINE CORPORATION
P.O. BOX 2096
EAST SYRACUSE, NY 13220

APP.	DATE	C.O. NO.	REV.

DRAFTING STD. PER ROTRON STD. NO.1 UNLESS OTHERWISE SPECIFIED

NO BURRS ALLOWED. INSIDE AND OUTSIDE CORNERS UNLESS SPECIFIED MAY HAVE .010 MAX BREAK

TOLERANCE UNLESS SPECIFIED
2 PL DEC. ±
3 PL DEC. ±
ANGULAR ±

EG&G ROTRON
INDUSTRIAL DIV. ROTRON INC. SAUGERTIES, NY 12477

INLINE FILTER

MC- 515122 F

SCALE NONE

SHEET 2 OF 3

REV

AMETEK®
ROTRON TECHNICAL MOTOR DIVISION
[illegible]
North Street
Saugerties, New York 12477
Phone: (914) 246-3401
Fax: (914) 246-3802

OPERATION & MAINTENANCE MANUAL

TRI-LINE CORPORATION
P.O. BOX 2096
EAST SYRACUSE, NY 13220

Rotron Moisture Separator

Thank you for purchasing an AMETEK Rotron MS series moisture separator. When matched with the correct Rotron blower, and properly installed and maintained, this separator will effectively and efficiently remove moisture from the air stream. To ensure good results, please take the time to read these instructions before starting the installation of your moisture separator.

Sizing for Optimal Efficiency

Separator	Max. CFM	Max. Vac	Capacity	Blowers
MS200P(S)	200	12* IHg	7 gal.	EN101-EN555, EN513, EN523, EN623
MS200D(S)	200	22 IHg	10 gal.	EN101-EN555, EN513, EN523, EN623
MS300P(S)	300	12* IHg	7 gal.	EN606, EN6, EN707, EN823
MS300D(S)	300	22 IHg	10 gal.	EN606, EN6, EN707, EN823
MS350B(S)	350	22 IHg	40 gal.	EN808, EN1223
MS500B(S)	500	22 IHg	40 gal.	EN858
MS600B(S)	600	22 IHg	40 gal.	EN909
MS1000B(S)	1000	22 IHg	65 gal.	EN14
Note: "S" suffix denotes presence of XP high level switch. * Special Construction with 20 IHg capability available.				

Installation

1. Unpacking - For MS200/300, remove drain valve taped to packing material and box containing liquid level switch, if so equipped. For MS350/500/600, remove box containing valve hardware as well as box containing liquid level switch (if so equipped) and remove internal cardboard packaging and cable ties from screen assembly.

2. Bolt Down (w/ feet included) - For MS200/300 models, built-in feet or a mounting ring is included. It is recommended that these units be bolted in place. All models will only work in an upright position.

3. Piping - Attach to system piping with flexible couplings to minimize stress incurred by rigid system piping. The connections should be airtight but not sealed with an adhesive for ease of disassembly during routine maintenance. Install drain valve, using teflon tape on threads.

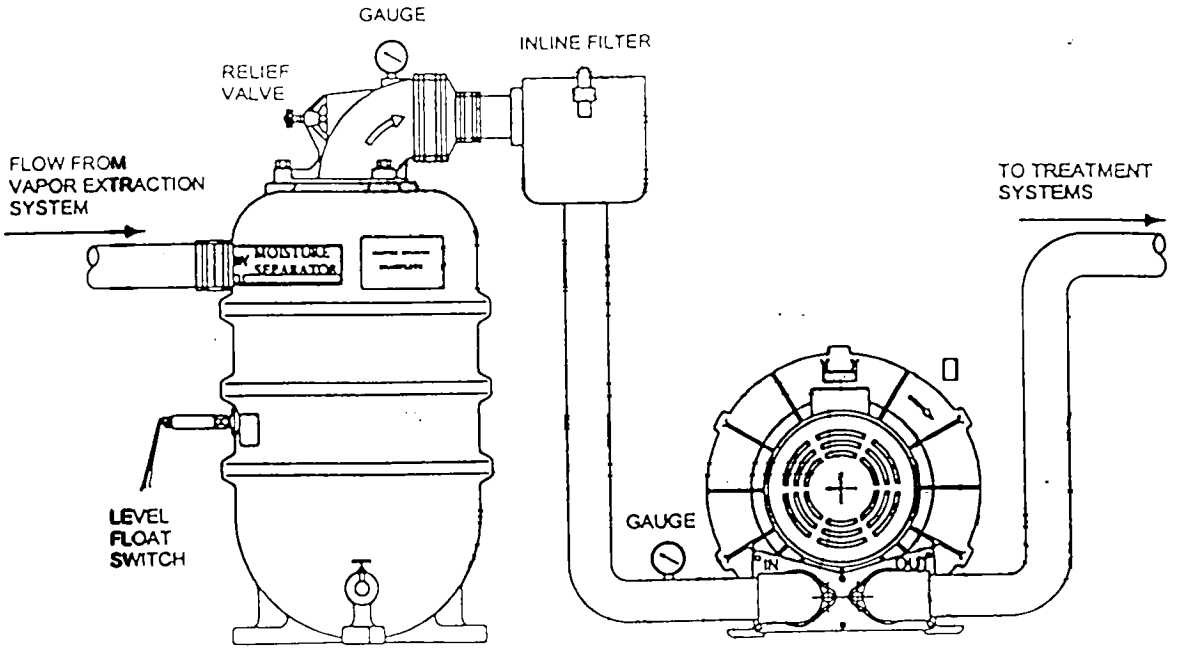
4. Installation and Wiring of Liquid Level Switch - Remove plug from the bulkhead fitting. Thread the switch by hand until snug with index arrow pointing down. Wire in accordance with the nameplate wiring schematic. Typically, the wiring is connected back to the starter to shut down the system but can be used for other purposes.

5. Install/Adjust Relief Valve - For MS500/600, first install the relief valve with teflon tape on threads. Use a wrench, but tighten only enough to prevent leakage. Next step for all MS units, back off the relief valve adjuster relaxing spring pressure. Then block the moisture separator inlet while measuring the motor current. Adjust the valve until the motor current is 90% of the max. nameplate blower amps.

6. Continuous Service - For cold weather service, appropriate steps should be taken to prevent freezing. Also, the maximum vacuum ratings are based on 115°F maximum. Consult factory for higher potential ambients.

Note: A moisture separator is not a substitute for an inline air filter. A Rotron inline filter should be used to remove particles that pass through the separator.

Typical Vapor Extraction System



Operation

Moisture-laden air enters the separator through the tangential inlet. Cyclonic action removes free moisture from the air stream and allows the air to discharge through the top of the separator. When the separator is full, the float valve shuts off the air flow through the separator, and the relief valve opens to limit the vacuum of the blower.

To drain the separator, turn off the blower and open the drain valve at the bottom of the separator. Caution: The liquid contained in the separator should be analyzed before it is released back into the environment. It may be considered hazardous waste in certain geographical areas and require special treatment/disposal. Once the liquid is drained, the unit can be reset by turning the blower back on.

Automatic draining options are at the discretion of the customer.

Maintenance

This MS series moisture separator has been designed to require minimal maintenance. During normal operation a layer of sludge may build up on the bottom of the separator. As necessary, the top assembly of the moisture separator should be removed and the inside cleaned out with water. Keeping the inside clean will prevent the valve from becoming clogged with sediment. The relief valve should be inspected upon emptying the separator and readjusted (per installation instruction 5) upon restart.

If you have any questions regarding this product, contact your local sales representative or our Application Engineering Department at the factory.

Revised 5/6/98

Filtration Accessories

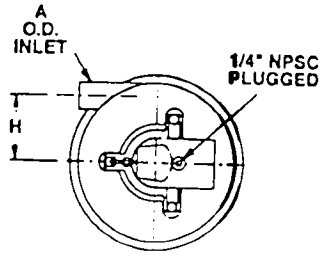
Blower Connection Key
NPT – American National Standard Taper Pipe Thread (Male)
NPSC – American National Standard Straight Pipe Thread for Coupling (Female)
SO – Slip On (Smooth – No Threads)

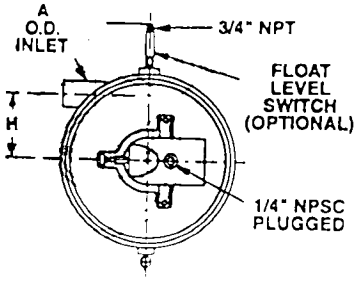
Moisture Separator™

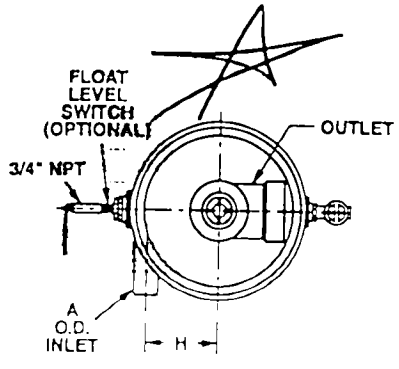
By separating and containing entrained liquids, Rotron's moisture separator helps protect our regenerative blowers and the end treatment system from corrosion and mineralization damage. Recommended for all soil vacuum extraction applications.

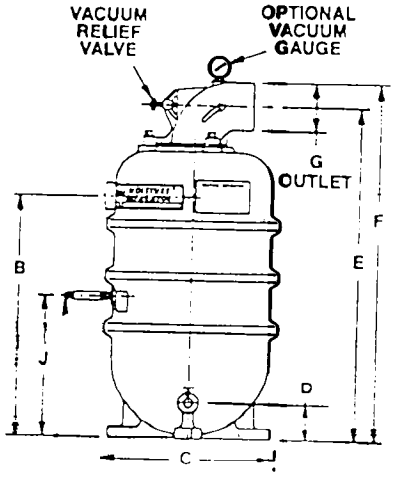
SPECIFICATIONS:

SEPARATION METHOD – High Efficiency Cyclonic
RELIEF VALVE MATERIAL – Brass & Stainless Steel
FLOAT MATERIAL – Copper
FLOAT SWITCH – SPDT, Explosion-proof
NEMA 7&9, 5 Amp max.

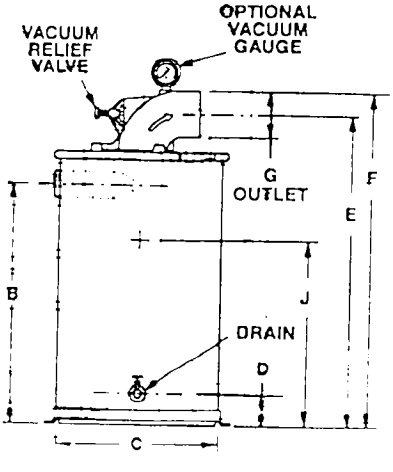




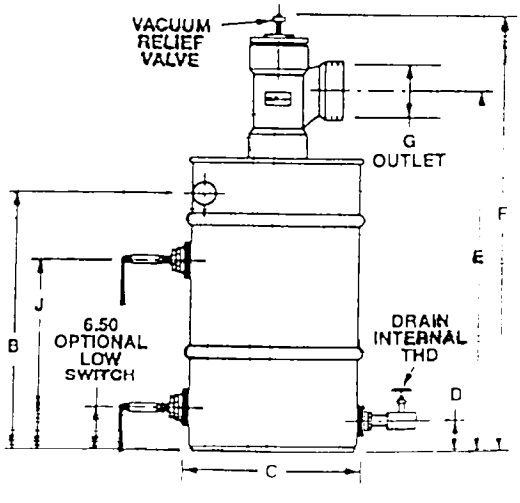




PLASTIC "P" DESIGN



METAL "D" DESIGN



METAL "B" DESIGN

Model	Part No.	CFM Max.	A Dia.	B	C Dia.	D	E	F	G Dia.	H	J Switch	Drain Internal THD	Shipping Weight
MS200PS	038519	200	2.38	22.46	16.42	3.25	31.05	33.30	4.50 OD	6.00	13.25	3/4" NPT	42 lb
MS300PS	038520	300	2.88										
MS200DS	080086	200	2.00	24.50	14.00	3.00	39.00	30.33		6.01	15.00		
MS300DS	080087	300	2.50							5.76			
MS350BS	038357	350	3.25	28.39	23.00	5.00	30.75	41.25		9.75	16.87	1" NPT	82 lb
MS500BS	038354	500					37.37	54.50	6.63 ID				95 lb
MS600BS	038353	600	4.00	27.87						9.25			96 lb
MS1000BS	038914	1000	6.00	31.00	27.00		46.00	59.00	9.25 OD	10.50	24.00		150 lb

Models without float switch available. Metal MS200/300DS models are not the standard stocked, but are available.

Blower Model Reference Key	
A = SPIRAL	E = DR/EN/CP 606, S543, 6, 623, S7, S75
B = DR/EN/CP 068, **083**, 101, 202	F = DR/EN/CP 707, 808, S85, 858, S9, P9 (Inlet Only)
C = DR/EN/CP 303, **312**, 313, 353	G = DR/EN/CP 823, S13, P13 (Inlet Only)
D = DR/EN/CP 404, **454**, 513, **505**, 555, 523	H = DR/EN/CP 909, 1223, 14, S15, P15 (Inlet Only)

2.0 Moisture Separator™ Specifications

2.1 DUTY

The moisture separator shall be designed for use in a soil vapor extraction system capable of continuous operation with a pressure drop of less than six inches of water at the rated flow of _____ SCFM. The separator shall be capable of operation under various inlet conditions ranging from a fine mist to slugs of water with high efficiency.

2.2 PRINCIPLE OF OPERATION

The moisture separator shall incorporate cyclonic separation to remove entrained water. The separator must protect against an overflow by fail safe mechanical means. An electrical switch or contact(s) alone is not an acceptable means of protection against overflow, but is a good backup.

2.3 CONSTRUCTION

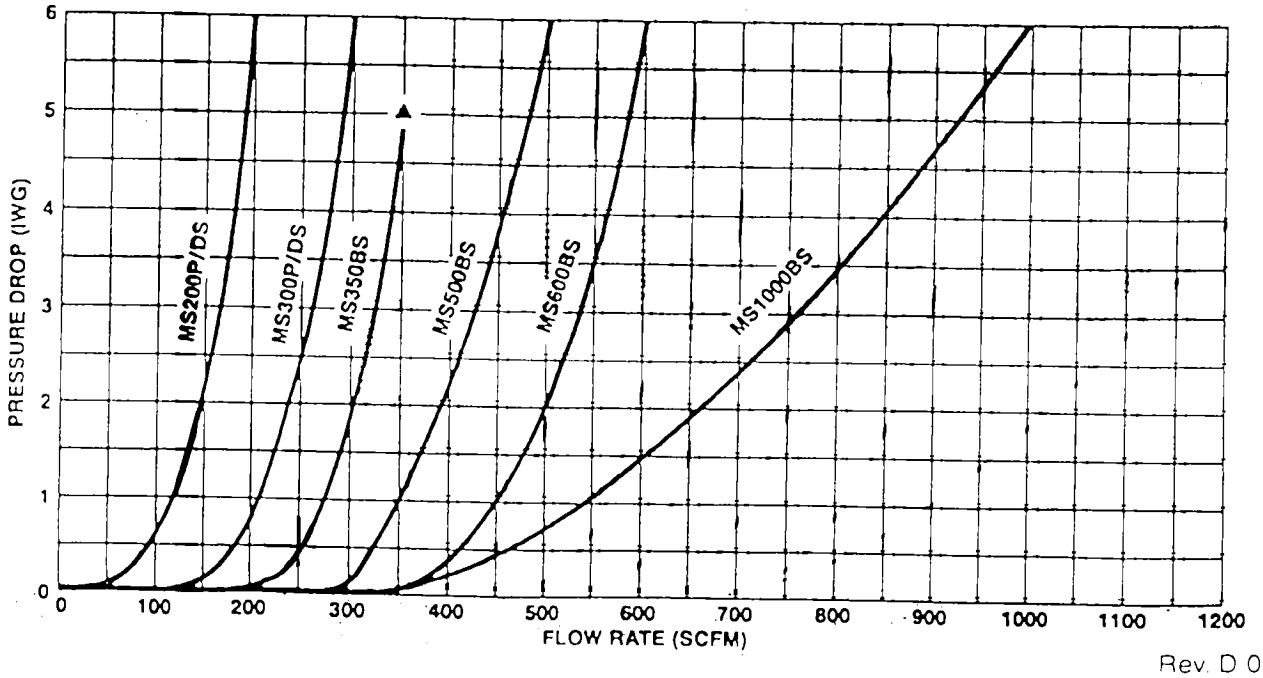
The body of the moisture separator shall be constructed of heavy wall plastic or heavy gauge cold rolled steel. The steel interior and exterior shall be epoxy (powder) coated to resist abrasion, corrosion, and chipping that might expose the surface. The inlet shall be tangentially located and welded to the body. The outlet port shall be constructed of PVC or cast aluminum alloy, flanged and sealed to the center of the top of the separator. The separator shall incorporate a non-sparking copper float ball and an adjustable relief valve to protect against overflow and overheating the blower.

2.4 CAPACITY AND DIMENSIONS

The moisture separator must have a liquid capacity of _____ gallons. The inlet shall be _____ inch OD slip-on type. The outlet shall be _____ inch OD slip-on type.

For DR/EN/CP Blower Model	Selector Moisture Separator Model	Liquid-holding Capacity (gallons)	Inlet (OD)	Outlet	Max Vacuum Allowed (IHg)
404, 454, 505, 513	MS200PS	7	2.38	4.5" OD	12
523, 555, 623, 823	MS200DS	10	2.0		22
606, 6	MS300PS	7	2.88		12
707	MS300DS	10	2.5		22
808	MS350BS	40	3.25	6.63" ID	
858, 1223	MS500BS				
909	MS600BS		4.0"		
14	MS1000BS	65	6.0"	9.25" OD	

2.5 PRESSURE DROP



AMETEK

ROTRON TECHNICAL MOTOR DIVISION
REGENERATIVE BLOWER GROUP

Field Service Tool - FST1.

Relief Valve Adjustment Procedure - Preset

Model	Part #	Range	System
2½" Relief Valve	550246	4 Psig - Factory Preset	Pressure
	550247	8 IHg - Factory Preset	Vacuum

A preset relief valve is one that has been factory tested and set at the listed rating as defined by the nameplate. A preset relief valve may be adjusted by cutting the wire attached to the lock screw. **Cutting this wire voids your warranty.**

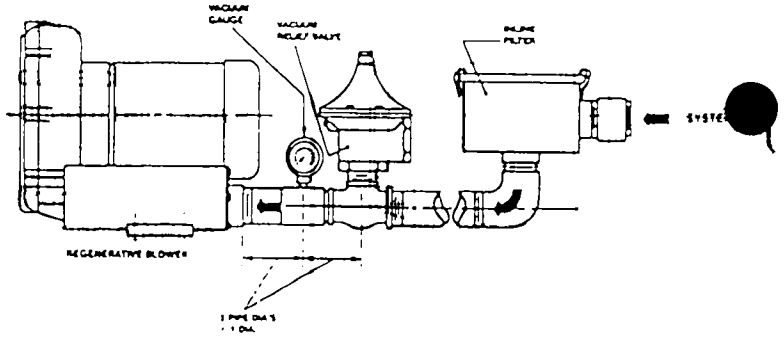
Procedure

1. Mount the valve and gauge as shown in the system diagram.
2. Cut the wire to locknut and loosen.
3. Turn the top of the valve counterclockwise , obtaining a low pressure/vacuum relief valve cracking point.
4. Fully impede air stream to/from the application. Energize blower and observe system pressure/vacuum.
5. Adjust relief valve by turning the top of the valve clockwise to obtain a pressure/vacuum about 10% below published maximum pressure/vacuum.
6. Tighten locknut and retest for appropriate setting, repeatedly allowing air to flow through delivery line and then impeding air stream until relief valve cracks. Readjust as necessary.

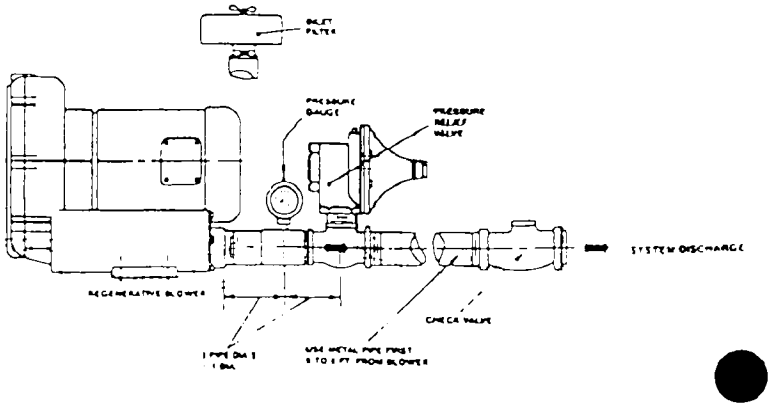
Caution

During any relief valve setting procedure, the system pressure/vacuum must be maintained within published maximums to prevent damage to the blower. This can be accomplished by monitoring gauges and by not exceeding maximum blower amps.

Typical Vacuum System



Typical Pressure System



Performance Products

PRODUCT DATA SHEET

CARULITE® 200 Catalyst

CARULITE® 200 extruded catalyst is recommended for the destruction of toxic and corrosive ozone. It is available in both 1/8" and 3/16" extrusions.

TYPICAL ANALYSIS

Bulk Density	0.93 g/cc or 58 lbs/ft³
Surface Area	≥ 175 m²/g
Crush Strength	
1/8" Extrusions	> 8 kg
3/16" Extrusions	> 10 kg
Weight Loss	< 1%
Particle Size Distribution	
1/8" Diameter Extrusions	95% on 8 mesh
3/16" Diameter Extrusions	97% on 5 mesh

APPLICATIONS

Water and Wastewater
Removes excess ozone off-gas used to treat water and wastewater.

Corona Treaters
Removes unwanted ozone formed during corona treatment of paper, plastic and other materials.

Office Equipment
Removes irritating ozone produced by copiers, printers and other office equipment.

Other
Removes ozone to improve indoor air quality. Used to remove excess ozone used in industrial processes.

DESCRIPTION

Manganese dioxide/copper oxide catalyst extrusions are black in color and odorless.

HANDLING

Use of a dust respirator is advised. Eye protection and gloves should also be worn.

STORAGE

Store in a cool, dry area in closed container. Protect containers against physical damage. Segregate from easily oxidizable materials.

INCOMPATIBILITY

Avoid contact with easily oxidizable materials, peroxides, chlorates, and acids.

SHIPPING

CARULITE® 200 Catalyst is not regulated by DOT.

Proper Shipping Name: Manganese dioxide compound.

ID Number: Not regulated by DOT.

Schedule B or Harmonized Code: 38169000 (090 0A)

PACKAGING

CARULITE® 200 Catalyst is packed in 45 lb net plastic drums. One pallet contains 24 drums, 1,080 lb net (1,221 lb gross).

(F495)
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Performance Products

Ozone Destruction in Water and Wastewater

CARULITE® 200 Catalyst

Uses of Ozone

Nearly everyone knows that the ozone layer in the upper atmosphere protects us from harmful radiation. Ozone is also very efficient oxidant that can disinfect polluted water without the smell and irritation associated with chlorine. Common uses of ozone include treatment of and disinfection of potable water, disinfection in hospitals, medical treatment, pulp bleaching, perfume manufacturing, and wastewater treatment.

Unfortunately, excess ozone present where we work and play is extremely dangerous to our health and environment and must be destroyed. Exposure to even small quantities of ozone can cause serious health problems. Ozone is also a very reactive gas and will quickly corrode most metals and damage most plastics.

Excess Ozone Destroyed with CARULITE® Catalyst

To prevent the harmful effects of excess ozone, CARULITE® 200 catalyst pellets are used to destroy residual ozone off-gas in water or wastewater plants, where ozone concentrations may range from one to several thousand parts per million.

CARULITE® 200 catalyst quickly destroys ozone using only one fifth of the reaction time needed for thermal destruction. In addition, CARULITE® 200 catalysts work at room temperature compared to 650 °F required for thermal destruction.

CARULITE® 200 catalyst decomposes ozone into oxygen, while activated carbon generates carbon dioxide and a small amount of carbon monoxide. Activated carbon reacts with ozone and requires replacement. CARULITE® 200 catalyst is not consumed by ozone.

Design Recommendations for Off-Gas Ozone Destruction:

The key to using CARULITE® 200 catalyst is proper design of the ozone destruction unit. Excess ozone can be effectively destroyed and the useful lifetime of the CARULITE® catalyst can be greatly extended by using design recommendations that are based on Carus Chemical Company laboratory experience:

* Raise linear velocity to 2.2 ft/sec. or higher;
* Decrease GHSV to 5,000 hr^{-1} or less (Raise residence time to 0.72 seconds or higher);
* Heat the gas stream 15 °F above ambient temperature before contact with the catalyst bed to prevent water condensation; and
* Remove catalyst poisons from the air stream. Catalyst poisons include acids, nitrogen oxides, and compounds that contain sulfur, phosphorus, or halogens like chlorine.

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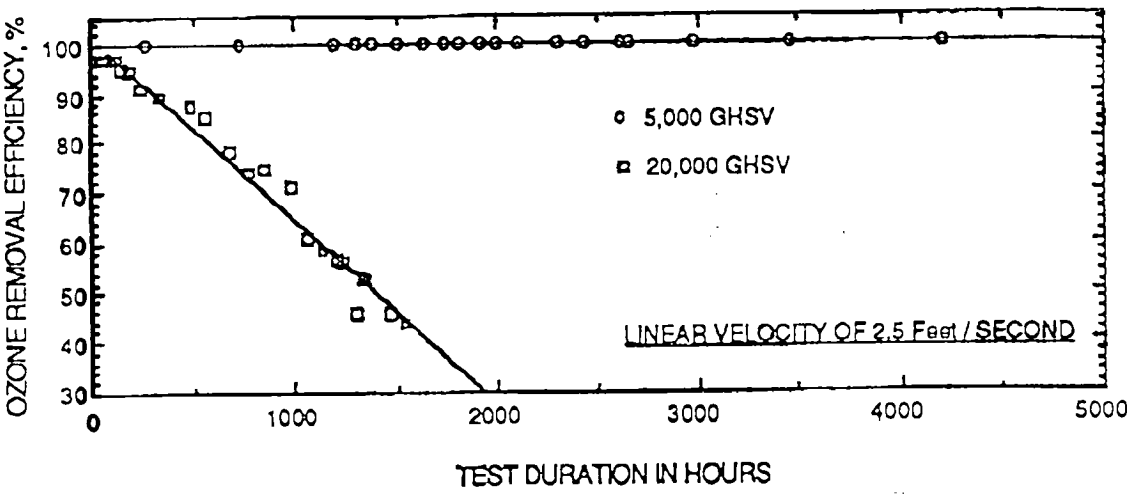
By using the recommendations, CARULITE® 200 catalyst gives stable ozone destruction efficiency even after four thousand hours of operation.

Ozone Destruction with CARULITE® 200 1/8" Extrusions



Temperature = 70 °F Humidity = 100% R.H. Inlet ozone = 1,000 ppm

A linear equation was fitted to the above data which resulted in the following set of equations:

GHSV	Ozone Destruction Efficiency as a function of Time
5,000 hr^{-1}	% O_3 Destruction = 100.00 - 0.0 (Running Time, hours)
20,000 hr^{-1}	% O_3 Destruction = 101.15 - 0.0367 (Running Time, hours)

In summary, to get optimum efficiency from CARULITE® 200 catalyst:

* Heat the gas stream 15 °F above ambient temperature before contact with the catalyst bed;
* Increase linear velocity to 2.2 ft/sec or higher;
* Decrease GHSV to 5,000 hr^{-1} or lower (Increase residence time to 0.72 seconds or higher); and
* Remove catalyst poisons from the air stream.

(F-193)

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Performance Products

Catalyst Calculations

CARULITE® 200 Catalyst

The key to using CARULITE® catalyst is proper design of the equipment. Proper design starts with determining the dimensions of the catalyst bed. Optimizing the catalyst bed will improve the efficiency of the catalyst and greatly extend the useful lifetime of the catalyst.

Optimizing the bed requires an air flow passing from top to bottom through the CARULITE® catalyst and by using the recommended liner velocity and Gas Hourly Space Velocity (GHSV) for the application. If the gas flow is known in cubic feet per minute (CFM), the optimum bed size can be easily calculated.

Determining Bed Volume and the Pounds of Catalyst Required

Gas flow can be expressed in terms of Gas Hourly Space Velocity or residence time. GHSV is the volume of gas per volume of bed per hour and is related to residence time (empty bed contact time):

$$\text{Residence Time (sec)} = \frac{3600 \text{ sec/hr}}{\text{GHSV } (hr^{-1})}$$

If the air flow in ft^3/min (CFM) is known along with the recommended GHSV for the application, catalyst bed volume is calculated from the following equation:

$$\text{Catalyst Bed Volume, } ft^3 = \frac{\text{Air flow, } ft^3/\text{min} \times 60 \text{ min/hr}}{\text{GHSV } (hr^{-1})}$$

The quantity of CARULITE® catalyst required can be easily calculated by multiplying the bed volume by the bulk density of the catalyst (57 pounds per cubic foot):

Bed Volume, ft^3 x Bulk Density, lbs / ft^3 = lbs of CARULITE® catalyst

Determining the Dimensions of the CARULITE® Catalyst Bed

Once the bed volume has been calculated, the bed cross sectional area can be determined by using the recommended linear velocity:

$$\text{Bed Cross-Sectional Area, } ft^2 = \frac{\text{CFM (ft3/min)}}{60 \text{ sec/min}} \times \frac{1}{\text{LV (ft/sec)}}$$

As long as the proper bed cross-sectional area is used, the exact dimensions of the length and width are flexible.

$$\text{Bed Height, ft} = \frac{\text{Bed Volume, } ft^3}{\text{Bed Cross-Sectional Area, } ft^2}$$

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Example

CARULITE® 200 catalyst is to be used to destroy off-gas ozone in an ozone cleaning system. The air flow rate requested by the customer is 100 ft^3/min (CFM).

The recommended GHSV (hr^{-1}) for CARULITE® 200 catalyst for the non-water and wastewater ozone applications is 10,000 hr^{-1}. The bed volume of catalyst is:

$$\text{Bed Volume, } ft^3 = \frac{(100\ ft^3/min) \times 60\ min/hr}{10{,}000\ GHSV\ (hr^{-1})} = 0.6\ ft^3$$

$$\text{Pounds of catalyst} = 0.6\ ft^3 \times 57 \text{ pounds of catalyst per } ft^3$$

$$= 34 \text{ pounds of CARULITE® 200 catalyst will be required.}$$

The recommended linear velocity (ft/sec) for CARULITE® 200 catalyst in non-water and wastewater off-gas ozone applications is 2.2 ft/sec. The catalyst bed cross section area is:

$$\text{Bed Cross-Sectional Area, } ft^2 = \frac{(100\ ft^3/min)}{60\ sec/min} \times \frac{1}{2.2\ (ft/sec)}$$

$$= 0.76\ ft^2$$

The actual length and the width of the catalyst bed can be determined by the equipment designer, but the cross-sectional area should be a maximum of 0.76 ft^2 for a 100 CFM unit.

The minimum suggested bed height for CARULITE® 200 is 0.83 ft (10 inches) of catalyst pellets.

$$\text{Bed Height} = \frac{0.60\ ft^3}{0.76\ ft^2} = 0.79\ ft$$ A deeper bed recommended

A square design with a length and width of 0.85 ft and a minimum bed depth of 0.83 ft could be used. A 0.96' diameter pipe filled to a height of 0.83 ft with catalyst would also meet our recommendations.

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Performance Products

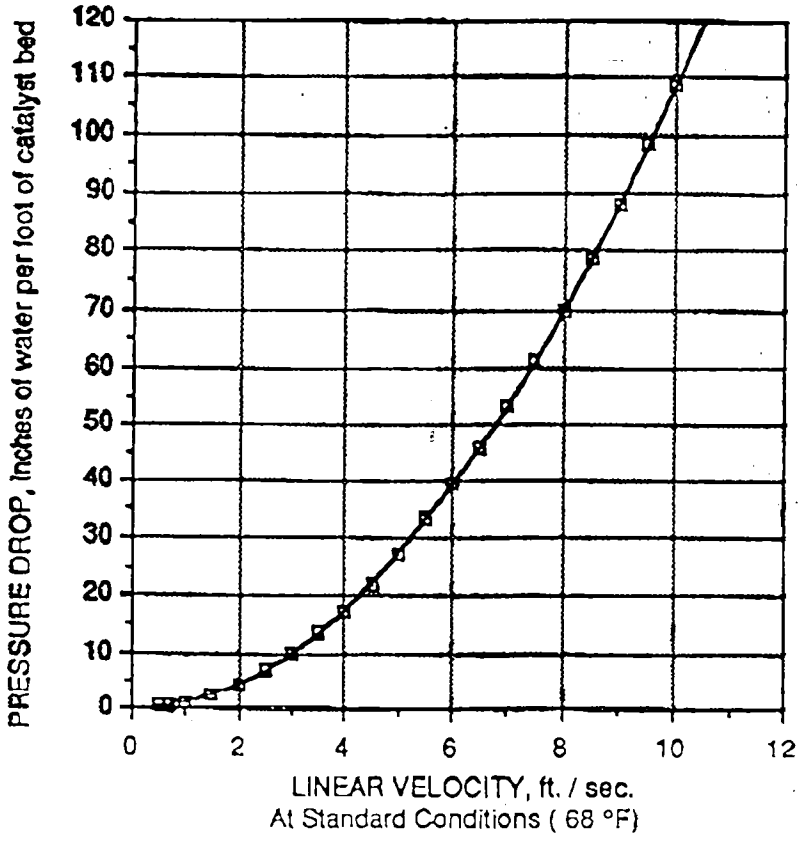
Pressure Drop of 1/8" Extruded Catalyst

CARULITE® Catalyst

Pressure drop across a bed of CARULITE® Catalyst is proportional to the linear velocity of the gas flowing through the bed and the depth of the catalyst bed.

The ΔP across the catalyst bed at room temperature (68 °F) can be predicted using this graph:

Predicted Pressure Drop: 1/8" CARULITE® Catalyst



The equation for predicting pressure drop for 1/8" extruded catalyst is as follows:

$$\Delta P = -0.00035264 + 0.059313x + 1.0823\ x^2$$

Where ΔP is the pressure drop in inches of water per foot of CARULITE® Catalyst bed and x is the linear velocity in feet per second.

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Here is a data table from the graph:

Linear Velocity Standard Conditions ft./sec.	68 °F ΔP
0.5	0.300
1.0	1.141
1.5	2.524
2.0	4.447
2.5	6.912
3.0	9.918
3.5	13.465
4.0	17.553
4.5	22.182
5.0	27.353
5.5	33.064
6.0	39.317
6.5	46.111
7.0	53.446
7.5	61.322
8.0	69.739
8.5	78.697
9.0	88.197
9.5	98.237
10.0	108.819

ΔP is the PRESSURE DROP in inches of water per foot of CARULITE® catalyst bed.

(F 193)
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Material Safety Data Sheet

CARULITE® 200 Low Temperature Oxidation Catalyst

Section I Product Identification

MANUFACTURER'S NAME: CARUS CORPORATION	TELEPHONE NUMBER FOR INFORMATION: (815) 223-1500
MANUFACTURING FACILITY: Carus Chemical Company 1500 Eighth Street P. O. Box 1500 LaSalle, IL 61301	EMERGENCY TELEPHONE NO.: (800) 435-6856
PRODUCT NAME: CARULITE® 200 Catalyst	
SYNONYMS: None	
CLASS: Inorganic oxides	

DEPARTMENT OF TRANSPORTATION INFORMATION:

Proper Shipping Name . . . . . .
Manganese dioxide compound
ID Number . . . . . .
not regulated by DOT
Chemtrec Telephone No. (800) 424-9300

NOTICE: CARULITE® 200 Low Temperature Oxidation catalyst contains 37-39% manganese compounds (CAS Reg. No. N/A) and 9-11% copper compounds (CAS Reg. No. N/A) as part of the mixture and is subject to the reporting requirements of Section 313 of the Title III Superfund Amendments and Reauthorization Act of 1986 and 40CFR Part 372.

Section II Hazardous Ingredients

Material or Component	CAS No.*	%	Hazard Data
Manganese Dioxide	1313-13-9	60-75%	PEL** C**** 5 mg Mn per cubic meter of air TLV-TWA*** 5 mg Mn per cubic meter of air
Copper Oxide	1317-38-0	11-14%	PEL 1 mg Cu per cubic meter of air TLV-TWA 1 mg Cu per cubic meter of air
Aluminum Oxide	1344-28-1	15-16%	TLV-TWA 10 mg Al per cubic meter of air

* Chemical Abstract Service Number
** OSHA Permissible Exposure Limit, manganese compounds (as Mn), copper dusts and mists (as Cu), 29CFR 1910.1000 Table Z-1
*** American Conference of Governmental Hygienists, 1988/1989. TLV-TWA = the time weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.
**** Ceiling Exposure Limit or maximum exposure concentration not to be exceeded under any circumstances.

Section III Physical Data

BOILING POINT, 760 mm Hg Not applicable	VAPOR PRESSURE (mm Hg) Not applicable
SOLUBILITY IN WATER % BY SOLUTION Insoluble	
SPECIFIC GRAVITY 4.7 g/cm³ Bulk density 1.0 g/cm³	PERCENT VOLATILE BY VOLUME Not volatile
MELTING POINT Starts to decompose with evolution of oxygen at 454°C (850°F)	
APPEARANCE AND ODOR Black extruded, granulated, or powdered solid; odorless	

Section IV Fire and Explosion Hazard Data

The material itself is noncombustible but may accelerate the burning of combustible material.
FLASHPOINT None
FLAMMABLE OR EXPLOSIVE LIMITS Lower: Nonflammable Upper: Nonflammable
EXTINGUISHING MEDIA Use large quantities of water
SPECIAL FIREFIGHTING PROCEDURES None
UNUSUAL FIRE AND EXPLOSION HAZARDS Should not be heated or rubbed in contact with organic matter or other oxidizable substances. Keep away from heat and flammable materials. Strong oxidizer.

Section V Health Hazard Data

ROUTES OF EXPOSURE

1. Inhalation
   Inhalation of dust may cause irritation to the respiratory tract.
2. Skin Contact
   Dehydrating effect on skin.
3. Eye Contact
   Dust may cause eye irritation.
4. Ingestion
   May have a dehydrating effect on mouth and throat.

EFFECTS OF ACUTE AND CHRONIC EXPOSURE

1. Acute Exposure
   May cause respiratory tract and eye irritation.
2. Chronic Exposure
   Prolonged inhalation of manganese compounds above the threshold limit value may cause lung irritation and central nervous system disorders. The symptoms simulate Parkinson's disease.
3. Carcinogenicity
   NTP: not listed IARC Monographs: not listed OSHA Regulated: not listed
4. Medical Conditions Generally Aggravated by Exposure
   Dust or fine powder may further irritate mucous membranes or open wounds.

EMERGENCY AND FIRST AID PROCEDURES

1. Eyes
   Immediately flush eyes with large amounts of water for at least 15 minutes holding lids apart to ensure flushing of the entire surface. Seek medical attention if irritation persists.
2. Skin
   Wash contaminated areas with plenty of soap and water. Remove contaminated clothing. Wash clothing before reuse.
3. Inhalation
   Get person out of contaminated area to fresh air.
4. Ingestion
   Never give anything by mouth to an unconscious or convulsing person. If conscious, give large quantities of water. Seek medical help immediately.

Section VI Reactivity

STABILITY Stable under normal conditions.
CONDITIONS TO AVOID Contact with incompatible materials or heat (454°C/850°F)
INCOMPATIBLE MATERIALS Contact with peroxides and chlorates may cause violent reaction under certain conditions, such as elevated temperature or friction. May ignite organic material, especially organic solvents. May initiate polymerization of monomers. May form unstable acetylides in contact with acetylene.
HAZARDOUS DECOMPOSITION PRODUCTS None
CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION Material is not known to polymerize.

Section VII Spill or Leak Procedures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED Clean up spills immediately by scooping CARULITE® catalyst into a metal drum. Deactivate by soaking with water. Cover loosely. Flush contaminated floors with abundant quantities of water into sewer, if permitted by federal, state, or local regulations.
WASTE DISPOSAL Dispose of deactivated CARULITE® catalyst in a permitted landfill.

Section VIII Protective Equipment To Be Used

VENTILATION REQUIREMENTS Provide sufficient mechanical and/or local exhaust to maintain exposure levels below threshold limit values.
RESPIRATORY PROTECTION In cases where high dust exposure may exist, the use of NIOSH-MSHA dust and mist respirator (such as NIOSH-MSHA TC-21C) or an air supplied respirator is advised. Engineering or administrative controls should be implemented to control dust.
EYE PROTECTION Primary eye protection (safety glasses or goggles).
GLOVES Rubber or plastic gloves should be worn.
OTHER PROTECTIVE EQUIPMENT Normal work clothing is sufficient.

Section IX Special Precautions and Other Comments

Protect containers against physical damage. Store in a cool, dry area in closed container. Segregate from easily oxidizable materials, peroxides, chlorates, and acids.

Revision Date: May, 1995

The information contained herein is accurate to the best of our knowledge. However, data, safety standards and government regulations are subject to change and, therefore, holders and users should satisfy themselves that they are aware of all current data and regulations relevant to their particular use of product. CARUS CHEMICAL COMPANY DISCLAIMS ALL LIABILITY FOR RELIANCE ON THE COMPLETENESS OR ACCURACY OR THE INFORMATION INCLUDED HEREIN. CARUS CHEMICAL COMPANY MAKES NO WARRANTY, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE OR PURPOSE OF THE PRODUCT DESCRIBED HEREIN. All conditions relating to storage, handling, and use of the product are beyond the control of Carus Chemical Company, and shall be the sole responsibility of the holder or user of the product.

carus CHEMICAL COMPANY

Division of Carus Corporation
315 5th Street
Peru, IL 61354

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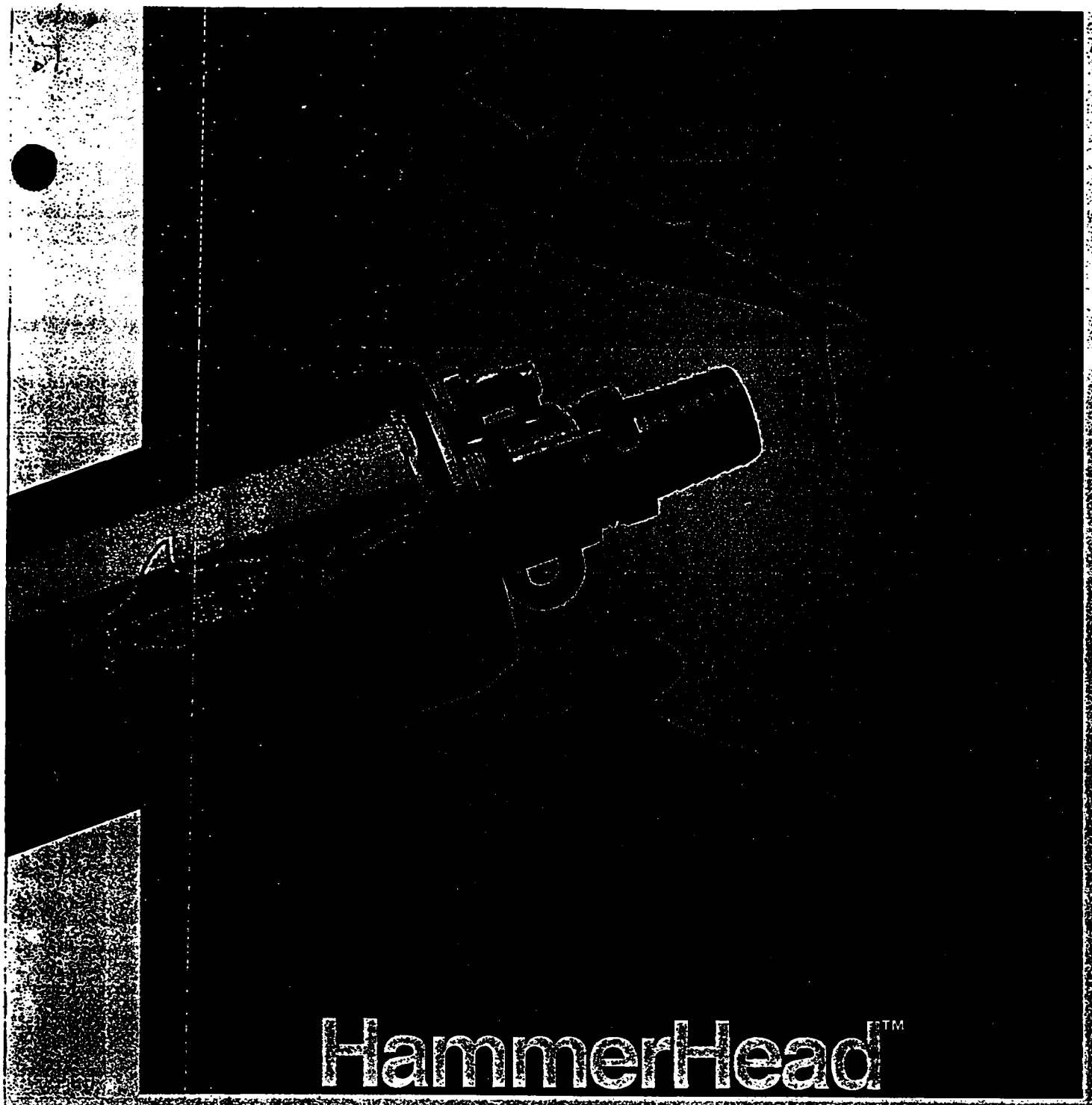

HammerHead™

H4 Series (wells 4" & up)

INSTALLATION & OPERATION MANUAL

Models H45SSB, H45SEB, HF45SSB, HF45SEB,
H45SET, HF45SET, and HF43SET

HAMMERHEAD
CLEANUP PUMPS

GEO Ground Water Specialists
P.O. Box 3726, Ann Arbor, MI 48106 USA
Part No. 95067
REV. #2 1-2-95

TABLE OF CONTENTS

H4 SERIES MODEL CODE SYSTEM

Each letter or number represents a different descriptive characteristic of the model.

H45SET
H = HammerHead Pump Series (standard 3/4" discharge tube)
4 = Well Size, minimum (4")
5 = Nominal Pump Length (5')
S = Pump Material (Stainless Steel)
E = Float (Epoxy for free product)
T = Inlet style (Top)

HF45SET
HF = HammerHead Pump Series (high flow 1.25" discharge tube)
4 = Well Size, minimum (4")
5 = Nominal Pump Length (5')
S = Pump Material (Stainless Steel)
E = Float (Epoxy for free product)
T = Inlet style (Top)

HF43SET
HF = HammerHead Pump Series (high flow 1.25" discharge tube)
4 = Well Size, minimum (4")
3 = Nominal Pump Length (3')
S = Pump Material (Stainless Steel)
E = Float Material (Epoxy for free product)
T = Inlet style (Top)

S4S, S6S, S8S, S4L, S6L, S8L, S4X, S6X, S8X, V4S, V6S, V8S, V4X, V6X, V8X—Well Caps
Example:
S = Slip-fit cap, or V (vacuum)
4 = 4" Well Size (or 6" or 8")
S = SPTUBE, or L (hose, 1" I.D.), X (MAXTUBE)

H45SSB
H = HammerHead Pump Series (standard 3/4" discharge tube)
4 = Well Size, minimum (4")
5 = Nominal Pump Length (5')
S = Pump Material (Stainless Steel)
S = Float Material (Stainless Steel)
B = Inlet style (Bottom)

H45SEB
H = HammerHead Pump Series (standard 3/4" discharge tube)
4 = Well Size, minimum (4")
5 = Nominal Pump Length (5')
S = Pump Material (Stainless Steel)
E = Float Material (Epoxy for free product)
B = Inlet style (Bottom)

HF45SSB
HF = HammerHead Pump Series (high flow 1.25" discharge tube)
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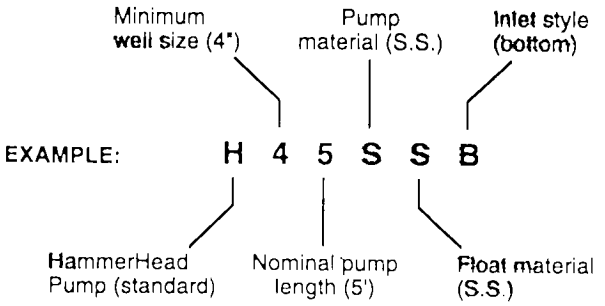
5 = Nominal Pump Length (5')
S = Pump Material (Stainless Steel)
S = Float Material (Stainless Steel)
B = Inlet style (Bottom)

HF45SEB
HF = HammerHead Pump Series (high flow 1.25" discharge tube)
4 = Well Size, minimum (4")
5 = Nominal Pump Length (5')
S = Pump Material (Stainless Steel)
E = Float Material (Epoxy for free product)
B = Inlet style (Bottom)



HAMMERHEAD™ CLEANUP PUMPS

HammerHead™ H4 Series pumps (patent pending) are high-rate, air-driven pneumatic pumps primarily useful for total fluids applications. They run automatically, with the Hammer Drive magnetic relay and internal float system. The system senses liquid level in the pump, turning the air supply on when the pump is full, and turning it off as soon as the pump empties.

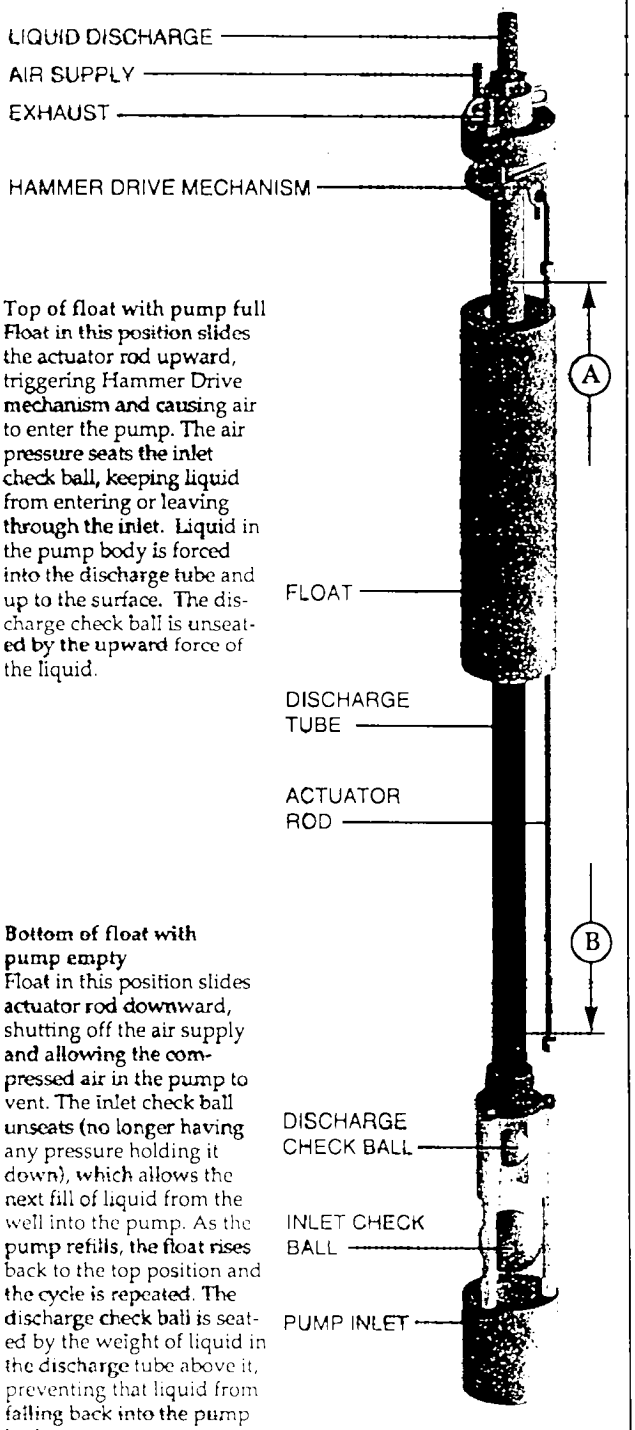
With built-in control, a HammerHead pump doesn't require air cycle timers or on-off level controls at the wellhead, simplifying system design. System setup is easy—just run air to each well. Continued operation is truly hands-off. The pump constantly reacts to changes in well yield, so it always pumps at the highest rate possible, and shuts down automatically when the well drops below pumping level. (NOTE: H4 Series pumps require a minimum of 3.5 feet of liquid above the bottom of the inlet in order to run.)

Because cycling is controlled downwell, a HammerHead pump is either refilling or discharging 100% of the time. There's no waiting between active phases of the cycle for the entire length of air supply tubing to re-pressurize. This operating efficiency enables H4 Series pumps to deliver maximum flow rates of more than 11 gallons per minute while also saving on air supply requirements. It also keeps air out of the liquid discharge system, preventing over-pumping, foaming, and emulsification.

The HammerHead pumping mechanism uses the same high-clearance design and stay-clean ball check valves that set the PULSE PUMP® standard for field performance without clogging or breakdowns. All parts, including the Hammer Drive system, are easily field serviceable.

HOW THE HAMMERHEAD PUMP WORKS

- An H4 Series pump requires a minimum depth of 42" of liquid (measured from the bottom of the pump) to begin pumping.
- The pump automatically shuts off when the liquid level is pumped down below this level, and will automatically begin pumping again once well level has recovered.



A. Top of float with pump full
Float in this position slides the actuator rod upward, triggering Hammer Drive mechanism and causing air to enter the pump. The air pressure seats the inlet check ball, keeping liquid from entering or leaving through the inlet. Liquid in the pump body is forced into the discharge tube and up to the surface. The discharge check ball is unseated by the upward force of the liquid.

B. Bottom of float with pump empty
Float in this position slides actuator rod downward, shutting off the air supply and allowing the compressed air in the pump to vent. The inlet check ball unseats (no longer having any pressure holding it down), which allows the next fill of liquid from the well into the pump. As the pump refills, the float rises back to the top position and the cycle is repeated. The discharge check ball is seated by the weight of liquid in the discharge tube above it, preventing that liquid from falling back into the pump body.

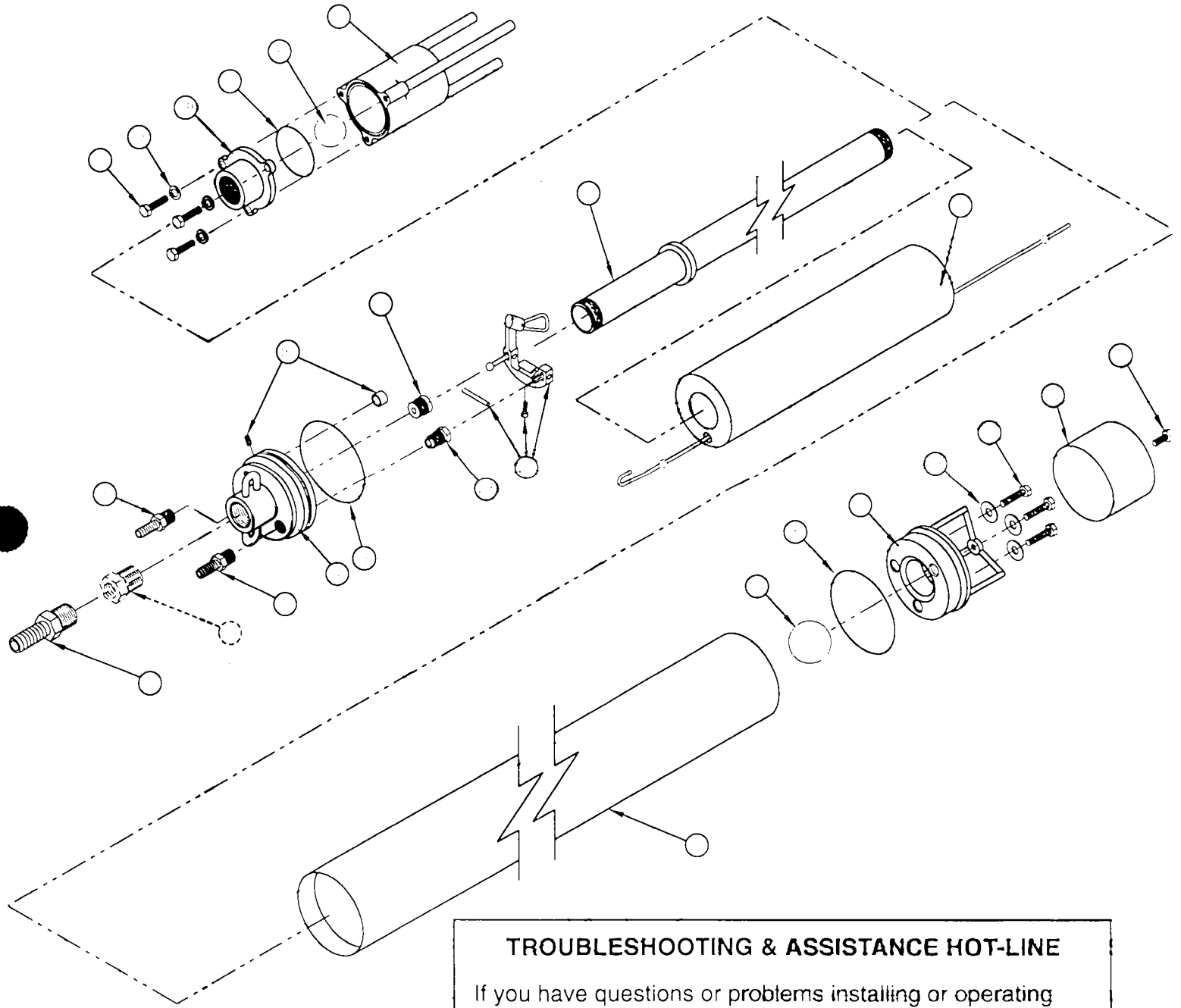
H4 SERIES SPECIFICATIONS

	H4 Series Bottom Inlet	H4 Series Top Inlet	Short H4, Top Inlet
Model No.	H45SSB, H45SEB, HF45SSB, HF45SEB	H45SET, HF45SET	HF43SET
Pump Type	Positive Air Displacement	Positive Air Displacement	Positive Air Displacement
Inlet	Bottom	Top	Top
O.D.	3.5" (89 mm)	3.5" (89 mm)	3.5" (89 mm)
Length	55" (140 cm)	60" (152 cm)	42" (105 cm)
Weight	23.5 lbs. (10.7 kg)	24.0 lbs. (10.9 kg)	16.0 lbs. (7.3 kg)
Materials	Stainless steel construction, with Teflon® inlet and discharge check balls, stainless steel or epoxy float, Viton O-rings	Stainless steel, Q-Tal & brass construction, with Teflon® inlet and discharge check balls, epoxy float, Viton O-rings	Stainless steel, Q-Tal & brass construction, with Teflon® inlet and discharge check balls, epoxy float, Viton O-rings,
Fittings: Type*	Barb	Barb	Barb
Sizes: Liquid Discharge	3/4" (19 mm) O.D. (H45SSB, H45SEB) or 1-1/4" (32 mm) O.D. (HF45SSB, HF45SEB)	3/4" (19 mm) O.D. (H45SET) or 1-1/4" (32 mm) O.D. (HF45SET)	1 1/4" (32 mm) O.D. Tube
Air Supply	3/8" (9 mm) O.D. Tubing	3/8" (9 mm) O.D. Tubing	3/8" (9 mm) O.D. Tubing
Exhaust	1/2" (13 mm) O.D. Tubing	1/2" (13 mm) O.D. Tubing	1/2" (13 mm) O.D. Tubing
Pump Stroke	0.8 gal. (2850 ml.)	0.8 gal. (2850 ml.)	0.32 gal. (1200 ml.)
Operating pressure range	10-160 psi (70-1,100 kPa)	10-160 psi (70-1,100 kPa)	10-100 psi (70- 695 kPa)
Maximum lift	300 ft. (90 m)	300 ft. (90 m)	200 ft. (60 m)
Maximum flow rate	14+ GPM (54+ LPM) HF45SSB, HF45SEB	11+ GPM (41+ LPM) HF45SET	10 GPM (38 LPM)
Minimum submergence	42" (107 cm) above pump bottom	Top Inlet Port— 58" (147 cm) above bottom of pump	Top Inlet Port— 38" (97 cm) above bottom of pump
Density of pumped liquid	1.0 g/cc (stainless float); 0.7 g/cc up (epoxy float)	0.7 g/cc up (epoxy float)	0.7 g/cc up (epoxy float)
Cap sizes**	4", 6", and 8" (100, 150, & 200 mm) diameter (standard and vacuum seal)	4", 6", and 8" (100, 150, & 200 mm) diameter (standard and vacuum seal)	4", 6", and 8" (100, 150, & 200 mm) diameter (standard and vacuum seal)

* Note: Pumps are available with tubing or hose; quick disconnect fittings are available on request.

** Special caps available.

PUMP ASSEMBLY DIAGRAM



TROUBLESHOOTING & ASSISTANCE HOT-LINE

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PARTS LIST—HF45SSB

ITEM	P/N	DESCRIPTION
53	37025	Seat, Air Supply - Kit
52	37030	Seat, Exhaust - Kit
51	37031	Magnet - Kit
50	37024	Cam Assembly - Kit
37	37006	Bolt, hex 1/4-20 x 1/2
36	36852	Screen
35	36832	Inlet, EP
34	36902	Ball , 2 dia. Teflon
33	37151	Body, H4
32	36830	Housing, EP
31	36901	Ball, 1-1/2 dia. Teflon
30	36464	O-ring Viton U/F 2-034
29	36834	Cover, EP
28	35584	Washer, 5/16" Belleville
27	36912	Bolt, 1/4-20 x 1"
26	37008	Actuator Assembly (S.S. Float)
25	36836	Dip-tube, H4
5	35325	O-ring Viton U/F 2-235
4	36831	Head, EP
3	36401	Barb, 1/2 T x 3/8 MPT
2	37159	Check Barb, 3/8 T x 1/4 MPT
1	37005	Barb, 1-1/4 T x 1 MPT

PARTS LIST—HF45SEB

ITEM	P/N	DESCRIPTION
53	37025	Seat, Air Supply - Kit
52	37030	Seat, Exhaust - Kit
51	37031	Magnet - Kit
50	37024	Cam Assembly - Kit
37	37006	Bolt, hex 1/4-20 x 1/2
36	36852	Screen
35	36832	Inlet, EP
34	36902	Ball , 2 dia. Teflon
33	37151	Body, H4
32	36830	Housing, EP
31	36901	Ball, 1-1/2 dia. Teflon
30	36464	O-ring Viton U/F 2-034
29	36834	Cover, EP
28	35584	Washer, 5/16" Belleville
27	36912	Bolt, 1/4-20 x 1"
26	37054	Actuator Assembly (Epoxy Float)
25	36836	Dip-tube, H4
5	35325	O-ring Viton U/F 2-235
4	36831	Head, EP
3	36401	Barb, 1/2 T x 3/8 MPT
2	37159	Check Barb, 3/8 T x 1/4 MPT
1	37005	Barb, 1-1/4 T x 1 MPT

PARTS LIST—H45SSB

ITEM	P/N	DESCRIPTION
53	37025	Seat, Air Supply - Kit
52	37030	Seat, Exhaust - Kit
51	37031	Magnet - Kit
50	37024	Cam Assembly - Kit
44	37088	Bushing, Reducer, 3/4 FPT x 1 MPT
37	37006	Bolt, hex 1/4-20 x 1/2
36	36852	Screen
35	36832	Inlet, EP
34	36902	Ball , 2 dia. Teflon
33	37151	Body, H4
32	36830	Housing, EP
31	36901	Ball, 1-1/2 dia. Teflon
30	36464	O-ring Viton U/F 2-034
29	36834	Cover, EP
28	35584	Washer, 5/16" Belleville
27	36912	Bolt, 1/4-20 x 1"
26	37008	Actuator Assembly (S.S. Float)
25	36836	Dip-tube, H4
5	35325	O-ring Viton U/F 2-235
4	36831	Head, EP
3	36401	Barb, 1/2 T x 3/8 MPT
2	37159	Check Barb, 3/8 T x 1/4 MPT
1	36634	Barb, 3/4 T x 1 MPT

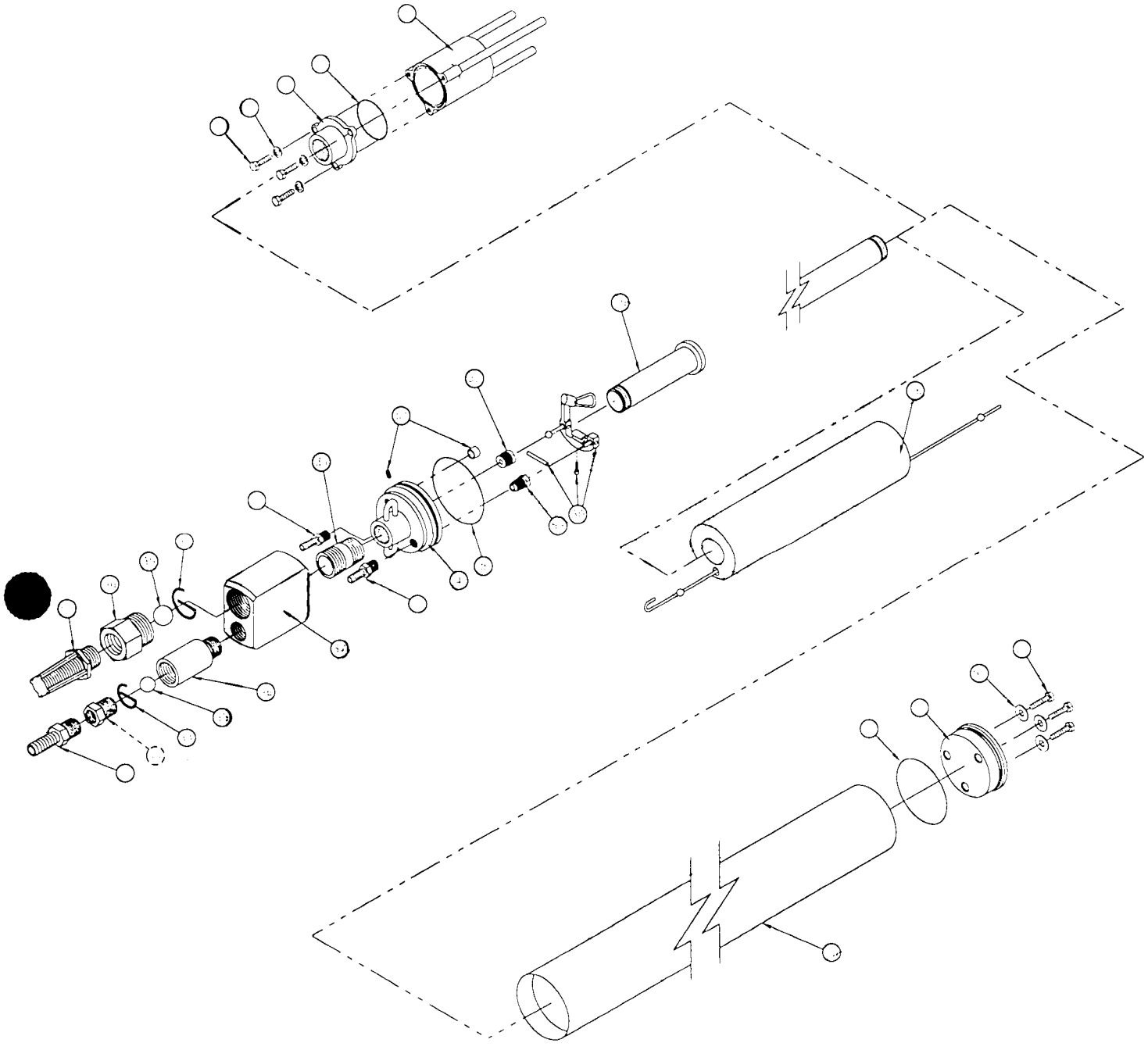
PARTS LIST—H45SEB

ITEM	P/N	DESCRIPTION
53	37025	Seat, Air Supply - Kit
52	37030	Seat, Exhaust - Kit
51	37031	Magnet - Kit
50	37024	Cam Assembly - Kit
44	37088	Bushing, Reducer, 3/4 FPT x 1 MPT
37	37006	Bolt, hex 1/4-20 x 1/2
36	36852	Screen
35	36832	Inlet, EP
34	36902	Ball , 2 dia. Teflon
33	37151	Body, H4
32	36830	Housing, EP
31	36901	Ball, 1-1/2 dia. Teflon
30	36464	O-ring Viton U/F 2-034
29	36834	Cover, EP
28	35584	Washer, 5/16" Belleville
27	36912	Bolt, 1/4-20 x 1"
26	37054	Actuator Assembly (Epoxy Float)
25	36836	Dip-tube, H4
5	35325	O-ring Viton U/F 2-235
4	36831	Head, EP
3	36401	Barb, 1/2 T x 3/8 MPT
2	37159	Check Barb, 3/8 T x 1/4 MPT
1	36634	Barb, 3/4 T x 1 MPT

TUBING CLAMPS

HF45SSB, HF45SEB		H45SSB, H45SEB	
37032	Clamp, 1-1/4 O.D.	35211	Clamp, 3/4 O.D.
35209	Clamp, 1/2 O.D.	35209	Clamp, 1/2 O.D.
35187	Clamp, 3/8 O.D.	35187	Clamp, 3/8 O.D.

PUMP ASSEMBLY DIAGRAM



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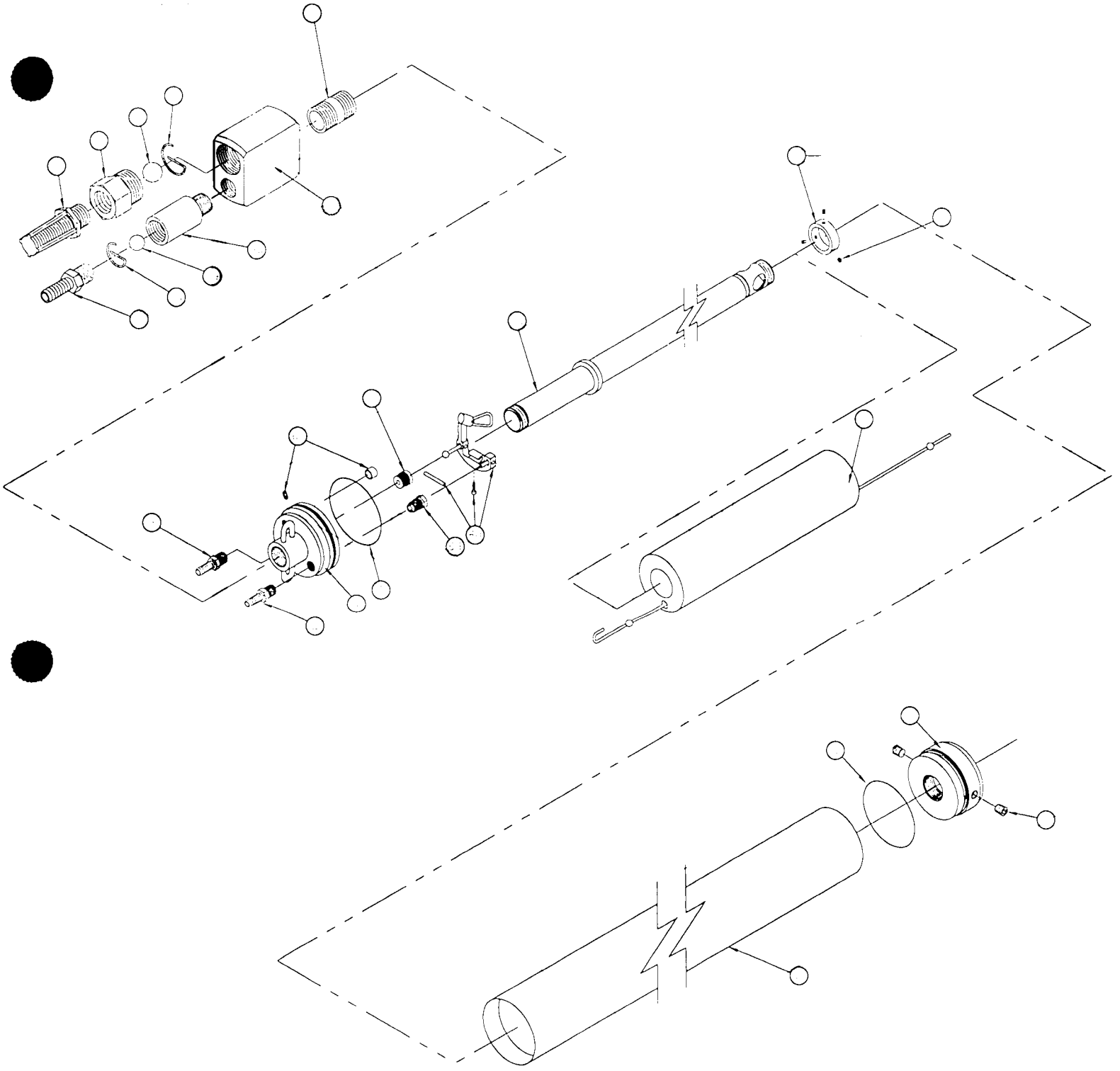
PARTS LIST—H45SET

ITEM	P/N	DESCRIPTION
59	37143	Washer, Sealing
58	37163	Inlet, Solid H4
57	37164	Screen, Nylon H4
56	37169	Seat, Check H4
55	37172	Ball, Teflon 1 3/16" Dia.
54	37170	Ring, Retainer "G"
53	37025	Seat, Air Supply—Kit
52	37030	Seat, Exhaust—Kit
51	37031	Magnet—Kit
50	37024	Cam Assembly—Kit
44	37088	Bushing, Reducer 1" MPT x 3/4" FPT
37	37160	Body, Top Inlet
36	37161	Check, Cartridge
35	36936	Ball, Teflon 7/8" Dia.
34	37162	Ring, Retainer "G"
33	37151	Body W/Shark Logo
32	36830EP	Housing EP
31	37087	Nipple S.S. 1" NPT x 2" Long
30	36464	O-Ring Viton L/F 2-034
29	36834EP	Cover EP
28	35584	Washer, 5/16" Bellville
27	36912	Bolt, 1/4-20 x 1"
26	37054	Actuator Assembly, Epoxy
25	36836	Dip-tube
5	35325	O-Ring Viton L/F 2-235
4	36831EP	Head EP
3	36401	Barb, 1/2 T x 3/8 MPT
2	37159	Check Barb Kit 3/8"T x 1/4" MPT
1	36634	Barb, 3/4 T x 3/4 MPT

PARTS LIST—HF45SET

ITEM	P/N	DESCRIPTION
59	37143	Washer, Sealing
58	37163	Inlet, Solid H4
57	37164	Screen, Nylon H4
56	37169	Seat, Check H4
55	37172	Ball, Teflon 1 3/16" Dia.
54	37170	Ring, Retainer "G"
53	37025	Seat, Air Supply—Kit
52	37030	Seat, Exhaust—Kit
51	37031	Magnet—Kit
50	37024	Cam Assembly—Kit
37	37160	Body, Top Inlet
36	37161	Check, Cartridge
35	36936	Ball, Teflon 7/8" Dia.
34	37162	Ring, Retainer "G"
33	37151	Body W/Shark Logo
32	36830EP	Housing EP
31	37087	Nipple S.S. 1" NPT x 2" Long
30	36464	O-Ring Viton L/F 2-034
29	36834EP	Cover EP
28	35584	Washer, 5/16" Bellville
27	36912	Bolt, 1/4-20 x 1"
26	37054	Actuator Assembly, Epoxy
25	36836	Dip-tube
5	35325	O-Ring Viton L/F 2-235
4	36831EP	Head EP
3	36401	Barb, 1/2 T x 3/8 MPT
2	37159	Check Barb Kit 3/8"T x 1/4" MPT
1	37005	Barb, 1 1/4 T x 1 MPT

PUMP ASSEMBLY DIAGRAM



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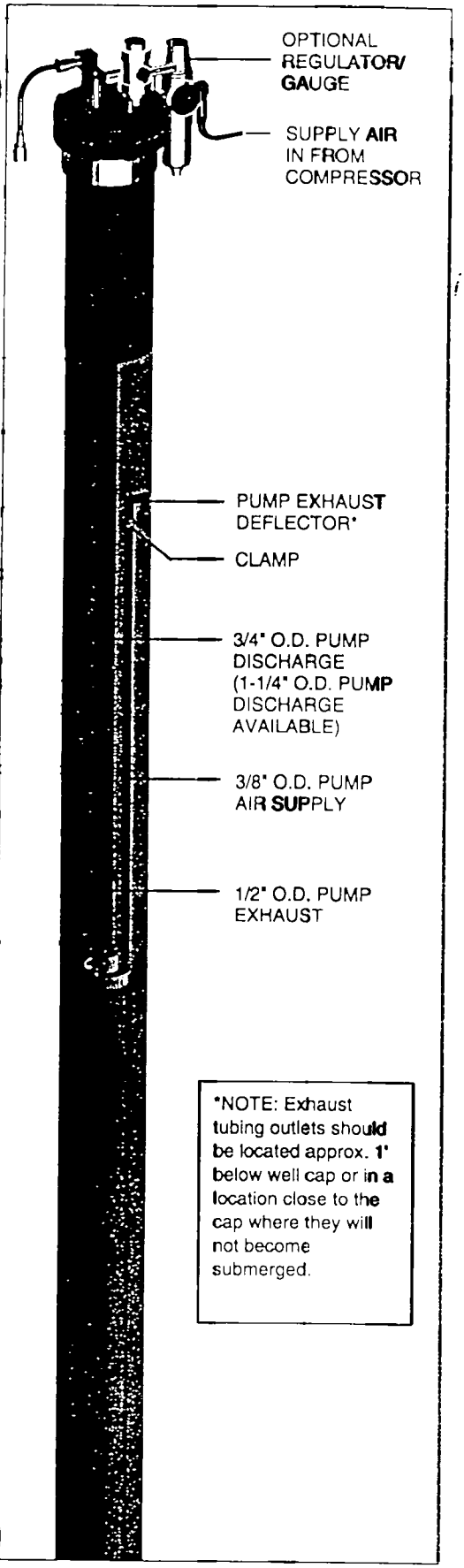
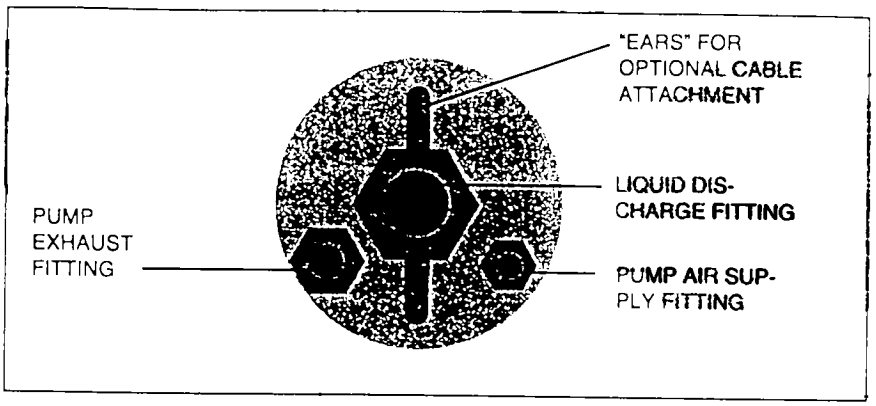
PARTS LIST—HF43SET

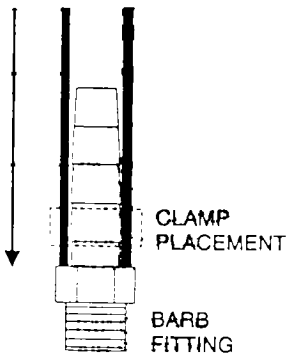
ITEM	P/N	DESCRIPTION
63	37025	Seat, Air Supply—Kit
62	37030	Seat, Exhaust—Kit
61	37031	Magnet—Kit
60	37024	Cam Assembly—Kit
57	37227	Plug, Pipe 1/4" MPT Brass
56	37191	Collar, Clamping S.S.
55	37187	Inlet, Solid Short Body
54	37164	Screen, Nylon H4
53	37169	Seat, Check H4
52	37172	Ball, Teflon 1 3/16" Dia.
51	37170	Ring, Retainer "G"
37	37160	Body, Top Inlet
36	37161	Check, Cartridge
35	36936	Ball, Teflon 7/8" Dia.
34	37162	Ring, Retainer "G"
33	37195	Body Short W/Shark Logo
31	37087	Nipple S.S. 1" NPT x 2" Long
26	37190	Actuator Assembly, Epoxy
25	37189	Dip-tube
5	35325	O-Ring Viton L/F 2-235
4	36831EP	Head EP
3	36401	Barb, 1/2 T x 3/8 MPT
2	37159	Check Barb Kit 3/8"T x 1/4" MPT
1	37005	Barb, 1 1/4 T x 1 MPT



*NOTE: Exhaust tubing outlets should be located approx. 1' below well cap or in a location close to the cap where they will not become submerged.



STEP 1. Attach Tubing to Pump



A. Cut back sheathing on tubing set approximately 1 foot.

B. Slip clamps over appropriate tubes prior to connecting to barbs.

C. Push tubing down flush with the fitting's nut if possible; cover at least 3 barbs if 3 or more are present. (Note: in freezing weather, this is easier if tubing is dipped in warm water for a few seconds to soften the nylon.)

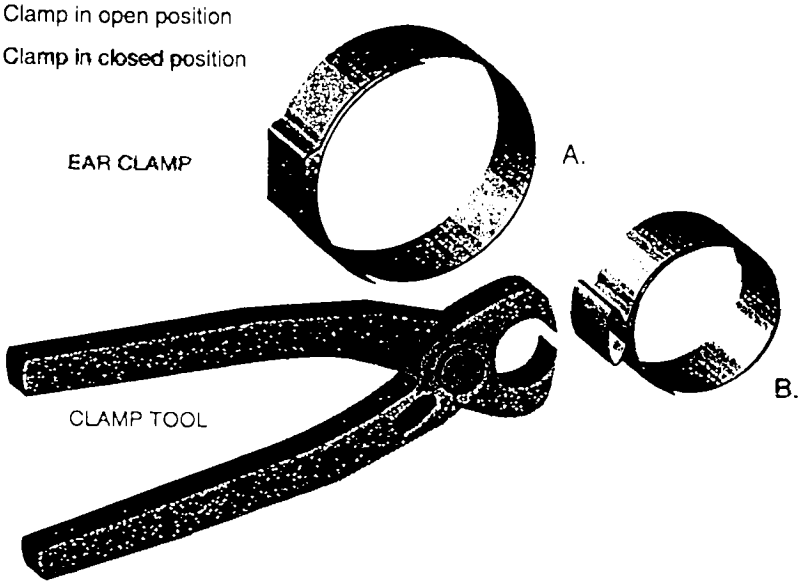
D. Place clamp over lowest barb completely covered by tubing.

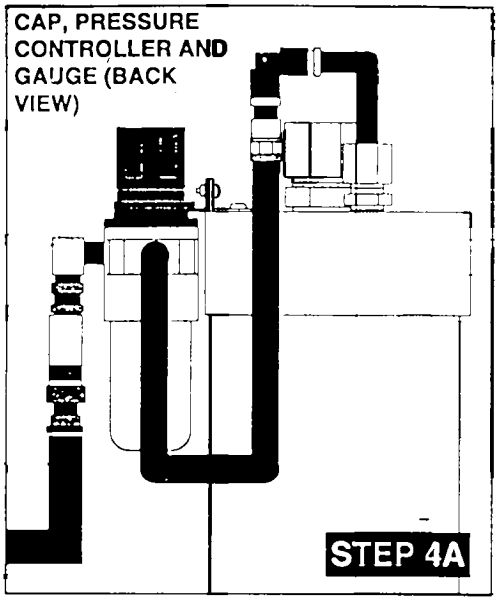
STEP 2. Tighten Clamps

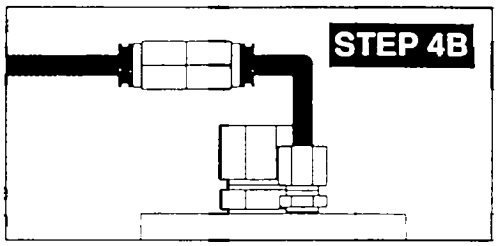
A. Place clamp tool over the dimpled ear portion of the clamp and squeeze ear together (as shown).

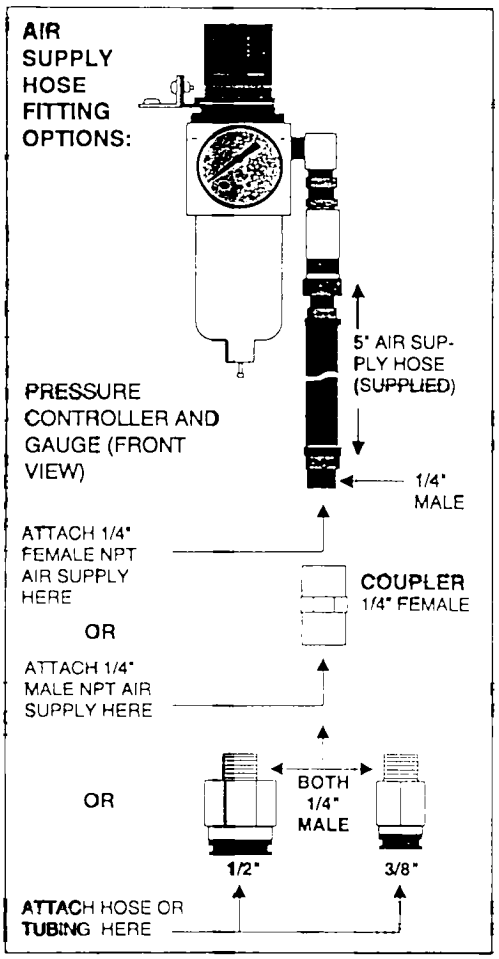
A. Clamp in open position

B. Clamp in closed position









STEP 3. Install Pump in Well

A. Lower pump to desired depth.

B. Once pump depth has been determined, measure off approximately 1 ft. of tubing length (measured from the top of well casing) from the pump exhaust line.

C. Cut exhaust line.

D. Attach the pump exhaust deflector to the pump exhaust line. (See clamp instructions in step 2.)

E. Pass pump discharge and air supply lines through the well cap: place well cap on casing.

F. Re-adjust pump to desired depth.

G. Cut air supply and discharge tubes to desired length.

H. Tighten fittings down onto air/discharge lines, and tighten well cap clamp if present.

STEP 4. Connect Air Supply and Discharge

A. If optional pressure regulator is used, connect short (≈1 foot) hose from regulator to pump air supply line with attached push-on elbow; attach 5' flexible hose to quick-connect fitting on regulator and to air supply line from compressor. See illustration at lower left for air supply hose fitting options.

OR

B. If optional pressure regulator is not used, connect air supply line from compressor directly to pump air supply line above well cap (fittings and coupler for 3/8" and/or 1/2" connections).

C. Connect pump discharge tube to discharge header. (Barb and clamps supplied with pump.)

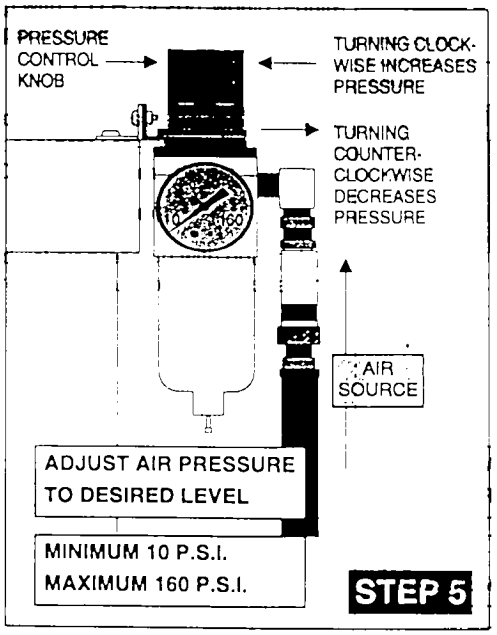
STEP 5. Set Air Pressure

NOTE: Flow Rate is dependent on the amount of air pressure that is received by the pump. Flow rates can be increased by increasing air pressure to the pump or decreased by decreasing air pressure to the pump. For satisfactory performance, pressure should be set at or above 1 psi for every 2 feet of total discharge head—i.e., a pump with T.D.H. of 200' would require 100 psi or more to pump effectively.

A. Adjust air pressure to desired level at compressor—minimum 10 psi, maximum 160 psi.

OR

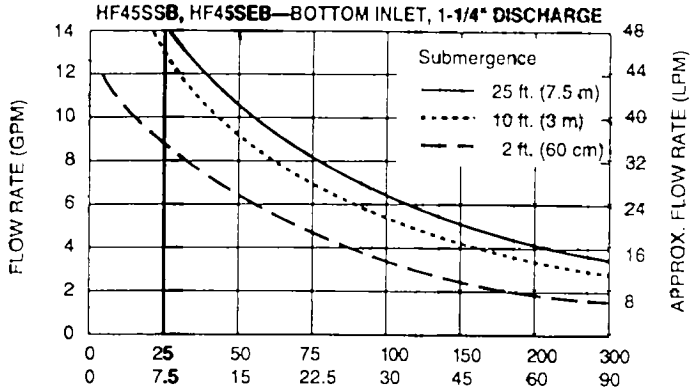
B. Adjust air pressure with optional pressure regulator (see illustration).



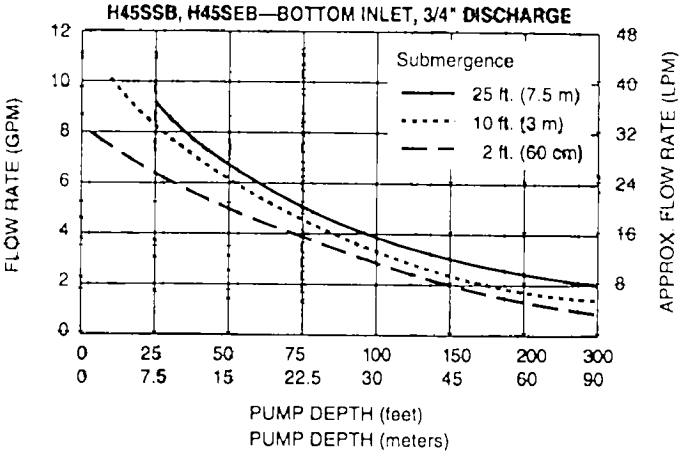
H4 SERIES FLOW PERFORMANCE CURVES

*100 psi (700 kPa) drive air pressure was supplied for all pump depths less than 150 feet (45 meters); 160 psi was supplied for all pump depths greater than 150 feet.

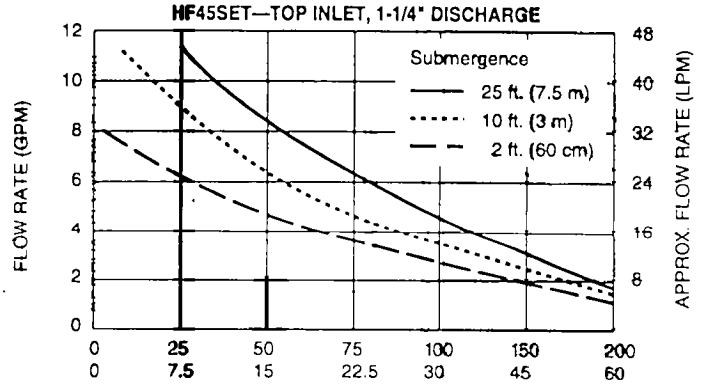
HF45SSB, HF45SEB—BOTTOM INLET, 1-1/4" DISCHARGE



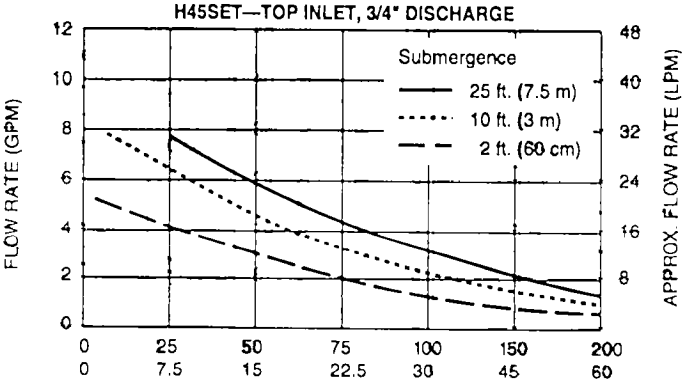
H45SSB, H45SEB—BOTTOM INLET, 3/4" DISCHARGE



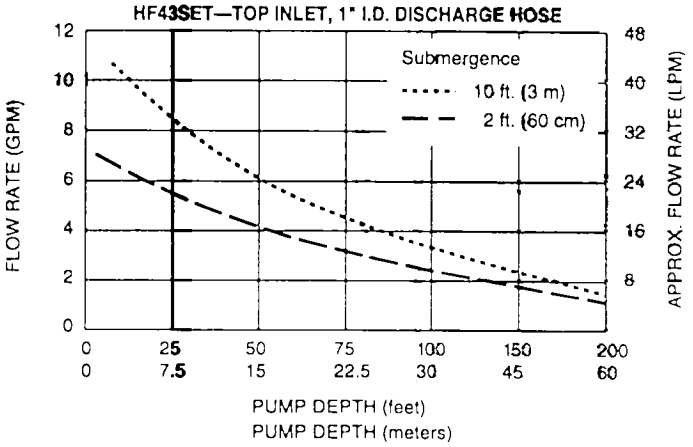
HF45SET—TOP INLET, 1-1/4" DISCHARGE



H45SET—TOP INLET, 3/4" DISCHARGE



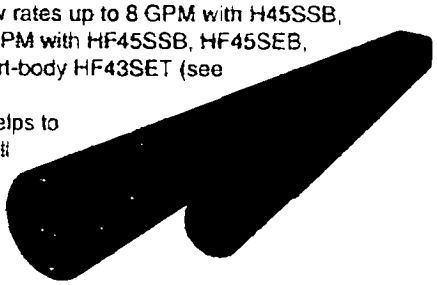
HF43SET—TOP INLET, 1" I.D. DISCHARGE HOSE



NOTE: Pump depth is measured down from the top of the well casing to the top of the pump fittings. Submergence is measured up from the lowest inlet point on the pump inlet to the top of the static water or product in the well.

TUBING

Two tubing packages are available for H4 series pumps. The standard SPTUBE provides flow rates up to 8 GPM with H45SSB, H45SEB, and H45SET models. The high flow MAXTUBE increases maximum flow up to 14+ GPM with HF45SSB, HF45SEB, and HF45SET pumps. Hoses and quick-connects are available for all models, including the short-body HF43SET (see "Accessories" for details).



Both sets are QED's exclusive Jacketed Tubing, with a smooth, continuous nylon sheath that helps to prevent hangups and kinks, makes pump installation easier (especially in narrow or obstructed well casing), and eliminates the nicked fingers and other hazards of old-fashioned tubing ties.

Tubing sets are supplied cut to custom lengths. Jacketed tubing and sheath are both Nylon 12, which doesn't swell in water and provides excellent resistance to most liquids and cleanup conditions, including hydrocarbons, fuels, and alkalies. For extremes of acidity, consult QED for alternative.

Model	SPTUBE	MAXTUBE
Description	Contains 4 tubes—discharge, exhaust, air supply, and bubbler tubing*	Contains 3 tubes—discharge, exhaust and air supply
Discharge O.D.	3/4" (19 mm)	1-1/4" (32 mm)
Exhaust O.D.	1/2" (13 mm)	1/2" (13 mm)
Air Supply O.D.	3/8" (9 mm)	3/8" (9 mm)
Bubbler O.D.	1/4" (6 mm)	—
Min. Bend Radius	7" (18 cm)	12" (30 cm)
Max. Pressure	325 psi (2,250 kPa)	165 psi (1,150 kPa)
†Max. Cont. Length	200' (60 m)	150' (45 m)

*Bubbler tubing is used for referenced depth measurement. More information on this is supplied with custom wellhead completion packages.

† These are maximum lengths that can be shipped via UPS. For longer continuous lengths, consult QED.

HAMMERHEAD CAPS AND ACCESSORIES

NOTE: each cap, flange and accessory kit comes with an illustrated instruction sheet.

STANDARD (SLIP-FIT) CAPS

MODEL**	PUMP MODEL	WELL DIAM.	DESCRIPTION	TUBING TYPE
S4S	All H4 pumps	4" (100 mm)	Cap - Standard	SPTUBE
S6S	All H4 pumps	6" (150 mm)	Cap - Standard	SPTUBE
S8S	All H4 pumps	8" (200 mm)	Cap - Standard	SPTUBE
‡S4L	All HF4 pumps	4" (100 mm)	Cap - High Flow	HOSE, 1" I.D.
‡S6L	All HF4 pumps	6" (150 mm)	Cap - High Flow	HOSE, 1" I.D.
‡S8L	All HF4 pumps	8" (200 mm)	Cap - High Flow	HOSE, 1" I.D.
S4X	All HF4 pumps	4" (100 mm)	Cap - High Flow	MAXTUBE
S6X	All HF4 pumps	4" (100 mm)	Cap - High Flow	MAXTUBE
S8X	All HF4 pumps	4" (100 mm)	Cap - High Flow	MAXTUBE

VACUUM CAPS

MODEL**	PUMP MODEL	WELL DIAM.	DESCRIPTION	TUBING TYPE
V4S	H45SSB, H45SEB, H45SET	4" (100 mm)	Cap - Standard - Vacuum	SPTUBE
V6S	H45SSB, H45SEB, H45SET	6" (150 mm)	Cap - Standard - Vacuum	SPTUBE
V8S	H45SSB, H45SEB, H45SET	8" (200 mm)	Cap - Standard - Vacuum	SPTUBE
V4X	HF45SSB, HF45SEB, HF45SET	4" (100 mm)	Cap - High Flow - Vacuum	MAXTUBE
V6X	HF45SSB, HF45SEB, HF45SET	6" (150 mm)	Cap - High Flow - Vacuum	MAXTUBE
V8X	HF45SSB, HF45SEB, HF45SET	8" (200 mm)	Cap - High Flow - Vacuum	MAXTUBE

**Add F after Model Number to include Filter/Regulator/Gauge with cap.
‡ Hose option to be sold with support line (cable or rope)

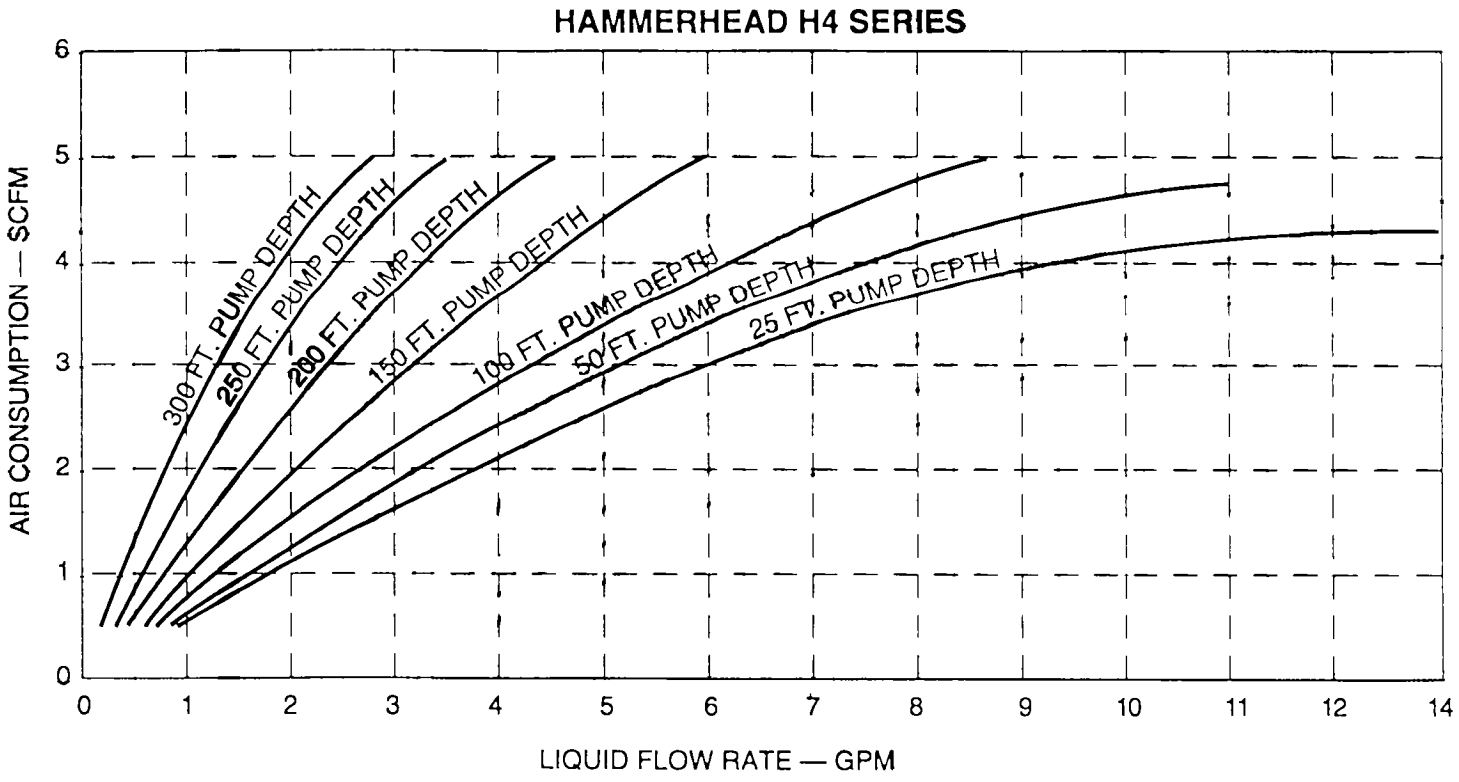
ACCESSORIES

MODEL	PUMP MODEL	DESCRIPTION
37000	All Models	Pump Cycle Counter (for Flow Totalization)
L374	All Models	Tank Full Shutoff
37050	All Models	Kit - Regulator/Gauge
KIH4ST	All Bot. Inlet mod.	Kit - Top Inlet Conversion - H4
KIH4SB	All Top Inlet mod.	Kit - Bottom Inlet Conversion - H4
CH52	All Bot. Inlet mod.	Can - 2' (60 cm) Length (Leachate)
95067	All Models	HammerHead O&M Manual
SPTOOLS	All Models	Clamp Tool, Tube Cutter

MODEL	PUMP MODEL	DESCRIPTION
37058	All Models	Kit - Cable Attachment
37060	All Models	Cable - 3/16" (5 mm) S.S. - order by ft.
37207	All Models	Rope - 3/8" (9 mm) Polypro. - order by ft.
37212	All Models	Cable Sling Assembly
37216	HF4 Series	* Hose - 1" (25 mm) I.D. Discharge (Black)
37217	HF4 Series	* Hose - 3/8" (9 mm) I.D. Air Supply (Red)
37218	HF4 Series	* Hose - 3/8" (9 mm) I.D. Exhaust (Gray)
37208	HF4 Series	Kit - Quick Connect - Discharge/Air Supply - Pump
37209	HF4 Series	Kit - Quick Connect - Discharge/Air Supply - Well Top
36824	All Models	Flow Throttle Valve

* Hose to be sold with quick connects only

AIR CONSUMPTION



IMPORTANT — AIR FLOW IS ACTUAL. A MAXIMUM "ON-TIME" DUTY CYCLE FOR THE COMPRESSOR MUST BE CONSIDERED IN SELECTING A COMPRESSOR CAPACITY.

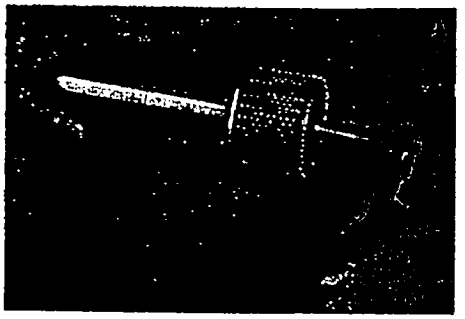
MINIMUM AIR FLOW REQUIRED 0.5 SCFM @ 10 PSI
MAXIMUM AIR PRESSURE 160 PSI

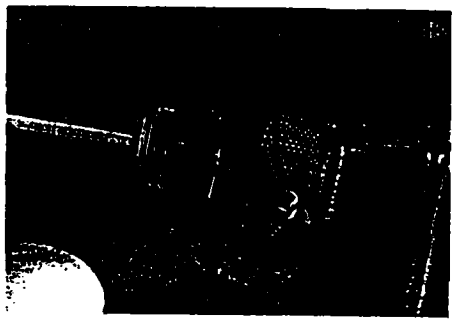
H4 SERIES: REMOVING SHIPPING FLOAT RESTRAINT BEFORE USE

Remove single screw securing inlet screen with 7/16" socket (preferred) or other wrench of your choice **(A).**

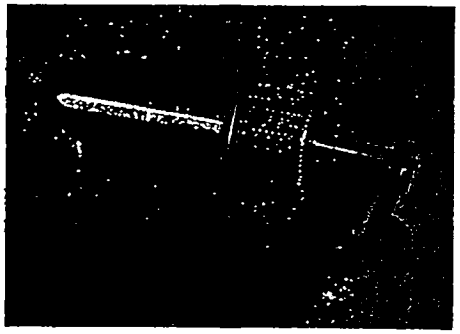
Remove inlet screen and pull out full length of protective shipping tube protruding out of inlet (B).

Reattach inlet screen. Internal float should move freely when pump is tipped from bottom to top.

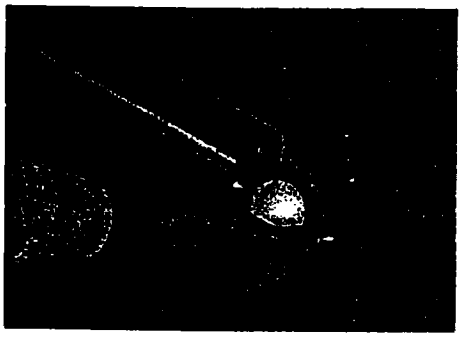




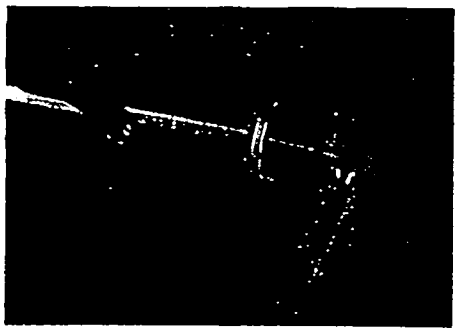
BOTTOM FILLING PUMPS: DISASSEMBLY/REASSEMBLY FOR CLEANING



STEP 1: Remove 1 screw from inlet screen using 7/16" socket wrench. Then remove inlet screen.

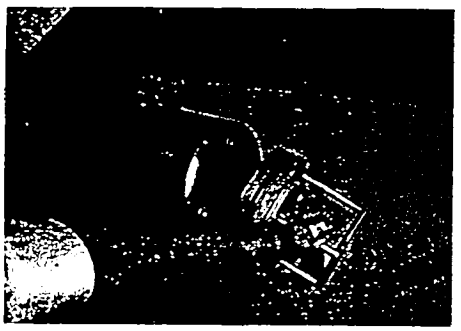


STEP 4: Tip pump to allow inlet check ball to roll out.

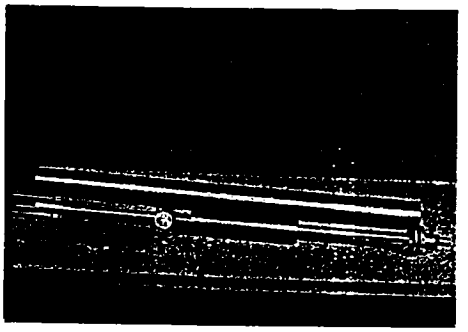


STEP 2: Remove 3 screws and 3 washers from inlet using 7/16" socket wrench.

STEP 5: Remove remaining internal pump subassembly—grasp top of pump, wiggle side to side and twist while pulling out of body.



STEP 3: Remove inlet—wiggle side to side while pulling out.



STEP 6: All parts are now removed from pump. Reverse the process to reassemble pump, starting with STEP 7.

STEP 7: Slide internal subassembly into pump body. O-ring should slide into body. NOTE: body is universal—pump can slide into either end.

STEP 8: Replace inlet check ball (2" diameter) between 3 "legs" inside lower end of pump.

STEP 9: Replace inlet. Push inlet in and rotate until the 3 legs inside body line up with the 3 counterbores. Then, push inlet in the rest of the way, so O-ring is seated inside pump body.

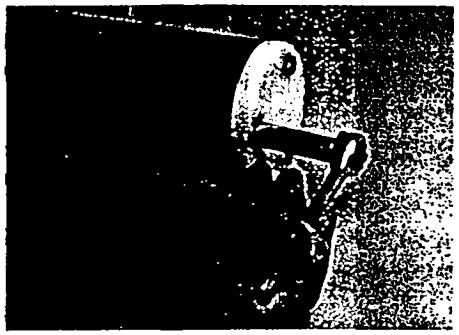
STEP 10: Make sure threads on 3 inlet screws and 3 inlet legs (inside body) are clean and free of silt or sediment. Place washers on screws, insert, and tighten with 7/16" socket wrench.

STEP 11: Place inlet screen over 3 legs of inlet. Insert to reattach screen. As in Step 10, make sure screw and threads are clean. Finish tightening with 7/16" socket wrench.

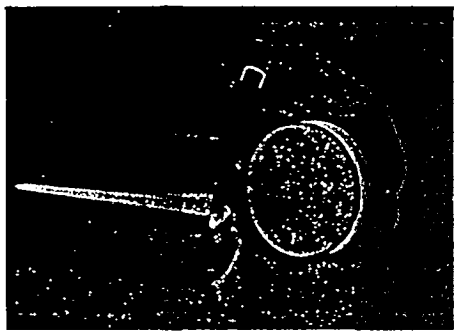
STEP 12: Tip pump over from top to bottom. You should hear float sliding freely inside body.

Note: for field repair or service of parts, please contact customer service at 1-800-624-2026.

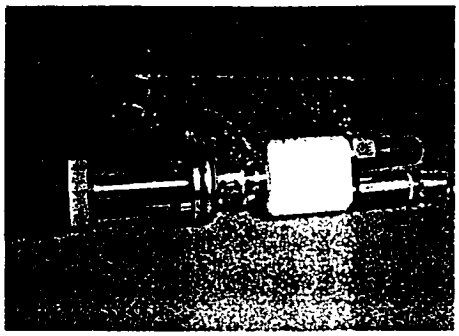
TOP FILLING PUMPS: DISASSEMBLY/REASSEMBLY FOR CLEANING: MODELS H45SET AND HF45SET



STEP 1: Remove 3 screws and 3 sealing washers from bottom plate using the 7/16" socket wrench provided.



STEP 2: Remove bottom plate.



STEP 3: Remove remaining internal pump subassembly—grasp top of pump, wiggle side to side and twist while pulling out of body. Reverse the process to reassemble the pump, starting with STEP 4.

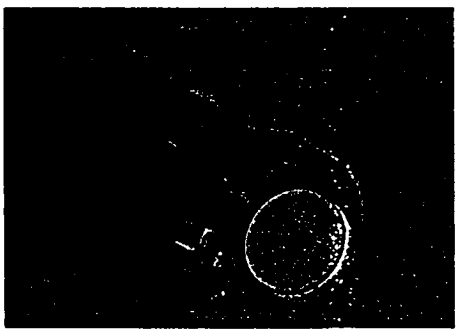
STEP 4: Slide internal subassembly into pump body. O-ring should slide into body. NOTE: body is universal—pump can slide into either end.

STEP 5: Replace bottom plate. Push in and rotate until the 3 legs (inside body) line up with the 3 counterbores. Then, push the plate in the rest of the way, so O-ring is seated inside pump body.

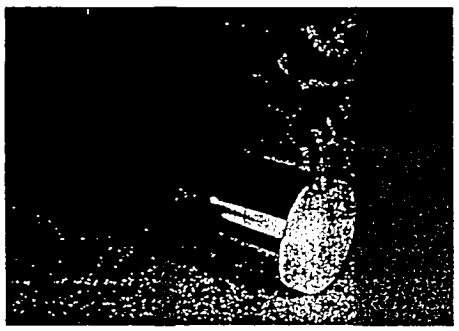
STEP 6: Make sure threads on 3 bottom plate screws and 3 legs (inside body) are clean and free of silt or sediment. Place sealing washers on screws—insert and tighten. Finish tightening with 7/16" socket wrench. Do not over-torque.

SHORT BODY MODEL HF43SET

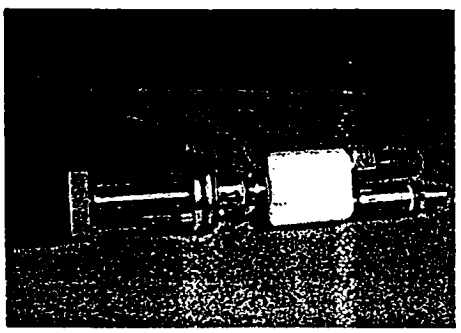
STEP 1: Remove 1/4" pipe plug using 1/4" hex wrench.



STEP 3: Remove bottom plate.



STEP 2: Insert screw driver into hole. Unthread bottom plate (CCW direction).



STEP 4: Remove remaining internal pump subassembly—grasp top of pump, wiggle side to side and twist while pulling out of body. Reverse the process to reassemble the pump, starting with STEP 5.

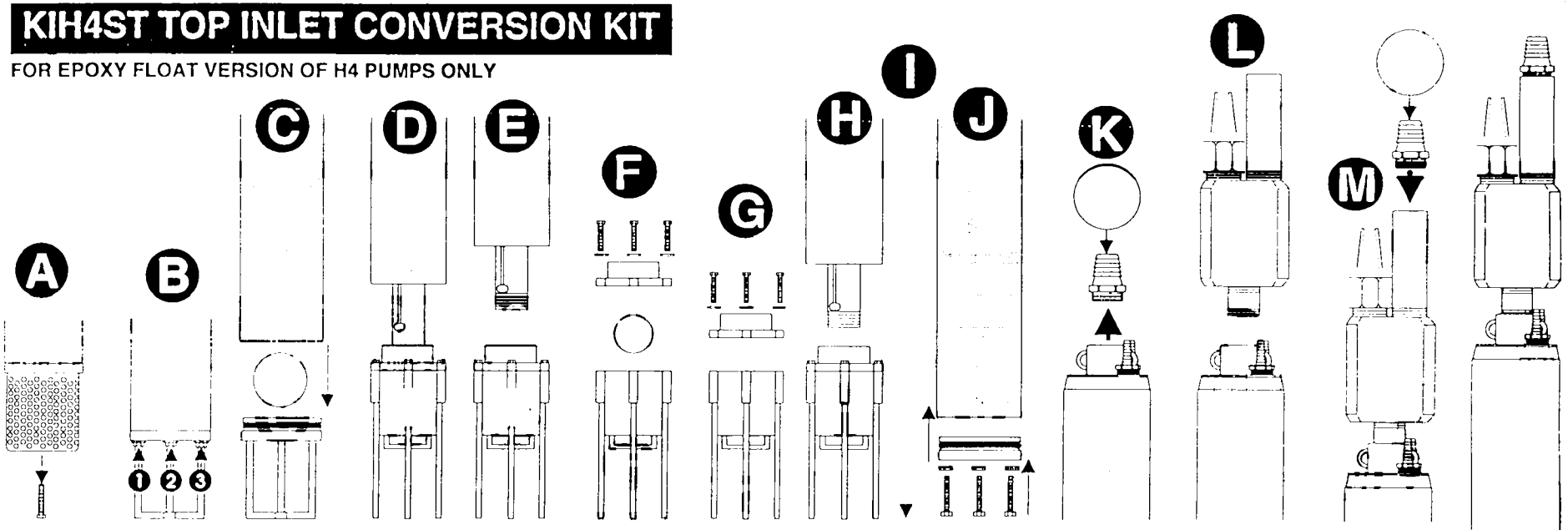
STEP 5: Slide internal subassembly into pump body. O-ring should slide into body. NOTE: body is universal—pump can slide into either end.

STEP 6: Replace bottom plate. Align threads in bottom plate with threads on dip tube.

STEP 7: Insert screw driver into the 1/4" pipe plug hole and tighten bottom plate (clockwise direction). Do not over-tighten. Insert 1/4" pipe plug and tighten with 1/4" hex wrench. It is recommended to use Teflon tape on threads of dip tube and 1/4" pipe plug.

KIH4ST TOP INLET CONVERSION KIT

FOR EPOXY FLOAT VERSION OF H4 PUMPS ONLY



NOTE: It is recommended to put Teflon tape on all threads.

A. Remove screw from top inlet screen. Remove inlet screen.

B. Locate and remove the three bottom inlet screws and washers.

C. Remove inlet and o-ring. Remove check ball.

D. Remove the pump's body to expose internal components.

E. Unthread discharge check assembly from pump discharge tube.

F. Remove the three screws and washers on the top of the discharge check assembly. Remove check ball.

G. Replace the three screws and washers back into the discharge assembly.

H. Thread the discharge check ball assembly into the discharge tube and tighten securely. Slide the pump's outer shell back over the pump's internal components.

I. If your pump has a stainless steel float assembly you will need to change it to an epoxy float assembly **following the directions on the backside of this** sheet. Once float assembly has been changed, proceed on to instruction lettered "J".

J. Insert the new solid inlet plate with the o-ring into the open bottom of the pump. Thread the three screws and sealing washers, (supplied with your kit, make sure that the rubber sealing side of the washer is next to the inlet plate itself), into the sloid inlet plate and tighten securely.

K. Remove discharge barb fitting from pump discharge outlet. (NOTE: If your pump is a 3/4" discharge remove the reducing bushing along with the barb).

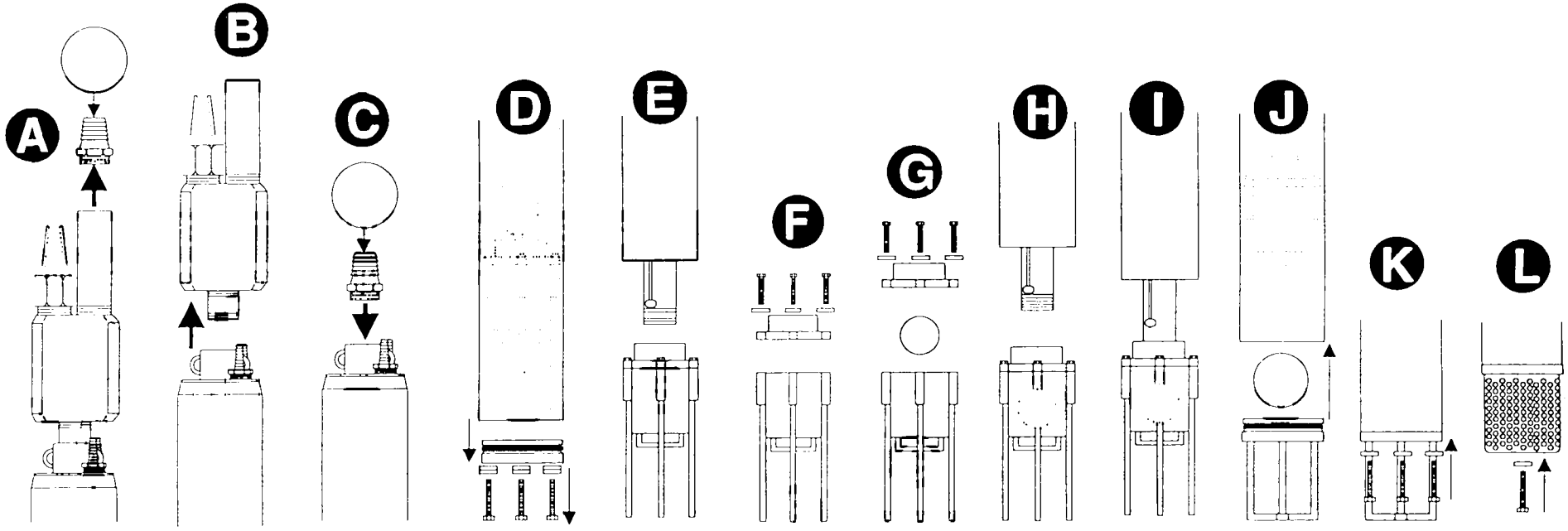
L. Thread the new top inlet adaptor assembly into the pump discharge outlet and tighten securely, (NOTE: align top inlet assembly so that the air line and the exhaust line will straddle the pump body without kinking the tubing.)

M. Thread discharge barb fitting, (along with the reducing bushing if pump is 3/4" discharge), into the discharge outlet of the new top inlet assembly and tighten securely.

P/N 95091 REV.#2 11-15-94

KIH4SB BOTTOM INLET CONVERSION KIT

FOR EPOXY FLOAT VERSION OF H4 PUMPS ONLY



A. Unthread and remove pump discharge fitting, (along with the reducing bushing if pump is 3/4" discharge), from the discharge outlet of the top inlet adaptor.

NOTE: It is recommended to put Teflon tape on all threads.

B. Unthread and remove the top inlet adaptor assembly from the pump discharge outlet.

C. Thread discharge barb fitting, (along with the reducing bushing if pump is 3/4" discharge), into the pump discharge outlet. Tighten securely.

D. Remove the three screws and sealing washers holding the solid bottom inlet plate in place. Remove the solid bottom inlet plate and o-ring.

E. Remove the pump's body to expose internal components. Unthread the discharge check ball assembly from the discharge tube.

F. Remove the three screws and washers from the top of the discharge check ball assembly.

G. Place the smaller check ball, (from your kit), into the discharge check ball assembly. Replace the three screws and washers. Tighten securely.

H. Thread discharge check ball assembly back onto the pump discharge tube. Tighten securely.

I. Slide the pump's body back over the pump's internal components.

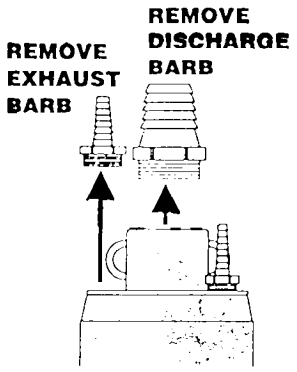
J. Place the larger check ball, (from your kit), into the pump bottom. Insert the inlet and o-ring, (from your kit), into the pump bottom.

K. Align the three screw holes on the inlet and thread in the three screws and sealing washers (provided with your kit). Tighten securely.

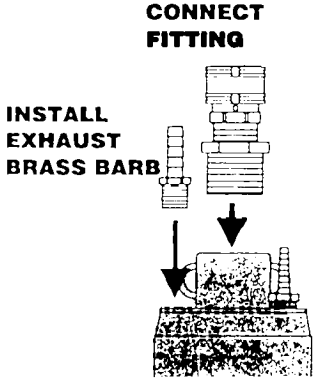
L. Slide the pump inlet screen, (from your kit), over the inlet assembly. Thread in the screw and tighten securely.

P/N 95092 REV.#2 11-15-94

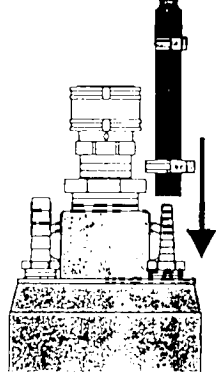
37208 KIT FOR USE WITH 4" HAMMERHEADS WITH HOSE



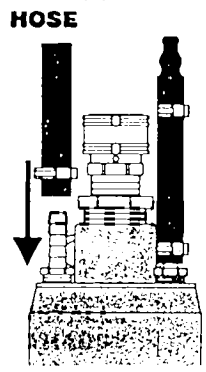
STEP 1



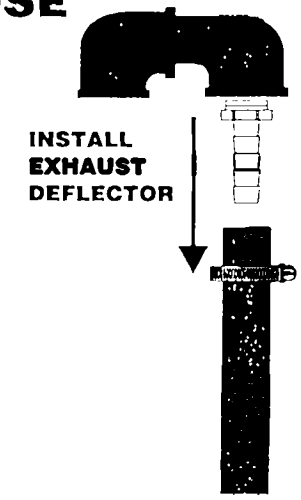
STEP 2



STEP 3

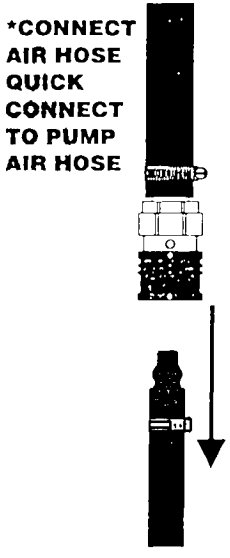


STEP 4

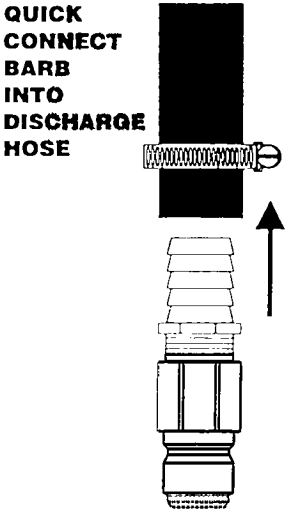


STEP 5

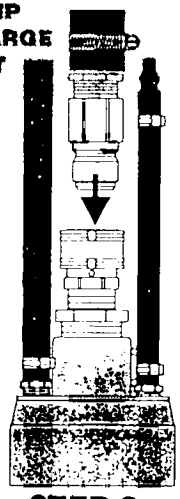
STEP 6



STEP 7



STEP 8

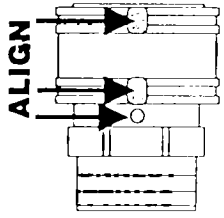


STEP 9

* USE OF LOCKING QUICK CONNECTS

*QUICK CONNECT FITTINGS HAVE A LOCK MECHANISM

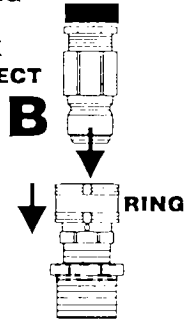
A



TO UNLOCK FITTING ALIGN UP NOTCHES WITH FITTING BALL AS SHOWN

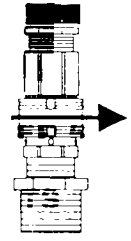
TO INSERT FITTING INTO QUICK CONNECT

B



SLIDE RING DOWN AND HOLD WHILE FULLY INSERTING FITTING INTO QUICK CONNECT THEN RELEASE RING

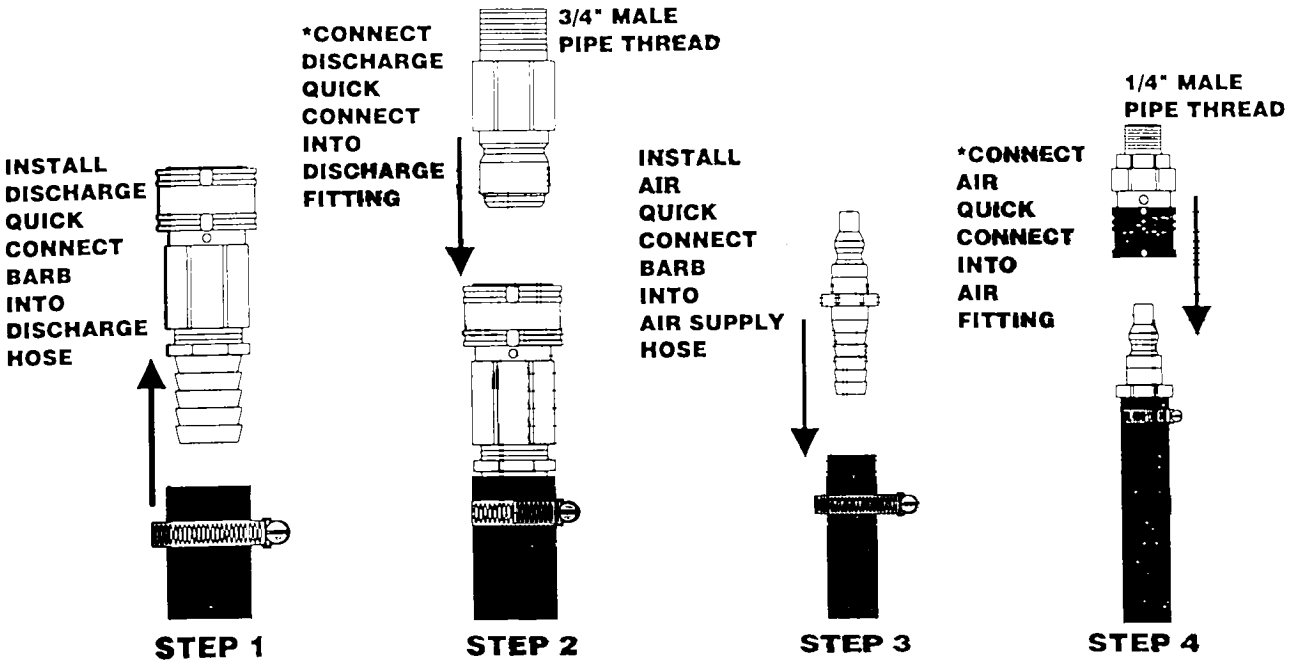
C



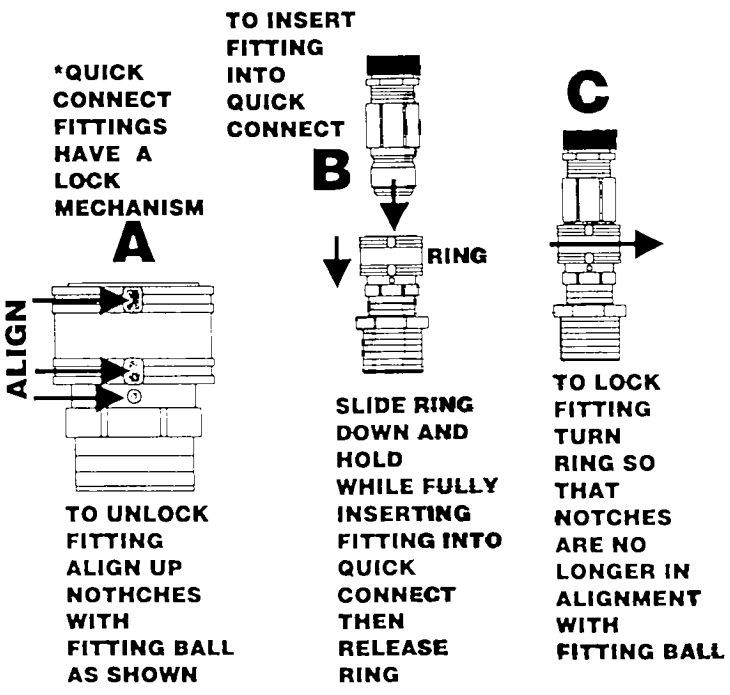
TO LOCK FITTING TURN RING SO THAT NOTCHES ARE NO LONGER IN ALIGNMENT WITH FITTING BALL

P/N 95100 11-3-94

37209 KIT
QUICK CONNECT WELL HEAD FITTINGS
FOR 4" HAMMERHEADS WITH HOSES



* USE OF LOCKING QUICK CONNECTS



P/N 95101 11-3-94

PULSE PUMP™ WARRANTY

QED Environmental Systems, Inc. (QED) warrants to the original purchaser of its products that, subject to the limitations and conditions provided below, the products, materials and/or workmanship shall reasonably conform to the descriptions of the products and shall be free of defects in materials and workmanship. Any failure of the products to conform to this warranty will be remedied by QED in the manner provided herein.

This warranty shall be limited to the duration and the conditions set forth below. All warranty durations are calculated from the original date of purchase.

1. Liquid contacting equipment including pumps (QED bladder style pumps are excluded from this warranty) and tubing are warranted for one year.

2. Control devices, control device mounting, and surface air supply hose are warranted for one year.

3. Separately sold parts and spare parts kits are warranted for ninety (90) days.

4. Repairs performed by QED are warranted for ninety (90) days from date of repair or for the full term of the original warranty, whichever is longer.

Buyer's exclusive remedy for breach of said warranty shall be as follows: (a) and only if QED is notified in writing within the applicable warranty period of the existence of any such defects, shall find the same to be within the term of the warranty running from QED to Buyer, QED will, at its option, as soon as reasonably possible, replace or repair any such product without charge to Buyer. If QED for any reason cannot repair a product covered hereby within one (4) weeks after receipt of the original purchaser's Buyer's notification of a warranty claim, then QED's sole responsibility shall be, at its option, either to replace the defective product with a comparable new unit at no charge to the Buyer or to refund the purchase price. In no event shall such allegedly defective products be returned to QED without its consent and QED's obligations of repair, replacement or refund are conditioned upon the Buyer's return of the defective product to QED.

IN NO EVENT SHALL QED ENVIRONMENTAL SYSTEMS, INC. BE LIABLE FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES OR BREACH OF SAID WARRANTY.

The foregoing warranty does not apply to major subassemblies and other equipment, accessories and other parts manufactured by others and such parts, accessories and equipment are subject only to the warranties, if any, supplied by their respective manufacturers. QED makes no warranty concerning products, accessories not manufactured by QED. In the event of failure of any such product or accessory, QED will give reasonable assistance to Buyer in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY (INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE), WHICH OTHER WARRANTIES ARE EXPRESSLY EXCLUDED HEREBY. And, any other obligations or liabilities on the part of QED and QED neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with all products, materials and/or workmanship.

It is understood and agreed that QED shall in no event be liable for incidental or consequential damages resulting from its breach of any of the terms of this agreement, nor for special damages, nor for improper selection of any product described or referred to for a particular application.

This warranty will be void in the event of unauthorized disassembly of component assemblies. Defects in any equipment that result from abuse, operation in any manner outside the recommended procedures, use and applications other than for intended use, or exposure to chemical or physical environment beyond the designated limits of materials and construction will also void this warranty.

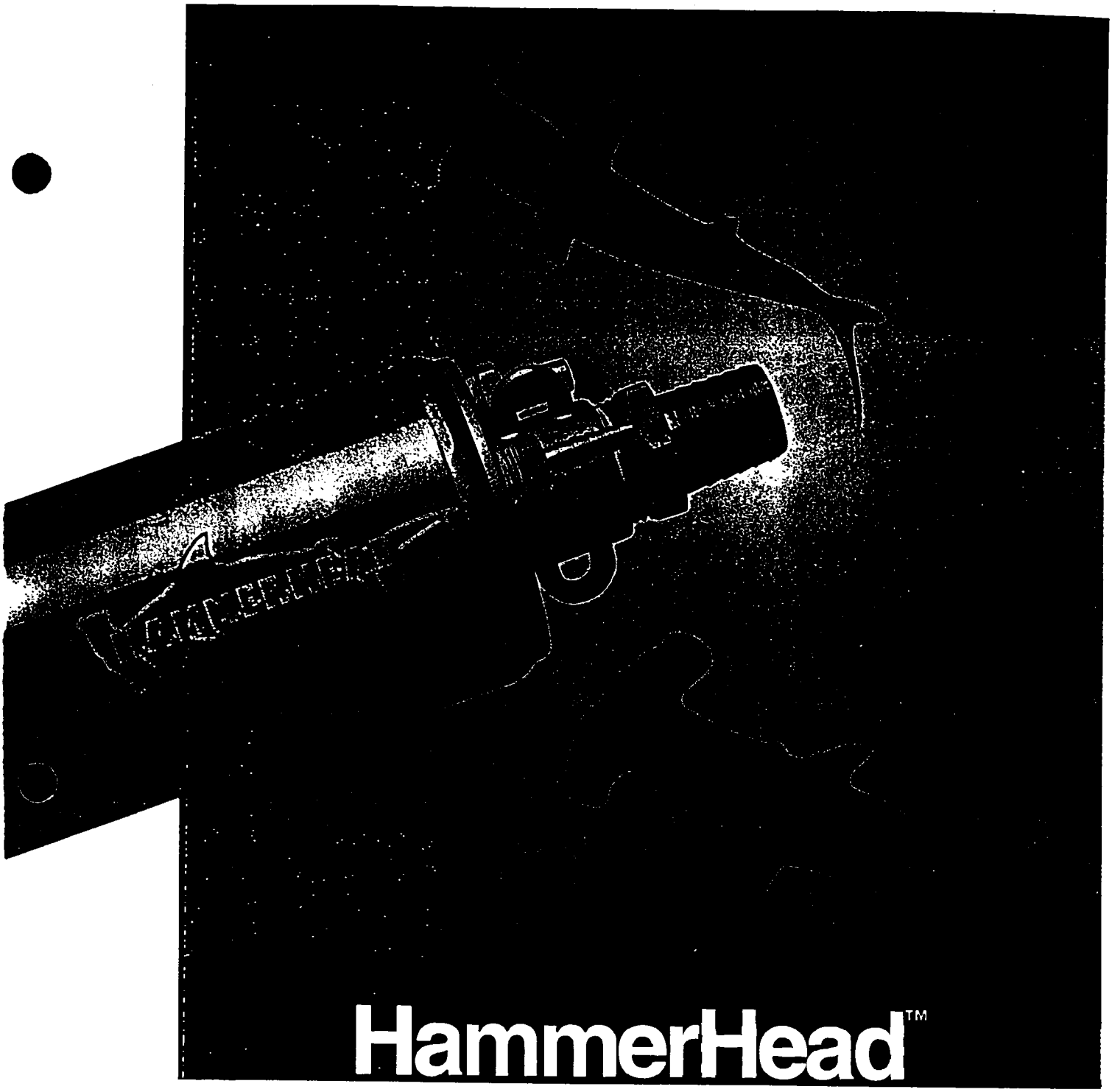
Chemical attack to liquid contacting equipment and supplies shall not be covered by this warranty. A range of materials is available from QED and it is the Buyer's responsibility to select materials to fit the Buyer's application. QED will only warrant that the supplied liquid contacting materials will conform to published QED specifications and generally accepted standards for that particular material.

QED shall be released from all obligations under all warranties if any product covered hereby is repaired, modified or worked upon by persons other than QED's service personnel unless such repair by others is made with the written consent of QED. If any product covered hereby is actually defective within the terms of this warranty, Purchaser must contact QED for determination of warranty coverage. If the return of a component is determined to be necessary, QED will authorize the return of the component at Buyer's expense. If the product proves not to be defective within the terms of this warranty, then all costs and expenses in connection with the processing of the purchaser's claim and all costs of repair, parts and labor as authorized by Buyer hereunder shall be borne by the purchaser.

The original Purchaser's sole responsibility in the instance of a warranty claim shall be to notify QED of the defect, malfunction or other manner in which the terms of this warranty are believed to be violated. QED may require performance of obligations hereunder by contacting the customer service department of QED and:

1. Identify the product by model or serial number or other sufficient description that will allow QED to determine which product is involved.
2. Specifying where, when and how long the product was used.
3. Describing the nature of the defect, malfunction covered by this warranty.
4. Sending the malfunctioning component after authorization by QED to:

QED Environmental Systems, Inc.
2355 Bishop Road
Ann Arbor, MI 48103
Telephone: 1-800-624-8826
1-734-995-7551



HammerHead™

H4 Series (wells 4" & up)

FIELD SERVICE MANUAL

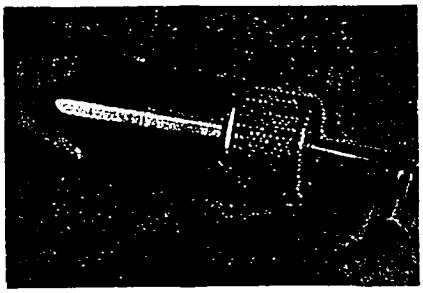
Models H45SSB, H45SEB, HF45SSB, HF45SEB,
H45SET, HF45SET, and HF43SET

HAMMERHEAD™
CLEANUP PUMPS

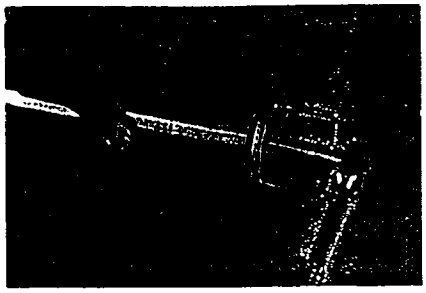
QED *GroundWater Specialists*®
P.O. Box 3726 Ann Arbor, MI 48106 USA

Part No. 95104
REV 1.16.95

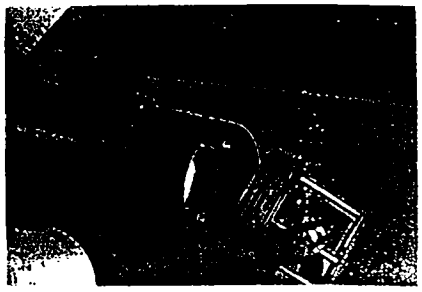
BOTTOM FILLING PUMP DISASSEMBLY



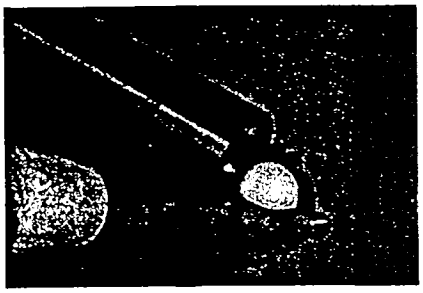
STEP 1: Remove 1 screw from inlet screen using 7/16" socket wrench provided. Then remove inlet screen.



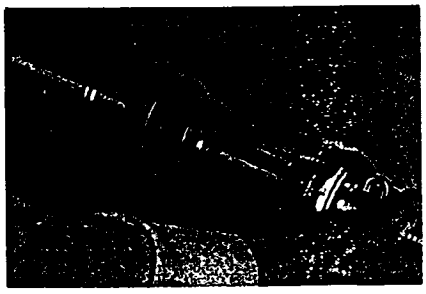
STEP 2: Remove 3 screws and 3 washers from inlet using 7/16" socket wrench.



STEP 3: Remove inlet--wiggle side to side while pulling out.

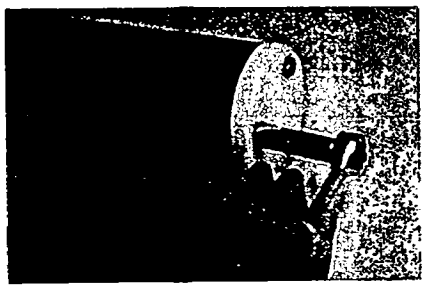


STEP 4: Tip pump to allow inlet check ball to roll out.

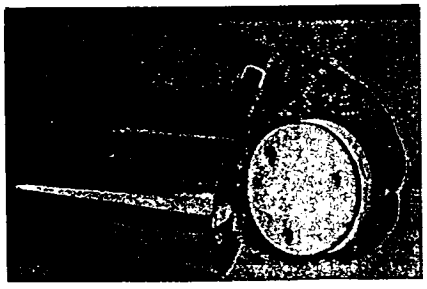


STEP 5: Remove remaining internal pump subassembly--grasp top of pump, wiggle side to side and twist while pulling out of body.

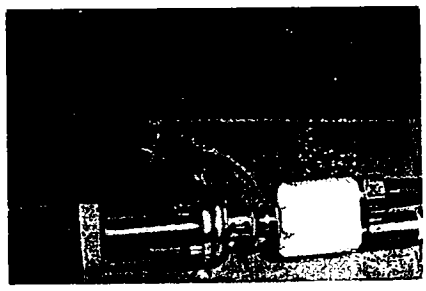
TOP FILLING PUMP DISASSEMBLY



STEP 1: Remove 3 screws and 3 sealing washers from bottom plate using the 7/16" socket wrench provided.

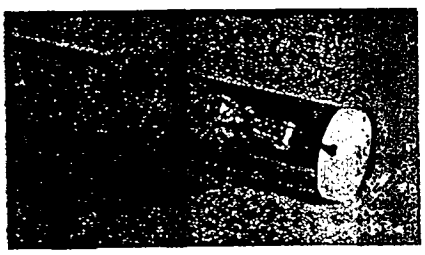


STEP 2: Remove bottom plate.

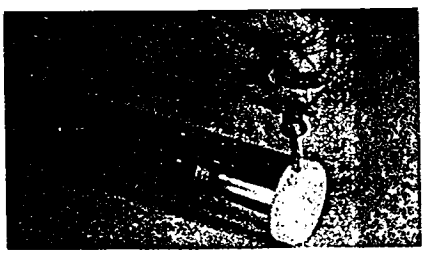


STEP 3: Remove remaining internal pump subassembly--grasp top of pump, wiggle side to side and twist while pulling out of body.

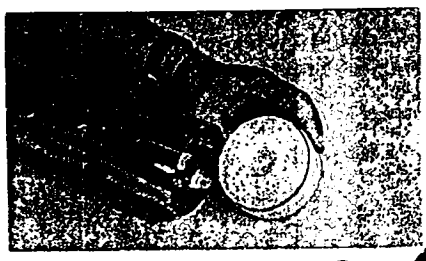
SHORT BODY MODEL DISASSEMBLY



STEP 1: Remove 1/4" pipe plug using 1/4" hex wrench.

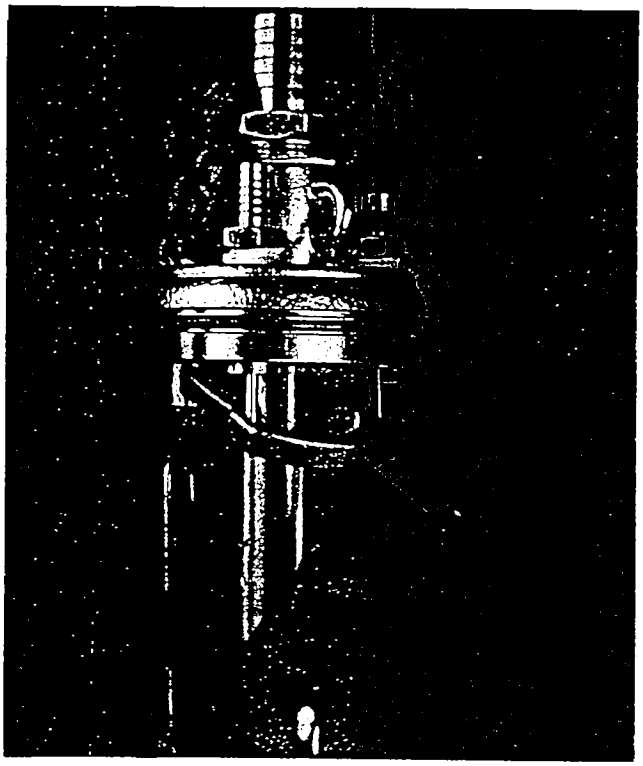


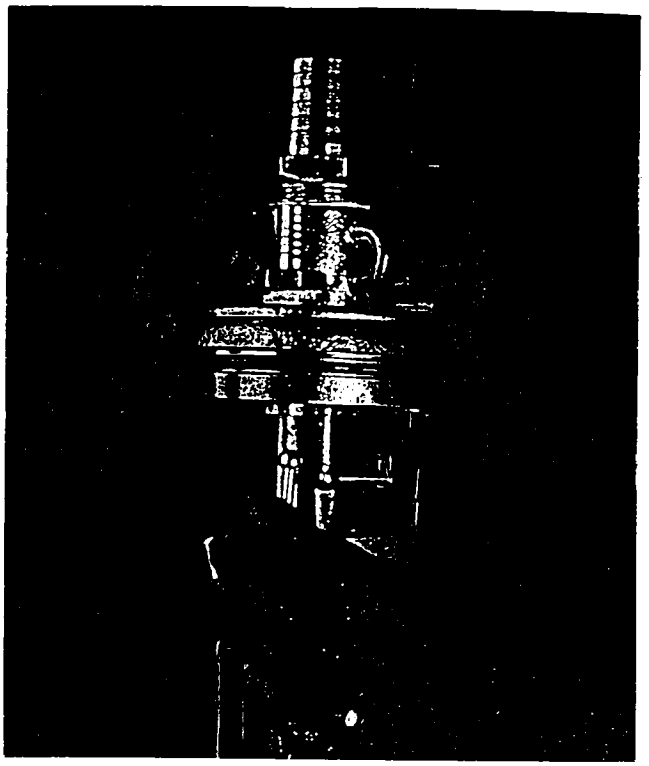
STEP 2: Insert screw driver into hole. Unthread bottom plate (CCW direction).



STEP 3: Remove bottom plate. Remove remaining internal pump subassembly--grasp top of pump, wiggle side to side and twist while pulling out of body.

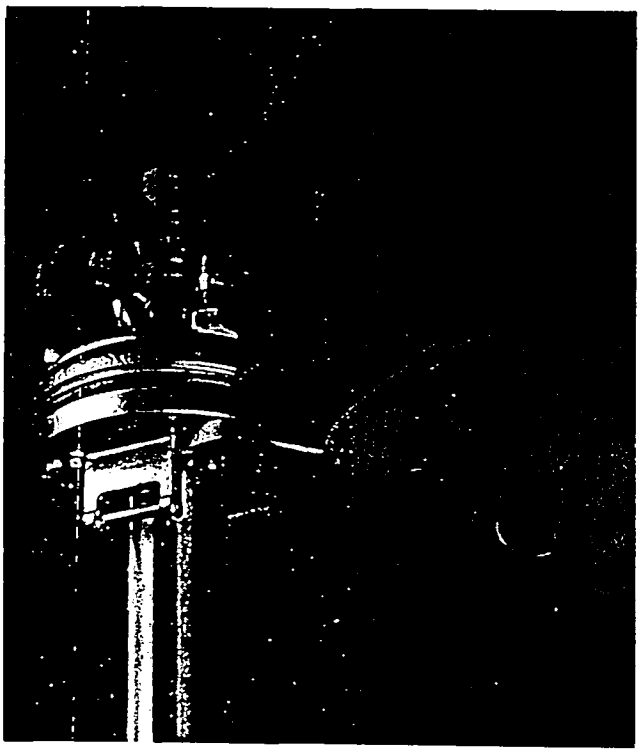
CAM REMOVAL

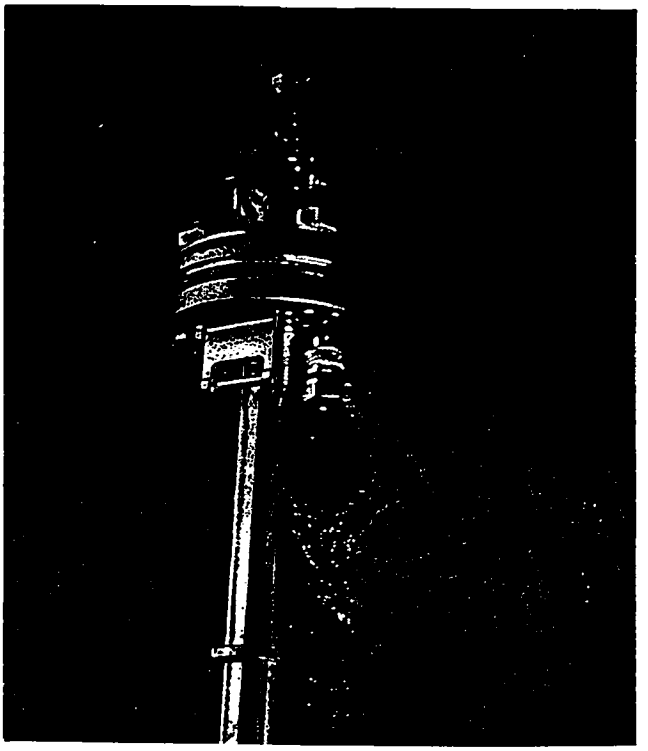




Loosen the Hammerdrive cam mechanism with a 9/64" hex wrench and remove.

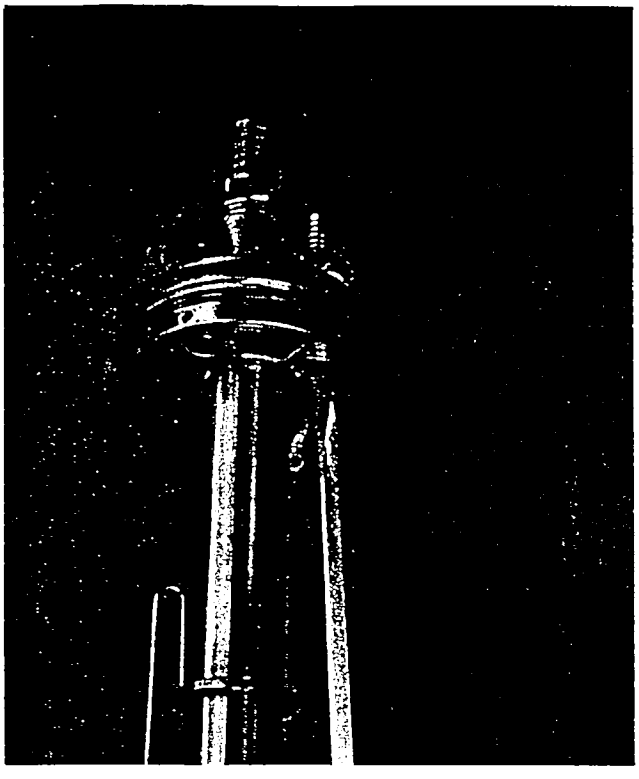
AIR SUPPLY SEAT REMOVAL

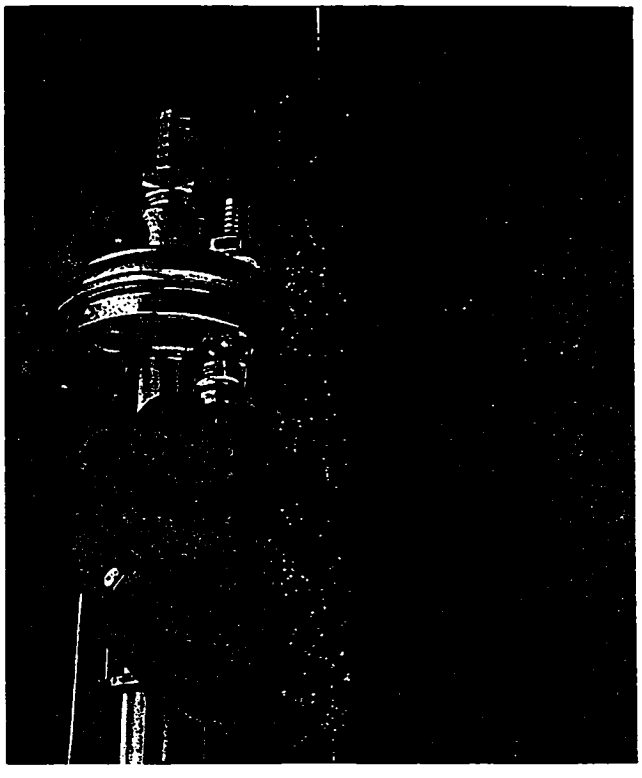




Loosen air supply valve seat with a 9/16" open end wrench and remove.

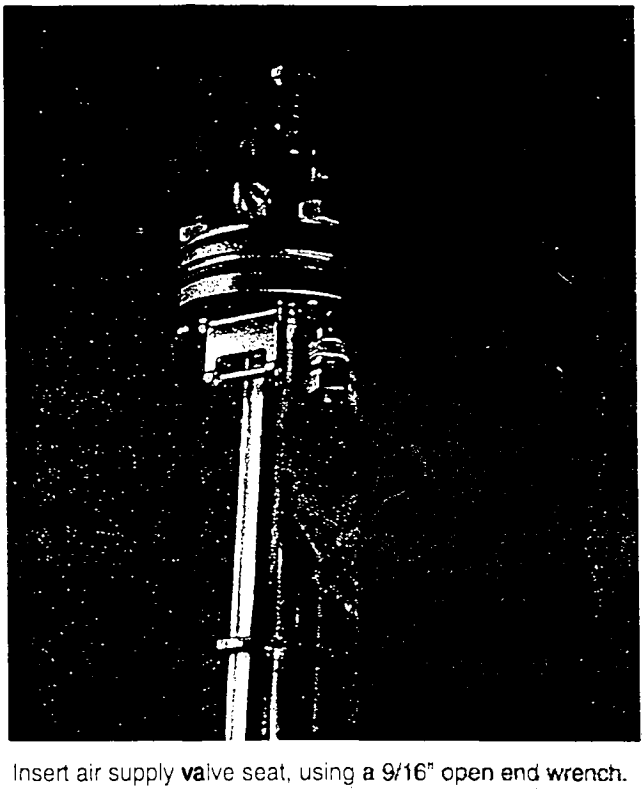
EXHAUST SEAT REMOVAL

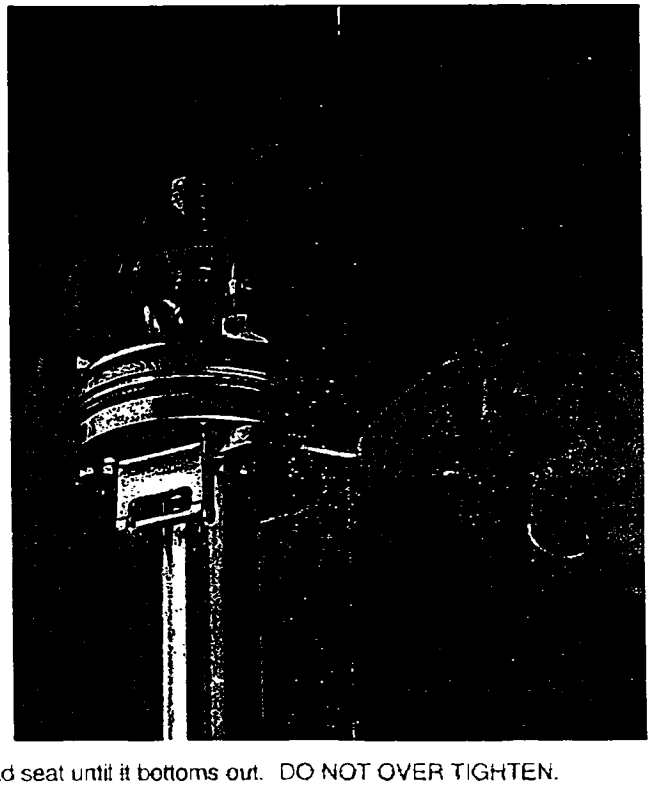




Loosen the pump exhaust valve seat with a flat head screw driver and remove.

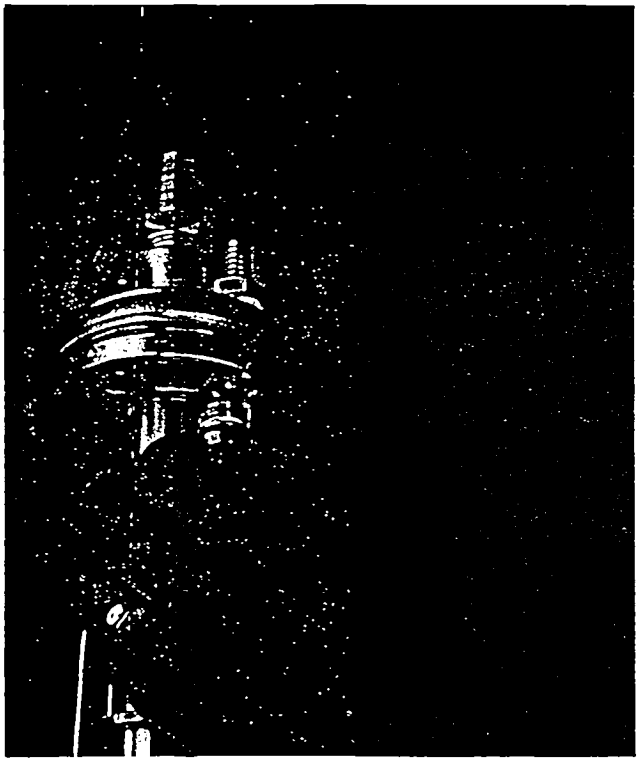
REPLACE AIR SUPPLY SEAT

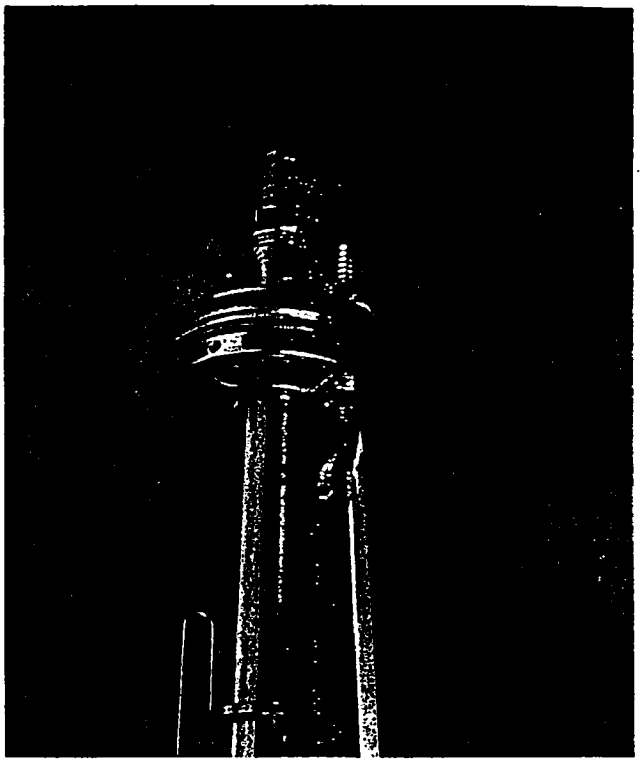




Insert air supply valve seat, using a 9/16" open end wrench. Thread seat until it bottoms out. DO NOT OVER TIGHTEN.

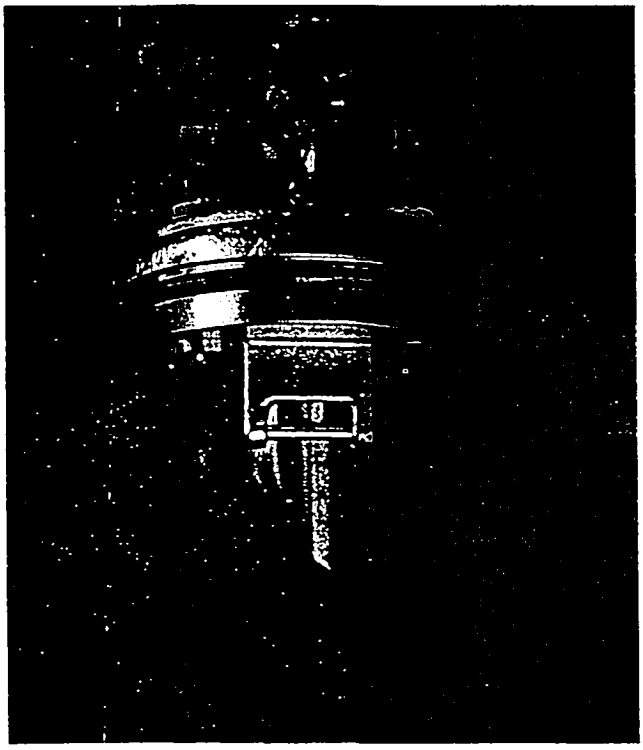
REPLACE EXHAUST SEAT



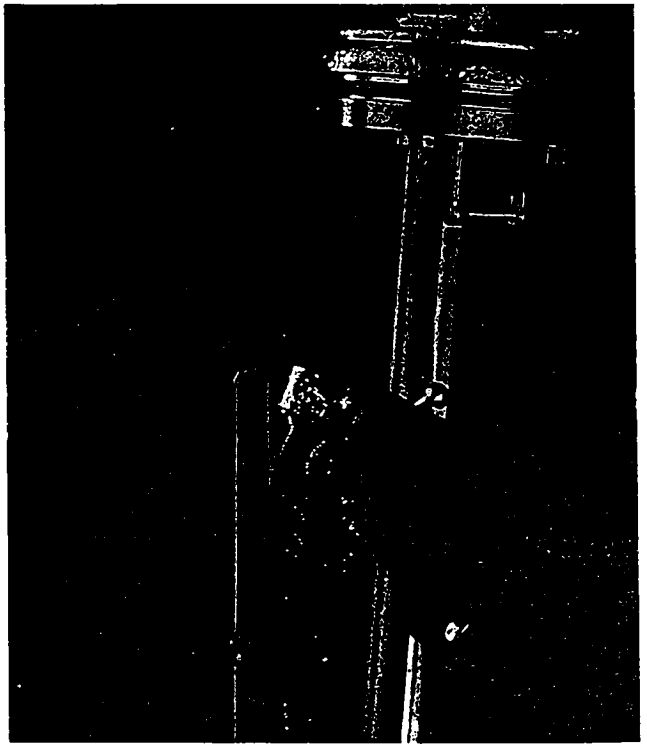


Insert the pump exhaust valve seat using a flat head screw driver. Thread seat until it bottoms out. DO NOT OVER TIGHTEN.

REINSTALLING CAM

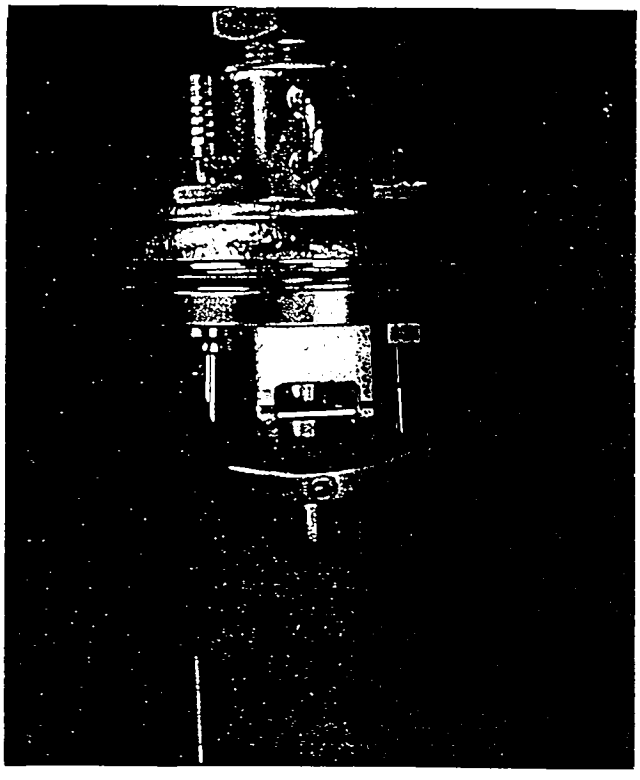


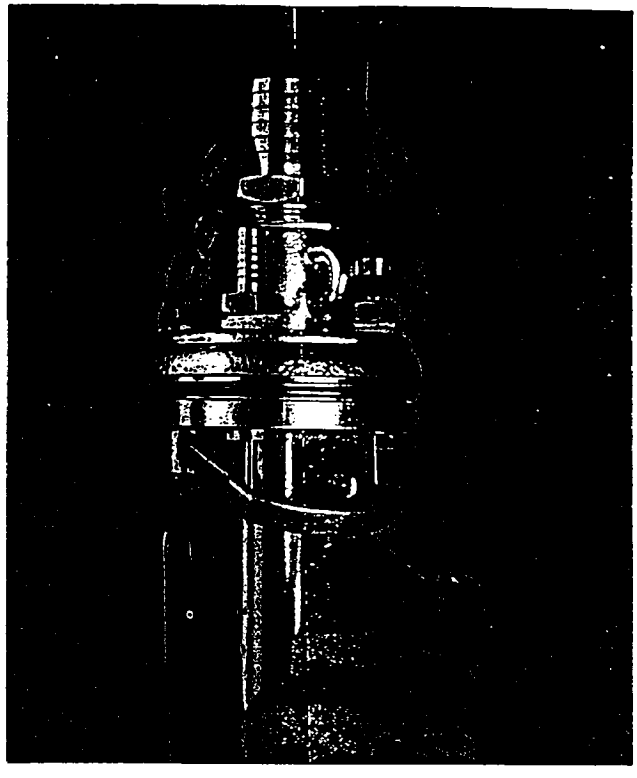
Ensure free floating pivot is centered.



Orientate the actuator linkage as shown.

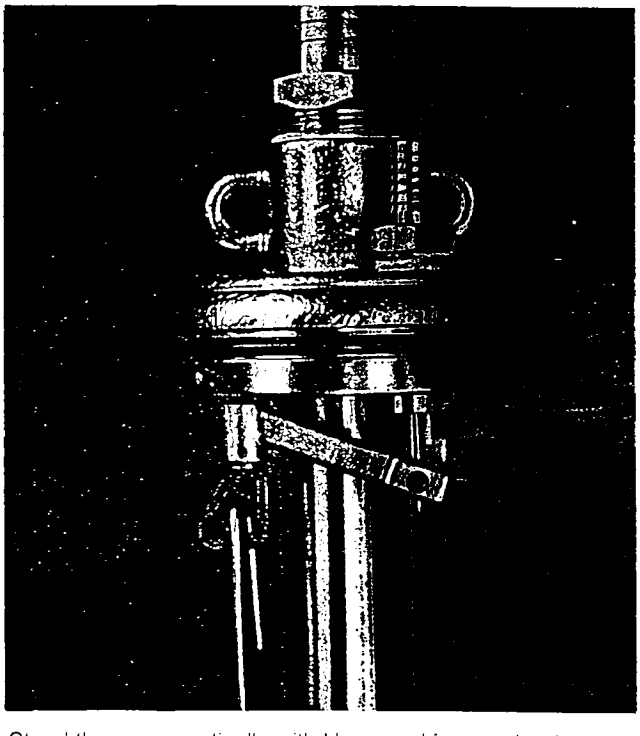
LOCATING CAM



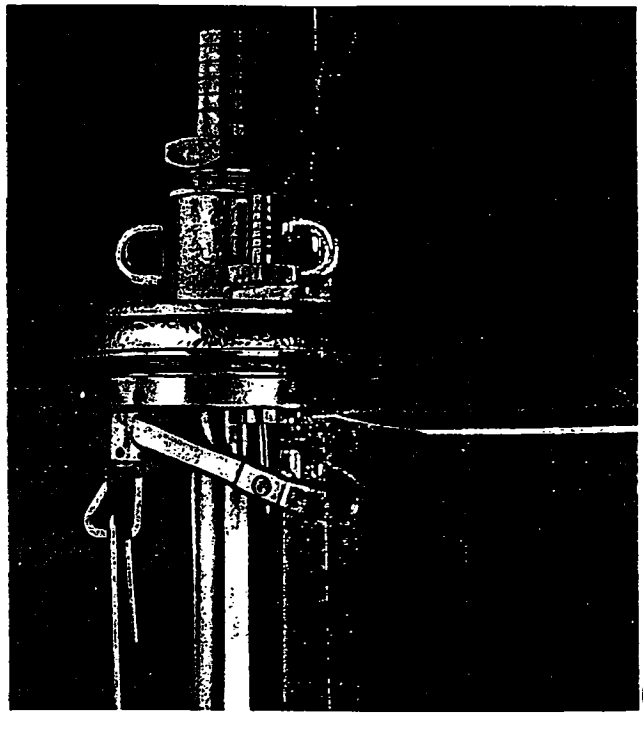


Make certain both the exhaust and air stems are inserted into both valves simultaneously as the Hammerdrive mechanism is placed on the pivot. Tighten mounting screw. DO NOT OVER TIGHTEN.

EXHAUST VALVE ADJUSTMENT

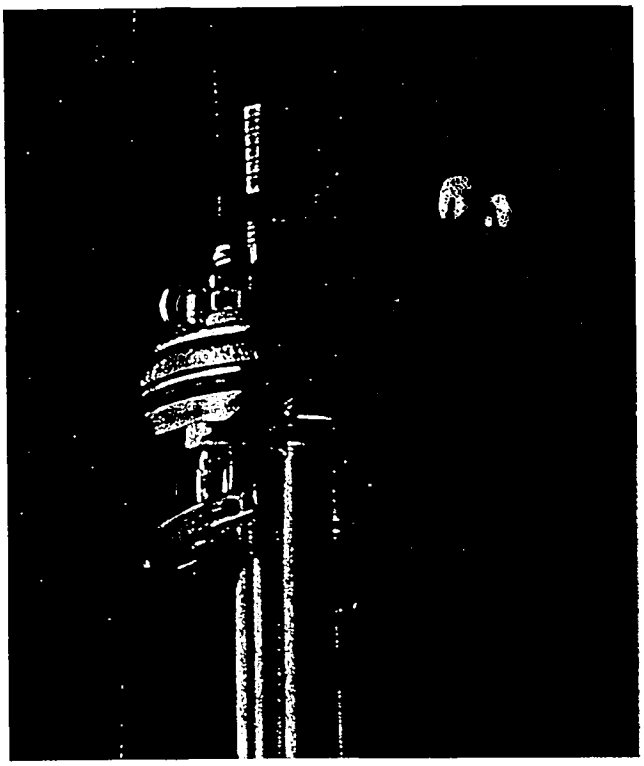


Stand the pump vertically with Hammerdrive mechanism latched upward. Using a flat head screwdriver, rotate the exhaust valve clockwise (CW), viewing from the top of the pump, until the hammer backs away from the head.



Rotate the exhaust valve CCW (viewing from the top of the pump) until the hammer closes the gap. Rotate the valve CCW an additional 360 degrees up into the pump head.

AIR VALVE ADJUSTMENT

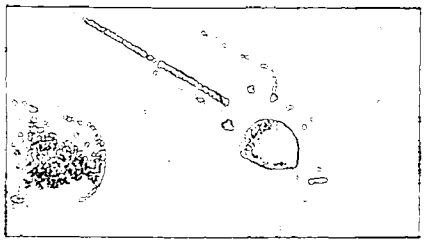


Supply the air valve with 100 psi. Stand the pump vertically, with the Hammerdrive latched in the up position, rotate the air valve CW (viewing from the top of the pump) just until air begins to bleed through the valve.

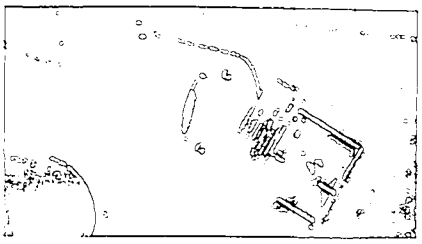
Rotate the air valve an additional 90 degrees CW (viewing from the top of the pump). Air should now be flowing freely. Lower and raise the Hammerdrive several times to ensure proper operation.

BOTTOM FILLING PUMP REASSEMBLY

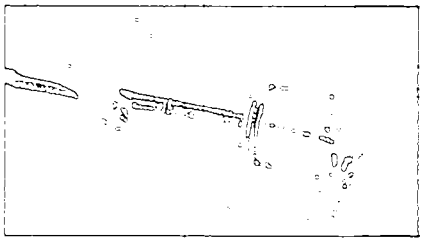
STEP 1: Slide internal subassembly into pump body. O-ring should slide into body. NOTE: body is universal--pump can slide into either end.



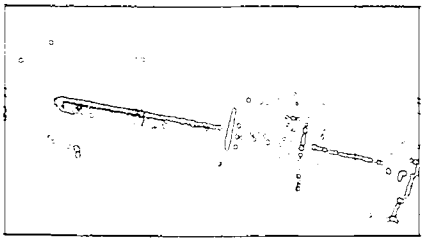
STEP 2: Replace inlet check ball (2" diameter) between 3 "legs" inside lower end of pump.



STEP 3: Replace inlet. Push inlet in and rotate until the 3 legs inside body line up with the 3 counterbores. Then, push inlet in the rest of the way, so O-ring is sealed inside pump body.

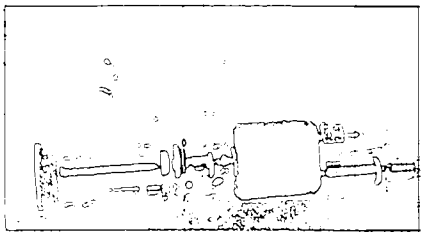


STEP 4: Make sure threads on 3 inlet screws and 3 inlet legs (inside body) are clean and free of silt or sediment. Place washers on screws, insert, and tighten with 7/16" socket wrench.

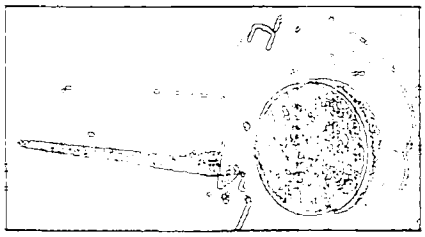


STEP 5: Place inlet screen over 3 legs of inlet. Insert screw to reattach screen. As in Step 10, make sure screw and threads are clean. Finish tightening with 7/16" socket wrench. Tip pump over from top to bottom. You should hear float sliding freely inside body.

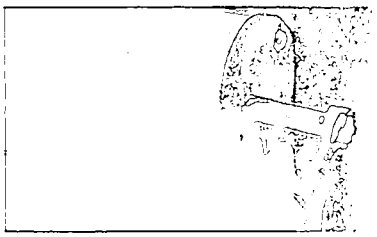
TOP FILLING PUMP REASSEMBLY



STEP 1: Slide internal subassembly into pump body. O-ring should slide into body. NOTE: body is universal--pump can slide into either end.

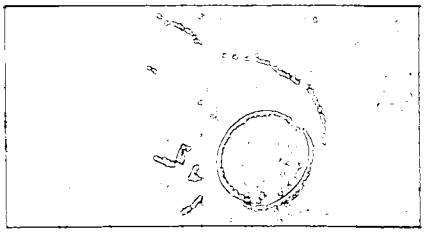


STEP 2: Replace bottom plate. Push in and rotate until the 3 legs (inside body) line up with the 3 counterbores. Then, push the plate in the rest of the way, so O-ring is seated inside pump body.

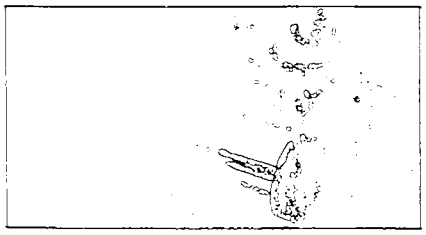


STEP 3: Make sure threads on 3 bottom plate screws and 3 legs (inside body) are clean and free of silt or sediment. Place sealing washers on screws--insert and tighten. Finish tightening with 7/16" socket wrench. Do not over-torque. Tip pump over from top to bottom. You should hear float sliding freely inside body.

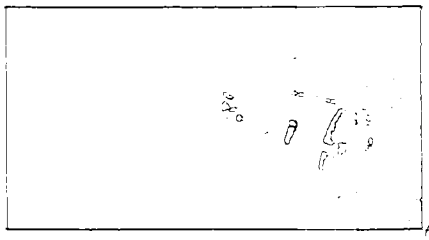
SHORT BODY MODEL REASSEMBLY



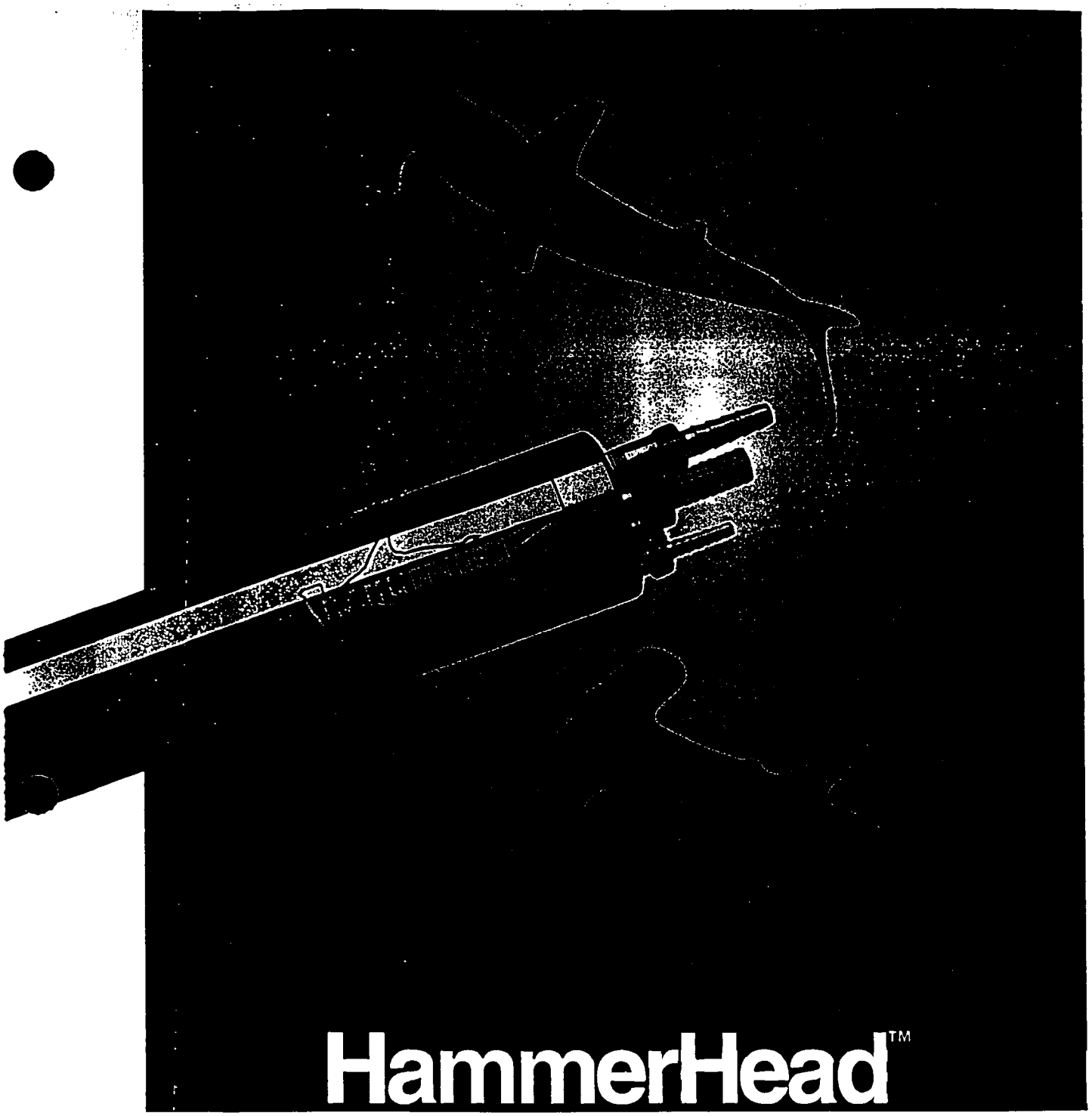
STEP 1: Slide internal subassembly into pump body. O-ring should slide into body. NOTE: body is universal--pump can slide into either end. Replace bottom plate. Align threads in bottom plate with threads on dip tube.



STEP 2: Insert screw driver into the 1/4" pipe plug hole and tighten bottom plate (CW direction). Do not over-tighten.



STEP 3: Insert 1/4" pipe plug and tighten with 1/4" hex wrench. It is recommended to use Teflon tape on threads of dip tube and 1/4" pipe plug. Tip pump over from top to bottom. You should hear float sliding freely inside pump.



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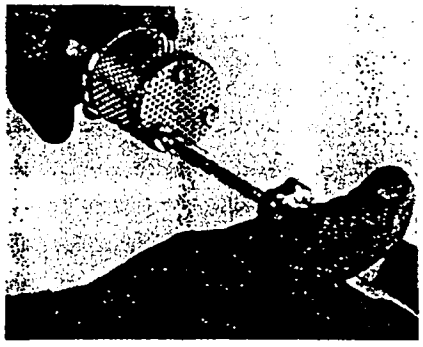
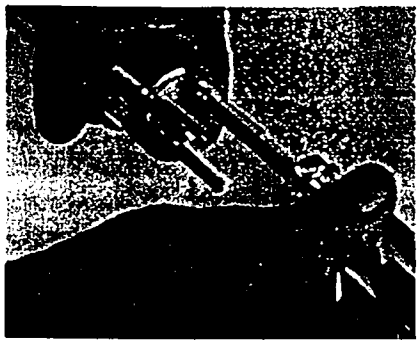
BOTTOM FILLING PUMP DISASSEMBLY

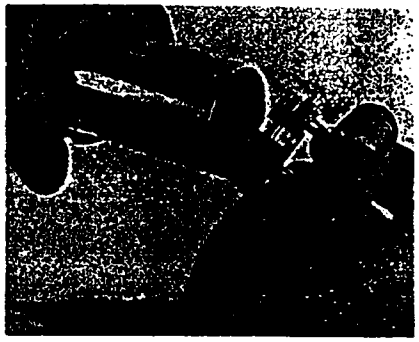
NOTE: Do not loosen the two socket screws on top of the pump between barbs. These are not used to hold pump together.



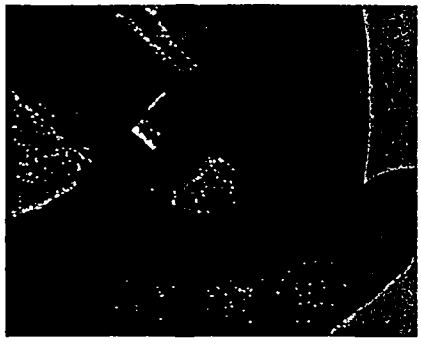
STEP 1: Remove three screws and three washers from inlet screen using the 1/4" nut driver provided. Then remove inlet screen.



STEP 2: Remove three screws and three washers from inlet using 1/4" nut driver.



STEP 3: Remove inlet—wiggle side to side while pulling out.

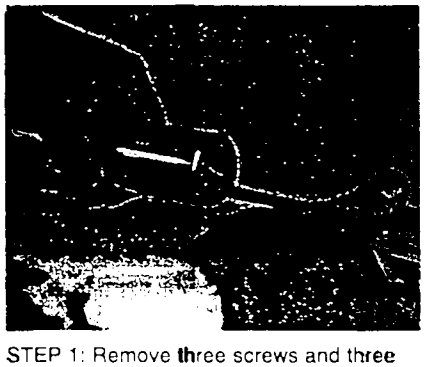


STEP 4: Tip pump to allow inlet check ball to roll out.

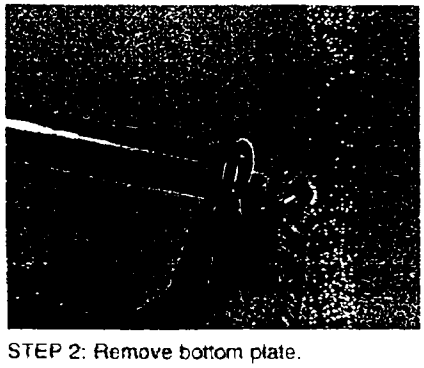
STEP 5: Remove remaining internal pump subassembly—grasp top of pump, wiggle side to side and twist while pulling out of body.

TOP FILLING PUMP DISASSEMBLY

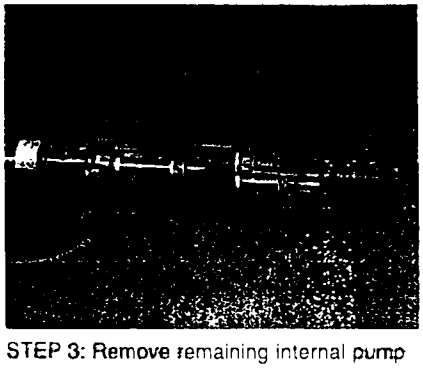
NOTE: Do not loosen the two socket screws on top of the pump between barbs. These are not used to hold pump together.



STEP 1: Remove three screws and three sealing washers from bottom plate using the 1/4" nut driver provided. Then remove inlet screen.

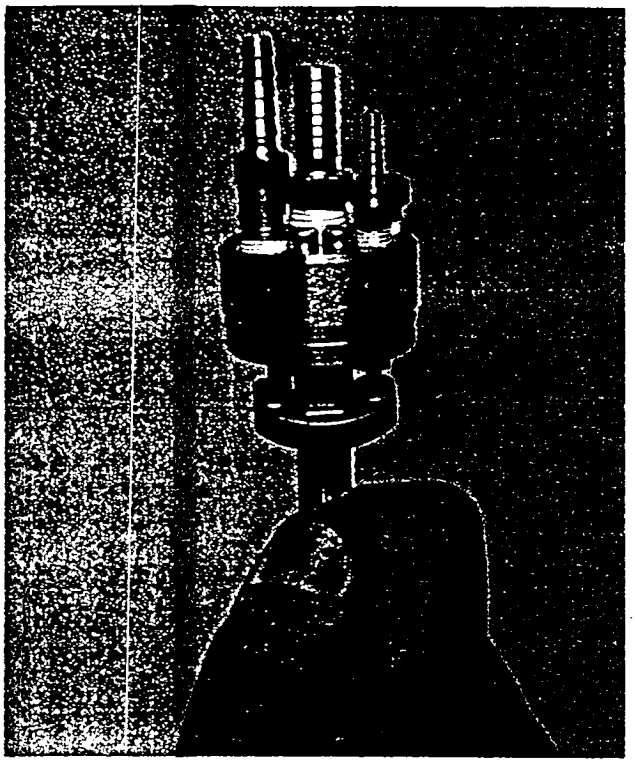


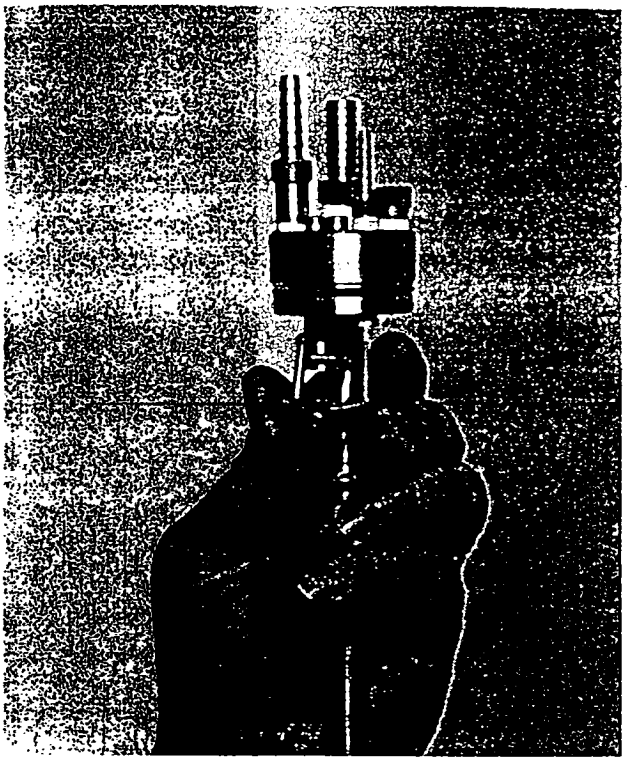
STEP 2: Remove bottom plate.



STEP 3: Remove remaining internal pump subassembly—grasp top of pump, wiggle side to side and twist while pulling out of body.

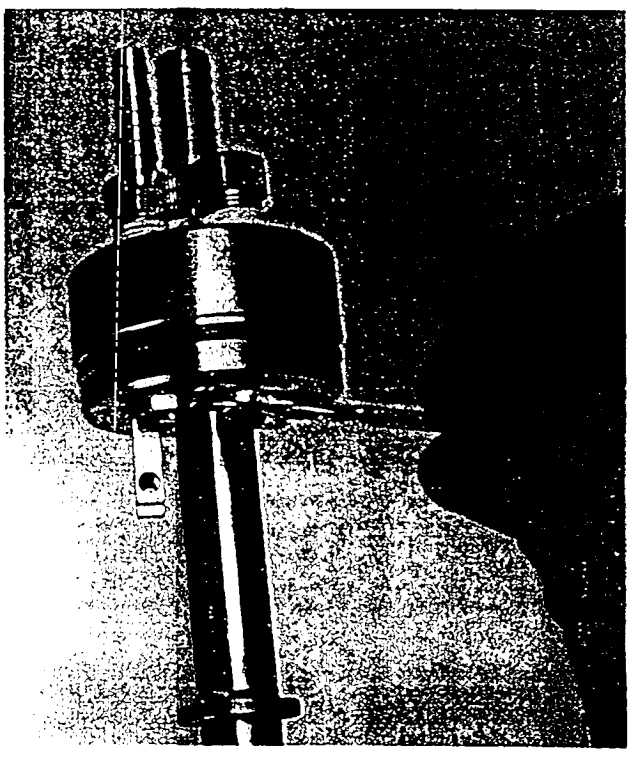
CAM REMOVAL

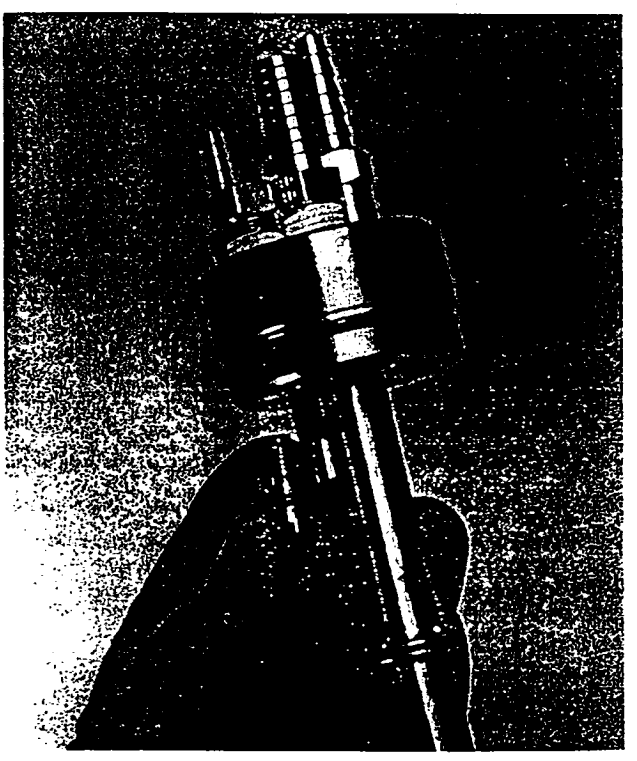




Loosen the Hammerdirve with a 1/16" hex wrench and remove.

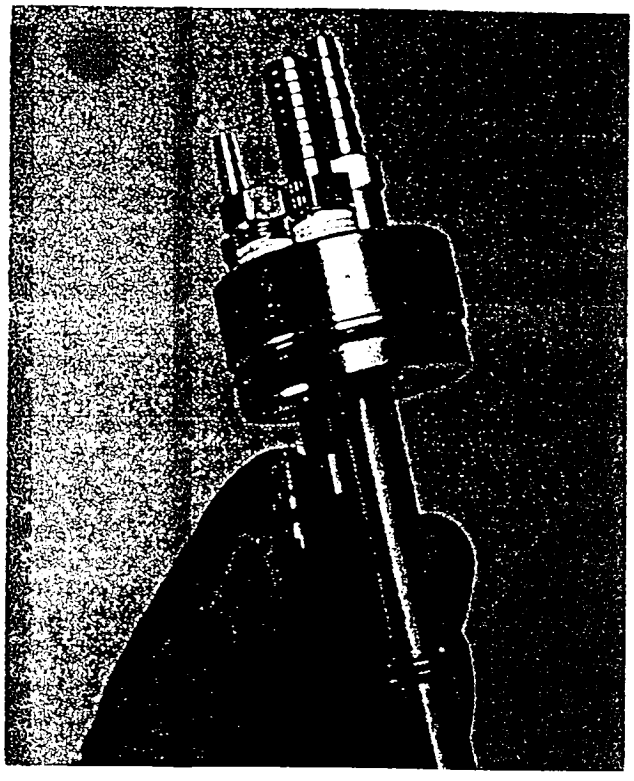
AIR SUPPLY SEAT REMOVAL

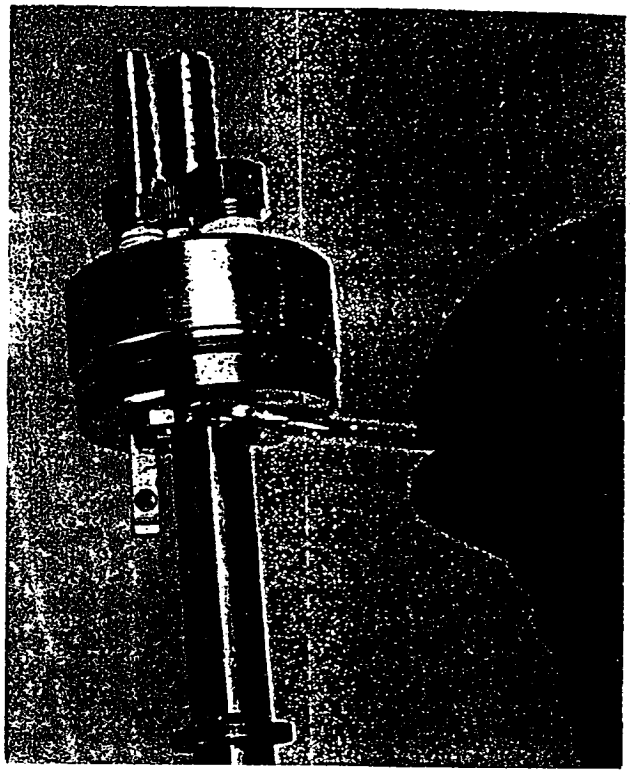




Loosen air supply valve seat with a 7/16" open end wrench and remove. NOTE: exhaust seat is built into discharge head.

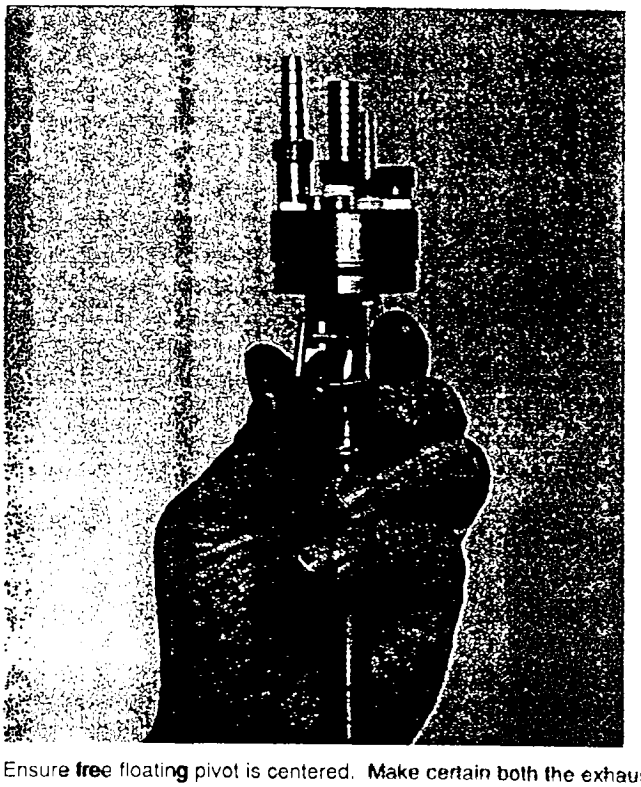
REPLACE AIR SUPPLY SEAT

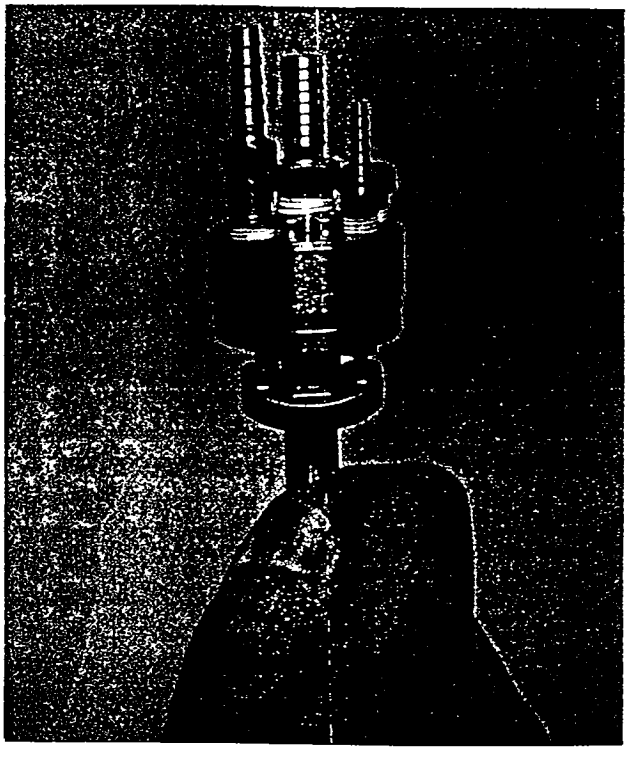




Insert air supply valve seat, using a 7/16" open end wrench. Thread seat until it bottoms out.

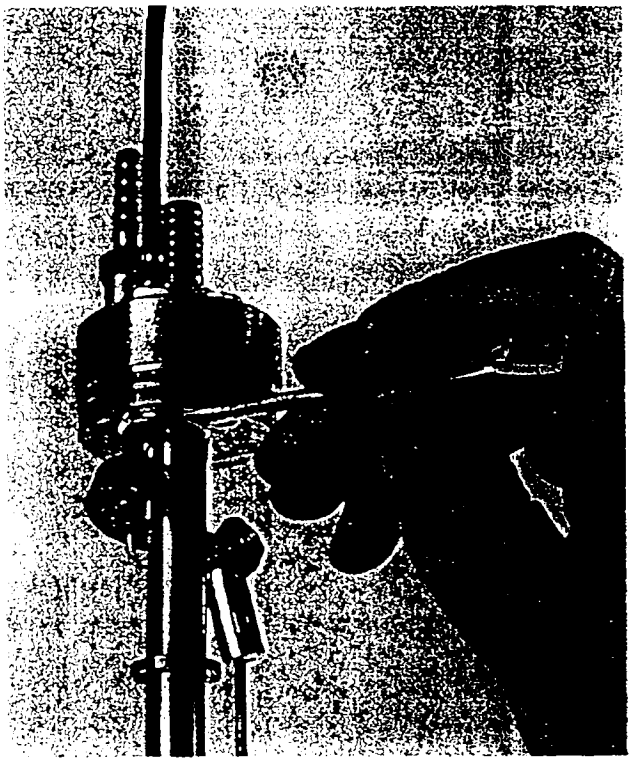
REINSTALLING CAM



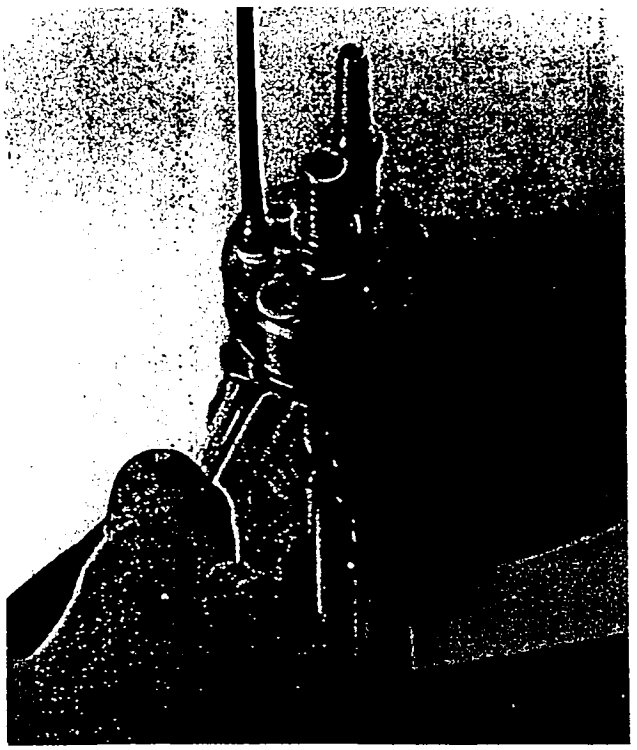


Ensure free floating pivot is centered. Make certain both the exhaust and air stems are inserted into both valves simultaneously as the hammerdrive mechanism is placed on the pivot. Tighten mounting screw with 1/16" hex wrench. DO NOT OVER TIGHTEN.

AIR VALVE ADJUSTMENT

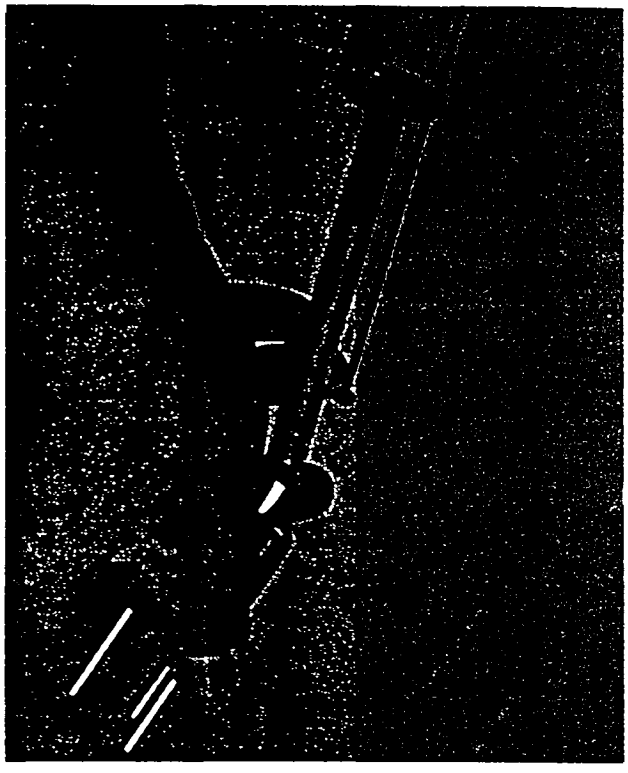


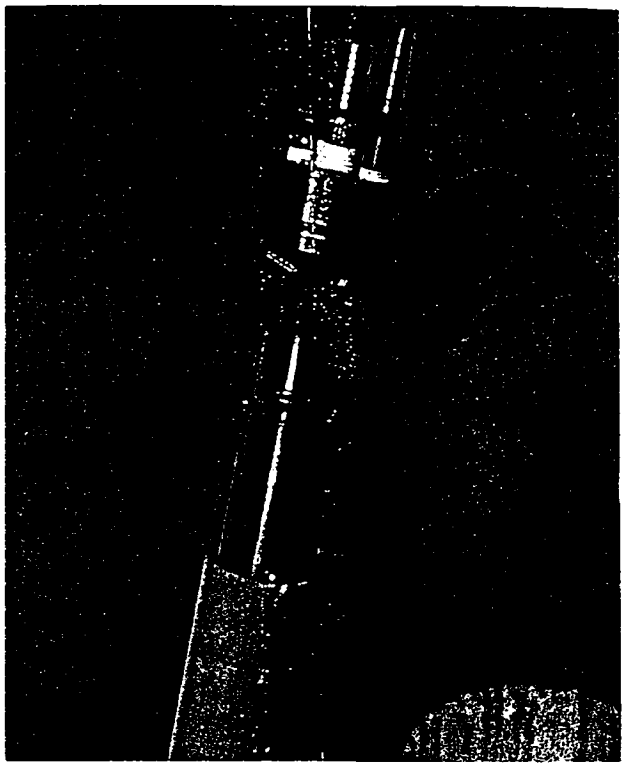
Supply the air valve with 100 psi. Stand the pump vertically, with the hammerdrive latched in the up position, rotate the air valve CW (clockwise)—viewing from the top of the pump—just until air begins to bleed through the valve. NOTE: exhaust seat is built into discharge head and no adjustment is required.



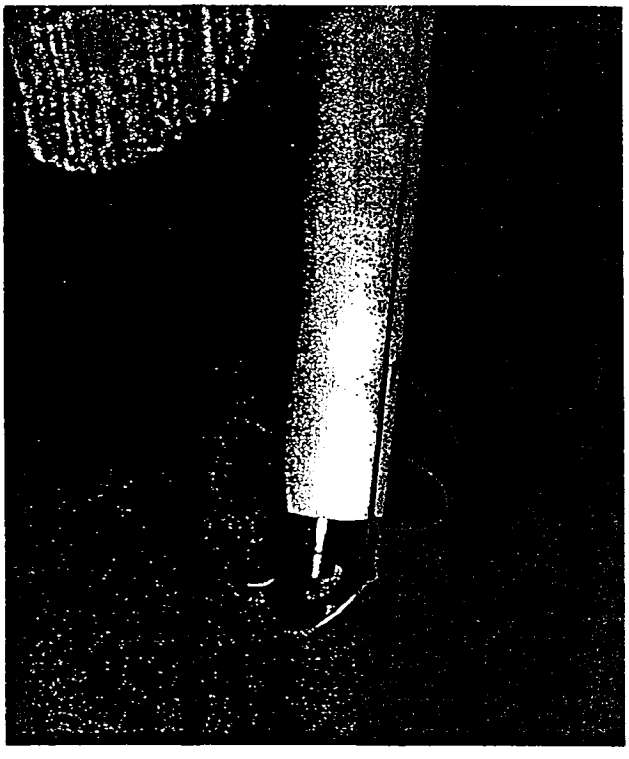
Rotate the air valve an additional 90 degrees CW (viewing from the top of the pump). Air should now be flowing freely. Lower and raise the hammerdrive several times to ensure proper operation.

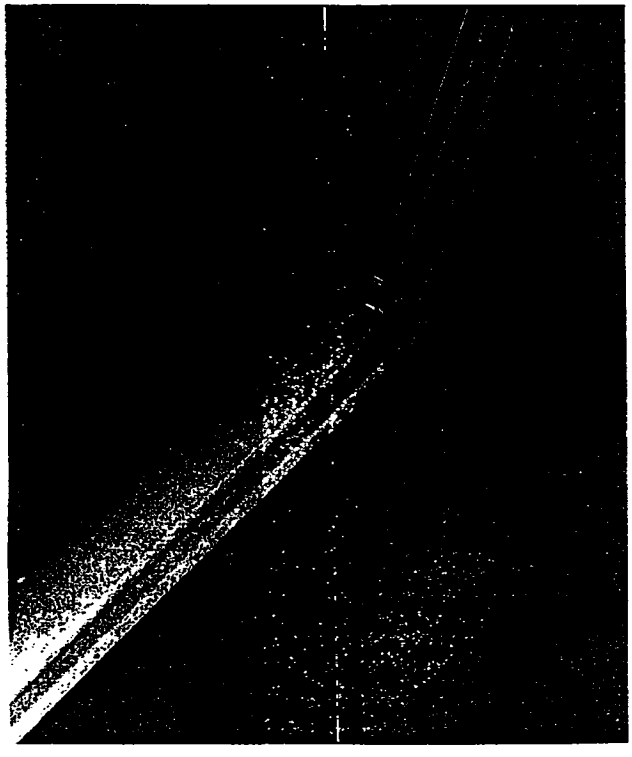
FLOAT REMOVAL





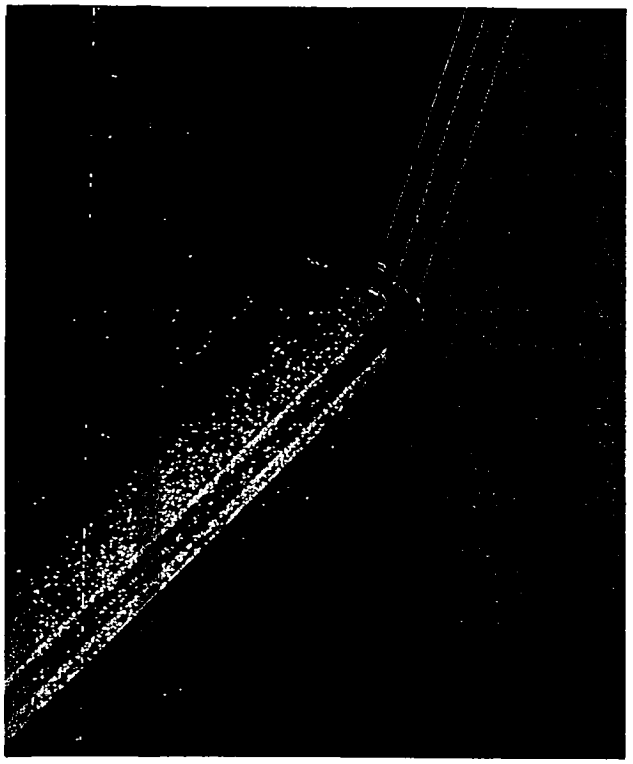
Unthread check housing from dip tube. Remove screws with a small flat head screw driver (two on top and two on bottom).

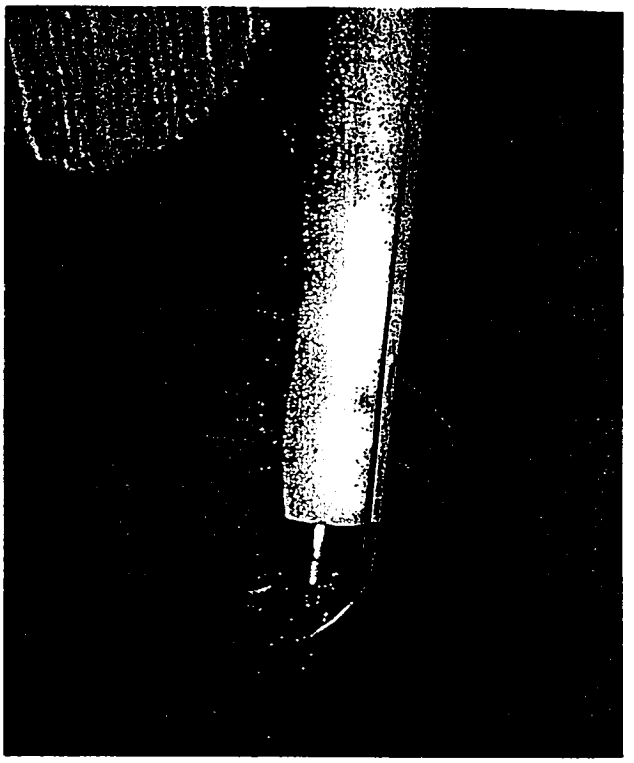




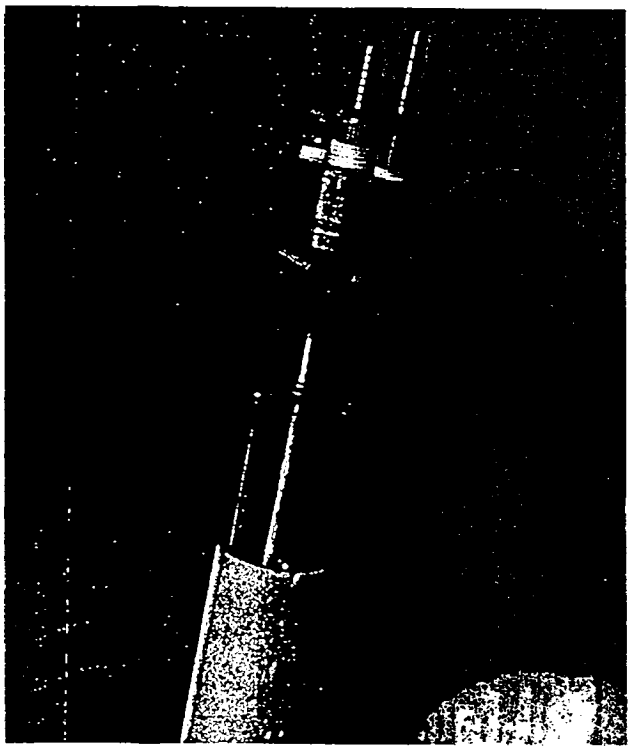
Slide float down. Slide guide plate off dip tube. Slide float off dip tube.

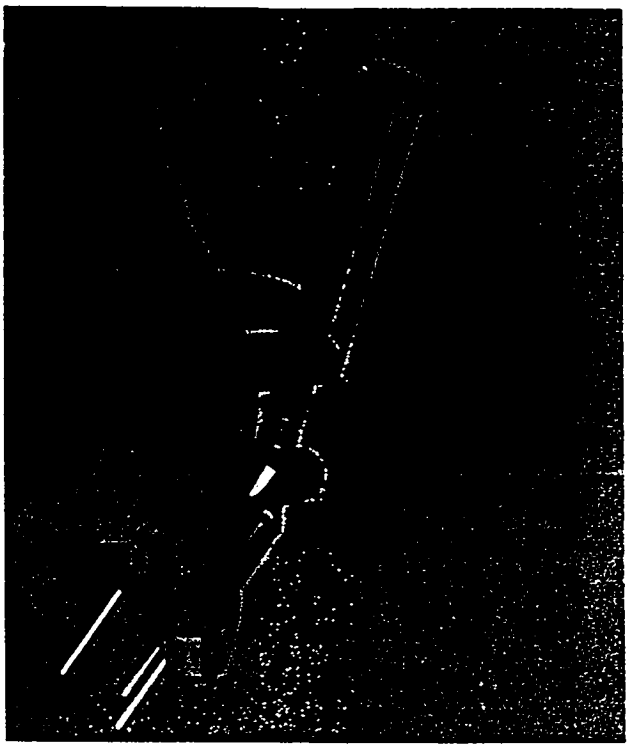
FLOAT REPLACEMENT





Slide float onto dip tube. Slide guide plate onto dip tube.





Align holes in float with holes in guide plate. Actuator rod to lay in slot in float. Tighten two screws on top and two screws on bottom. DO NOT OVER TIGHTEN. Use Teflon tape on dip tube thread. Thread check housing onto dip tube.

BOTTOM FILLING PUMP REASSEMBLY

STEP 1: Slide internal subassembly into pump body. O-ring should slide into body. NOTE: body is universal—pump can slide into either end.

STEP 2: Replace inlet check ball (7/8" diameter) between three "legs" inside lower end of pump.

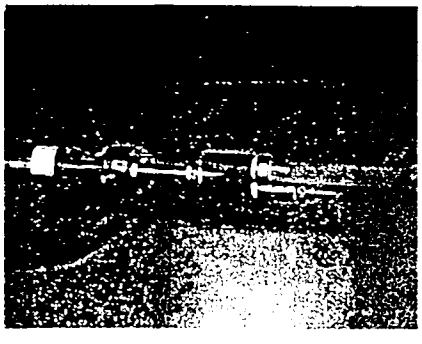
STEP 3: Replace inlet. Push inlet in and rotate until the three legs inside body line up with the three counterbores. Then push inlet in the rest of the way so O-ring is sealed inside pump body.

STEP 4: Make sure threads on three inlet screws and three inlet legs (inside body) are clean and free of silt or sediment. Place washers on screws, and start with fingers—screws should thread in freely to assure proper alignment and prevent stripping of threads. Finish tightening with 1/4" nut driver. Do not over-torque.

STEP 5: Place inlet screen over three legs of inlet. Place washers on three screws and insert to reattach screen. As in Step 4, make sure screw and leg threads are clean, and start screws with fingers to assure proper alignment. Finish tightening with 1/4" nut driver. Do not over-torque.

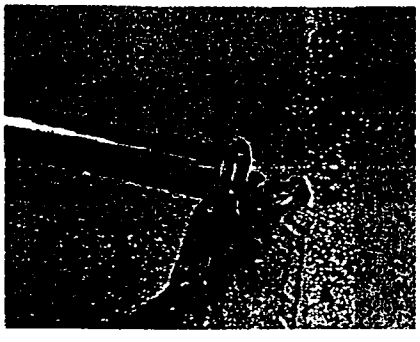
STEP 6: Tip pump over from top to bottom. You should hear float sliding freely inside body.

TOP FILLING PUMP REASSEMBLY



STEP 1: Slide internal subassembly into pump body. O-ring should slide into body. NOTE: body is universal—pump can slide into either end.

STEP 4: Tip pump over from top to bottom. You should hear float sliding freely inside body.



STEP 2: Replace bottom plate. Push in and rotate until the three legs inside body line up with the three counterbores. Then push plate in the rest of the way so O-ring is sealed inside pump body.

STEP 3: Make sure threads on three bottom plate screws and three legs (inside body) are clean and free of silt or sediment. Place washers on screws, and start with fingers—screws should thread in freely to assure proper alignment and prevent stripping of threads. Finish tightening with 1/4" nut driver. Do not over-torque.

BRAINARD•KILMAN™

EVACUATOR II

All information, illustrations and specifications in this manual are based on the latest information available at the time of publication. We reserve the right to make changes at any time without notice and without incurring any obligation.

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INTRODUCTION

The Brainard-Kilman™ EVACUATOR II pneumatic pump is available in two versions: a top and bottom loading version or a top loading only version to pump fluids to the surface for treatment. The pump is designed to fit in groundwater wells as small as 4 inches (102 mm) in diameter. The EVACUATOR II uses a down-well pneumatic logic system to automatically determine the optimal pumping rate needed to maintain a constant groundwater depression level. The pneumatic valve, located on the pump, eliminates the need for any controls at the surface.

This concise manual introduces the EVACUATOR II and provides step-by-step guidelines for successful installation and operation. Please read this information carefully before using the pump and keep the manual handy for field reference.

SYSTEM COMPONENTS

This section introduces the EVACUATOR II pump system which consists of an EVACUATOR II pump, a 4-inch diameter Well Clincher, and a 5-micron filter with auto drain, all standard with the purchase of each pump. It also details the hoses required for the pump and the air compressor required to power the pump.

EVACUATOR II

The EVACUATOR II, shown in Figure 1, consists of a stainless steel assembly with intake ports at the top and bottom or top only and connections for air, exhaust, and product discharge tubing. The intake port on the top of the EVACUATOR II is a stainless steel, poppet check valve with a Viton® o-ring seal. The bottom water intake port consists of a Buna-N check ball in a stainless steel seat. A Buna-N float rides on a stainless steel rod providing the mechanism to cycle the pump (Figure 2).

WELL CLINCHER

The EVACUATOR II pump system comes complete with a 4-inch (102 mm) diameter Well Clincher which is used at the well head for pump support, air and discharge connections, and to provide a watertight seal. The Well Clincher is made of PVC, precision machined so that its inner diameter matches the outer diameter of 4-inch PVC well monitor pipe. The Well Clincher features an o-ring seal for vacuum applications. It comes complete with brass fittings required to connect to the EVACUATOR II pump system and a stainless steel eye hook to attach a pump support cable.

HOSES

The following is a brief description of the hoses required to operate the EVACUATOR II pump system.

1. The optional down-hole hose assembly is PVC bundled and color-coded to enable simple, tangle-free installation. The bundled tubing includes a white 1/2" (13 mm) poly air supply and a1/8"(3.2mm) pilot tube inside a 1/2"(13mm) black tube, a blue 3/4" (19 mm) ID Buna-N discharge hose, also a green and blue1/8" (3.2 mm) nylon air supply and air exhaust for the pump logic. All lines are color-coded to insure proper connection. This tubing assembly is custom made for the Evacuator II.

2. Air supply and fluid discharge to the well clincher are 1/2" (13 mm) and 3/4" (19 mm) connections.

AIR SOURCE

The EVACUATOR II pump system uses compressed air to displace the water in the pump and force it to the surface. An air source is not included with the EVACUATOR II pump system due to the wide variation in compressor requirements for each site. We recommend clean, dry air to prolong the life of the EVACUATOR II and prevent the introduction of further contamination in the groundwater. In freezing temperatures, the addition of an air dryer may be required to avoid freeze damage to the system.

AIR FILTRATION

A coalescing filter and air regulator assembly is included with each EVACUATOR II pump system. **This assembly should never be submersed in water.** It must be installed at the well head to assure that clean air is supplied to the EVACUATOR II, within its working pressure range of 40 psi to 100 psi (275 kPa to 690 kPa). CAUTION: air pressures greater than 100 psi (690 kPa) applied to the EVACUATOR II may damage the pneumatic logic system.

The air consumption rate of the EVACUATOR II pump system will depend on several site-specific variables including operating air pressure and total fluid recovery rate. A worksheet in Appendix A shows the air consumption for the pump system. Once the air consumption rate has been determined, a local air compressor dealer will be able to specify the appropriate size compressor (and air dryer if applicable).

PRINCIPLES OF OPERATION

The EVACUATOR II pumps fluids by air displacement: compressed air forces the fluids out of the annular space of the pump to the surface.

The EVACUATOR II operates in two stages: the ON, or discharge stage, and the OFF, or filling stage. The stages are controlled by a float inside the annular space of the pump which rides on the top of the fluid. When the pump is in the OFF stage, the bottom and top inlet valves are open and fluid is entering the annular space of the pump. As the annular space fills, the float reaches its maximum height which triggers a valve to initiate the ON stage. During the ON stage, high pressure air closes the top and bottom inlet valves, forcing the fluid to evacuate the annular space of the pump through the discharge pipe. When all of the fluid has been removed from the annular space, the float, which has now reached its lower limit, triggers the three-way valve to stop pressurizing and exhaust the annular space which closes the valve and begins the OFF stage again. This cycle is repeated as rapidly as the pump fills up with fluid; therefore, the EVACUATOR II automatically determines its own pumping rate. The pumping rate can be decreased by regulating the flow at the surface using a gate valve.

The EVACUATOR II is designed to maintain a maximum fluid level in the well which is even with the top of the pump. This level is 36 inches from the bottom of the pump and is located approximately at the seam that separates the pump top from the annular tube. If the EVACUATOR II is being used in the optional "top loading only" configuration, the fluid level will be maintained 39 inches from the bottom of the pump, flush with the top of the top cap.

The standard EVACUATOR II pump system, configured for top and bottom loading, is designed to pump a maximum of 10.0 gpm (40 L/min). The optional top-loading-only EVACUATOR II will pump at a maximum of 4.8 gpm (18 L/min).

INSTALLATION AND OPERATION

The EVACUATOR II may be used to remove fluids from wells that are 4 inches (102 mm) in diameter or larger. The relative location of the pump to the air supply and the recovery system on the surface may differ from site to site. Similarly, the length of discharge and air hoses required to connect the pump may vary; otherwise, the installation and operation of the EVACUATOR II is essentially the same for any application.

> WARNING: Any electrical components used in an explosive atmosphere must be located in compliance with Chapter 5 of the National Electric Code and any other local codes. This would apply to electrically-powered air compressors.

INSTALLATION PROCEDURE

The following steps outline the hose connections when using the bundled down-hole assembly, part no. TR-730.

1. Determine at what depth the pump will be installed. Measure from the top of the pump head to the top of your well casing and add 6" (152 mm) for hose length.

2. Place the bottom half of the Well Clincher on the top of the recovery well pipe. Make sure that the top of the recovery well is smooth and straight. The Well Clincher should fit snugly.

3. Pump Logic - Attach the green and blue 1/8" (3.2 mm) color-coded air supply and air exhaust tubing to the matching colors on the pump head by pushing the Swagelok® fitting together.

4. Air Pilot Supply- Attach the natural color 1/8"(3.2 mm) pilot supply to prestolok fitting on 3 way valve and to prestolok fitting on pump head. **Insert tube into prestolok untill tube bottoms out then pull tube to make sure tube is locked in place.**

5. Discharge - Attach the 3/4" (19 mm) Buna-N discharge hose to the matching color on the 3/4" (19 mm) discharge on the pump.

6. NOTICE: We recommend that a teflon coated, steel safety cable be attached to the EVACUATOR II in order to minimize the tension on the down hole hoses. Stainless steel eye hooks can be found on the top of the pump and inside the top cap of the Well Clincher.

7. Connect the down-hole hoses and safety cable to the under side of the Well Clincher top (Figure 4). The 1/8" (3.2 mm) exhaust supply and 1/8" (3.2 mm) logic supply hoses are connected to the Well Clincher using a Prestolok fitting. Simply cut the tubing square and insert it into the Prestolok fitting until the tube bottoms out then pull tubes to make sure tubes are locked in place. To release, push the locking shoulder of the fitting down and pull tubing out.

8. Lower the EVACUATOR II down the well and secure the top cap of the Well Clincher to the bottom half which was previously attached to the well.

9. Connect the fluid discharge line to the appropriate fitting on the top of the Well Clincher, see Figure 4.

NOTE: Tubing in bundle is nylon and polypropylene, the discharge hose is Buna-N and the bundle's outer jacket is PVC. Check chemical compatibility BEFORE installation.

10. Attach the air regulator/coalescing filter assembly to the side of the well vault. **FILTER MUST BE MOUNTED HORZONIAL TO WORK PROPERLY AND SHOULD NEVER BE SUBMERSED IN WATER.**

11. Connect the main air supply line to the inlet of the regulator/filter assembly.

12. Connect the outlet of the regulator/filter assembly to the air supply line on the top of the Well Clincher, see Figure 4.

13. Adjust the supply air at the regulator/filter assembly to the appropriate pressure. **REMEMBER: DO NOT EXCEED 100 psi (690 kPa).**

14. Open the air supply valve to begin pump operation.

APPENDIX A

AIR CONSUMPTION

The EVACUATOR II pump uses compressed air to transport fluid from a recovery well to the surface. The volume of compressed air required will be dependent on three factors:

1. Number of EVACUATOR II pumps
2. Operating air pressure of the pumps
3. Pumping rates (gallons or liters per minute)

As the number of EVACUATOR II pumps increases, the compressed air consumption rate will also increase.

As the operating air pressure of the EVACUATOR II pump is increased, the volume of air consumed during each pump cycle increases. The following table outlines the air consumption rate per cycle of the EVACUATOR II at different operating air pressures.

TABLE A-1

Operating Air Pressure		Compressed Air Consumption Rate	
psi	kPa	(ft^3/cycle)	cm^3/cycle
60	414	0.83	14
70	483	0.94	15
80	552	1.05	17
90	620	1.15	19
100	690	1.26	21

Very few sites will require an operating air pressure of 100 psi (690 kPa), but it is recommended that the highest air consumption rate, 1.26 ft^3/cycle (21 cm^3/cycle) be used when determining the total compressed air consumption for the site.

The pumping rate required to achieve the desired water table depression will directly influence the compressed air consumption rate. The EVACUATOR II pump draws 1.2 US gallons (4.5 L) of fluid/cycle and can pump a maximum of 10.0 gpm (41 L/min) with the top and bottom loading version.. The pumping rate of each recovery well should be determined so that the total pumping rate of the site can be calculated.

The following questions will help determine the compressed air consumption rate:

1. How many recovery wells will be used on this site?
2. What is the pumping rate for each recovery well?
3. What is the total pumping rate for the site? (Add pumping rates from question 2)
4. Use the total pumping rate calculated in question 3 in the following formula to determine the air consumption rate.

$$\text{AIR CONSUMPTION } [ft^3/min] = \frac{\text{Total Pumping Rate [gal/min]}}{10.0} \times \text{Air consumption per cycle } (ft^3) \text{ at operating pressure*}$$

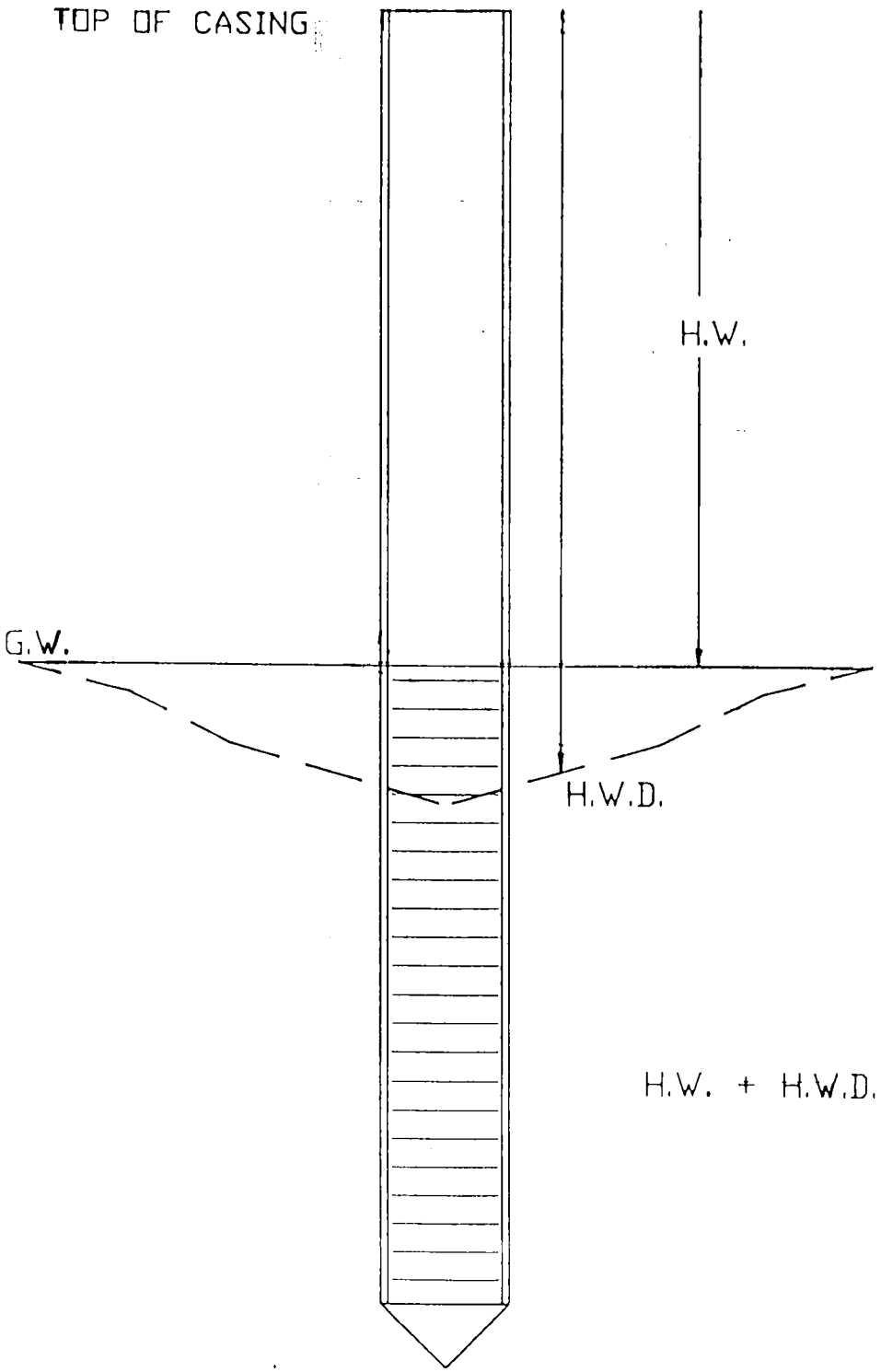
$$\text{AIR CONSUMPTION } [cm^3/min] = \frac{\text{Total Pumping Rate [L/min]}}{40} \times \text{Air consumption per cycle } (cm^3) \text{ at operating pressure*}$$

The operating air pressure will depend on the amount of force the EVACUATOR II will need to push the water from the pump to the remediation equipment on the surface (total dynamic head). As the operating air pressure is set higher, more air will be consumed with each cycle of the pump due to the physical characteristics of compressed air. For example, at an operating pressure of 60 psi (414 kPa), the EVACUATOR II will consume 0.8 ft^3 (14 cm^3) of air/cycle. At an operating pressure of 100 psi (690 kPa), the EVACUATOR II will consume 1.26 ft^3 (21 cm^3) of air/cycle. The total water recovery rate will dictate how often the pump cycles.

* see table A-1, page 6

LIST OF FIGURES

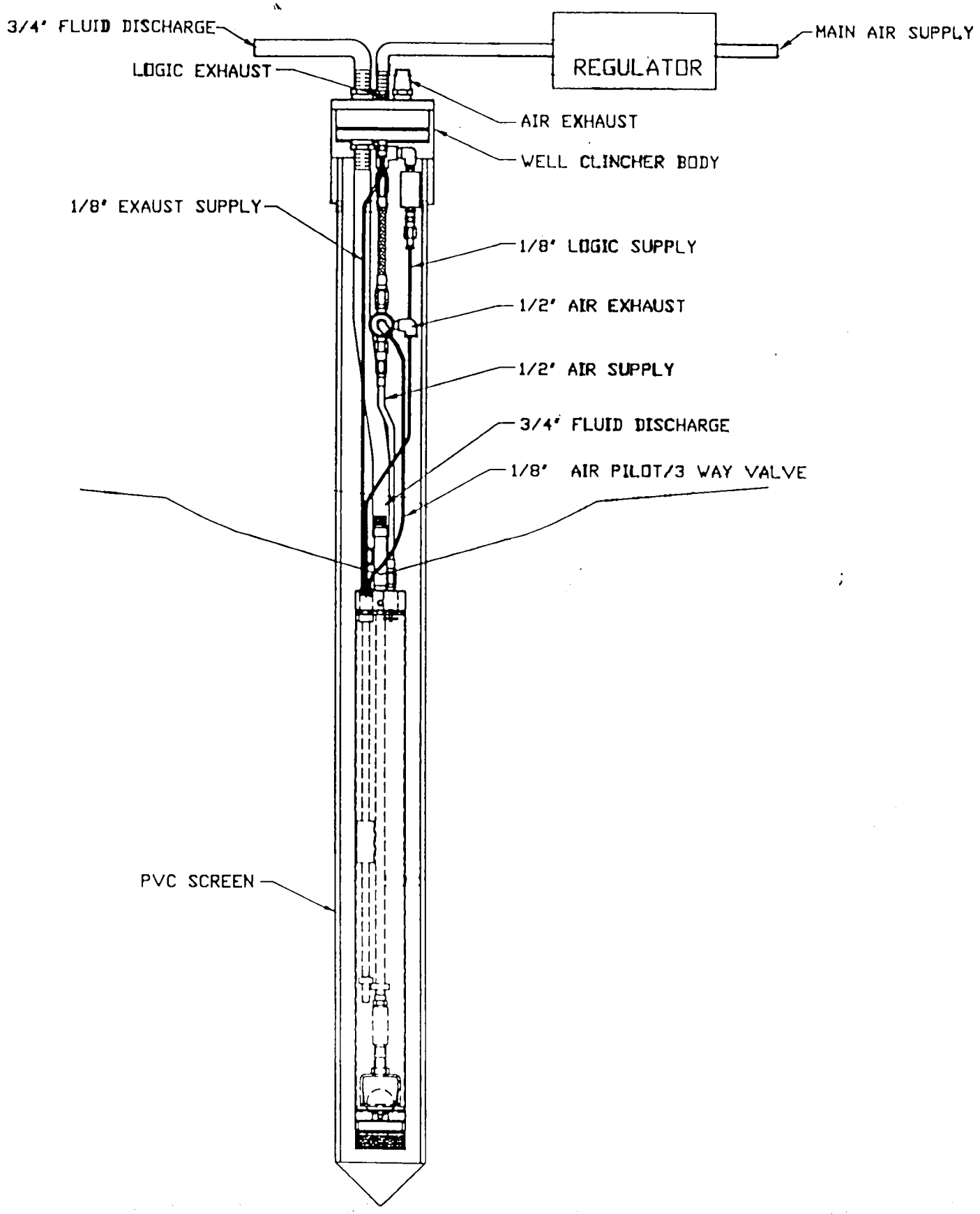
(FIG. 3)



EVACUATOR II

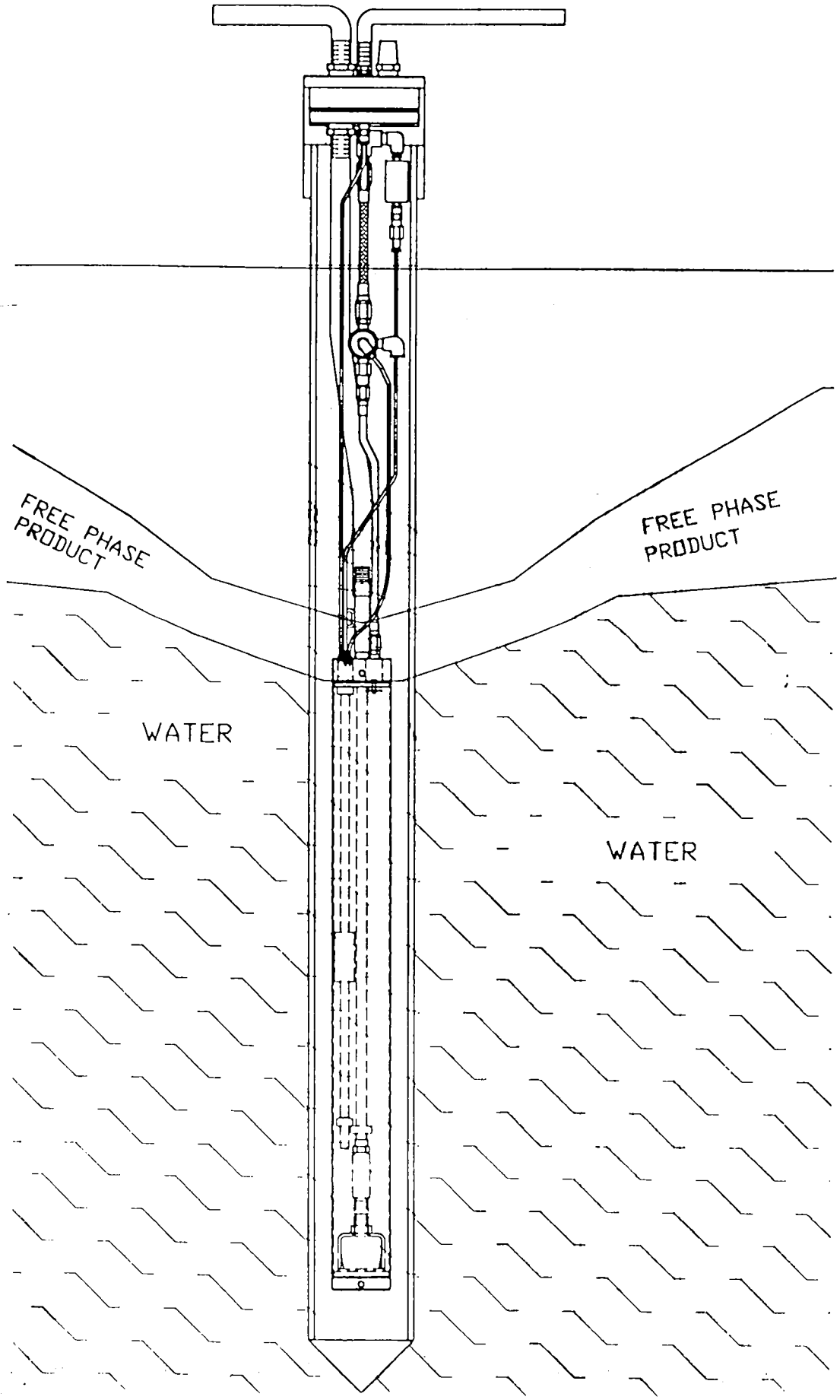
TOP/BOTTOM LOADING

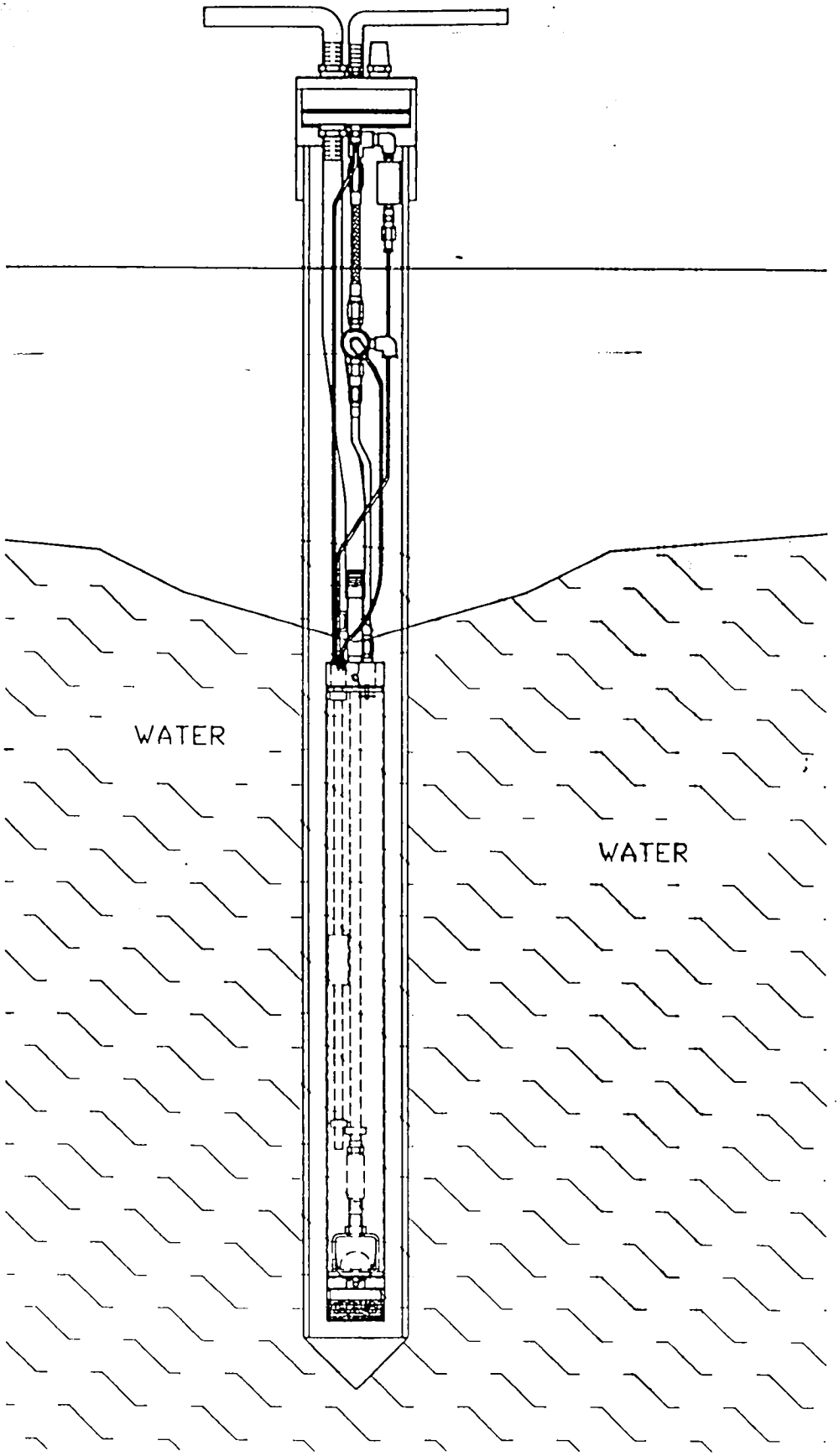
(FIG. 4)



(FIG. 5)

TOP LOADING

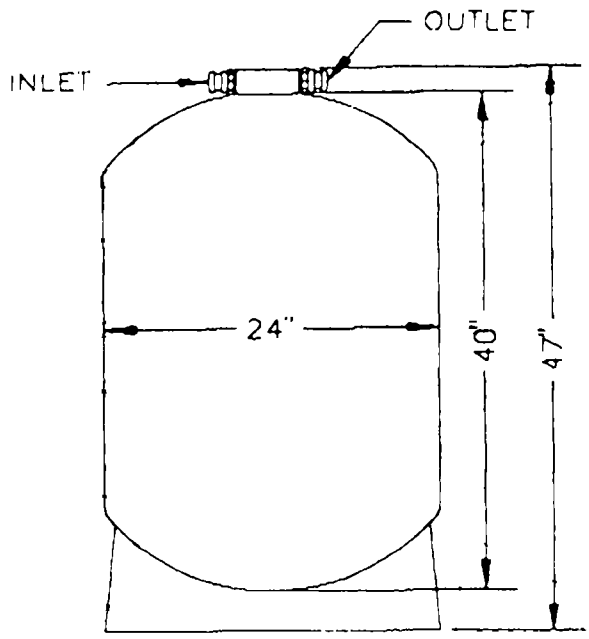



WATER
WATER

Carbon Service Company

AQUA 200 *HP*

TYPICAL FLOWS	2-8 gpm
MAXIMUM SUGGESTED FLOW#	10 gpm
MAXIMUM PRESSURE	150 psig
MAXIMUM TEMPERATURE	150°F



STANDARD FEATURES

* 200 lbs. of Atochem™ virgin carbon, domestic coal base, 8 x 30 mesh.
* 1" FNPT inlet and outlet connections.
* Heavy duty, corrosion resistant *Polyglass*™ composite poly vessel.
* An advanced internal distribution and collection system designed to maximize flow and carbon utilization.
* High Pressure vessel rated to 150 psig operation @ 150° F.

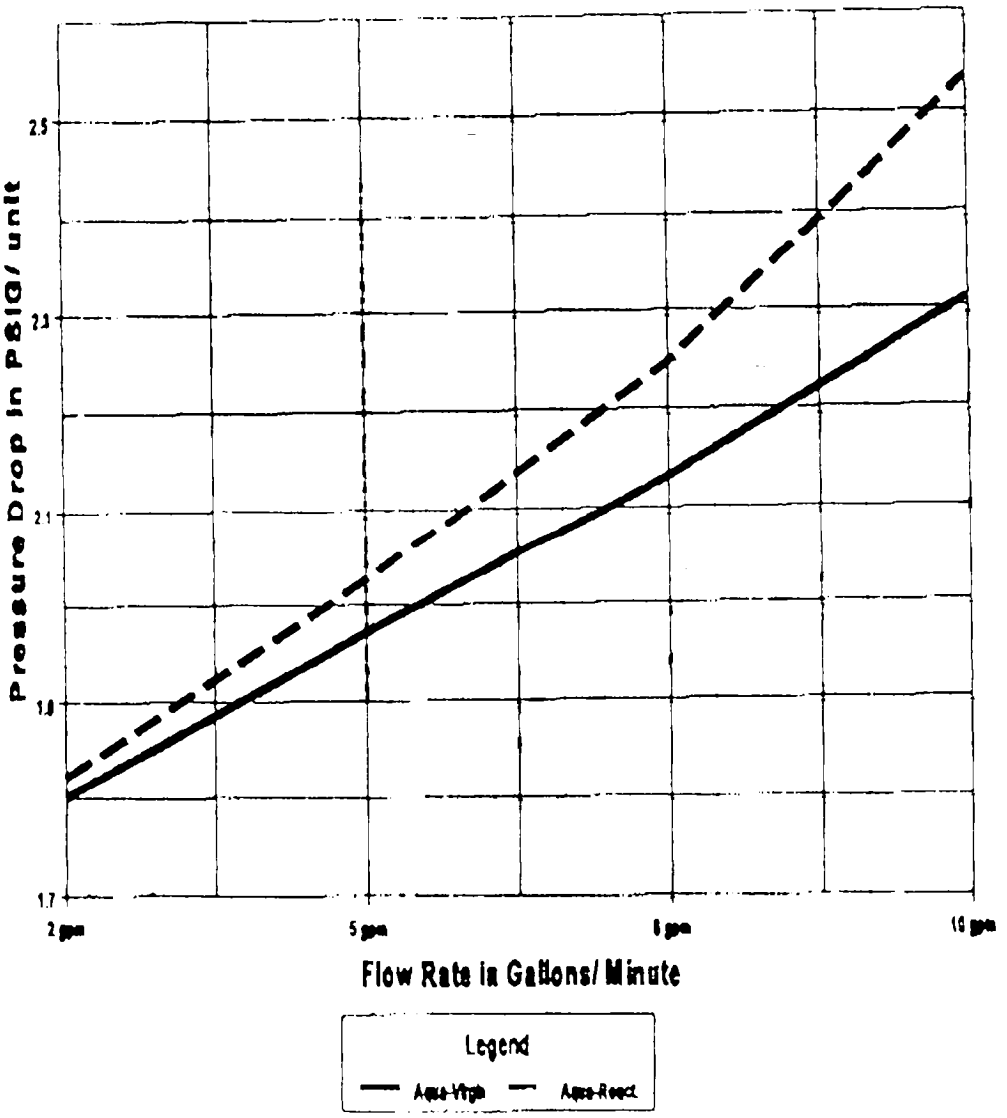
OPTIONAL FEATURES

* Reactivated 8 x 30 mesh carbon. (-$ 60.00)
* 1" Cam-Lok™ fittings w/ caps. (+$ 27.50)
* Mobile Dolly frame. (+$ 200.00)
* Sample port assembly. (+$ 15.00)
* Pressure gauge assembly. (+$ 37.50)
* Flexible hose assemblies. See page (SE-3)
  1" x 3' (+$ 30.00 to $ 60.00)
  1" x 6' (+$ 40.00 to $ 95.00)
* Solids prefilter systems. See page (SE-4)

(#) Based on (2) two units operating in-series and may not be effective in all applications.

Aqua 200 HP

PRESSURE DROP CURVES



Model: C180A
230v/3ϕ/60Hz
~~1.5~~ 1½ Hp comp 14.5A
½ Hp Pump 1.5A

COOLMASS Ultra

HIGH EFFICIENCY CYCLING CHILLER

OWNER'S MANUAL

REFRIGERATION TYPE PROCESS CHILLERS

PIONEER

INNOVATIVE
QUALITY
SYSTEMS

INTRODUCTION

Thank you for purchasing Pioneer Air System's Cool Mass High Efficiency Cycling Chiller.

This manual contains information and recommendations for installing, operating, and servicing Pioneer Refrigeration-type Process Chillers. The Pioneer systems are designed and manufactured to the highest standard of quality. All totally self-contained units have been tested and inspected before shipment from the factory. The information in this manual is in accord with the data applicable to standard equipment at the time of printing (Non-standard changes may not be included). The manufacturer reserves the right to make changes without notice and without incurring obligation. The customer should read this manual carefully before locating and installing the equipment.

WARRANTY

Cool Mass High Efficiency Cycling Chillers feature a ten-year prorated warranty on the heat exchanger and compressor(s).

Cool Mass High Efficiency Cycling Chillers are warranted to be free from defects in material and workmanship for a period of one year from the date of shipment, provided the equipment is procured, installed and used according to Pioneer Air System's recommendations. Pioneer Air Systems' liability is limited to the repair, refund, or replacement in kind at its sole option. In no event will Pioneer be liable or responsible for incidental and consequential damages, even if the possibility of such has been made known to the company. This warranty does not cover usual maintenance and replacement-type products and components. One year mechanical parts only warranty applies to equipment outside the mainland U.S.A, Canada, and Mexico.

Customer responsibility includes the following routine preventive maintenance:

1. Keeping condenser clean
2. Keeping heat exchangers clean
3. Providing proper ventilation in the area
4. Maintaining proper flow, pressure and temperature through the chiller (in the case of water-cooled condensers)
5. Maintain proper electrical requirement
6. Removal of corrosive elements from the fluid and atmosphere

NOTE: When a factory technician is requested for service due to one or more of the above reasons, customer will be invoiced on a non-warranty service call basis.

For factory service, call Pioneer Air Systems service department, 423-346-6693, 8 am–5 pm EST, Monday–Friday to obtain service authorization. Have your model number and serial number available before calling. Pioneer Air Systems, Inc. will not be responsible for unauthorized service performed, or for shipments to its facility or to its distributors' facilities without written authorization.

COOLMASS

HIGH EFFICIENCY CYCLING CHILLERS

Refrigeration-type Process Chillers

Owner's Manual

CONTENTS

PIONEER

INNOVATIVE QUALITY SYSTEMS

RECEIVING & INSPECTION

1. Remove crate and packaging.

2. Examine the unit for external and internal shipping damage. Report damages to transportation agency at once. This is the responsibility of the cosignee.

3. Check the nameplate to be sure power supply is correct. Improper voltage or fluctuating voltage may damage equipment.

4. Standard Pioneer Systems are charged with refrigerant, tested and operated before leaving the factory. They are ready to run after connecting to the proper services.

LOCATION & PIPING

1. A process chiller should be installed as close to the point of use as possible to minimize loss of cooling capacity and fluid pressure.

2. Piping to and from process chiller and point of use should be insulated to prevent external condensation and loss of cooling capacity.

3. Standard systems are designed for installation in areas where the ambient temperature ranges between 50°F - 100°F. For installation in lower and higher temperature areas consult factory. Position the unit to permit free circulation of cooling air for the condenser. Consider heat rejection when locating the unit.

4. In case of water cooled systems, make condenser water connections to the systems. Make sure water piping is large enough to handle the flow requirements. (To be safe make pipe size at least equal to condenser water connections on the system.)

5. Process fluid piping should be large enough to carry process fluid. If not sure, make pipe size at least equal to the connections on the system.

COOLING REQUIREMENTS FOR CHILLER SYSTEM

Typical Heat Rejection

Air Cooled Units:
Approx. 15,000 BTU/Comp. H.P.

Water Cooled Units:
Approx. 1,000 BTU/Comp. H.P. to ambient and approx. 14,000 BTU/Comp. H.P. to cooling water.

Approx. Water Flow Requirements
(water cooled only)

Water Temp.	*G.P.M/Comp. H.P.*
70°F	1.5
80°F	2.0
90°F	3.0

HOW IT WORKS

The refrigerant compressor compresses cold gaseous refrigerant into warm or hot high pressure gaseous refrigerant. Because of compression the refrigerant is at high enough temperature to transfer heat to atmosphere (air cooled units) or water (water cooled units). Hot or warm refrigerant flows into the condenser where it is cooled and condensed into liquid. Liquid refrigerant flows to an expansion valve through a filter-dryer and receiver. The function of the receiver is to assure availability of liquid refrigerant for expansion. The filter-dryer filters the refrigerant and removes any traces of moisture and contaminants which may be in the system. The expansion valve expands the liquid refrigerant thereby lowering the refrigerant pressure and temperature. In a typical chiller system the refrigerant temperature is lowered 5 to 10°F below the desired fluid temperature. This cold liquid refrigerant flows into the evaporator where it cools process fluid and evaporates into a cold vapor. Vaporized (cold) refrigerant flows into the accumulator. From the accumulator, the vaporous (cold) refrigerant flows to the compressor suction. The purpose of the accumulator is to hold liquid and pass on the gaseous refrigerant. To provide relatively constant refrigerant temperature in the evaporator some systems are also equipped with an optional hot-gas bypass valve. It mixes hot refrigerant with cold refrigerant to give stable suction pressure and temperature. Thus, near constant temperature is maintained at fluctuating load condition. These are typically noncycling chillers.

The Cool Mass advantage

When the chiller outlet temperature drops below the performance low set point, the refrigerant compressor will cycle off. The compressor will stay off until the outlet temperature rises above the performance high set point. Since the heat exchanger reservoir tank holds a significant thermal mass of cold water, the cold water already in the tank will cool the incoming water for a period of time. When the cold water temperature reaches the high set point, the refrigerant compressor cycles on. The cycling saves on energy costs.

CAUTION

1. A refrigeration compressor operating under sustained overload conditions caused by excessively high inlet fluid temperature will continue to work at higher discharge pressure until either the compressor motor fails or the compressor cycles on high pressure cut out control. Allowing it to cycle on high pressure control will burn the compressor motor. If the chiller is unable to maintain the desired temperatures, check flow rates, temperatures and heat load.

2. Because of higher pressures and electrical voltage, only qualified service personnel should work on equipment.

3. Freezing of process fluid may damage the chiller. To prevent freeze up, set the low point at least 10°F above the freeze point of the process fluid.

START-UP PROCEDURE

1. A qualified electrician should check nameplate voltage and amperage. Bring properly sized power leads to equipment. Power should be supplied through a fused disconnect (supplied by user).

2. After all power and fluid connections have been made to the system, it is ready for operation. Generally the systems are shipped with a full charge of refrigerant with all refrigeration service valves open.

3. Turn on power to the system. This allows compressor crankcase heater to warm up compressor lube oil. If unit is started immediately, compressor may be damaged. Leave crankcase heater on for a minimum of eight (8) hours before running the compressor.

4. When loosening of compressor bolts is required, an instruction tag is provided.

5. Temperature Control Adjustment:

   Set temperature controller to the desired fluid temperature. Controller will cycle refrigerant compressor "on" and "off " between the temperature settings. To prevent freeze-up

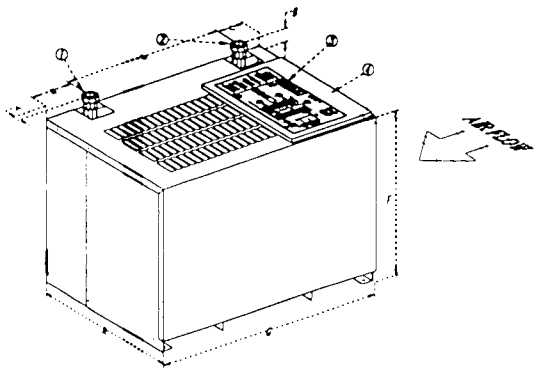


Figure 1. Models C60–C120

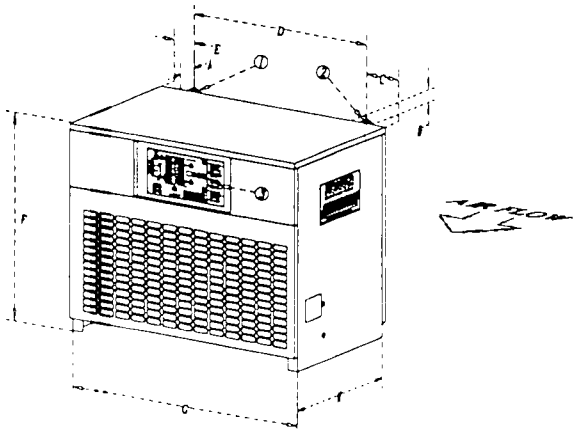


Figure 2. Models C180–C360

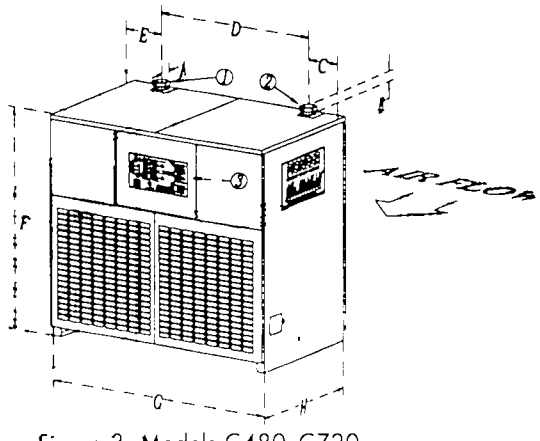


Figure 3. Models C480–C720

TYPICAL DIMENSIONS

Cabinet is standard in models C60–C720; optional in C900 and larger sizes.

MODEL	A IN.	A MM	B IN.	B MM	C IN.	C MM	D IN.	D MM	E IN.	E MM	F IN.	F MM	G IN.	G MM	H IN.	H MM	IN & OUT IN.
C60-C120	1	25.4	2	50.8	4	101.6	22	558.8	6	152.4	22	558.8	32	812.8	23	584.2	3/4
C180-C360	2	50.8	3	76.2	8	203.2	31	787.4	4	101.6	36	914.4	45	1143.0	26	660.4	1
C480-C720	2	50.8	2	50.8	5	127.0	42	1066.8	10	254.0	51	1295.4	56	1422.4	34	863.6	2

all Pioneer chillers are equipped with freeze control thermostat which is factory set at 35°F. If temperature below 40°F is desired use appropriate Freeze Protector solution and reset freeze control at 10°F below the desired fluid temperature. In systems with cabinets, the freeze control is installed inside the cabinet whereas temperature controller is installed outside the cabinet. The pump runs continuously. Factory setting for temperature controller is on at 60°F and off at 50°F.

MAINTENANCE

1. Periodically blow any dirt off the condenser.
2. Replace process fluid periodically to keep fluid and the evaporator clean.
3. Add process fluid on need basis.

TROUBLESHOOTING GUIDE

PROBLEM	CAUSE	REMEDY
Process fluid too cold	Temperature controller set too low	Raise temperature controller setting & allow time for fluid to warm up
Process fluid not cold enough	1. Temperature controller set too high 2. Refrigeration capacity not enough 3. Increased heat load	1. Lower temperature controller setting 2. You may need larger chiller system; consult factory 3. Add chiller capacity or consult factory
No flow	1. Cooling fluid is freezing in chiller system 2. Fluid lines or evaporator plugged 3. Pump failure	1. Raise temperature controller setting & allow time for fluid to warm up; may need to add more Freeze Protector to lower freeze point 2. Clean evaporator 3. Replace pump
System shut down	1. Low refrigerant pressure shutdown 2. High refrigerant pressure shutdown or compressor cycling on high pressure control	1. System low on refrigerant; check for leaks and add refrigerant 2. May be due to one of the following: A. Overload; reduce load or install larger system B. Dirty atmosphere; clean condenser and relocate the system or install ambient filter for condenser C. High ambient temperature; relocate the system if possible or consult factory for system suitable for high ambient temperature D. Condenser fan motor failure; replace motor

TYPICAL SCHEMATIC DIAGRAMS

TYPE 1

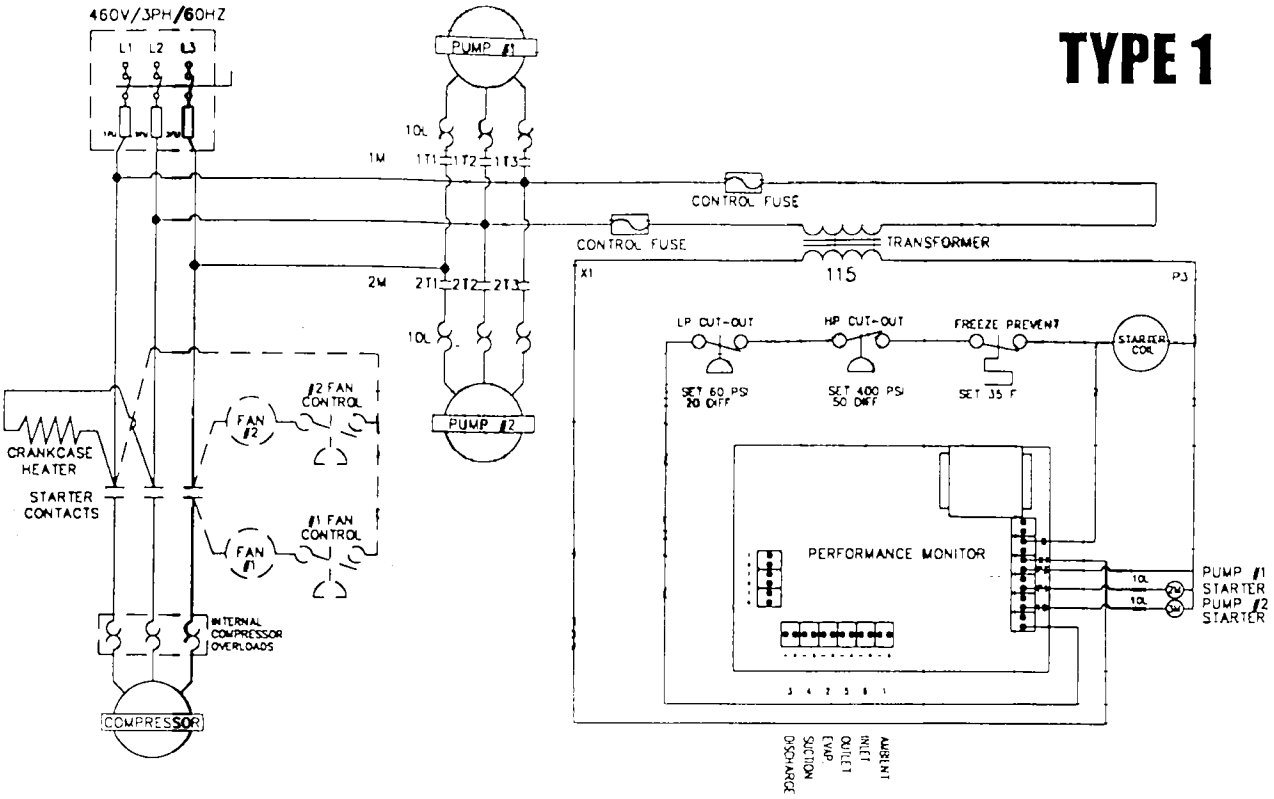


Figure 4. Typical **Type** 1 Cool Mass Chiller; with optional dual pump; C60–C1800A

TYPE 2

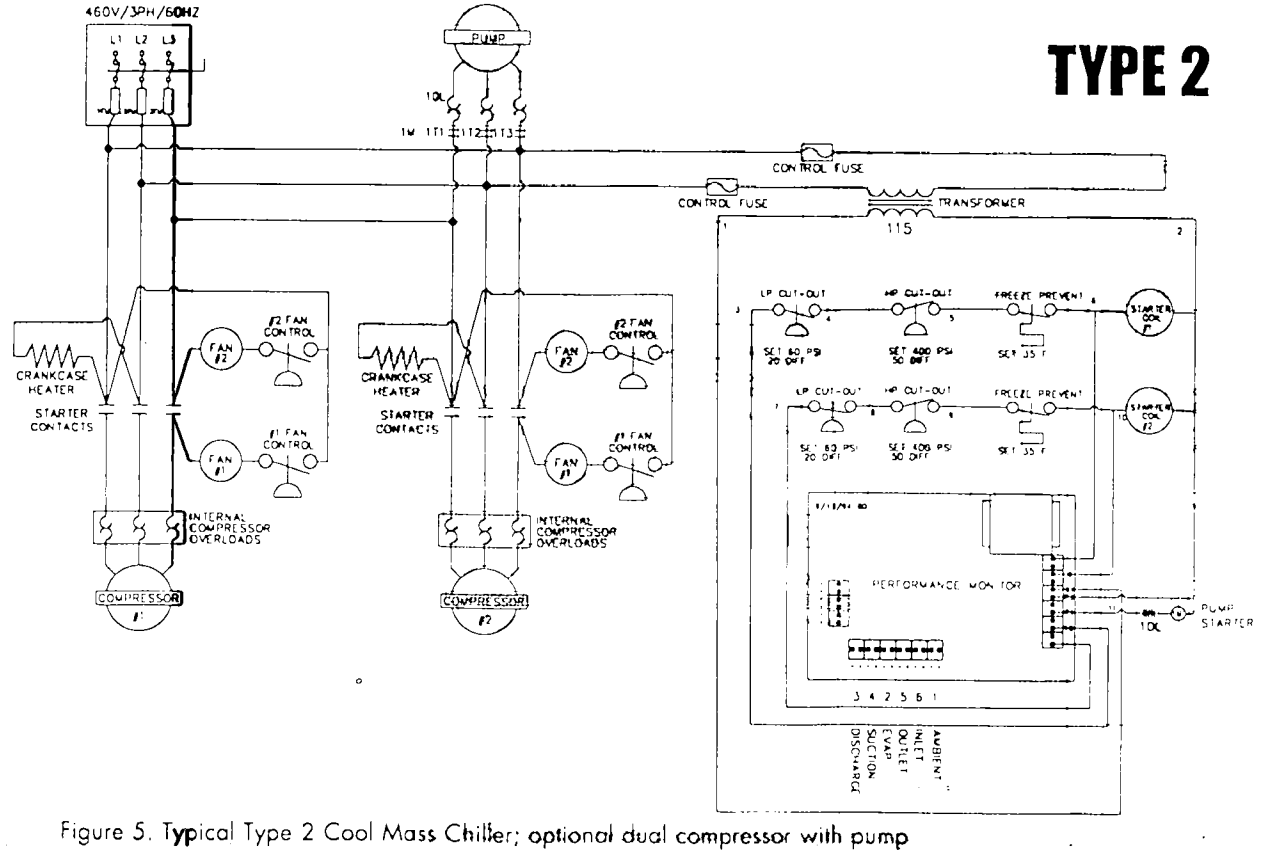


Figure 5. Typical Type 2 Cool Mass Chiller; optional dual compressor with pump

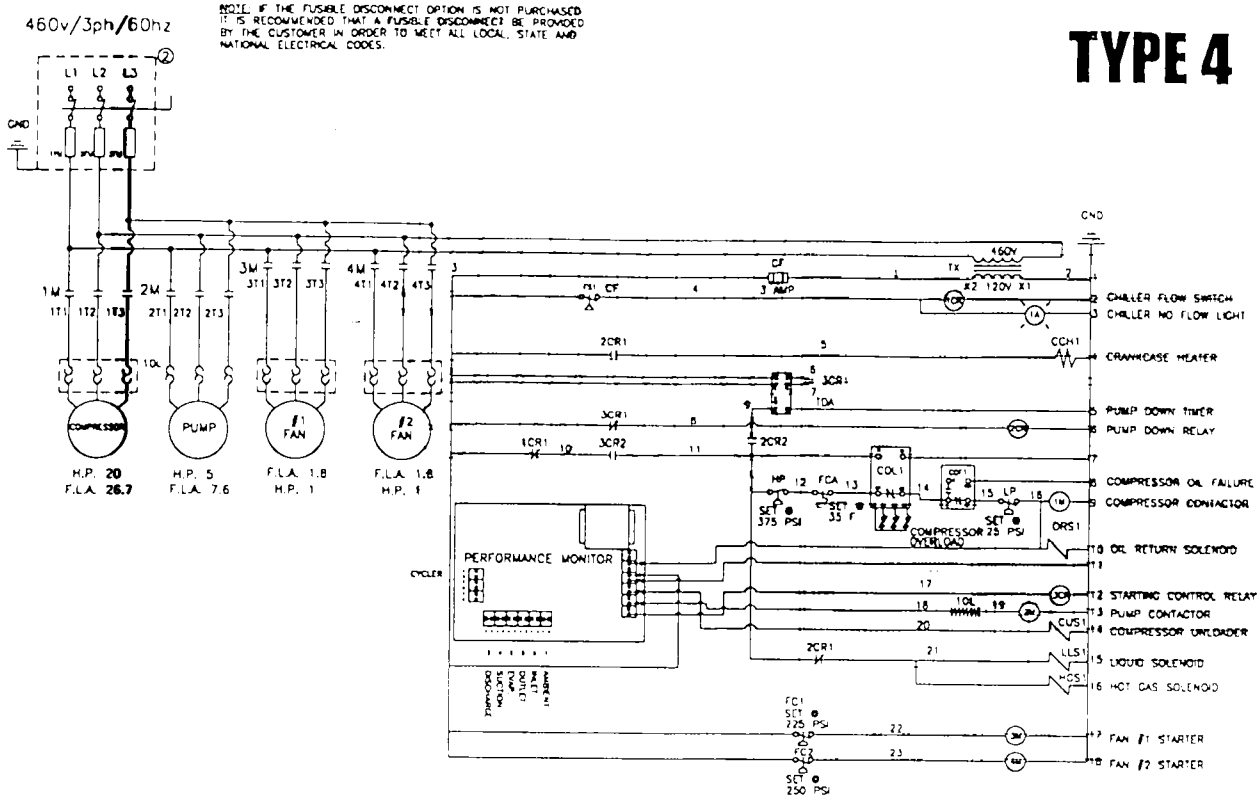


Figure 6. **Typi**cal Type 4 Cool Mass Chiller; 4 cylinder Discus compressor with pump; C2400A–C3000A

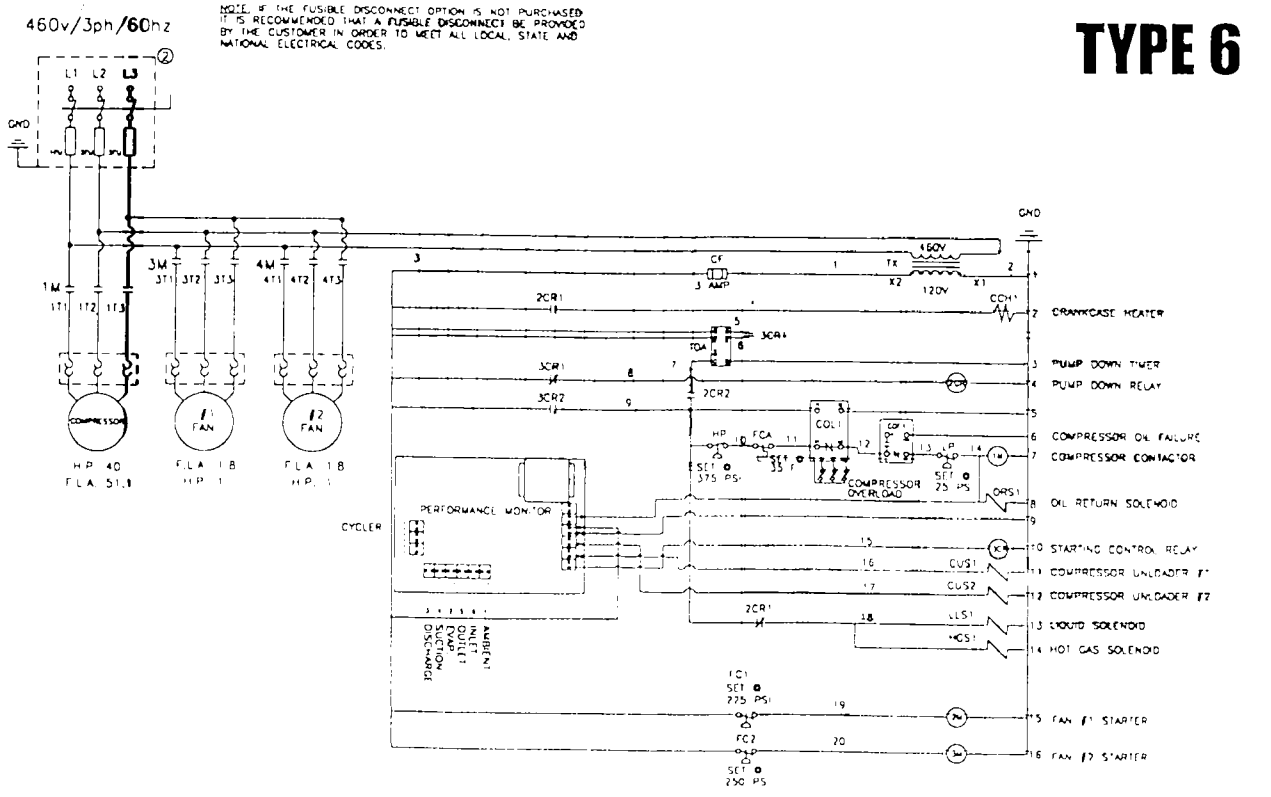


Figure 7. Typical Type 6 Cool Mass Chiller; 6 or 8 cylinder Discus compressor; C3600A–C7200A

RECOMMENDED SPARE PARTS

DESCRIPTION	C60	List Price	C90	List Price	C120	List Price
115/1/60 Compressor	A5-00020-34003	$690	A5-00010-10075	$630	-	-
230/1/60 Compressor	A5-00020-34004	$410	A5-00010-10076	$630	A5-00010-10100	$510
230/3/60 Compressor	A5-00010-10100	$510	A5-00010-10100	$510	A5-00010-10100	$510
460/3/60 Compressor	A5-00010-10102	$850	A5-00010-10102	$850	A5-00010-10102	$850
115V Fan motor	C4-00023-10050	$111	C4-00023-10075	$205	-	-
230V Fan motor	C4-00023-10051	$111	C4-00023-10076	$224	C4-00023-10076	$224
460V Fan motor	C4-00023-10102	$262	C4-00023-10102	$262	C4-00023-10102	$262
Fan blade	C4-00024-10050	$20	C4-00024-10075	$35	C4-00024-10075	$35
230 Contactor Assy.	C4-00020-10101	$185	C4-00020-10101	$185	C4-00020-10101	$185
460 Contactor Assy.	C4-00020-10102	$346	C4-00020-10102	$346	C4-00020-10102	$346
115V Relay starter	C4-00020-10050	$12	C4-00020-10075	$26	-	-
230V Relay starter	C4-00020-10051	$13	C4-00020-10076	$24	C4-00020-10100	$36
115V Start Capacitor	C4-00021-10050	$16	C4-00021-10075	$20	-	-
230V Start Capacitor	C4-00021-10051	$16	C4-00021-10076	$23	C4-00021-10076	$23
115V Overload	C4-00022-10050	$27	C4-00022-10075	$16	-	-
230V Overload	C4-00022-10051	$10	C4-00022-10076	$11	C4-00022-10076	$11
460V Transformer	A8-00110-20236	$134	A8-00110-20236	$134	A8-00110-20236	$134
High Low Pres. Switch	C4-00026-10100	$295	C4-00026-10100	$295	C4-00026-10100	$295
Ref. High Pres. Switch	D2-00020-15061	$96	D2-00020-15061	$96	D2-00020-15061	$96
Ref. Low Pres. Switch	D2-00020-15056	$100	D2-00020-15056	$100	D2-00020-15056	$100
Expansion Valve	D3-00010-22005	$65	D3-00010-22005	$65	D3-00010-22010	$75
Hot gas bypass	D3-00030-15000	$175	D3-00030-15000	$175	D3-00030-15000	$175
Ref. Filter dryer	D1-00020-15002	$19	D1-00020-15002	$19	D1-00020-15002	$19
Freeze Prevent Safety	D2-00030-19036	$185	D2-00030-19036	$185	D2-00030-19036	$185
Fan Cycle #1	C4-00010-52099	$55	C4-00010-52099	$55	C4-00010-52099	$55
Performance Monitor	C9-00020-41195	$995	C9-00020-41195	$995	C9-00020-41195	$995

DESCRIPTION	C180	List Price	C240	List Price	C360	List Price
230/3/60 Compressor	A5-00010-10150	$855	A5-00010-10200	$919	A5-00010-10200	$919
460/3/60 Compressor	A5-00010-10151	$970	A5-00010-10201	$990	A5-00010-10301	$1009
230V Fan motor	C4-00023-10150	$273	C4-00023-10200	$262	C4-00023-10300	$262
460V Fan motor	C4-00023-10151	$348	C4-00023-10201	$262	C4-00023-10301	$262
Fan blade	C4-00024-10100	$45	C4-00024-10200	$55	C4-00024-10300	$60
230 Contactor Assy.	C4-00020-10101	$185	C4-00020-10101	$185	C4-00020-10101	$185
460 Contactor Assy.	C4-00020-10102	$346	C4-00020-10102	$346	C4-00020-10102	$346
460V Transformer	A8-00110-20236	$134	A8-00110-20230	$130	A8-00110-20230	$130
Ref. High Pres. Switch	D2-00020-15061	$96	D2-00020-15061	$96	D2-00020-15061	$96
Ref. Low Pres. Switch	D2-00020-15056	$100	D2-00020-15056	$100	D2-00020-15056	$100
Expansion Valve	D3-00010-22015	$80	D3-00010-22020	$85	D3-00010-22030	$116
Hot gas bypass	D3-00030-15000	$175	D3-00030-15000	$175	D3-00030-15000	$175
Ref. Filter dryer	D1-00020-15002	$19	D1-00020-15003	$19	D1-00020-15003	$19
Suction Line Filter	-	-	D1-00010-15139	$55	D1-00010-15139	$55
Freeze Prevent Safety	D2-00030-19036	$185	D2-00030-19036	$185	D2-00030-19036	$185
Fan Cycle #1	C4-00010-52099	$55	C4-00010-52099	$55	C4-00010-52099	$55
Fan Cycle #2	-	-	C4-00010-52098	$37	C4-00010-52098	$37
Performance Monitor	C9-00020-41195	$995	C9-00020-41195	$995	C9-00020-41195	$995

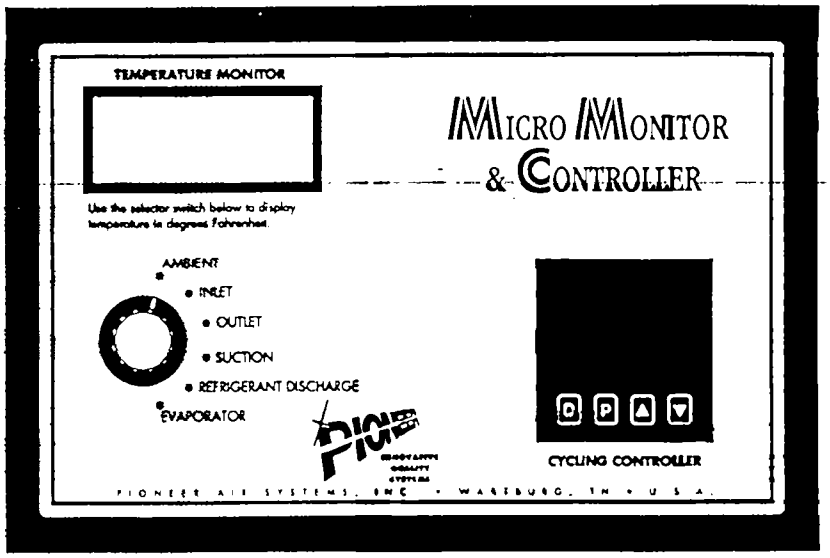
DESCRIPTION	C480	List Price	C600	List Price	C720	List Price
230/3/60 Compressor	A5-00020-34016	$940	A5-00020-34018	$1064	A5-00020-34018	$1064
460/3/60 Compressor	A5-00020-34017	$1052	A5-00020-34019	$1170	A5-00020-34019	$1170
230V Fan motor	C4-00010-52154	$280	C4-00010-52156	$285	C4-00010-52156	$285
460V Fan motor	C4-00010-52155	$275	C4-00010-52155	$275	C4-00010-52157	$250
Fan blade	C4-00010-52123	$61	C4-00010-52124	$55	C4-00010-52124	$55
230 Contactor Assy.	C4-00010-52090	$110	C4-00010-52090	$110	C4-00010-52090	$110
460 Contactor Assy.	C4-00010-52089	$85	C4-00010-52089	$85	C4-00010-52089	$85
460V Transformer	A8-00110-20236	$134	A8-00110-20236	$134	A8-00110-20236	$134
Ref. High Pres. Switch	D2-00020-15061	$96	D2-00020-15061	$96	D2-00020-15061	$96
Ref. Low Pres. Switch	D2-00020-15056	$100	D2-00020-15056	$100	D2-00020-15056	$100
Expansion Valve	D3-00010-15096	$125	D3-00010-15096	$125	D3-00010-15097	$130
Hot gas bypass	D3-00030-15000	$175	D3-00030-15000	$175	D3-00030-15000	$175
Ref. Filter dryer	D1-00020-15004	$25	D1-00020-15005	$61	D1-00020-15005	$61
Suction Line Filter	D1-00010-22030	$55	D1-00010-15139	$55	D1-00010-15139	$55
Freeze Prevent Safety	D2-00030-19036	$185	D2-00030-19036	$185	D2-00030-19036	$185
Fan Cycle #1	C4-00010-52099	$55	C4-00010-52099	$55	C4-00010-52099	$55
Fan Cycle #2	C4-00010-52098	$50	C4-00010-52098	$50	C4-00010-52098	$50
Performance Monitor	C9-00020-41195	$995	C9-00020-41195	$995	C9-00020-41195	$995

DESCRIPTION	C900	List Price	C1200	List Price
230/3/60 Compressor	A5-00020-34025	$1745	A5-00020-34030	$1855
460/3/60 Compressor	A5-00020-34026	$1838	A5-00020-34031	$1855
230V Fan motor	C4-00010-52162	$295	C4-00010-52162	$295
460V Fan motor	C4-00010-52167	$436	C4-00010-52167	$436
Fan blade	C4-00010-52168	$65	C4-00010-52169	$65
230 Contactor Assy.	C4-00010-52350	$114	C4-00010-52350	$114
460 Contactor Assy.	C4-00010-52360	$123	C4-00010-52360	$123
460V Transformer	A8-00110-20236	$134	A8-00110-20230	$135
Ref. High Pres. Switch	D2-00020-15061	$96	D2-00020-15061	$96
Ref. Low Pres. Switch	D2-00020-15056	$100	D2-00020-15056	$100
Expansion Valve	D3-00010-22050	$135	D3-00010-50943	$110
Hot gas bypass	D3-00030-15000	$175	D3-00030-15000	$175
Ref. Filter dryer	D1-00020-15005	$61	D1-00020-15005	$61
Suction Line Filter	D1-00010-15139	$55	D1-00010-15145	$75
Freeze Prevent Safety	D2-00030-19036	$185	D2-00030-19036	$185
Fan Cycle #1	C4-00010-52099	$55	C4-00010-52099	$55
Fan Cycle #2	C4-00010-52098	$50	C4-00010-52098	$50
Performance Monitor	C9-00020-41195	$995	C9-00020-41195	$995

NOTE: Prices, specifications and part numbers are subject to change. Consult your distributor or the manufacturer for current pricing and delivery.

MICRO MONITOR & CONTROLLER

C Series & CU Series Chillers



INNOVATIVE

QUALITY

SYSTEMS

MICRO MONITOR & CONTROLLER

The Micro Monitor & Controller is an analog controller that enables you to monitor temperature readings at six key locations by means of a selector switch. In addition, the Micro Monitor & Controller allows you to easily and conveniently set your unloader cycle ON and OFF settings.

Monitoring Temperatures

The temperature monitor displays the temperature at one of six locations: (1) ambient, (2) dryer inlet, (3) dryer outlet, (4) refrigerant suction, (5) refrigerant discharge, or (6) evaporator (dew point). To display a specific temperature, turn the selector switch knob until the marker on the knob points to the location that you wish to monitor. The LCD display will indicate the temperature in degrees Fahrenheit (Centigrade optional). To display the temperature of another location, simply turn the knob to the location you wish to monitor.

Controlling Cycle ON/OFF Settings

Press P (program). Display will alternate between *PROP* and *00*. If not, use the ▲ and ▼ buttons to adjust the reading to *00*.

Press P again. Display will alternate between *RL-1* and the Cycle 1 setting. Use ▲▼ to adjust to the desired Cycle 1 ON setting.

Press P again. Display will alternate between *RL-2* and the Cycle 2 setting. Use ▲▼ to adjust to the desired Cycle 2 ON setting.

Press P again. Display will alternate between *CNFP* and *NO*. Press ▲ four (4) times. Display will read *4-RL*. Press P nine (9) times. Display will read *RHYS* and display the desired differential temperature OFF setting. For example, if ON=*50* and *RHYS*=*4*, the unit will cycle OFF at 46°F (For centigrade controllers, if ON=*25* and *RHYS*=*2*, the unit will cycle OFF at 23°C). The OFF setting applies to both Cycle 1 and 2.

Press P again to alternate between *CNFP* and *NO*.

Press P again to end programming.

Green Display

Press D (display). %P illuminates (not used).

Press D again. Display indicates how far the system is from the Freeze Protect ON setting.

Press D again. Scale of temperature displays (°F or °C).

Press D again. Freeze Protect ON setting. This can be adjusted from 40 to 45°F (4 to 7°C) with the ▲▼ buttons. Freeze protect OFF is always 5°F (2°C) below this setting.

Red Display

The thermocouple temperature will be displayed in the proper scale (°F or °C).

01	illuminates when Freeze Protect is OFF
A1	illuminates when Cycle 1 is energized
A2	illuminates when Cycle 2 is energized

Display Accuracy

Accuracy ±2°F/±1°C between 60°F/17.5°C and 100°F/42.5°C ambient temperature. Accuracy decreases outside this range.

NOTE: *The two displays utilize independent probes and processors. Hence, a variance of a few degrees between the two readings*

REPLACEMENT PARTS

Part #	Description	List Price
C9-00020-40725	Electronic board & panel, °F	$895.00
C9-00020-40726	Electronic board & panel, °C	895.00

Prices subject to change without notice. Consult your local distributor for current pricing.

Information provided here is deemed current at time of publication. The company disclaims all liability for any errors resulting in loss or damage.

Pioneer Air Systems, Inc. & Pioneer Engineering, Inc.
210 Flatfork Road • Wartburg, TN 37887-3201 • Tel 423-346-6693 • Fax 423-346-3865

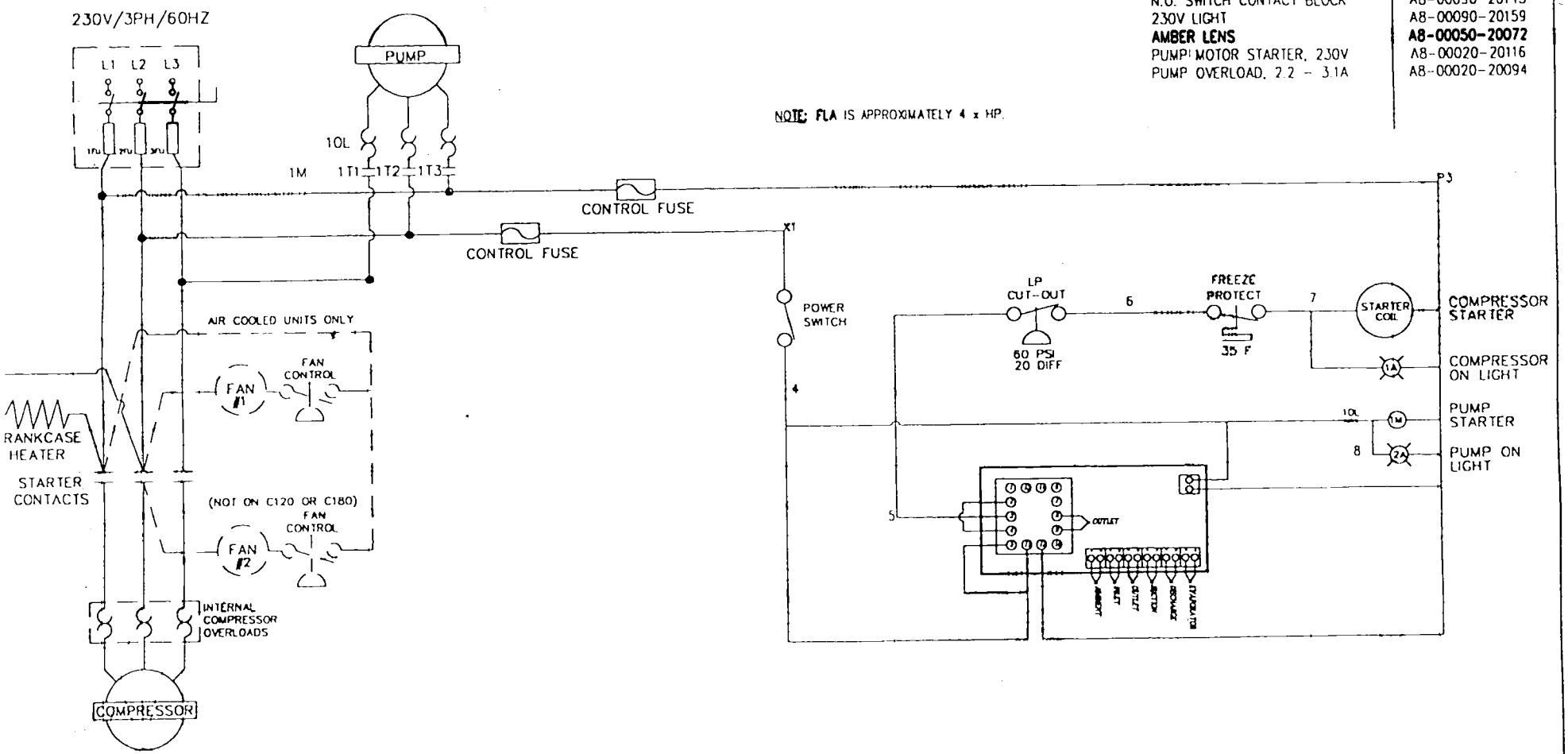
NOTE: A FUSIBLE DISCONNECT IS NOT INCLUDED.
IT IS RECOMMENDED THAT A FUSIBLE DISCONNECT BE PROVIDED BY THE CUSTOMER IN ORDER TO MEET ALL LOCAL, STATE AND NATIONAL ELECTRICAL CODES.

MODEL#	COMP. HP	TOTAL FAN HP	SUGGESTED PUMP HP*
C180	1.5	.33	.5

BILL OF MATERIALS

DESCRIPTION	PART NUMBER
CHILLER MONITOR BOARD, F, 230V	C9-00020-40727
TEMPERATURE CONTROLLER	D2-00030-48111
FREEZE PROTECTION SWITCH	D2-00030-19036
2 POSITION SELECTOR SWITCH	A8-00100-20132
N.O. SWITCH CONTACT BLOCK	A8-00090-20143
230V LIGHT	A8-00090-20159
AMBER LENS	**A8-00050-20072**
PUMP MOTOR STARTER, 230V	A8-00020-20116
PUMP OVERLOAD, 2.2 - 3.1A	A8-00020-20094

NOTE: FLA IS APPROXIMATELY 4 x HP.



PIONEER AIR SYSTEMS, INC.	DESCRIPTION: C180 W/PUMP ELECTRICAL SCHEMATIC, 230VAC/3PH/60HZ	SCALE: NONE	DR. BY: DSC	DRAWING NUMBER	REVISION
		DATE: 1/27/99	CK. BY:	65113-E1	D

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OZONIA

Ozonia North America
491 Edward H. Ross Drive
Post Office Box 455
Elmwood Pk, NJ 07407
Tel: 201-794-3100
Fax: 201-794-3358

OZONE SYSTEM

SHOP DRAWING SUBMITTAL

for

Osmose Wood Preserving Inc.

Buffalo, New York

by

OZONIA NORTH AMERICA

CONTRACT No. 0012-587
File No. 219

April 1999

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GENERAL INFORMATION

	Item	Ref.	Rev.
2.1	Ozone System Warranty	-	-
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OZONIA®

Ozonia North America
491 Edward H. Ross Drive
Post Office Box 455
Elmwood Pk, NJ 07407
Tel: 201-794-3100
Fax: 201-794-3358

WARRANTY

Customer: Osmose Wood Preserving
980 Ellicott Street
Buffalo, NY 14209
(716) 882-5905

Date: April 14, 1999

Contract Number: 0012-587
Purchase Order: 99-10-042
Project Name: Osmose Wood Preserving Inc.
Project Location: Buffalo, New York

Ozonia North America provides a limited warranty on all products of its manufacture. The warranty period is one (1) year for all parts, and five (5) years on dielectrics. Warranty commences from date of equipment delivery and is valid for twelve (12) months (sixty (60) for dielectrics). During the warranty period Ozonia shall provide a replacement for all parts that fail under normal operating conditions as described by the manufacturer. Warranty does not include freight, labor or transportation charges. This warranty does not cover items that fail due to abnormal operating conditions, operator neglect, improper feed gas, process flow backup or other misuse of equipment.

Material Safety Data Sheet

IDENTITY (As Used on Label and List):

OZONE (Gaseous)

Section I - General

Description: Occurs in the atmosphere from UV light action on oxygen at high altitudes where it acts as an atmospheric shield against UV light penetration. Derived by passage of air or oxygen between electrodes across which is maintained an alternating high voltage potential, or by heating silver difluoride in a dilute aqueous acid. It may also be found as a by-product in welding areas, in corona discharges by ultraviolet radiation and around high voltage equipment. Ozone's primary use is as an oxidizing agent. Also used as a disinfectant for air and water, in bleaching textiles, paper pulp, waxes, starch, and sugar. It is used in organic synthesis, processing certain perfumes, vanillin, camphor, peroxide production, rapid drying of varnish and printing inks. It is also used for mold and bacteria control in cold storage rooms, and refining mineral oils and their derivatives. Considered for deodorizing and disinfecting certain premises and purifying air. It is present in air at up to about 0.05 ppm at sea level (variable).

Cautions: A powerful oxidizing agent, ozone generally exists as a gas and is highly chemically reactive. Inhalation produces various degrees of respiratory effects from irritation to pulmonary edema (fluid in lungs) as well as affecting the eyes, blood, and central nervous system. Ozone can exist as a liquid and will cause severe burns when in contact with skin or mucous membranes.

Manufacturer: Onsite Generation
Ozonia North America
491 Edward H. Ross Drive
P.O. Box 455
Elmwood Park, NJ 07407

Emergency Telephone Number: 201-794-3100
Telephone Number for Information: 201-794-3100

Last Revision: 12/01/97

Section II - Ingredients/Occupational Exposure Limits

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA	ACGIH TLV	Other Limits	Recommended	% (optional)

Other Designations: CAS No. 10028-15-6, triatomic oxygen

1991 OSHA PELs
8-hr TWA: 0.1 ppm vol. (0.2mg/m^3)
15-min STEL :0.3 ppm vol. (0.6mg/m^3)

1991-1992 ACGIH TLVSee attached ANSI/ASTM 591 E -
Ceiling: 0.1 ppm (0.2 mg/m^3) "Safety and Health Requirements to Occupational Exposure to Ozone" for additional information

1990 IDLH
10 ppm

1990 DFG (Germany) MAK 1990 NIOSH REL
TWA:0.1 ppm (0.2mg/m^3) Ceiling: 0.1 ppm vol. (0.2mg/m^3)
Category 1: Local Irritant
Peak Exposure Limit: 0.2ppm
5 min momentary value, 8 per shift

Section III – Physical/Chemical Characteristics

Boiling Point:	-169 F (-111 C)	**Molecular Weight:**	48
Vapor Pressure:	>1 ATM	**Density:**	2.144 g/L (gas) @ 32 F (0 C)
Vapor Density (AtR =1):	1.6555	**Odor Threshold:**	0.0076 to 0.25 ppm
Melting Point:	-315 F (-193 C)	**Solubility in Water:**	0.49 mL @ 32 F (0 C), 3 ppm @ 20 C

Appearance and Odor: Colorless to blue gas (greater than 169 F) with a pungent odor above 0.01 ppm and disagreeable above 1-2 ppm. Olfactory fatigue develops rapidly.

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Section IV – Fire and Explosion Hazard Data

Flash Point: Nonflammable

Extinguishing Media: Use extinguishing agents suitable for surrounding fire or large amounts of water spray.

Special Fire Fighting Procedures: Wear a self contained breathing apparatus (SCBA) with a full facepiece operated in pressure demand or positive pressure mode. Discontinue production and if possible, without risk, remove container from the fire area. Do not release runoff from fire control methods to sewers or waterways.

Unusual Fire and Explosion Hazards: Decomposition of ozone into oxygen can increase strength of fire.

Section V – Reactivity Data

Ozone is unstable at normal temperatures and readily decomposes to diatomic oxygen. Ozone can accelerate the decomposition of rubber.

Description: Ozone is an oxidizing agent for both organic and inorganic materials; it is a stronger oxidizer than O2, but weaker than fluorine. Some of its reaction products, such as ozonides formed from unsaturated hydrocarbons, can be highly explosive.

Conditions to Avoid: Keep away from heat, flame, organics, strong reducing agents and combustible materials, such as grease and oil.

Incompatibility (Materials to Avoid): Acetylene, Alkyl Metals, Benzene, Aruline, Bromine, Charcoal + Potassium Iodide + Friction, Carbon, Isopropylidene compounds, Dicyanogen, Disthyl Ether, 1-2-3 Dichloro-2-Butane; 1,1-difluoroethylene; Hydrogen bromide, 2-Methyl-1, 3-Butadiene; Nitrogen, Nitrogen Oxide, Nitrogen Trichloride, Fluourothylene, Liquid Hydrogen (with solid O3), Ethylene (at -238 F/-150 C), (Carbon Monoxide, Ammonia, or Phosphine at 32 or -108 F/0 or –8 C), Liquid Oxygen Difluoride + Gaseous Hydrogen, Silica gel, Stibine (at -130 F/-90C), Tetrafluorohydrazine, and all other reducing materials, organic or inorganic. Ozone reacts with non-saturated organic compounds to produce ozonides which are unstable and may decompose with explosive violence.

Decomposition or Byproducts: Catalytic or Thermal oxidative decomposition of ozone accelerates ecomposition to oxygen.

Section VI – Health Hazard Data

Route(s) of Entry: Inhalation? Yes Skin? (Liquid Ozone)?

Health Hazards (Acute and Chronic): Ozone's toxic effects are largely due to its strong oxidative ability. Ozone has a radiomimeric structure (like ionizing radiation) and therefore has no true threshold limit and no exposure, no matter how small, is 'theoretically' without effect. Since ozone is only slightly water soluble, it does not solubilize in the mucous membranes along the respiratory tract but rather passes straight to the smallest bronchioles and alveoli. Exercise increases inhaled ozone's toxicity and olfactory fatigue can rapidly develop. Initial small exposures may reduce cell sensitivity and/or increase mucous thickness producing an adaptation to low levels of ozone. This is shown by the greater reaction of newly exposed individuals as compared with those previously exposed to similar levels. Industrial exposures are most likely due to leakage from ozone using processes and from exposure to high voltage electrical equipment and electrical welding. Acute damage from ozone appears to be mainly from its oxidizing effect on contact with tissue, but it may have chronic effects on lung tumor acceleration (see attached for further information).

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Carcinogenicity: No
Medical Conditions Generally Aggravated by Exposure: Respiratory Disorders
Target Organs: Blood, Respiratory and Central Nervous System
Emergency and First Aid Procedures: Remove from air containing ozone; get prompt medical help; administer oxygen if necessary.

Eye contact: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Inhalation: Remove exposed person to fresh air, support breathing, get medical help, and administer 100% humidified oxygen as needed.

Ingestion: Highly unlikely since ozone is a gas until -169 F

After first aid: get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Detection of lactate dehydrogenase in the blood may indicate increased lung permeability due to ozone damage. Administration of 100% oxygen may be all that is needed to relieve symptoms.

Signs and Symptoms of Exposure: Exposure above 0.1 ppm produces headaches as well as irritation of the respiratory tract, but symptoms subside when exposure stops. High concentrations and/or excessive duration of exposure above the TLV can produce nausea, pain in chest, cough, dysphea, reduced visual acuity, fatigue, and pulmonary edema. Inhalation of >20 ppm for an hour or more (or 50 ppm for 1/2 hour) can be fatal. Symptoms of edema from excessive exposure can be delayed one or more hours. Inhalation can cause nose, throat and respiratory tract irritation; difficulty breathing, visual disturbances, watering eyes, headaches, decreased pulse rate with a fall in blood pressure, lack of coordination, chest pain, substernal soreness, and fatigue. By analogy to animals, severe exposures cause hemorrhage, pulmonary edema (fluid in lungs), and death. Skin contact with liquid ozone can cause frostbite.

Section VII – Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled:

1) Discontinue Production
2) Properly isolate and vent area
3) Immediately notify personnel
4) Deny entry
5) Stay upwind
6) Follow applicable OSHA regulations

Waste Disposal Method: Consult Federal, State, and Local Regulations for acceptable disposal methods. Contact a licensed contractor for detailed recommendations.

Precautions to Be Taken in Handling and Storage: Ensure proper training for personnel. Establish evacuation plan prior to emergency condition. Where ozone is generated, or used, explosion hazard and health hazards will exist and must be guarded against by proper planning equipment, training, and work practices. Provide ventilation to dilute and disperse small amounts of ozone into the atmosphere to below OSHA PELs. Follow Federal, State, and Local regulations.

Other Precautions: Follow Federal, State, and Local regulations

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Section VIII – Control Measures

Respiratory Protection(Specify Type): Self Contained Breathing Apparatus; MICA/NIOSH approved.
Ventilation **Local Exhaust:** Yes **Special**
Mechanical (General): Yes **Other**
Protective Gloves: Plastic rather than rubber
Eye Protection: Wear protective eyeglasses or chemical safety goggles.
Other Protective Clothing or Equipment: N/A for gaseous ozone
Work/Hygienic Practices: Good, standard industry practices

Section IX – Special Precautions and Comments

Storage Requirements: Prevent physical damage to ozone containing equipment. If stored in containers (generally as a liquid), store containers in refrigerated areas away from reducing agents and flammable materials such as iron, copper, or chromium that may catalyze decomposition. Suitably insulate all electrical equipment and electrically ground and bond all equipment used in ozone manufacture, use, storage, transfer, and shipping.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

Sources:
ANSI/ASTM E 591 - 77, "Standard Practice for Safety and Health Requirements Relating to Occupational Exposure to Ozone"
MSDS collection, sheet #34: Ozone, Genium Publishing Company

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CHECKED:	TITLE:			SHT:
B.S. 4.7.98	Ozonia's Material Safety Data			4 of 4
APPROVED: B.S. 4.7.98	OZONIA · OZONIA NORTH AMERICA 491 EDWARD H. ROSS DRIVE ELMWOOD PARK, NJ 07407	A	DWG No. 14000-77-0012	REV: -

OZONE SYSTEM

	Item	Ref.	Rev.
A1	Ozone System Main Components	-	-
A2	Ozone System General Description	-	-
A3	Ozone System Drawings		
	a. Flow Diagram	B12587-77-0002	-
	b. Process & Instrumentation Diagram	B12587-77-0001	-
	c. Electrical Line Diagram	B12587-77-0201	-

A1. Ozone System Main Components

a. One (1) Ozonia OZAT CFS 6 Ozone Generator
b. One (1) Atlas Copco GA11 Rotary Screw Compressor
c. One (1) AirSep AS-250 Oxygen Generator
d. One (1) AirSep T-60 Surge Tank, 60 Gallon, Vertical, ASME rated
e. One (1) ATI Ambient Oxygen/Ozone Leak Detector
f. One (1) IN USA High Concentration Ozone Monitor
g. One (1) Panametrics Dewpoint Monitor

A2. Ozone System General Description

The ozone system is intended to continually generate ozone gas for the water treatment process. The OZAT CFS 6 Ozone Generator uses the corona discharge principle to produce ozone from dry (-76°F dewpoint) oxygen supplied by the AS-250 Oxygen Generator. The AS-250 uses molecular sieve to separate oxygen and nitrogen from compressed air supplied by the GA11 Rotary Screw Compressor.

The OZAT CFS 6 ozone generator must be turned on locally at the control panel after which a remote signal can be used for on/off control.

The CFS 6 Ozone Output can be adjusted from 5% to 100% of rated output. LOCAL or REMOTE ozone output control can be selected with a Selector Switch on the OZAT CFS 6 front control panel. In the LOCAL position ozone output is adjusted with the setpoint switch and display on the front panel. In the REMOTE position, output is adjusted with a 4 to 20 mA feedback signal from the plant control system (provided by others).

The AS-250 regulates the oxygen supply pressure to the ozone generator to a constant 45 PSIG. The ON/OFF command is executed at the oxygen generator local control panel. An AUTO/MANUAL selector switch allows the AS-250 to run continuously in the MANUAL position or to cycle with demand in the AUTO position.

The Ozone/Water contact system is provided by others.

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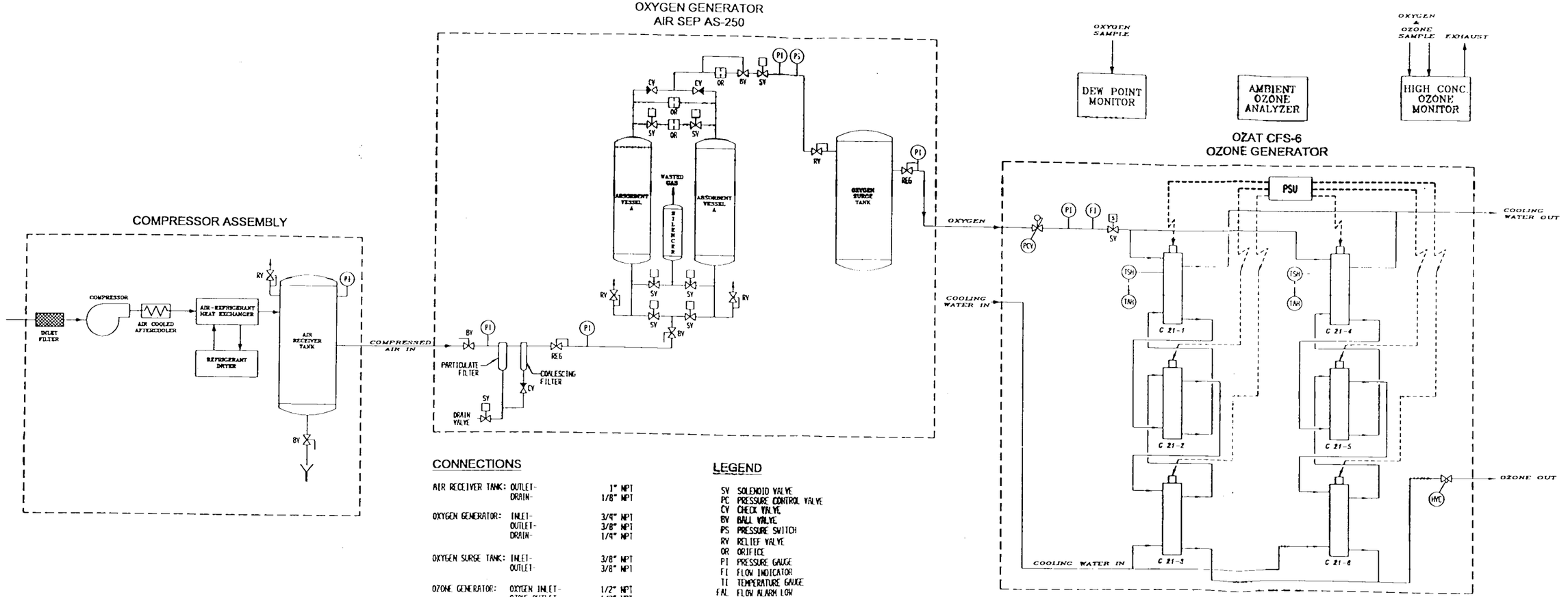
NOTES:

INSTALLATION OF ALL EQUIPMENT ITEMS IS BY OTHERS.

INTERCONNECTING PIPING, WIRING AND VALVING IS PROVIDED AND INSTALLED BY OTHERS.



CONNECTIONS

AIR RECEIVER TANK:	OUTLET-	1" NPT
	DRAIN-	1/8" NPT
OXYGEN GENERATOR:	INLET-	3/8" NPT
	OUTLET-	3/8" NPT
	DRAIN-	1/4" NPT
OXYGEN SURGE TANK:	INLET-	3/8" NPT
	OUTLET-	3/8" NPT
OZONE GENERATOR:	OXYGEN INLET-	1/2" NPT
	OZONE OUTLET-	1/2" NPT
	COOLING WATER IN/OUT-	1/2" NPT

LEGEND

SV	SOLENOID VALVE
PC	PRESSURE CONTROL VALVE
CV	CHECK VALVE
BV	BALL VALVE
PS	PRESSURE SWITCH
RV	RELIEF VALVE
OR	ORIFICE
PI	PRESSURE GAUGE
FI	FLOW INDICATOR
TI	TEMPERATURE GAUGE
FAL	FLOW ALARM LOW
FSL	FLOW SWITCH LOW
PAL	PRESSURE ALARM LOW
PSL	PRESSURE SWITCH LOW
TAH	TEMPERATURE ALARM HIGH
TSH	TEMPERATURE SWITCH HIGH
TAL	TEMPERATURE ALARM LOW
TSL	TEMPERATURE SWITCH LOW

REV.	DESCRIPTION	DRAWN	APPD.	DATE

SCALE: NONE
DRAWN: 04.08.99 Val
CHECKED: 04.08.99 ML
APPROVED:

TITLE: OZONE SYSTEM PROCESS & INSTRUMENTATION DIAGRAM

OZONIA NORTH AMERICA
Post Office Box 455
Elmwood Park, New Jersey 07407

SIZE: B
DWG. NO.: 12587-77-0001
SHT.: 1 OF 1
REV.: ---

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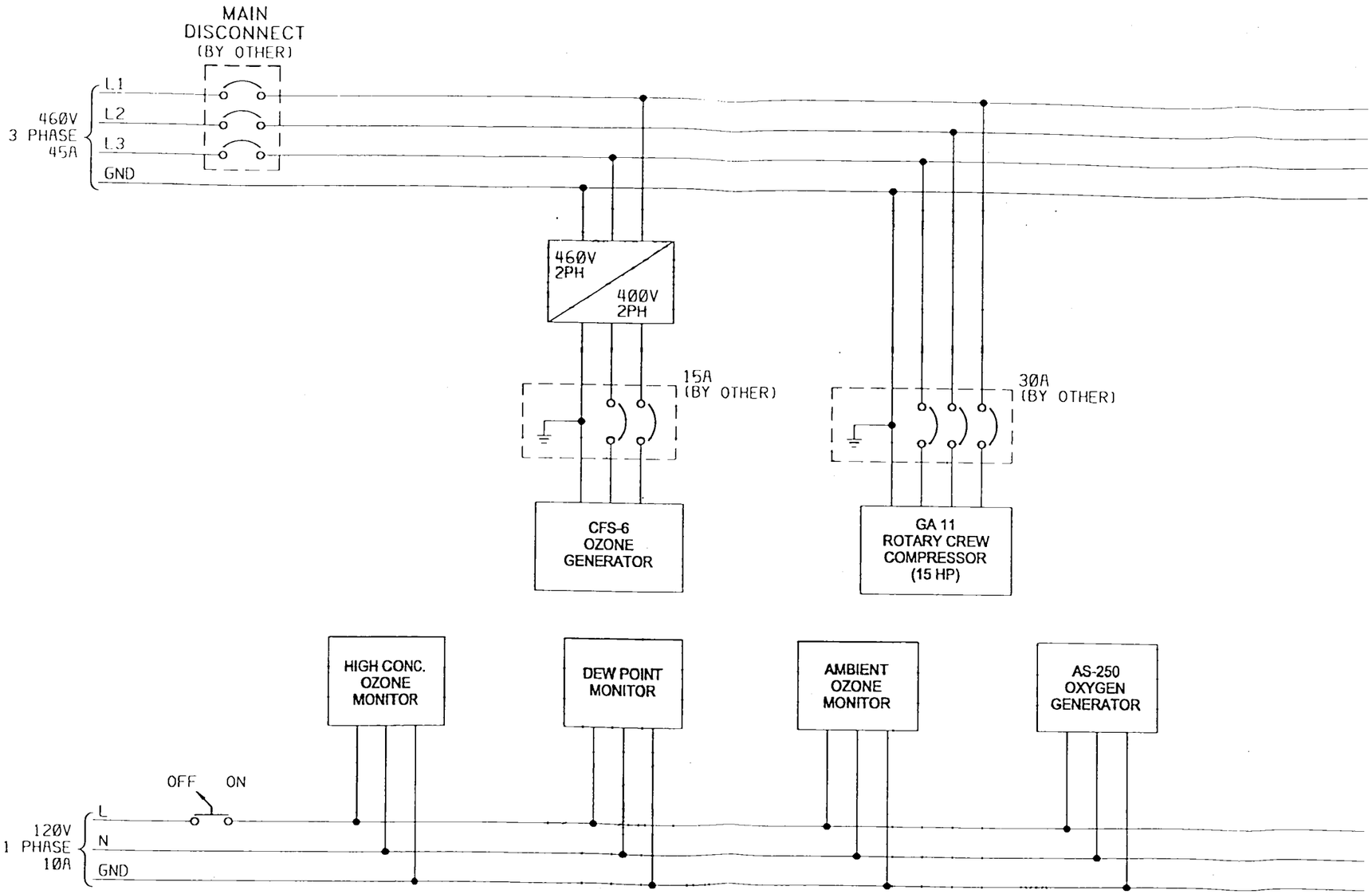


REV.	DESCRIPTION	DRAWN	APPD.	DATE

SCALE: NONE
DRAWN: 04.12.99 Val
CHECKED: 04.12.99 DW
APPROVED:

TITLE: ELECTRICAL LINE DIAGRAM --

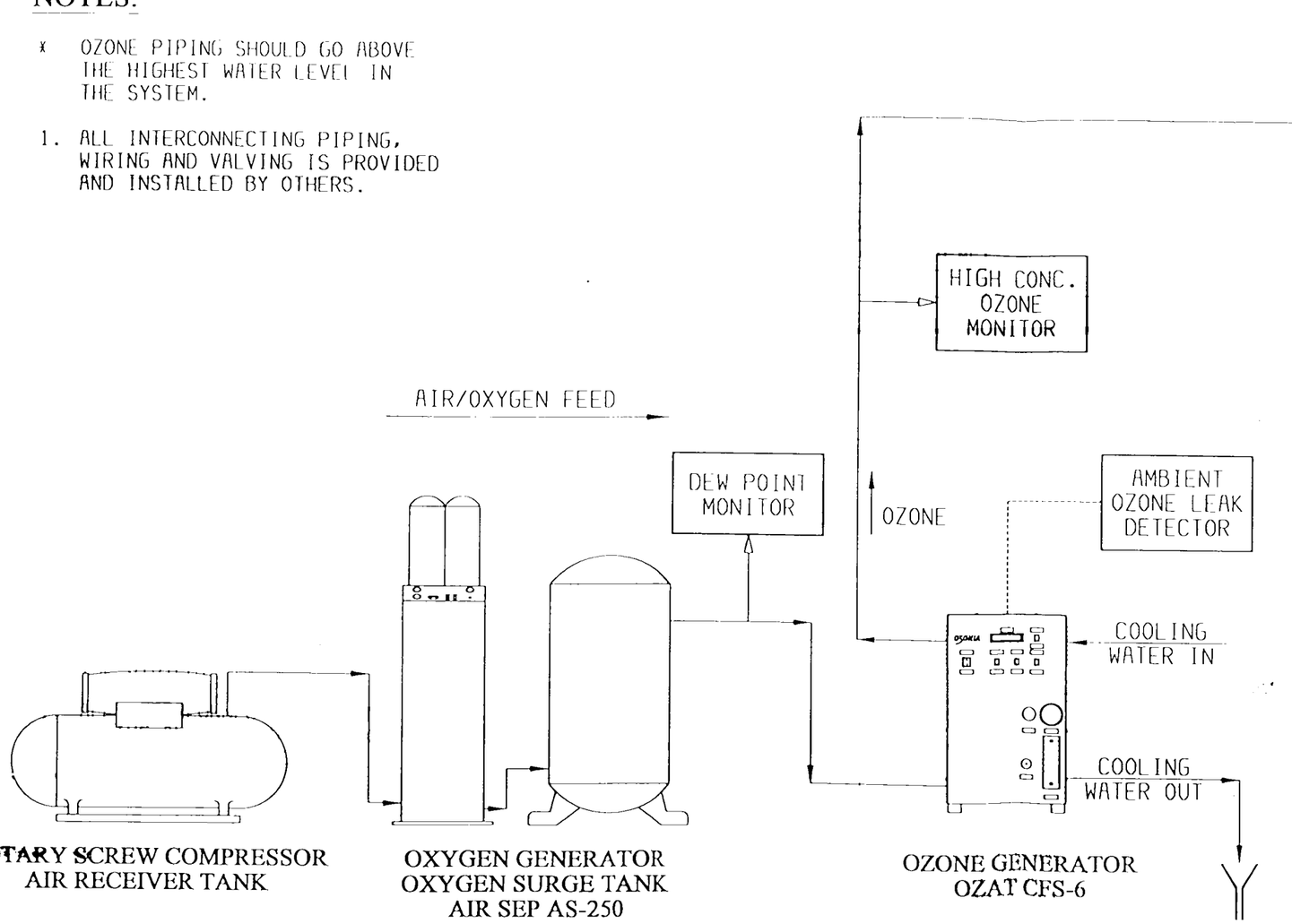
OZONIA NORTH AMERICA
Post Office Box 455
Elmwood Park, New Jersey 07407

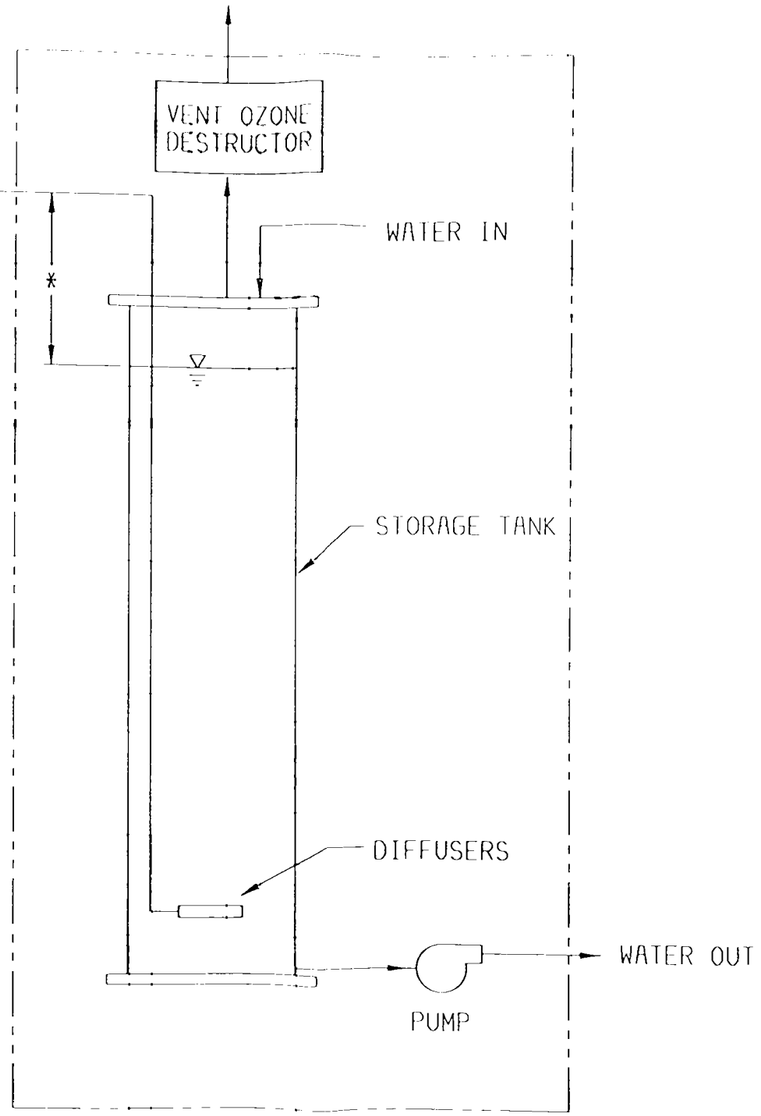
SIZE: B
DWG. NO.: 12587-77-0050
SHT.: 1 OF 1
REV.: ---

NOTES:

* OZONE PIPING SHOULD GO ABOVE THE HIGHEST WATER LEVEL IN THE SYSTEM.

1. ALL INTERCONNECTING PIPING, WIRING AND VALVING IS PROVIDED AND INSTALLED BY OTHERS.





TYPICAL OZONE CONTACT SYSTEM
(NOT PROVIDED)

REV.	DESCRIPTION	DRAWN	APPD.	DATE

SCALE: NONE
DRAWN: 04.08.99 Val
CHECKED: 04.08.99 ML
APPROVED:

TITLE: CONCEPTUAL FLOW TREATMENT DIAGRAM --

OZONIA
OZONIA NORTH AMERICA
Post Office Box 455
Elmwood Park, New Jersey 07407

SIZE: B
DWG. NO.: 12587-77-0002
SHT.: 1 OF 1
REV.: ----

OZONE GENERATOR

B1. Specifications

One (1) OZAT CFS 6 Ozone Generator is provided along with a 5 KVA, 480V primary x 400V secondary step down transformer shipped loose, to be field mounted (by others). Transformer dimensions and weight are 19" (h) x 16" (w) x 14" (d) and 90 lbs.

General

Output:	26 Lbs. ozone per day
Concentration:	6% by weight from oxygen
Dimensions:	15" (w) x 34" (d) x 25" (h)
Weight:	220 Lbs.

Connections:

Ozone Generator Power:	400V, 2P, 50/60 Hz
Transformer Power:	480V, 3P, 60 Hz
Oxygen:	1/2" NPTF
Ozone:	1/2" NPTF
Cooling Water In/Out:	1/2" NPTF

Oxygen Feed Gas:

Quality:	90% Purity (minimum)
Nitrogen:	200 ppm (minimum)
Dew Point:	-76°F or better @ 14.7 PSIA
Oil Content:	0.1 ppm (maximum)
Hydrocarbons:	15 ppm (maximum)
Particle Contamination:	1 µm (maximum)
Inlet Pressure:	29 to 101 PSIG
Temperature:	41 to 104 °F
Operational Pressure:	20.3 PSIG
Gas Flow:	26 to 260 SCFH (adjustable)

Cooling Water:

Quality:	6 to 8 pH
Chloride Content:	50 mg/l (maximum)
Inlet Temperature:	36 to 86 °F
Operational Pressure:	29 to 87 PSIG
Flow:	3 GPM @ 55°F

Environmental Conditions

Ambient Temperature:	41 to 104 °F Operational
Humidity:	≤ 65% annual average
Condensation:	Avoid
Protection Class:	IP 42 dust-free, dry environment
Vibration/Shock:	vibration-free environment
Heat Dissipation:	500 Watts (approx.)

B2. Electrical Data

INFORMATION:

The connection to the mains power is made using a plug and socket (L1/L2/PE). The line fuse must be sufficient to meet the local regulations and our requirements.

CFS-6A		
Fuse 6.3x32 mm (fast blow)	12.5	A
Line voltage, single phase	2x 400 ±10%	V_{AC}
Line frequency	48...63	Hz
Line current	11	A_{AC}
Line power consumption	4.25	kW
Line power factor	0.99	cosφ
DC-Power measurement Pe	160...4000	W_{DC}

External set-value signal: 4...20 mA (= 0...100%), (potential free)

- Internal resistance: 150 Ω
- Max. permissible current: 25 mA
- Max. permissible common mode voltage: ≤30 V

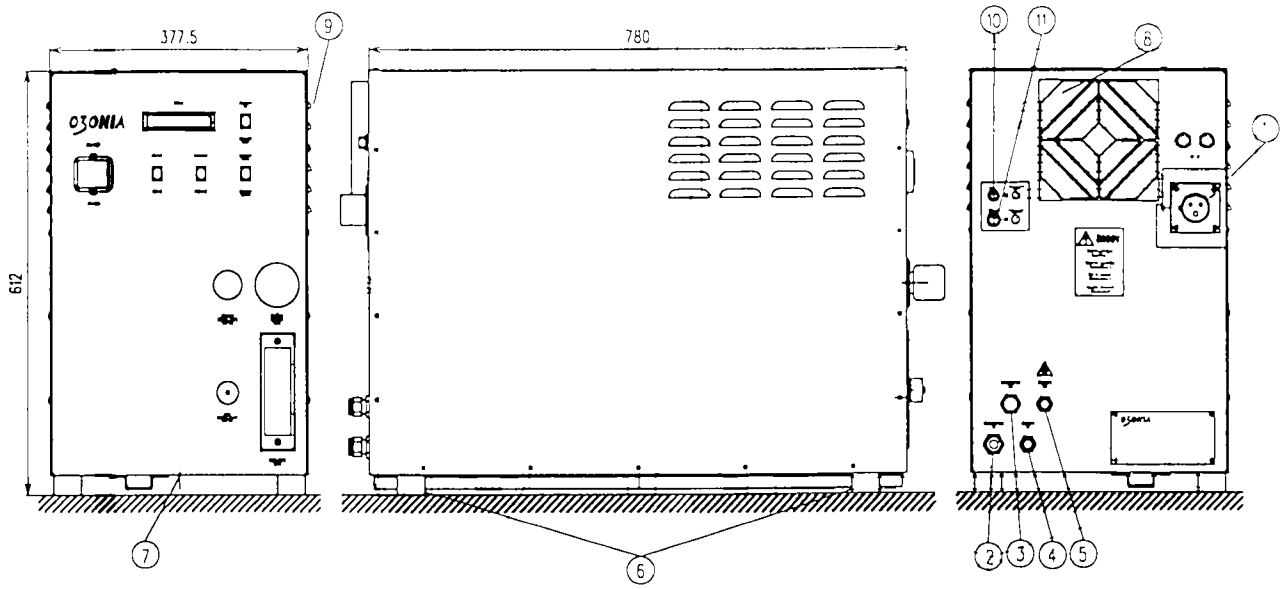
Signals to master controller: potential free contacts (rating ≤50 $V_{AC/DC}$, 1 A)

- Supply ON
- Collective alarm
- Set-value REMOTE

Voltages in the equipment:

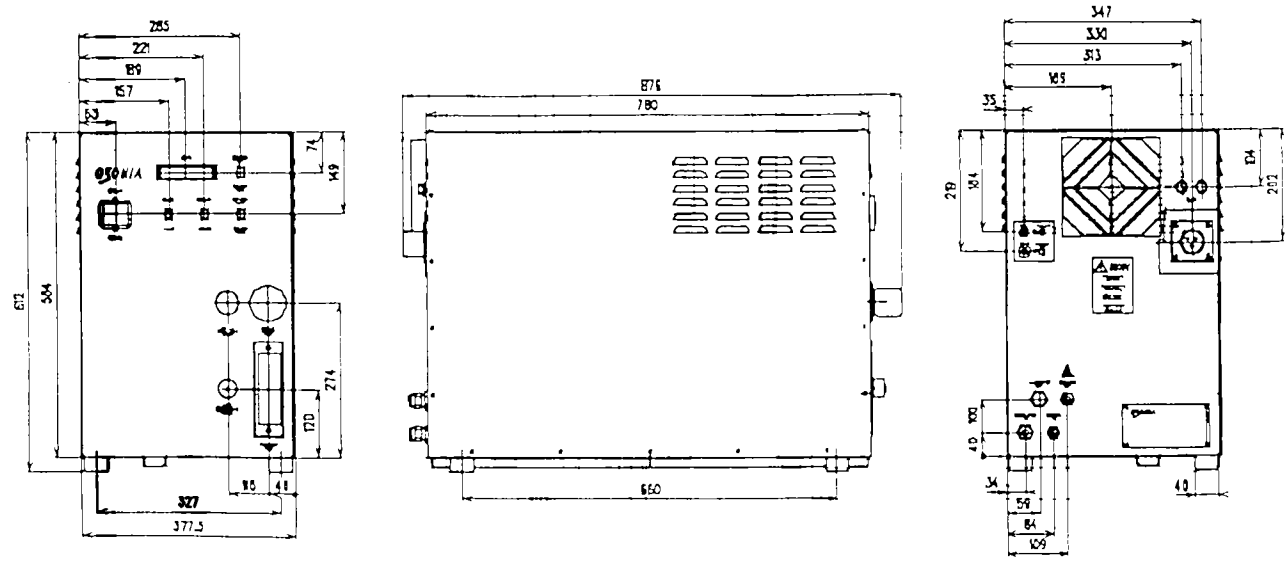
- In the intermediate cicuit: 650 V_{DC}
- At the ozone generator (13E1): ~5 kV, 1425 Hz

B3. Dimensions

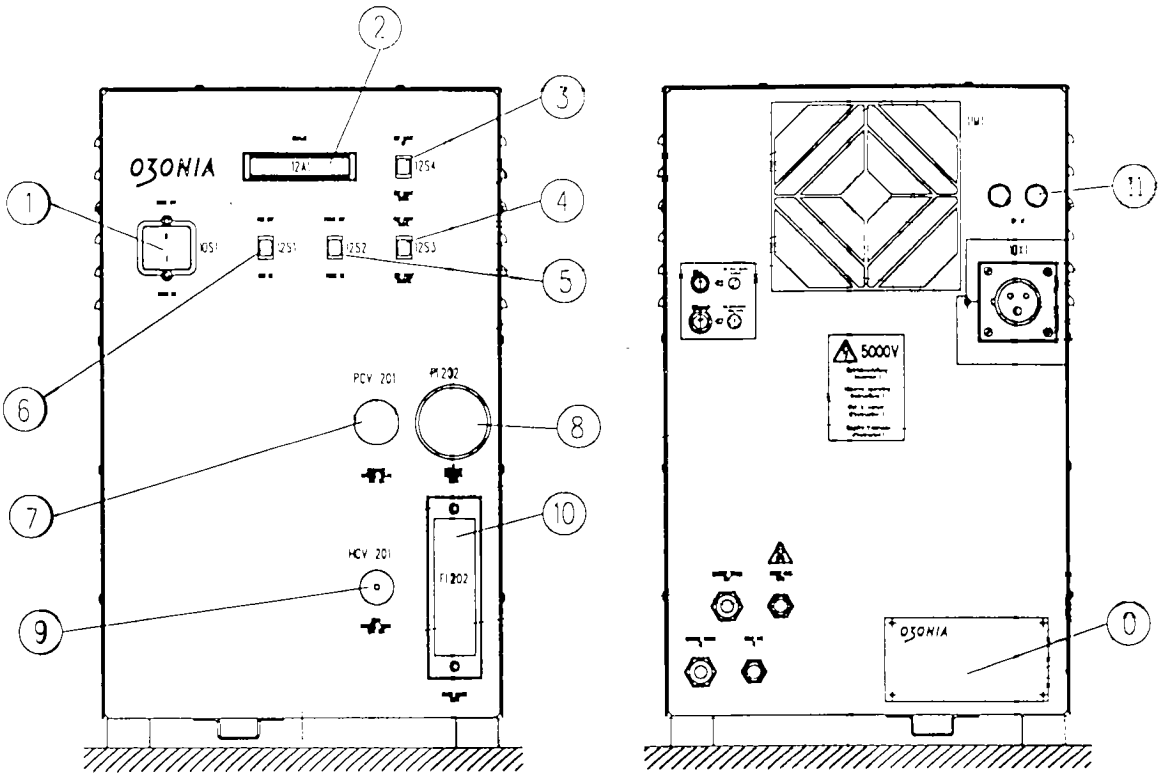


Caption:

1	Mains socket
2	Cooling medium inlet
3	Cooling medium outlet
4	Feedgas inlet
5	Ozone gas outlet
6	Rubber feet
7	Condensaite drain
8	Air fan inlet (minimum clearance 200mm)
9	Air outlet (minimum clearance 200mm)
10	Plug (X2) for external set value
11	Plug (X7) for external signalisation



B4. Control Panel

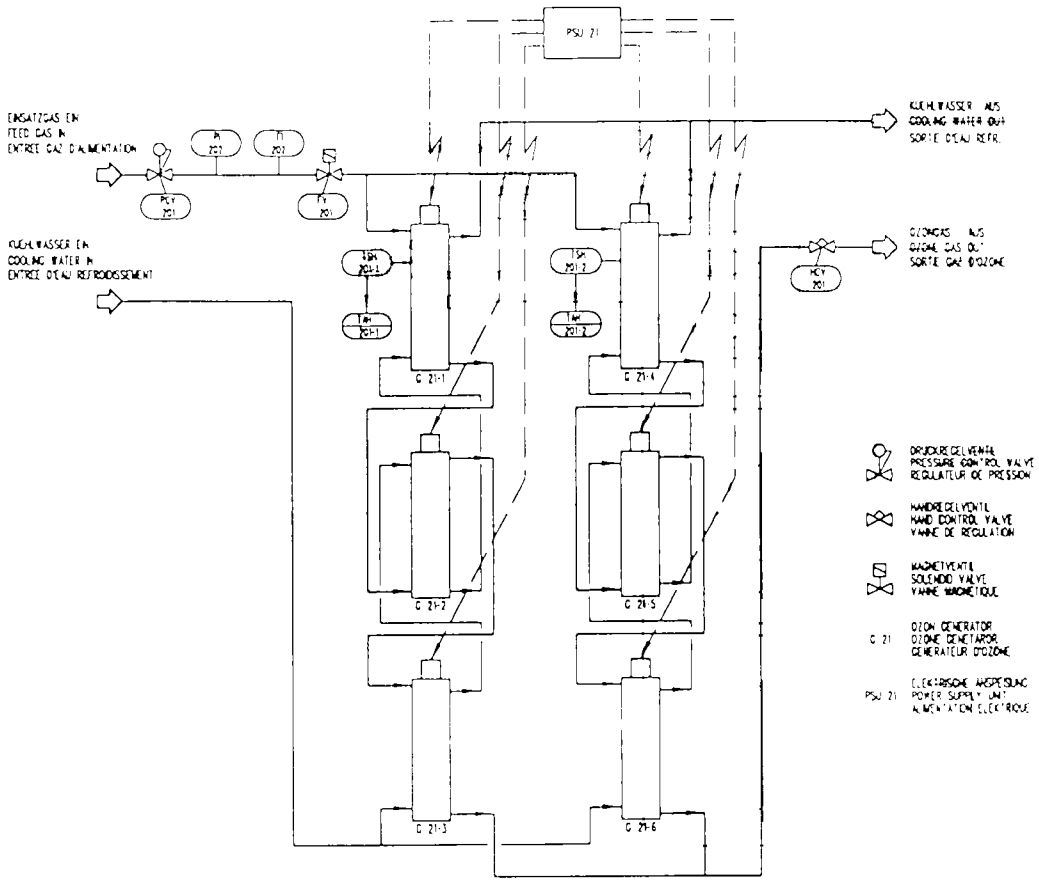


Caption:

0		Rating plate with CE marking
1	10Q1	Mains switch, red: "MAINS ON" **also EMERGENCY STOP**
2	12A1	Display: DC-Power Pe, Mode, Service hour counter, Failures
3	12S4	Switch, black: "SET POINT LOCAL UP/DOWN"
4	12S3	Switch, black: "SET POINT REMOTE"
5	12S2	Switch, black: "PURGE ON"
6	12S1	Switch, black: "POWER SUPPLY ON"
7	PCV201	Pressure control valve
8	PI202	Gas pressure gauge
9	HCV201	Hand operated control valve
10	FI202	Gas flow meter
11	10F1/F2	Fuse 6.3x32mm

The set value the DC rating Pe, which effects the ozone production rate, can be adjusted locally or remotely. The gas flow, however, can only be regulated on the apparatus.

B5. Process & Instrumentation Diagram



Caption:

PCV201	Pressure control valve
FV201	Solenoid valve
PI202	Gas pressure display
FI202	Gas flow display
G21-1...6	Ozone generator
TSH201-1...2	Temperature monitor switch
TAH201-1...2	Temperature alarm, high
HCV201	Hand operated control valve
PSU21	Electrical power supply

Re: Your P.O. [redacted]
Attn: Derek

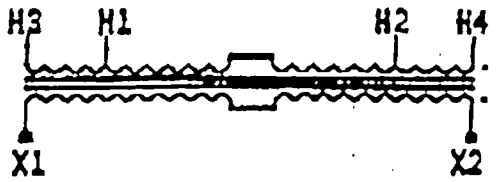
P/N P0127091

REX MANUFACTURING
DIVISION OF TRANSFACTOR INDUSTRIES INC.
25 BAYWOOD ROAD, REXDALE, ON M9V 3Y8 TEL: (416) 747-7818 FAX: (416) 747-1934

PRELIMINARY SPECIFICATION SHEET
ISOLATION TRANSFORMER
TYPE: ANN-SELF COOLED

CAT. NO.:	SCSHX/E12
KVA:	5
H.V.:	480 V
L.V.:	400 V
PHASE:	1
HZ:	60
WEIGHT:	90 Lbs
INSUL. CLASS:	220°C
TEMP. RISE (C):	150°C
% IMP.:	7.5
TAPS:	±5%

EFFICIENCY:	91.4 %
EXCITING I:	6.3 %
NOISE LVL.:	40 dB
REGULATION:	
@1.0 P.F.:	8 %
LOSSES	(WATTS)
NO LOAD:	72
LOAD :	400
TOTAL:	472

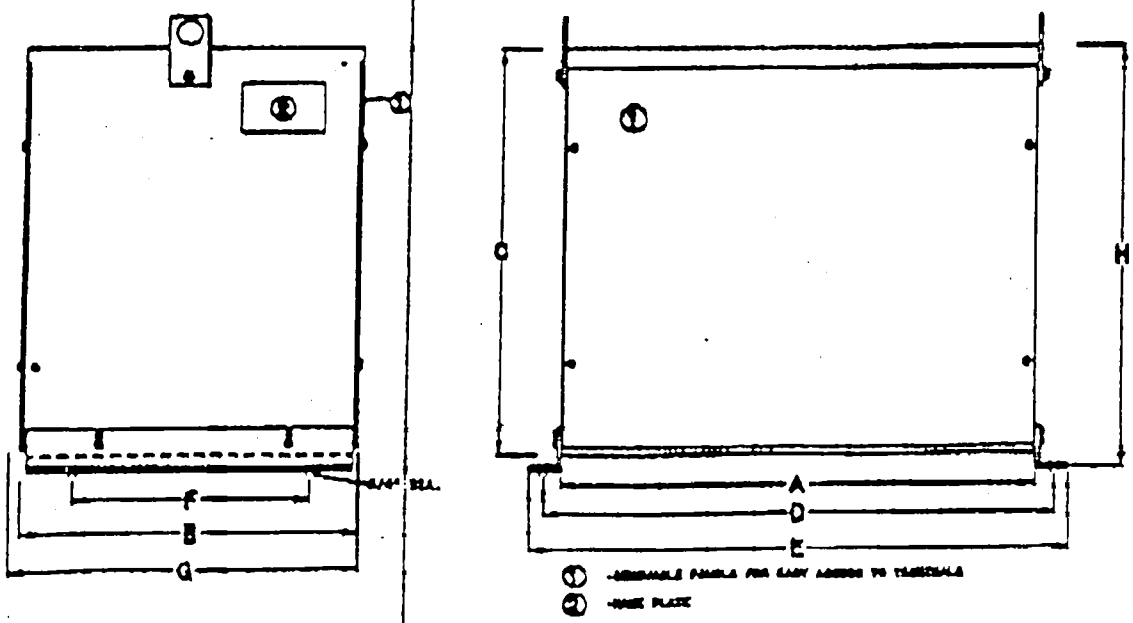


CSA ENCLOSURE
TYPE: E12 - DUST TIGHT INDOOR
MOUNTING: FLOOR

CONNECTORS(TERMINALS)
L.V.: 2 - 14 AWG LOCATION: BOTTOM/FRONT
H.V.: SCREWS LOCATION: FRONT

SPECIAL FEATURES: *ELL = 10KV, COPPER WOUND, ANTI-VIBRATION PADS.*

DIM.	A	B	C	D	E	F	G	H
IN.	15.25	17.38	17.75	17.50	19.25	11.13	14.25	18.13



130598 Please Refer to Drawing Identification No. When Ordering.

P:\ENG\DRAWINGS\PRELIMS\SCSHX12

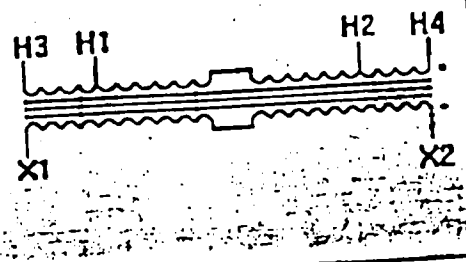
UL
E2V6 LISTED
POWER TRANSFORMER

REX MANUFACTURING
REM DIVISION OF TRANSFACTOR INDUSTRIES INC.
REXDALE, ONT.

CSA LR34488

CAT. NO. SC5HX/E12	KVA 5.0	ENCL TYPE-12	
SERIAL U 20044	HZ 60	TYPE AIN	
TRANSFORMER 1 PH. ISO.	% IMP. 5.0	AT 170 C.	
INSULATION CLASS 220	TEMPERATURE RISE 150 C.		
PRI.VOLTAGE 480	H2 - H3	BIL	
SEC.VOLTAGE 400	X1 - X2	WT. 130 LB	

PRI. VOLTAGE	LINES ON LIGNES SUR
105%	H3-H4
100%	H2-H3
95%	H1-H2



COMPRESSOR

	Item	Ref.	Rev.
C1	Description	-	-
C2	Atlas Copco Product Data	GA11-22.PD001 GA11-22.PD002 GA11-22.MTR001	- - -
C3	Atlas Copco Literature	-	-
C4	General Arrangement	1310 9012 77	-

C1. Description

Compressor

Manufacturer:	Atlas Copco
Model No.:	GA 11
Output:	64 ACFM @ 125 PSIG
Motor:	15 HP
Power:	460V, 3 Phase, 60 Hz, 17 Amp
Dimensions:	66" (l) x 31" (w) x 70" (h)
Weight:	992 Lbs.
Options Included:	Sound Attenuation Enclosure
	Integral Refrigerated Dryer

Air Receiver Tank

Type:	120 Gallon
Configuration:	Horizontal
Working Pressure:	200 PSI
Discharge Connection:	1 1/4" NPT
Drain:	1/8" NPT
Other:	Pressure Gauge
	Pressure Relief Valve
	Autodrain

Atlas Copco

Product Data: GA11-22.PD001
Page: 1 of 2
Effective: 7/11/95

GA11-22 SERIES

Oil Injected
Rotary Screw Compressors
15 thru 30 Horsepower

Model		GA11 100	GA11 125	GA11 150	GA11 175	GA15 100	GA15 125	GA15 150	GA15 175	GA18 100	GA18 125	GA18 150	GA18 175	GA22 100	GA22 125	GA22 150	GA22 175
Generat																	
Horsepower	HP	15				20				25				30			
Capacity	ACFM	71	64	57	52	95	88	80	73	111	108	97	89	131	128	116	106
Operating Pressure[1]	psig	100	125	150	175	100	125	150	175	100	125	150	175	100	125	150	175
Min Operating Pressure[1]	psig	58				58				58				58			
Max Operating Pressure[1]	psig	107	132	157	181	107	132	157	181	107	132	157	181	107	132	157	181
Drive System		Belt Drive				Belt Drive				Belt Drive				Belt Drive			
Power Requirements																	
BHP Compressor		16.5	16.5	16.5	16.7	22.6	23.1	23.5	23.2	26.7	28.7	28.6	28.5	32.6	34.9	34.6	34.3
BHP Compressor Fan		1.3				1.3				1.6				1.6			
BHP Pack Unit (Total)		17.8	17.8	17.8	18.0	23.9	24.4	24.8	24.5	28.3	30.3	30.2	30.1	34.2	36.5	36.2	35.9
BHP Dryer		2.0				2.0				2.8				2.8			
BHP Full Feature Unit (Total)		19.8	19.8	19.8	20.0	25.9	26.4	26.8	26.5	31.1	33.1	33.0	32.9	37.0	39.3	39.0	38.7
BHP Compressor @ No Load		4.8	4.3	4.2	4.2	6.5	6.0	5.8	4.8	7.4	7.1	6.6	4.5	8.6	8.0	7.9	8.0
Cooling																	
Cooling System		Air				Air				Air				Air			
Maximum Ambient Temp	°F	104				104				104				104			
Minimum Ambient Temp[2]	°F	32				32				32				32			
Cooling Air Flow																	
- Open, Pack	CFM	1482				1482				1800				1800			
- Full Feature	CFM	2436				2436				3018				3018			
Allowable Pressure Drop in Duct work	in H_2O	.12				.12				.12				.12			
Aftercooler Approach	°F	14				14				13				13			
Oil Capacity	gal	2.2				2.2				2.2				2.2			
Package Heat Rejection																	
- Open, Pack	BTU/hr	45,810				63,116				77,114				92,929			
- Full Feature	BTU/hr	50,900				68,206				84,240				100,058			
Airend																	
Male Rotor Diameter	mm	97.0				97.0				97.0				97.0			
Male Rotor Speed	rpm	3085	2810	2587	2390	4161	3864	3570	3256	4584	4765	4348	4030	5792	5636	5147	4752
Male Rotor Tip Speed	m/s	15.7	14.3	13.1	12.1	21.1	19.6	18.1	16.5	23.2	24.1	22.1	20.5	29.5	28.7	26.2	24.2
Noise Level																	
- Open	dB(A)	81	81	81	81	82	82	82	82	83	83	83	82	84	84	83	83
- Pack, Full Feature	dB(A)	76	76	76	76	78	78	78	78	79	79	79	79	80	80	79	79

[1] Full Feature units, dryer module air pressure drops must be included
[2] Freeze protection will be required in ambients below 32°F (Reference Price Page)

Atlas Copco

Product Data: GA11-22 PD001

Effective: 7/11/95

GA11-22 SERIES

Oil Injected
Rotary Screw Compressors
15 thru 30 Horsepower

Model		GA11 100	GA11 125	GA11 150	GA11 175	GA15 100	GA15 125	GA15 150	GA15 175	GA18 100	GA18 125	GA18 150	GA18 175	GA22 100	GA22 125	GA22 150	GA22 175
Dimensions																	
Grill Size (LxW)		(Ref. Price Book GA11-22 Gen Arr. Drawing)															
Discharge Valve Connection																	
- Base Mount	NPT	1-1/4				1-1/4				1-1/4				1-1/4			
- Tank Mount	NPT	1				1				1				1			
Condensate Drain Connections																	
- manual	in	1/8				1/8				1/8				1/8			
- automatic	in	1/8				1/8				1/8				1/8			
Enclosure (LxWxH)[3]	in	40 x 31 x 46				40 x 31 x 46				40 x 31 x 46				40 x 31 x 46			
Tank Mounted (LxWxH)[3]	in	66 x 31 x 70				66 x 31 x 70				66 x 31 x 70				66 x 31 x 70			
Weights (approx)																	
Airend	lbs	99				99				99				99			
Motor	lbs	154				180				218				286			
Open / Pack																	
- Net	lbs	809 / 859				854 / 904				920 / 970				940 / 990			
- Shipping	lbs	938 / 988				990 / 1,040				1,066 / 1,116				1,089 / 1,139			
Full Feature																	
- Net	lbs	992				1,058				1,124				1,146			
- Shipping	lbs	1,141				1,217				1,293				1,318			
Refrigerant Dryer - INCLUDED																	
Full Feature Only																	
Dryer Module	Model	ID60				ID60				ID60T				ID60T			
Pressure Dewpoint[4]	°F	35-39				35-39				35-39				35-39			
Pressure Drop at Nominal Capacity	psig	2.2				2.5				2.9				2.9			
Cooling Air Flow	CFM	954				954				1218				1218			
Outlet Temperature Above Ambient	°F	5				5				4				4			
Refrigerant Type		R134A				R134A				R22				R22			
Refrigerant Charge	lbs	4.8				4.8				6.2				6.2			
Capacity of Liquid Receiver	gal	.7				.7				.7				.7			
Power Requirements																	
- Compressor	HP	1.7				1.7				2.3				2.3			
- Fan Motor	HP	.3				.3				.5				.5			
Recommended Filter[5]																	
1.0 micron/0.5 PPM	DD	40	25	25	25	65	40	40	40	65	65	65	40	65	65	65	65
0.01 micron/0.01 PPM	PD	40	25	25	25	65	40	40	40	65	65	65	40	65	65	65	65
Carbon .01 micron/0.003 PPM	QD	40	25	25	25	65	40	40	40	65	65	65	40	65	65	65	65

[3] Discharge valve adds 4.5 inches to installed length
[4] At maximum dryer inlet conditions:
- Ambient Temperature: 104°F
- Inlet Temperature: Aftercooler approach + 104°F
- Inlet Pressure: Model's operating pressure

[5] At standard filter inlet conditions (Ref. Filter Price Book Section)

Atlas Copco

GA11-22 SERIES

Oil Injected
Rotary Screw Compressors
15 thru 30 Horsepower

GENERAL DESCRIPTION

The GA11-22 Series are single stage, aircooled, oil injected rotary screw compressors. They include the compressor, drive motor, oil system, air system and electronic regulating controls. The machines are offered as Open, Packs or Full Feature units with all components contained in a sound attenuating enclosure. The Full Feature units include an integrally mounted refrigerated air dryer.

COMPRESSOR ELEMENT

The compressor element is a rotary screw design consisting of:

- Male rotor with four (4) lobes
- Female rotor with six (6) flutes
- Patented asymmetric rotor design
- Cycloid profile at the pitch diameter

The male rotor is driven using a triple V-Belt drive system. The belt system is equipped with a semi-automatic belt tensioner as standard.

DRIVE MOTOR (15-30 HP)

The drive motor is a horizontal AC squirrel cage induction type consisting of:

- Foot mounted
- Service factor: 1.25
- Insulation: Class F, Class B rise
- Enclosure: TEFC
- Motor speed: 3600 RPM
- Motor construction:
  - Rugged cast frame
  - Cast rotor
  - Non-hygroscopic insulation
  - Corrosion resistant hardware
  - Premium efficiency

STARTER CUBICLE

All GA11-22 units are equipped with a UL listed control cubicle consisting of:

- Direct on-line motor starter prewired and installed
- Control circuit transformer for 115V AC controls and 24V AC for the control module

GA11-22 SERIES

Oil Injected
Rotary Screw Compressors
15 thru 30 Horsepower

OIL SYSTEM

The oil system is of the differential pressure type consisting of:

- ASME approved air/oil separator tank with:
  - Separator element
  - Oil fill tube with pressure relieving plug
  - Drain hose
  - Minimum pressure/check valve
  - Oil level indicator
- Upright oil filter of the spin-on type rated at 10 microns.
- Aluminum oil cooler with dedicated radial impeller cooling fan.
- Oil cooler thermostatic by-pass valve.

AIR SYSTEM

The air system consists of:

- Isolated dry-type air intake filter rated at 3 microns
- Pneumatically operated air intake valve/unloader assembly
- Minimum pressure/check valve
- Air/oil separator tank with oil separator element
- Discharge air shut-off service valve
- Motor driven high capacity radial impeller cooling fan

AFTERCOOLER

- All units have a compact welded aluminum combination cooler.
- All units have a moisture separator/trap including both automatic and manual drain lines.

ASSEMBLY

The GA11-22 units include all of the standard equipment mounted on a fully enclosed metal floor/base, made from industrial grade steel. The units are completely piped and assembled, including the control cubicle (with starter) and aftercooler with separator/trap. The Pack and Full Feature units also include the necessary sound attenuated panels to yield 76-80 dB(A) noise levels.

GA11-22 SERIES

Oil Injected
Rotary Screw Compressors
15 thru 30 Horsepower

INCLUDED

INTEGRAL REFRIGERATED DRYER (Full Feature units)

An optional integral refrigerated dryer is available. The dryer module consists of:

- Precooler/reheater
- Refrigerant compressor
- Patented liquid separator (eliminates the need for a hot-gas-bypass)
- Pressostat regulator of condenser fan operation
- Expansion valve
- Environmentally Friendly R134A (GA11-15) and R22 (GA18-22) refrigerants
- Pressure dewpoint indicator (monitored through Elektronikon)

ELEKTRONIKON® CONTROL MODULE

The regulating system includes the Elektronikon® control module which measures data continuously. The on-board microprocessor automatically regulates, controls and monitors compressor operation. A partial list of the module's capabilities includes:

LED INDICATORS
- Automatic Operation
- Voltage On
- General Alarm

SERVICE INDICATORS
- Air Filter
- Oil Filter
- Oil Separator
- Oil

PUSH BUTTON/TACTILE SWITCH
- Start/Stop
- Latching Emergency Stop Button
- Function Keys (F1-F3)
- Scroll Keys
- Tabulator Keys (more data)

ALPHANUMERIC DISPLAYS
- Line 1 - Data Description
- Line 2 - Reading
- Line 3 - Status
- Line 4 - F Key Function

AVAILABLE DATA
- Element outlet temperature
- Delivery air pressure
- Dewpoint (FF units)
- Motor overload status
- Running hours
- Loaded hours
- Elektronikon regulator hours

CONFIGURATION PARAMETERS
- Time
- Date
- Format of date
- Language of display
- Units for pressure
- Units for temperature
- Motor start mode

Atlas Copco

Product Data: GA11-22.MTR001
Page: 1 of 1
Effective: 7/11/95

GA11-22 SERIES

Oil Injected
Rotary Screw Compressors
15 thru 30 Horsepower

TYPICAL MOTOR DATA, TEFC Premium Efficiency

Motor HP	15	20	25	30
Voltage	460	460	460	460
Phase	3	3	3	3
Hz	60	60	60	60
Insulation Class	F	F	F	F
Enclosure	TEFC	TEFC	TEFC	TEFC
Nominal Efficiency	91.0	92.0	92.0	92.0

Motor HP	15	20	25	30
Frame(tEC)	169	169	169	169
RPM - Full Load	3530	3535	3535	3525
Service Factor	1.25	1.25	1.25	1.25
Max Amb Temp °F	104	104	104	104
Design	B	B	B	B
Starting Type	DOL			

15 HP 460/3/60 (TYPICAL)

Load %	115	100	75	50	25
Efficiency %	91.0	91.0	91.7	90.3	83.3
Power Factor	.890	.890	.880	.840	.695
Full Load Amps	19.6	17.0	12.1	8.7	4.6
Locked Rotor Amps			136.1		

20 HP 460/3/60 (TYPICAL)

Load %	115	100	75	50	25
Efficiency %	92.0	92.0	92.4	91.4	84.2
Power Factor	.860	.850	.825	.795	.664
Full Load Amps	27.7	24.0	17.9	12.3	6.5
Locked Rotor Amps			194.4		

25 HP 460/3/60 (TYPICAL)

Load %	115	100	75	50	25
Efficiency %	91.8	92.0	92.1	91.1	86.6
Power Factor	.895	.900	.870	.849	.701
Full Load Amps	32.3	28.0	20.9	14.4	7.6
Locked Rotor Amps			226.8		

30 HP 460/3/60 (TYPICAL)

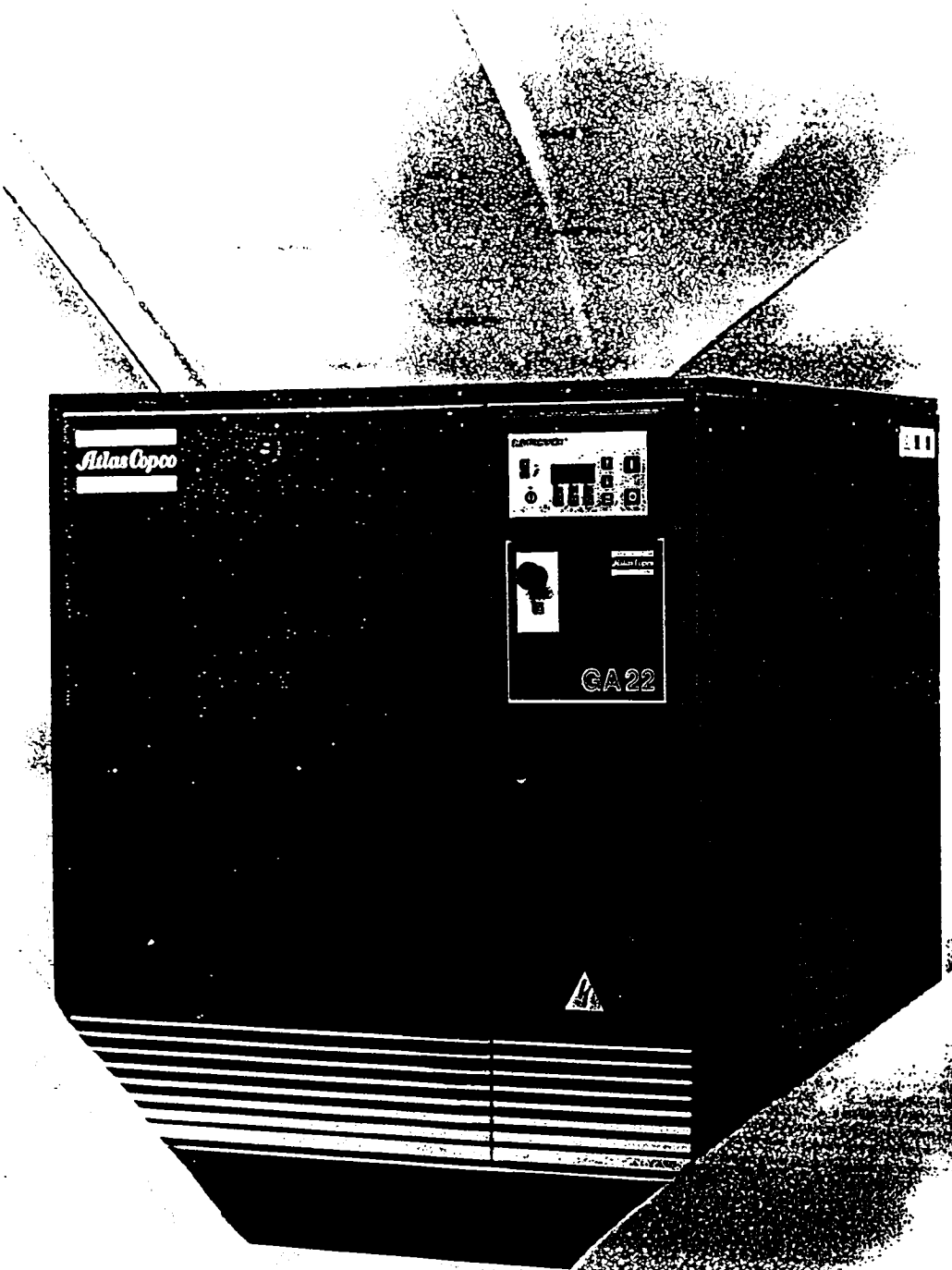
Load %	115	100	75	50	25
Effficiency %	92.0	92.0	92.2	91.3	84.3
Power Factor	.911	.920	.889	.867	.718
Full Load Amps	37.7	32.7	24.4	16.8	8.9
Locked Rotor Amps			266.5		

Rotary screw air compressors

GA11 – 22 Series

with integrated refrigerated dryer

Atlas Copco



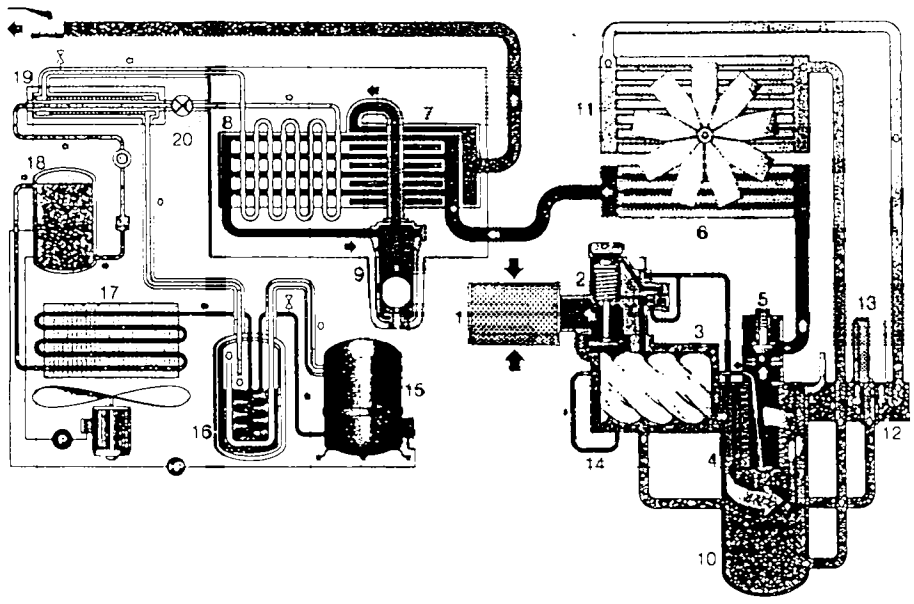
Enhance Your System With the Integrated Dryer Option

Because moisture in plant air can damage compressed air tools and equipment and contaminate products, there is an increasing demand for dry compressed air. Dry compressed air keeps plant air systems and production operations running smoothly. By choosing the integrated refrigerated dryer option, you can ensure a constant supply of clean, dry air to your system.

The dryer is designed to match compressor performance, and will achieve a 35-39°F pressure dew point. Atlas Copco's patented liquid separator ensures constant dewpoint, regardless of load conditions, and eliminates the need for troublesome hot-gas bypass valves. The dryer also features a Pressostat that senses condensed refrigerant pressure and turns off the cooling fan during low demand periods. The precooler-reheater reduces the load to the refrigeration cycle, providing energy-efficient operation.

All Atlas Copco refrigerated dryers use either R22 or R134A refrigerant in compliance with the EPA's Clean Air Act.

Flow diagram



Air flow
1. Air intake filter
2. Air intake valve
3. Compression element
4. Oil separator element
5. Minimum pressure valve
6. After cooler
7. Air-refrigerant heat exchanger
9. Water separator with drain

Oil flow
10. Oil reservoir
11. Oil cooler
12. Thermostatic bypass valve
13. Oil filter
14. Oil scavenge line

Refrigeration flow
15. Refrigerant compressor
16. Liquid separator
17. Condenser
18. Refrigerant receiver
19. Refrigerant-refrigerant heat exchanger
20. Automatic expansion valve

Refrigerant liquid
Refrigerant gas/liquid
Refrigerant gas
Compressed refrigerant gas
Insulation
Water
Oil
Intake air
Air/oil mixture
Wet air
Dry air

About Atlas Copco

The world Leader in Compressed Air

Atlas Copco has engineered and manufactured air compressors for the industrial and construction markets for more than 75 years. This experience, plus a dedicated program of research and development, has made Atlas Copco the largest manufacturer of compressed air systems in the world. Innovative advances in the GA11-22 Series have evolved from this technological leadership.

Support from Atlas Copco equipment is available through a comprehensive network of authorized distributors strategically located throughout the United States. Their personnel are factory trained and certified to provide the application assistance, service and parts resources required to ensure maximum efficiency and reliability for your compressed air system.

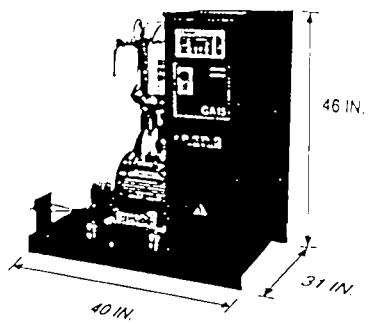
Technical Specifications

Model	Motor HP	Working Pressure PSIG	Capacity ACFM[1]	Sound Level[2] dB(A)			Net Weight Lbs.		
				Open	Pack	Full Feature	Open	Pack	Full Feature
GA11	15	100	71	81	76	76	809	859	992
		125	64	81	76	76			
		150	57	81	76	76			
		175	52	81	76	76			
GA15	20	100	95	82	78	78	854	904	1058
		125	88	82	78	78			
		150	80	82	78	78			
		175	73	82	78	78			
GA18	25	100	111	83	79	79	920	970	1124
		125	108	83	79	79			
		150	97	83	79	79			
		175	89	82	79	79			
GA22	30	100	131	84	80	80	940	990	1146
		125	128	84	80	80			
		150	116	83	79	79			
		175	106	83	79	79			

(1) Unit performance measured according to CAGI-Pneurop PN2CPTC2.
(2) Maximum noise level measured at a distance of 3 feet according to CAGI-Pneurop PN8NTC2 test code.

Danger: Compressed air should never be supplied as breathing air unless air is properly purified for breathing. Atlas Copco assumes no responsibility or liability related to the purchaser's/user's breathing air system.

Open Unit



Member:

COMPRESSED AIR AND GAS INSTITUTE CAGI ®

Atlas Copco Compressors Inc.
161 Lower Holyoke Road
Holyoke, MA 01040
Tel. 413-536-0660 Fax. 413-536-0091

This information contained herein is general in nature and is not intended for specific construction, installation or application purposes.

FAB 11/95 20M

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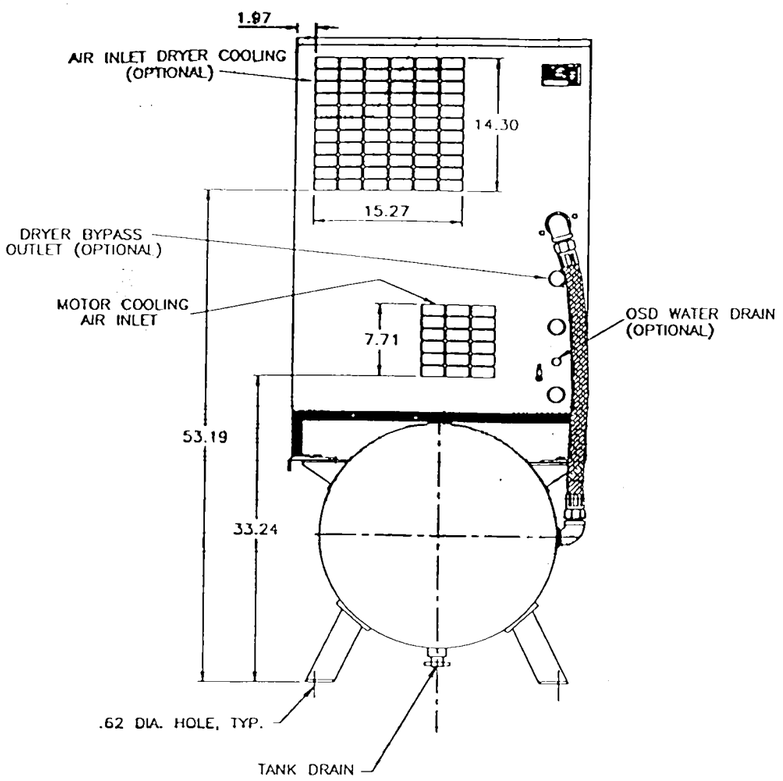
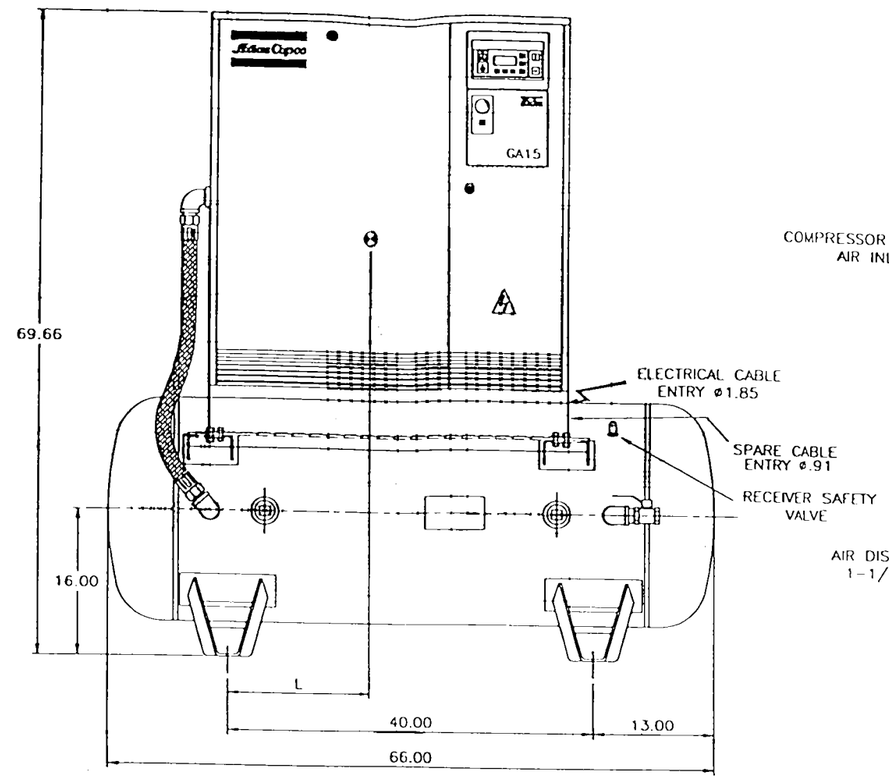
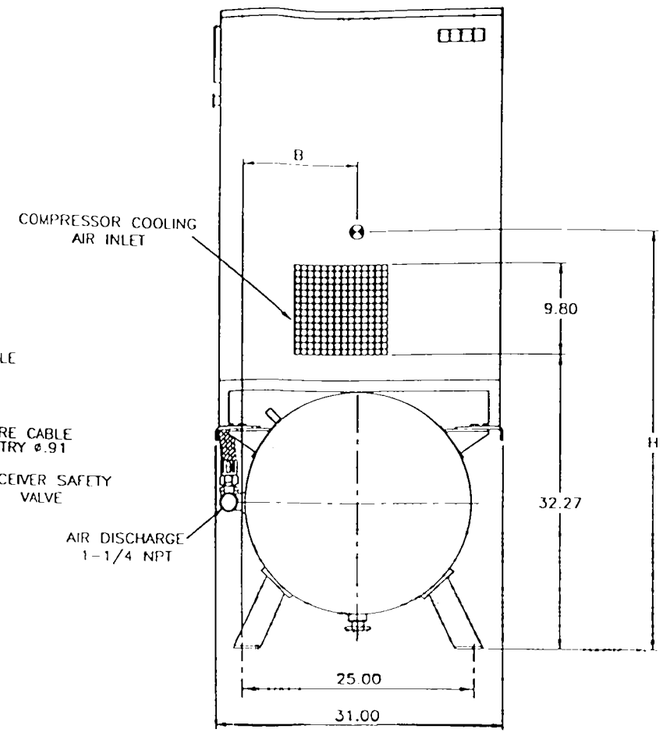
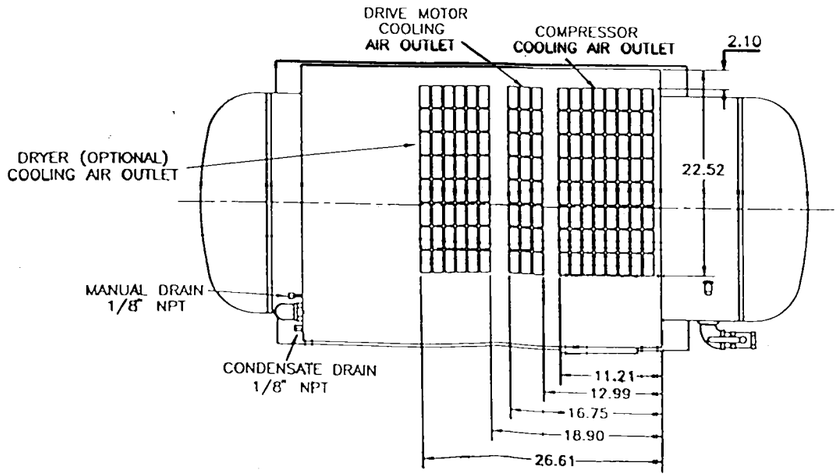






CENTER OF GRAVITY							WEIGHT	
	FULL FEATURE			PACK			FULL FEATURE	PACK
TYPE	L	B		L	B	H	OIL=17.60 LBS.	INCLUDED
GA11	17.70	12.38	40.20	19.13	12.88	37.78	1442	1309
GA15							1508	1354
GA18							1574	1420
GA22							1574	1420
DIMENSIONS ARE IN INCHES: ±.78							WEIGHTS ARE IN LBS. ±22LBS.	



TOP VIEW

NOTE	MODIFIED FROM	P.S.O.	DATE

THIS DOCUMENT IS OUR PROPERTY AND SHALL NOT WITHOUT OUR PERMISSION BE ALTERED, COPIED, USED FOR MANUFACTURING OR COMMUNICATION TO ANY OTHER PERSON OR COMPANY.

ATLAS COPCO COMPRESSORS, INC.

TOLERANCES PER A/C STANDARD 1350K

DR. BY	SCALE	APP'D.	DISK
JG	1:8		

TITLE: GENERAL ARRANGEMENT TANK MOUNTED MK III — GA11-22 PACK & FF

THIRD ANGLE PROJECTION

MAT'L

COMPARE | DATE 95/06/23

DESIGNATION 1310 9012 77

SHEET 1/1

2M BP 8/95

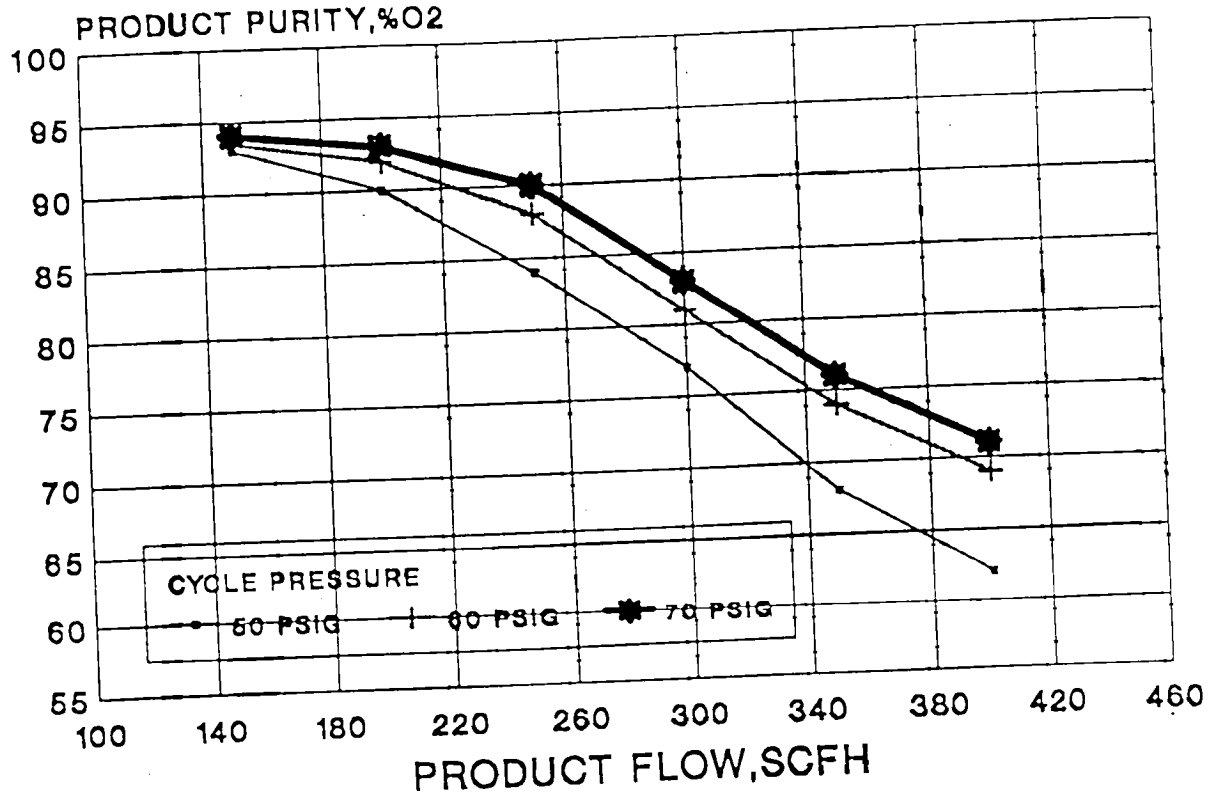
OXYGEN GENERATOR

	Item	Ref.	Rev.
D1	Specifications	AirSep	-
D2	Performance Curve	AirSep	-
D3	Process Flow Description	AirSep	-
D4	Connections	AirSep	-
D5	Layout	AirSep	-
D6	Wiring Schematic	AirSep	-
D7	Process Flow Schematic	AirSep	-
D8	Oxygen Receiver Tank	TA012	0B

2.3 Model AS-250 ™

Oxygen Output*	250 SCF/hr @ 0-45 psig 6.6 Nm^3/hr @ 0-310 kPa
Dewpoint	-150°F (-100° C)
Oxygen Purity	90% +/- 5%
Air Requirement	2800 SCF/hr @ 90-150 psig 73.6 Nm^3/hr @ 620-1035 kPa
Sound Levels	79 dba @ 1 meter, open field conditions.
Dimensions	30 x 28 x 78 inch (WxDxH) 76 x 71 x 198 cm (WxDxH)
Weight	1000 lb (454 kg)
Oxygen Receiver Tank (If Supplied)	60 gallons (227 liters), 145 lb (65 kg) 20 x 51 inch (Dia. x H) 50 x 130 cm (Dia. x H)
Power Requirement	**Domestic Model** 120 VAC, 60 Hz, Single Phase 1.5 ampere **Export Model** 220 VAC, 50 Hz, Single Phase 1.5 ampere

*For performance at other than design conditions see figure 2, page 8.



Note: The AS-250 is designed to operate at a cycle pressure of 70 PSIG and deliver 250 SCFH of 90%+/-5% oxygen when supplied with minimum feed air pressure of 90 PSIG.

For operation at lower cycle pressures and/or higher flow rates a slight modification of the unit is required. Please contact your AirSep factory representative for assistance.

Figure 2: AS-250 Performance Curve

3. Oxygen Generator Parts And Controls

3.1 Basic Process Flow Description

This AirSep Oxygen Generator is designed to accept compressed air 90-150 psig (620-1035 kPa) into its filter assembly. The pre-filter (if present) removes condensed water and oil, dirt, scale, etc. The coalescing filter removes oil vapor. The normal flow of air through the unit is shown in the diagram below. After leaving the filter, the compressed air is regulated down to 65-70 psig (480 kPa) then directed by solenoid valves into one of two adsorbers containing molecular sieve. Molecular sieve has the unique property that it physically attracts or adsorbs nitrogen from air, leaving the oxygen to pass through to the receiver.

Since there are two adsorbers, while one is producing oxygen the other is being purged of the nitrogen it adsorbed (collected) while making oxygen. The oxygen from the adsorbers is stored in the receiver. From the receiver the oxygen is regulated to 0-45 psig (0-310 kPa) depending upon your particular use pressure.

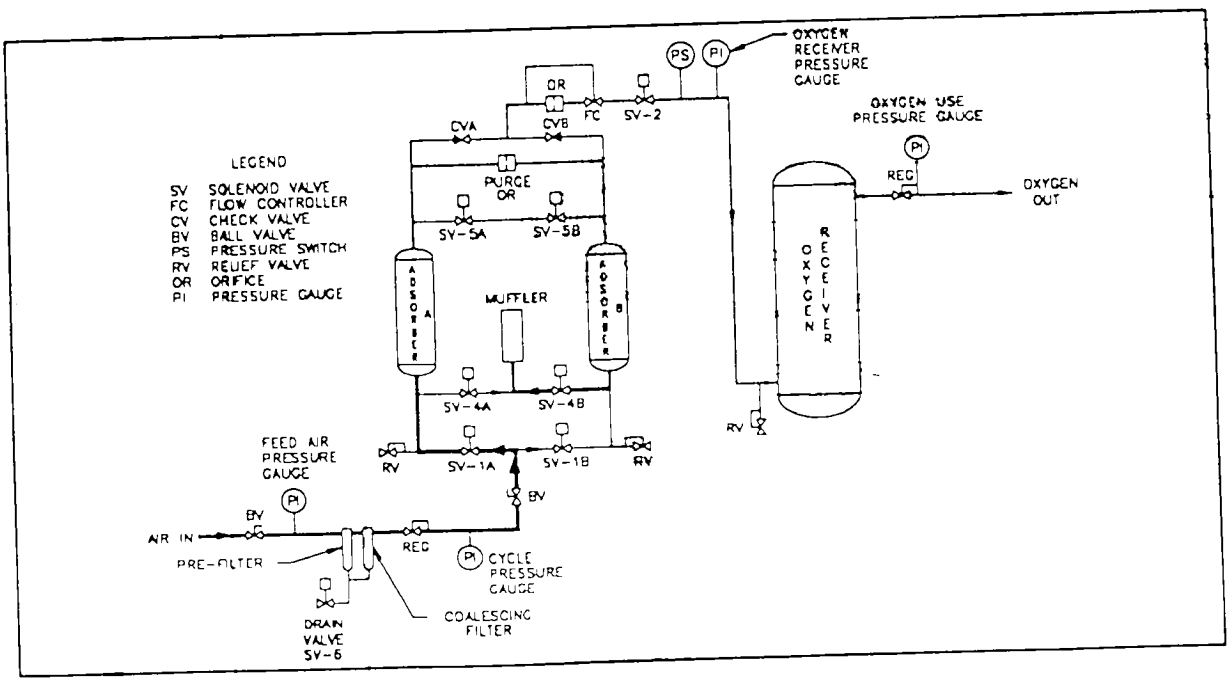


Figure 4: Flow Schematic For AirSep Oxygen Generators

3.3 CONNECTIONS

3.3.1. Generator Connections

(Refer to Figure 7 Pg 15)

9. Air Inlet

AS-160: 1/2" NPT Female bulkhead fitting with a 1/2" NPT Male x 1/4" NPSM Ball-End Joint adapter.

AS-250/450: 3/4" NPT Female bulkhead fitting with a 3/4" NPT Male x 3/4" NPSM Ball-End Joint adapter.

90 - 150 psig (620 - 1035 kPa) air supply from your compressor is connected to this fitting. *Feed Air Temperature 40° F / 5° C Minimum To 110° F / 43° C Maximum*

10. Oxygen Outlet

AS-160/250: 3/8" NPT Female bulkhead fitting with a 3/8" NPT Male x "B" size oxygen adapter.

AS-450: 3/8" NPT Female bulkhead fitting with 3/8" NPT x "C" size oxygen adapter.

Connects to oxygen receiver--lower port.

11. Condensate Outlet

1/4" NPT Female bulkhead fitting with a 1/4" NPT Male x 3/8" OD nylon tube adapter.

Removes moisture from air filters. ***This Port Must Not Be Plugged.***

Tubing may be connected as needed for proper disposal of condensate.

3.3.2. Receiver Connections

(Figure 8, See Below)

12. Oxygen Inlet Port
    3/8" NPT female fitting.
    Oxygen from the generator enters the receiver through this port.

13. Oxygen Supply Port
    3/8" NPT female fitting.
    Oxygen is delivered for use, from this port through Oxygen Pressure Regulator.

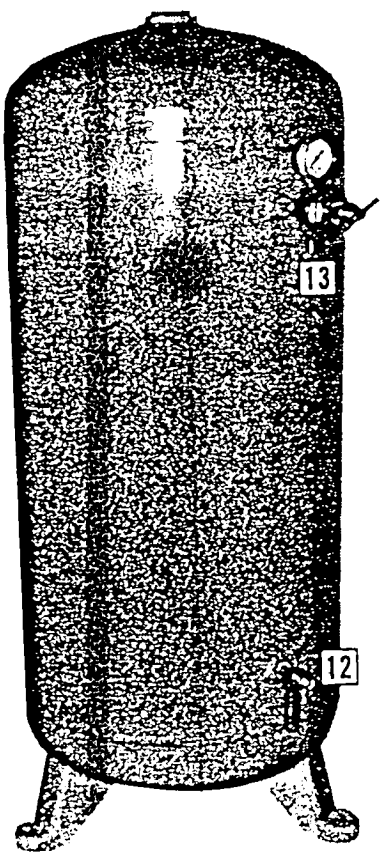


Figure 8: AS-160/250 Receiver Connections (1/4" NPT)
12. Oxygen Inlet Port
13. Oxygen Supply Port

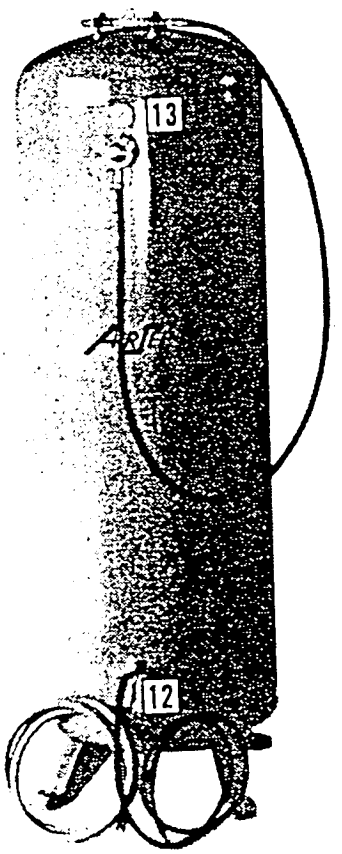
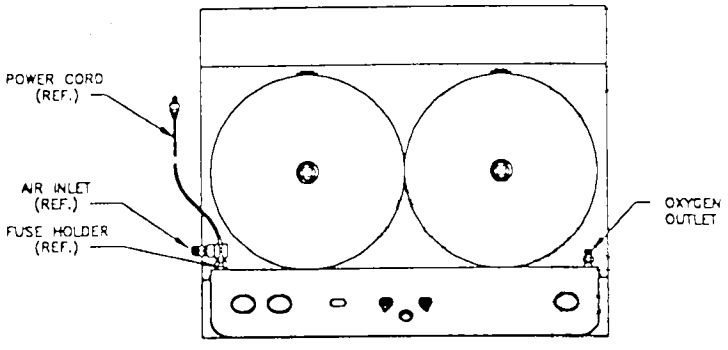


Figure 8a: AS-450 Receiver Connections (3/8" NPT)
12. Oxygen Inlet Port
13. Oxygen Supply Port



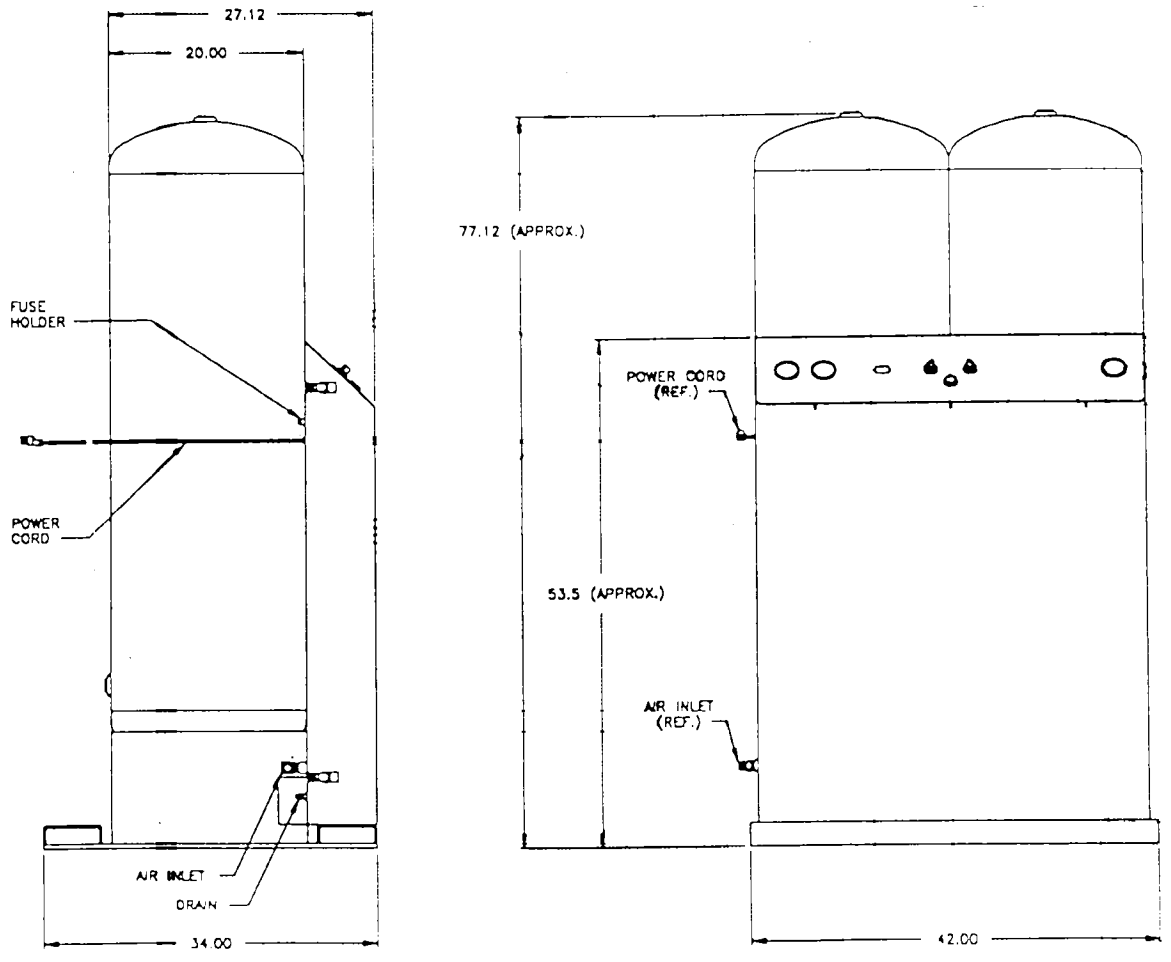


Figure 17: AS-450 Three View Drawing

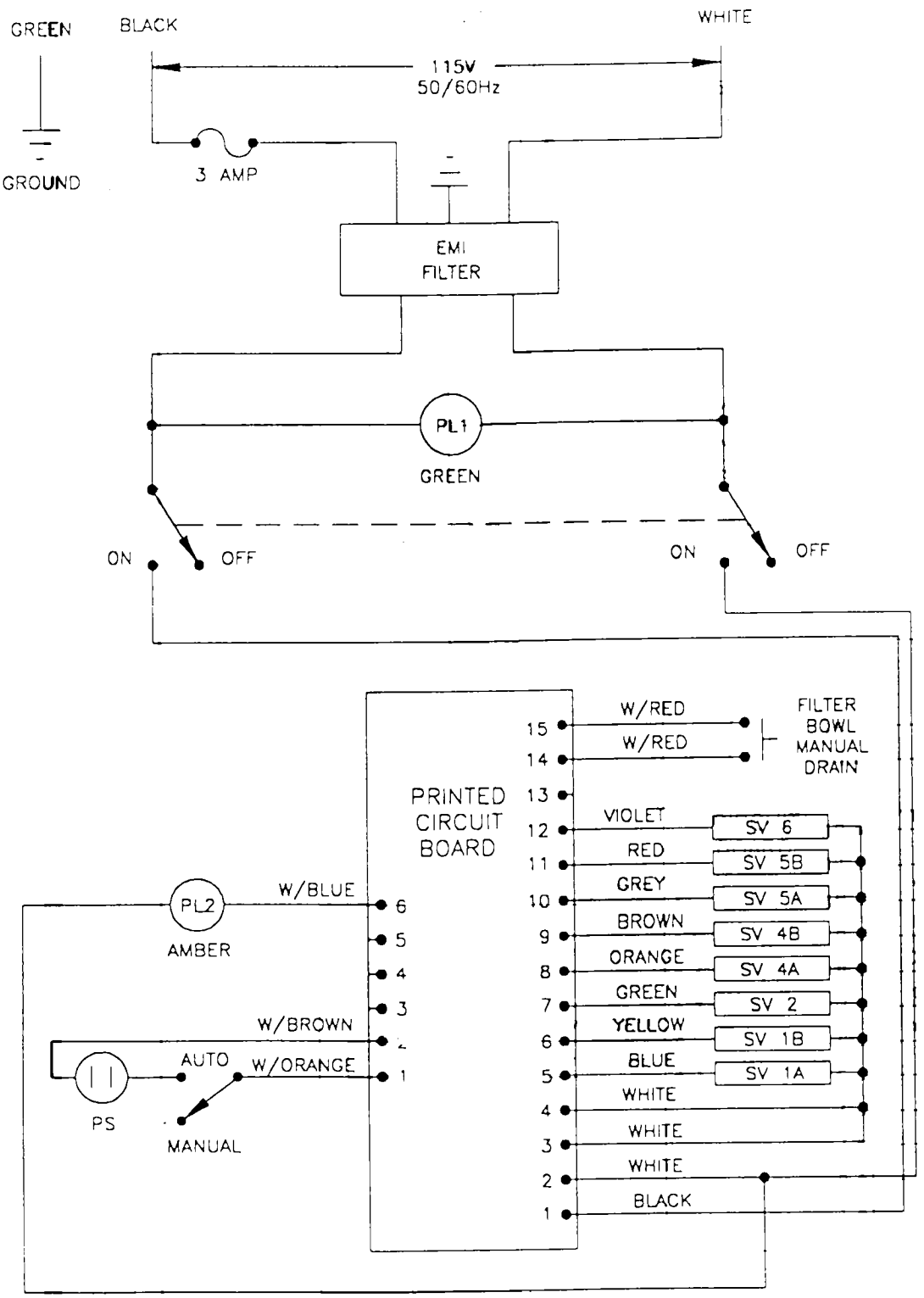


Figure 22: Wiring Schematic

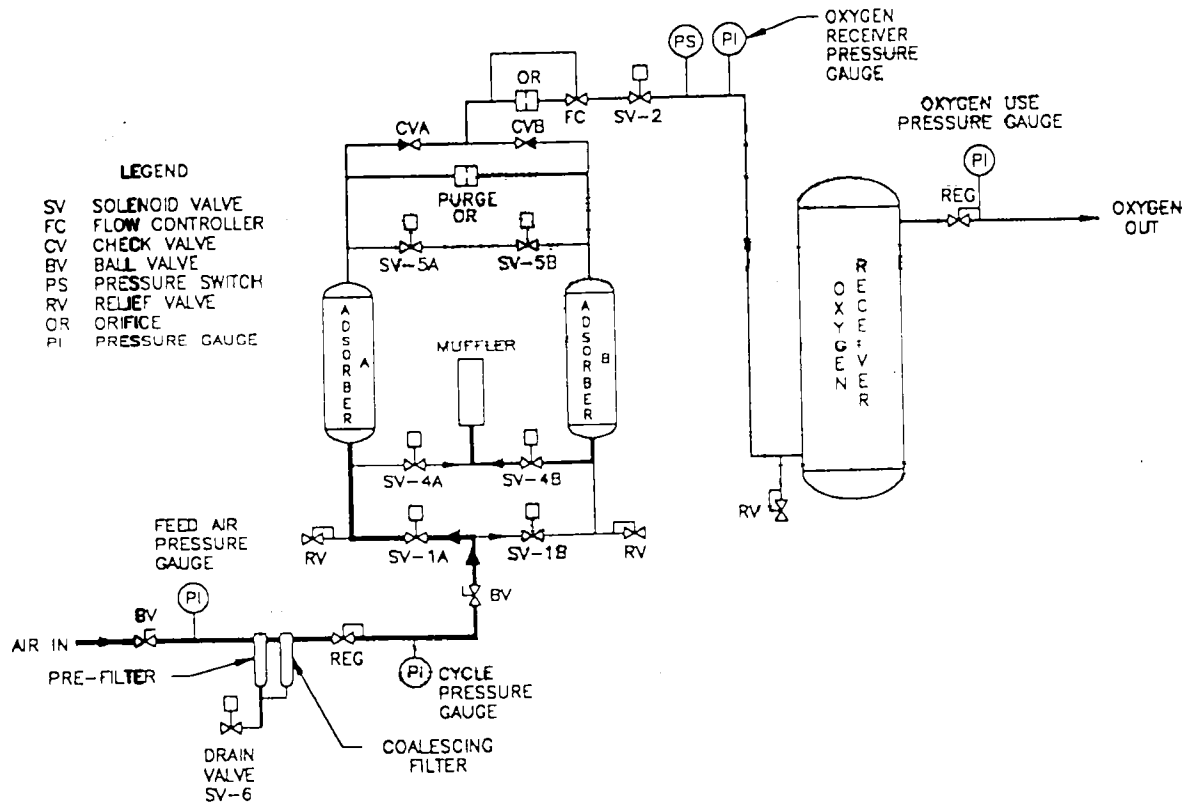


Figure 23: Flow Schematic For AirSep Oxygen Generators

NOTES:

1.) THE CHEMICAL AND PHYSICAL PROPERTIES OF ALL PARTS SHALL MEET THE REQUIREMENTS OF MATERIAL SPECIFICATIONS OF THE ASME BOILER AND PRESSURE VESSEL CODE

2.) DESIGN, CONTRUCTION AND WORKMANSHIP SHALL CONFORM TO ASME RULES, SECTION VIII, DIVISION 1

3.) TANKS SHALL BE DEGREASED FOR OXYGEN SERVICE

4.) TANK CAPACITY: 120 U.S. GALLONS

5.) TANK WEIGHT: 275 LBS (125 ±5)

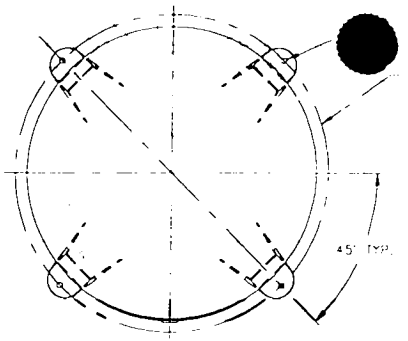
6.) **WORKING PRESSURE:** 150 PSIG

7.) SHELL THICKNESS: 0.170" MIN., 0.140" MIN. FOR HEADS.

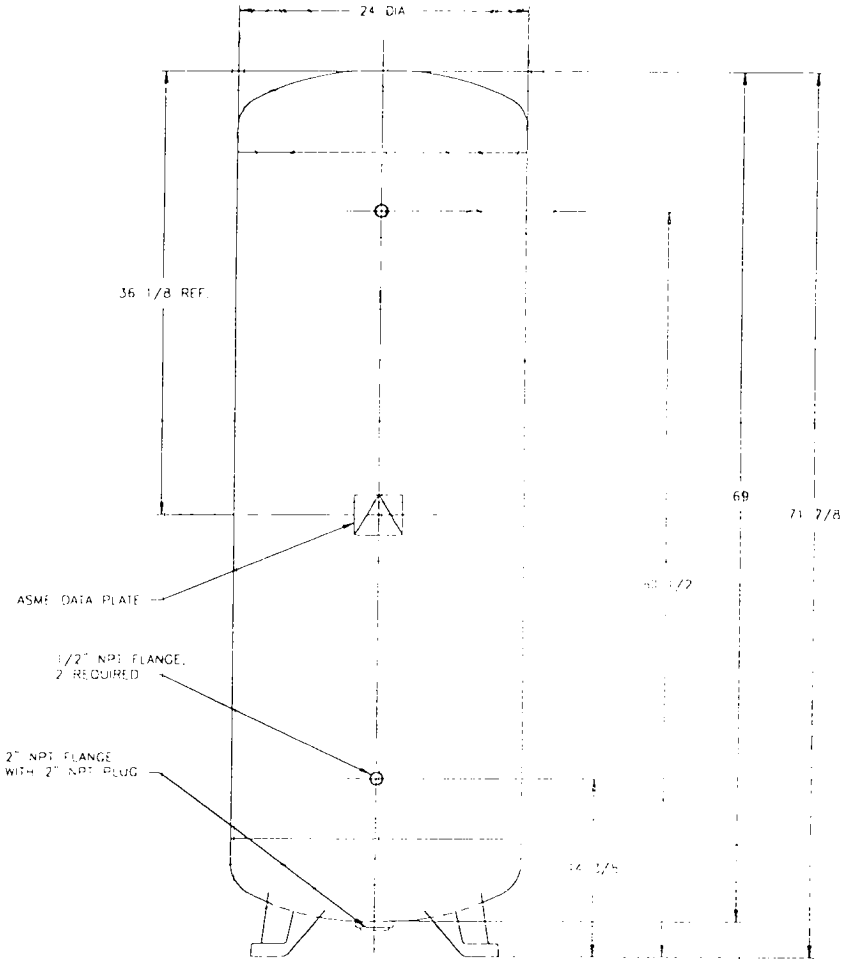
8.) FINISH: SHERWIN-WILLIAMS POLANE POLYURETHANE ENAMEL, ASA 61 GREY (AIRSEP P/N P1001-1)

9.) PRIMER & PAINT SHALL BE APPLIED UNDER THE PAINT MANUFACTURER'S RECOMMENDED APPLICATION METHOD AND **CONDITION.**

10.) **TANKS TO BE RECEIVED AT AIRSEP FREE OF PAINT DEFECTS** (i.e. RUNS, ORANGE PEEL, EXCESSIVE DUST, NON-UNIFORM COLOR OR ANY VISUAL DEFECTS)



FRONT VIEW



FRONT VIEW

REV	REVISION	DATE	APPD
B	REMOVED DASH 2 VERSION		
A	CHG'D PORT SIZE FROM 3/4" TO 1/2"		

UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DRAWING
DIMENSIONS ARE IN INCHES
DIMENSIONS APPLY AFTER PLATING OR COATING
REMOVE ALL BURRS
TOLERANCES
SURFACES ±.125
DRILLED HOLES ±.125
FILLETS R .035 MAX
EDGES BREAK 0.020 MAX
ANGULARITY < ± 2°30'
FORMED < ± .7
CHAMFERS ±.5
X ± .1
XX ± .02
XXX ± .005
FRACTION ± 1/32

	APPROVAL	DATE
DRAWN	S.P.V.	03/25/98
ENGR		
ENGR		
MFGR		
CHECKED		
MATERIAL	N/A	

AIRSEP® CORPORATION
Buffalo, New York 14228

TITLE: TANK, 120 GAL, 150 PSI, PAINTED, 02 CLEANED

SIZE	DWG NO	REV
C	TA012	OB

SCALE: 1/8" = 1" | SHEET 1 OF 1

MONITORS & INSTRUMENTATION

	Item	Ref.	Rev.
E1	Ambient Oxygen/Ozone Leak Detector Analytical Technology, Inc. Model A14/A11	-	-
E2	High Concentration Ozone Analyzer IN USA, Inc. Model H1-S	-	-
E3	Dewpoint Monitor Panametrics Series 5	-	-

ANALYZER DATA SHEET

Item	Ambient Oxygen/Ozone Analyzer	
Location	Ozone Generator Room	
Quantity	1	
Manufacturer	ATI	
Model No.	Receiver Module:	A14
	O3 Sensor/Transmitter:	A11-14-0002-1-2
	O2 Sensor/Transmitter:	A11-19-0025-3-2
Scale	Ozone:	0 to 2 ppm
	Oxygen:	0 to 25%
Enclosure	NEMA 4X	
Options Required	Dual Channel Electrochemical Sensors	
Power Supply Required	85-270 VAC, 50/60 hz	

ANALYTICAL TECHNOLOGY, INC

MODULAR GAS DETECTOR

GasSens **Product Specification Sheet**

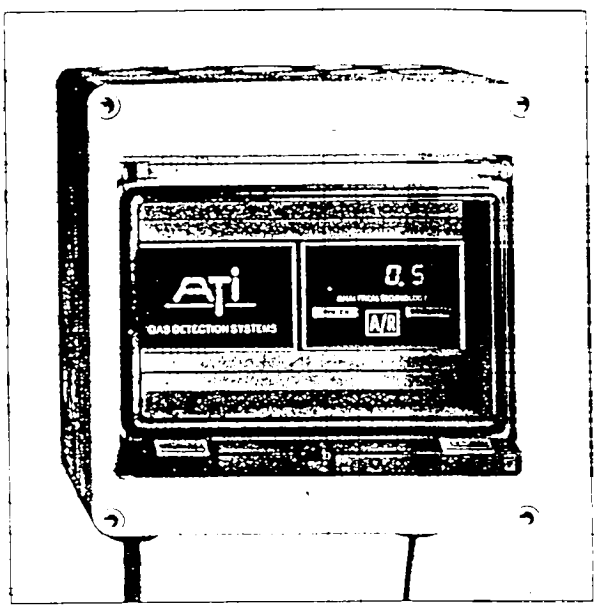
SELF CHECKING GAS SENSORS

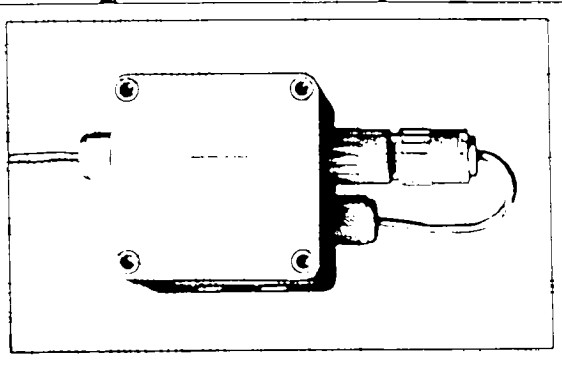
GasSens is a flexible component system providing a variety of options to meet individual gas detection and alarm requirements. From chemical and petrochemical plants to food processors, the *GasSens* system can be applied to the simplest or most complex gas detection application. Economical and low maintenance, this system is your best choice for reliable leak detection.

GasSens detection systems consist of individual modules that can be located where required. Sensor/transmitters, located in the area where gas leakage or buildup might occur, provide the basic measurement for the system. Sensor transmitters are available in either NEMA 4X or explosion-proof versions and can be supplied with ATI's exclusive Auto-Test automatic sensor testing system, greatly reducing operator testing requirements.

Receiver modules provide the electronic brains for the detection and alarm system. Each compact module includes a digital display of gas concentration, isolated analog output, and 4 relay outputs. Receivers may be located up to 10000 feet from sensor/transmitters for remote indication, or can provide local control functions such as valve shutoff while transmitting a 4-20 mA signal to remote displays or data loggers. NEMA 4X or explosion-proof packages allow application in almost any environment.

Universal power supply modules provide DC power to receivers. The power supply is housed in a compact module similar to the receiver, and will accept inputs from 85 to 255 volts, AC or DC, without adjustment. The power supply also provides a power failure relay and charging for an optional battery back-up unit.





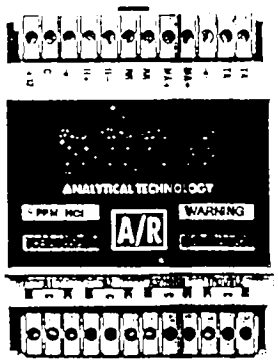
GasSens systems are available for:

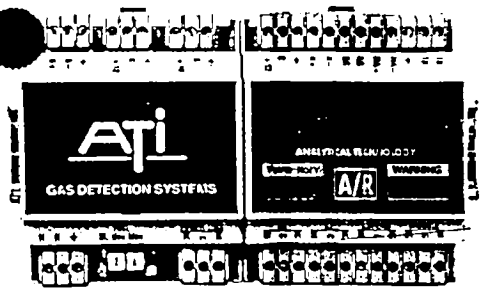
Chlorine	Chlorine Dioxide
Bromine	Hydrogen Peroxide
Ozone	Carbon Monoxide
Fluorine	Nitric Oxide
Ammonia	Nitrogen Dioxide
Hydrogen	Sulfur Dioxide
Oxygen	Hydrogen Chloride
Phosgene	Hydrogen Fluoride
Arsine	Hydrogen Cyanide
Phosphine	Hydrogen Sulfide
Silane	Hydrogen Selenide
Diborane	Germane

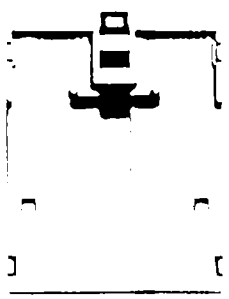
APPLICATIONS

Chemical & Plants
Pulp & Paper Mills
Semiconductor Fabrication
Food Processing
Water Treatment
Mineral Processing
Wastewater Treatment
Parking Facilities
Gas Processing
Petroleum Refining

Receiver Module







Receiver modules provide an interface between the detection system and external alarming and data logging requirements. One module is used with each sensor/transmitter and includes a variety of features.

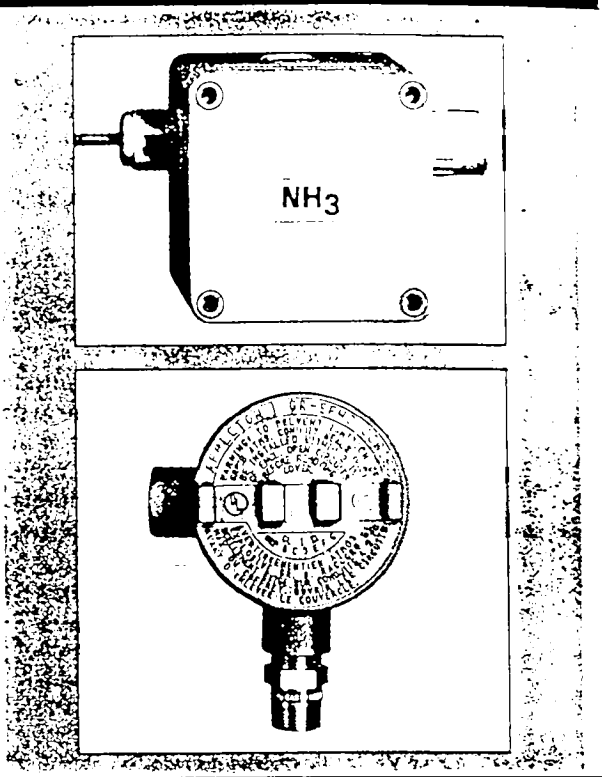
- ☐ LED Display. Indicates gas concentration directly in PPM, PPB, or %. The display may be operated in high intensity (sunlight readable) mode for outdoor use or in normal mode for indoor applications.
- ☐ Analog Output. An isolated 4-20 mA output is standard. The output will drive loads up to 1000 ohms for use in recording, data logging, or computer input.
- ☐ Two Alarm Setpoints. Alarm setpoints are factory adjusted to standard values but may be setto any value from 5% to 100% of range. Front panel LED's marked WARNING and ALARM indicate the status of each alarm setpoint. A standard alarm time delay of 2 seconds or a longer delay of 10 seconds may be selected. In addition, alarms may be switch programmed to activate either above or below the setpoint.
- ☐ Three Alarm Relays. Output relays are SPDT with unpowered contacts for use in activating external signaling devices, control elements, or for input to telemetry or annunciator systems. Each relay may be assigned to either alarm setpoint for application flexibility. Relays are factory set to energize on alarm, but may be switch programmed for fail-safe operation. Relays may also be set for either latching or non-latching operation.
- ☐ Trouble Alarm & Relay. Should the sensor/transmitter input be lost, a trouble light (LED) on the front panel will flash and an associated relay will activate. For those systems equipped with the sensor Auto-Test feature, this alarm will also activate if the sensor does not respond to the automated gas test.
- ☐ Front Panel Reset Switch. A single front panel switch marked A/R (Acknowledge/Reset) serves a number of functions. When an alarm occurs, the switch will silence an audible horn wired to the module and will change the alarm lights from flash to steady on. After the alarm condition has cleared, the switch may be used to reset any latching alarms. The switch will also activate an electronic module test, inhibit alarm contacts, and activate the sensor Auto-Test.
- ☐ Remote Reset Input. Terminals are provided for connection of a remote reset switch so that alarms can be acknowledged from a remote location or through a telemetry system.
- ☐ Pluggable Terminal Blocks. External electrical connections are made to plug-in terminal blocks. Should module service ever be needed, modules can be replaced in minutes.

Sensor/Transmitter

GasSens gas detection systems employ electrochemical sensors developed and manufactured by ATI. Expertise in electrochemistry and sensor design provide the foundation for leak detection systems that perform continuously with minimal maintenance. Sensors are rated for ambient temperatures from -25° to +50°C, allowing both indoor and outdoor applications. Excellent zero stability and high sensitivity and selectivity combine to make ATI sensors the best available on the market today.

Gas sensors are closely coupled to a digital transmitter for excellent noise immunity and the ability to transmit long distances using unshielded cable. The transmitter is powered from the receiver module and uses a unique current pulse position technique to send information to the receiver over a two wire connection. The receiver connection is not polarity sensitive, virtually eliminating the possibility of incorrect transmitter wiring. Sensor/transmitters can be located up to 1000 feet from receiver modules.

Sensor/transmitters are housed in shielded NEMA 4X enclosures for use in almost any industrial environment and are designed to meet intrinsic safety standards. An explosion-proof version of the transmitter is also available for applications where this type of protection is preferred.

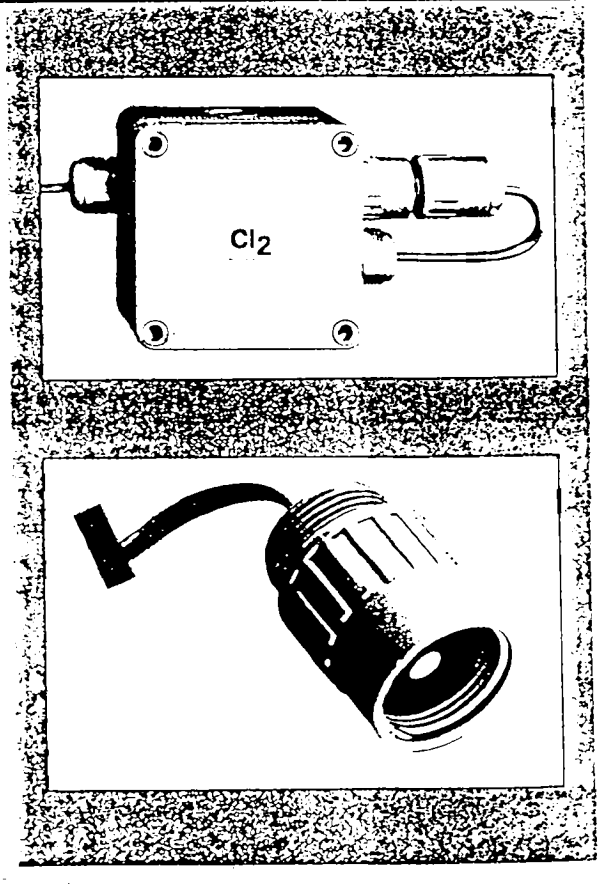


Sensor Auto-Test

A major expense in gas detection systems is the cost of regular testing to insure that sensors are responding. This requires a technician to inspect sensors weekly and apply a small amount of gas manually to check response. ATI has developed a unique system to reduce this maintenance requirement.

Available on most ATI digital sensor/transmitters is an option called Auto-Test. This option consists of an electrochemical gas generator closely coupled to the sensor. Every 24 hours, the receiver automatically activates the generator, producing a small amount of gas that diffuses into the sensor, just as it would if a gas leak occurred. The microcomputer in the receiver analyzes the output of the transmitter to determine that the sensor is responding normally. When proper sensor response is detected, the generator is turned off and the system goes back to normal operation. If no sensor response is detected, the TROUBLE light on the receiver will flash and the trouble relay will activate. During testing, alarm relays are inhibited so that external alarms are not activated.

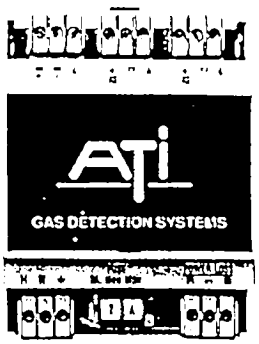
The Auto-Test feature insures that each sensor is regularly tested with gas. Premature sensor failure or blockage of the sensor membrane is quickly detected. In addition, self-testing will alert main-tenance personnel when a sensor has reached the end of its useful life. Since sensors normally last anywhere from 12 months to over 3 years, this feature allows users to determine when sensor replacement is needed.



Power Supply Module

To meet the needs of users throughout the world, ATI has developed a compact universal power supply in a DIN rail module similar to the receiver. The Power supply will accept any AC or DC input from 85 to 255 volts, without adjustment. No jumper changes or selection switches are required, and large variations in input voltage do not affect power supply operation. This power supply is suitable for operation of one or two receiver modules.

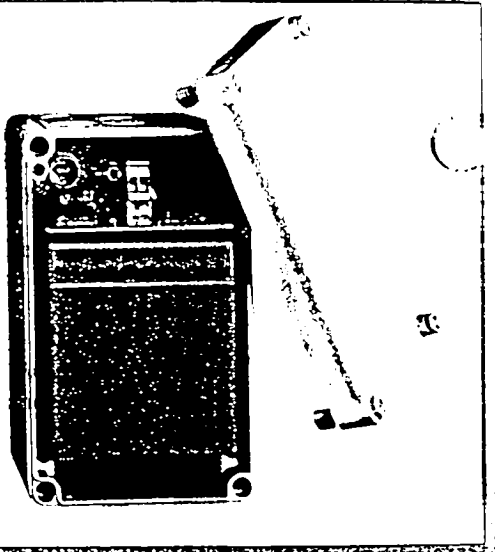
The power supply provides three 12 VDC output connections, two of which are designated for receiver module connection. A third connection is provided to automatically charge the optional external battery backup system. The power supply module is protected by a fuse conveniently located in a removable holder accessible from outside the module. For external power failure indication, the power supply contains a SPDT relay. The relay is normally energized, and de-energizes on power failure.



Battery Back-Up

Battery back-up systems are used in gas detection applications to insure that detectors remain operable, even when AC power fails. ATI offers a separate battery back-up unit that maintains power to detection equipment in the event of a power interruption. The battery back-up system consists of a rechargeable sealed lead acid battery housed in a NEMA 4X enclosure. An electronic circuit attached to the battery controls the charging rate and will disconnect the battery from the system if the battery voltage drops to a level where battery damage might occur. Charging is provided by the power supply module.

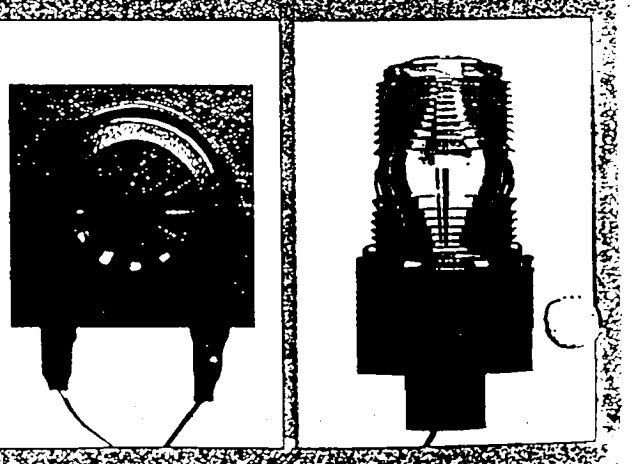
Battery back-up units will operate a single point detector for a minimum of 12 hours and an average of 24 hours. Two point systems will be maintained for 6 hours minimum and an average of 12 hours. The actual battery back-up time depends on whether the LED display is operated in high intensity mode and whether relays are in fail-safe mode (normally energized).



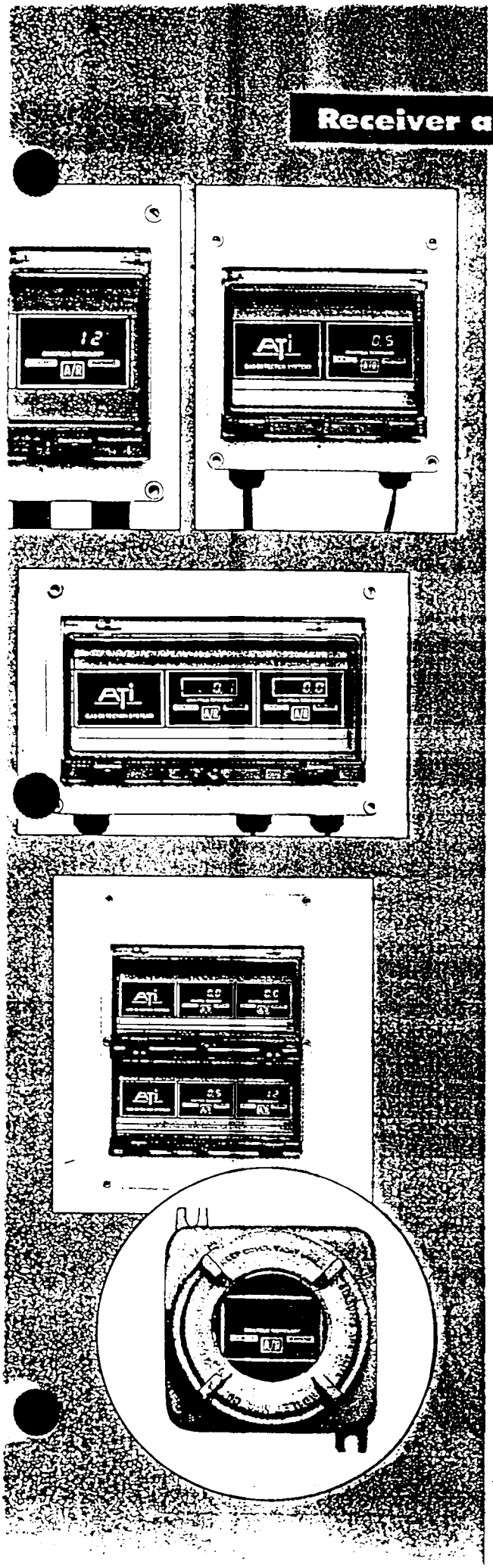
Horn/Strobe Options

A weatherproof piezoelectric audible horn is available for all gas detectors. The horn operates from 12 VDC supplied by the power supply module and can be activated from single or multiple receiver modules. The horn mounts easily in one of the enclosure knockouts, and produces an 85 dB signal for local alarming.

A 12 VDC Strobe is available for enhanced visual alarm indication. The strobe uses a xenon lamp with a bright ½ million CP flash firing 70 times/minute. Strobe housing is weatherproof lexan with red lens, and mounts to ½"conduit.



Receiver and Power Supply Enclosures



A variety of NEMA 4X enclosures are available to house receiver and power supply modules. ATI offers standard enclosures to house up to 6 modules, and can supply large enclosures for systems requiring more points of detection. System integrators can use standard 35 mm DIN rail for mounting modules in their own enclosure.

Single Module Enclosure: Houses a single receiver module for use in DC powered applications where the user supplies the DC power to the system.

Two Module Enclosure: Houses two receivers or one receiver and one power supply. Normally used for single point AC powered detectors.

Three Module Enclosure: Accommodates two receivers and power supply or three receivers. Used mainly for two point detection systems.

Six Module Enclosure: Suitable for two power supplies and four receivers or six receivers. This enclosure is used primarily for four point gas detection systems.

Explosion-proof Enclosure: To allow use of receivers in hazardous areas, ATI offers a standard explosion-proof enclosure suitable for housing one receiver or one power supply module. Larger enclosures house a receiver and a power supply.

Special Enclosure: Custom enclosures are available to handle systems of any size., Your ATI representative can assist with system design for larger applications.

S P E C I F

RECEIVER MODULE

Concentration Display: 4 digit LED, sunlight readable

Input: Digital signal, 2 wire connection to remote sensor/transmitter

Output: Isolated 4-20 mA or 0-20 mA DC, 1000 ohms maximum load

Alarms: Two adjustable concentration alarms, setpoints adjustable from 5-100% of range

Alarm Indicators: High intensity LED bars for WARNING (low setpoint) and ALARM (high setpoint)

Indicator Function: WARNING indicator non-latching, ALARM latching

Alarm Relays: Three assignable alarm relays, 10 A, 120 VAC (5A, 250 VAC) resistive Alarm relays assignable to either alarm set point

Relay Function: Configurable for normal/fail-safe, latching/non-latching, and fast/slow operation

Relay & Indicator Reset: Activated from front panel switch or through remote reset

Trouble Alarm: Front panel LED indicator and SPDT, 10 A, 120 VAC (5A, 250 VAC) resistive relay; Relay factory set to fail-safe operation

Trouble Function: Indicates loss of sensor/transmitter input or failure of sensor Auto-Test (if in use)

Gas Indicator: LED bar on front panel with gas symbol overlay

Mounting: Module mounts to 35 x 7.5 mm DIN rail

Electrical Connection: Quick disconnect plug-in terminal blocks

Module Enclosure: Noryl

Size: 2.8" W x 3.6" L x 2.3" D (70 mm x 90 mm x 58 mm)

Operating Temperature: -40° to +55°C

Humidity: 0-99% non-condensing

Power: 9-15 VDC, 300 mA maxium.

GASES & RANGES

GAS	STANDARD RANGE	MINIMUM RANGE	MAXIMUM RANGE
Ammonia	0-100 PPM	0-50 PPM	0-500 PPM
Carbon Monoxide	0-100 PPM	0-50 PPM	0-500 PPM
Hydrogen	0-4%	0-2000 PPM	0-10%
Nitric Oxide	0-100 PPM	0-50 PPM	0-500 PPM
Oxygen	0-25%	0-5%	0-25%
Phosgene	0-2 PPM	0-2 PPM	0-10 PPM
Bromine	0-2 PPM	0-1 PPM	0-10 PPM
Chlorine	0-10 PPM	0-5 PPM	0-50 PPM
Chlorine Dioxide	0-2 PPM	0-1 PPM	0-10 PPM
Fluorine	0-2 PPM	0-1 PPM	0-10 PPM
Ozone	0-2 PPM	0-1 PPM	0-10 PPM
Hydrogen Chloride	0-20 PPM	0-10 PPM	0-100 PPM
Hydrogen Cyanide	0-20 PPM	0-10 PPM	0-100 PPM
Hydrogen Fluoride	0-20 PPM	0-10 PPM	0-100 PPM
Hydrogen Sulfide	0-50 PPM	0-10 PPM	0-100 PPM
Nitrogen Dioxide	0-20 PPM	0-5 PPM	0-100 PPM
Sulfur Dioxide	0-20 PPM	0-10 PPM	0-100 PPM
Arsine	0-1000 PPB	0-1000 PPB	0-10 PPM
Diborane	0-1000 PPB	0-1000 PPB	0-10 PPM
Germane	0-1000 PPB	0-1000 PPB	0-10 PPM
Hydrogen Selenide	0-1000 PPB	0-1000 PPB	0-10 PPM
Phosphine	0-1000 PPB	0-1000 PPB	0-10 PPM
Silane	0-20 PPM	0-10 PPM	0-100 PPM

A T I O N S

SENSOR/TRANSMITTER

Measurement:	Gas type and range customer specified
Transmitter Type:	Two wire system, current pulse position signal
Sensor:	Electrochemical gas diffusion type (manufactured by ATI)
Enclosure:	NEMA 4X polystyrene
Optional Enclosure:	Explosion-proof cast aluminum, Class I, Division I Group B, C, & D.
Electrical Connection:	Quick disconnect terminal blocks (two wires without polarity)
Connection Distance:	Up to 1000 feet (300 m.) to receiver
Operating Temperature:	-25° to +55°C (-5° for oxygen)
Humidity:	0-99% non-condensing
Option:	Sensor Auto-Test (available for most gases)
Size:	5" L x 3.7" W x 2.2" D (127 mm x 94 mm x 57 mm)
Power:	12 VDC from receiver module

POWER SUPPLY MODULE

Input Voltage:	85-255 VAC, 50/60 Hz, or 85-255 VDC, self regulating
Output Voltage:	Regulated 13.7 VDC, 1 A.
Output Connections:	3 separate connections, two for receiver modules, and one for external battery back-up.
Alarm:	Loss of input power alarm relay, SPDT 10 A, 120 VAC (5A, 250 VAC) resistive
Operating Temperature:	-40° to +55°C
Humidity:	0-99% non-condensing
Module Enclosure:	Noryl
Size:	2.8" W x 3.6" L x 2.3" D (70 mm x 90 mm x 58 mm)
Electrical Connection:	Quick disconnect terminal blocks
Mounting:	Module mounts to 35 x 7.5 mm DIN rail

BATTERY BACK-UP

Battery:	12 VDC, 4 Ampere hour
Charge Control:	Current limited to .75 A max.
Low Voltage Cutoff:	Relay disconnect at 10 VDC
Fault Protection:	Relay disconnect on shorted charger wiring
Enclosure:	NEMA 4X Polystyrene
Size:	4.33" W x 6.81" L x 3.54" D (110 mm x 180 mm x 90 mm)

MODULE ENCLOSURES

Single Module Enclosure:	NEMA 4X Polystyrene, 4.33" W x 7.09 H x 4.33" D (110 x 180 x 110 mm)
Two Module Enclosure:	NEMA 4X Polystyrene, 7.17" W x 7.09 H x 4.33" D (182 x 180 x 110 mm)
Three Module Enclosure:	NEMA 4X Polystyrene, 10.0" W x 7.09 H x 4.33" D (254 x 180 x 110 mm)
Six Module Enclosure:	NEMA 4X Polystyrene, 14.21" W x 10.0 H x 4.33" D (254 x 180 x 110 mm)
Explosion-proof Enclosure:	Cast Aluminum, Class 1, Div I, Groups C & D

Ordering Information

Specify modules using the coding system below. Generate a part number for both the receiver and sensor/transmitter. Then select power supply and enclosure options as required.

MODEL A14 - C(□□) - D(□□□□) - E(□) Receiver Module

MODEL A11 - C(□□) - D(□□□□) - E(□) - F(□) Sensor/transmitter

Suffix CC — Gas Type

10 - Bromine 0-2 PPM*
11 - Chlorine 0-10 PPM*
12 - Chlorine Dioxide 0-2 PPM*
13 - Fluorine 0-2 PPM*
14 - Ozone 0-2 PPM*
15 - Ammonia 0-100 PPM*
16 - Carbon Monoxide 0-100 PPM
18 - Hydrogen 0-4%
19 - Oxygen 0-25%
20 - Phosgene 0-2 PPM%
21 - Hydrogen Chloride 0-20 PPM
22 - Hydrogen Cyanide 0-20 PPM*
23 - Hydrogen Fluoride 0-20 PPM*
24 - Hydrogen Sulfide 0-50 PPM*
25 - Nitric Oxide 0-100 PPM
26 - Nitrogen Dioxide 0-20 PPM*
27 - Sulfur Dioxide 0-20 PPM*
28 - Arsine 0-1000 PPB
29 - Diborane 0-1000 PPB
30 - Germane 0-1000 PPB
31 - Hydrogen Selenide 0-1000 PPB
32 - Phosphine 0-1000 PPB
33 - Silane 0-20 PPM

*Indicates Auto-Test Available

Suffix DDDD — Gas Type

Code the measurement range using a 4 digit number. The standard ranges are shown under suffix C above. For 0-10 PPM chlorine, the code would be 0010. For 0-200 PPM ammonia, the code would be 0200.

Suffix E — Units of Measurement

1 - PPM
2 - PPB
3 - %
4 - %LEL

Suffix F — Auto-Test System

1 - Without sensor auto-test function
2 - With sensor self-test

Options and System Enclosures

00-0055	Power Supply Module
00-0057	Battery Backup Unit
00-0058	Audible Horn
35-0002	Strobe with red lens
80-0005	Single Module Enclosure
80-0006	Two Module Enclosure
80-0007	Three Module Enclosure
80-0008	Six Module Enclosure
03-0039	Explosion-proof Sensor/Transmitter enclosure
03-0040	Explosion-proof Enclosure for receiver module only
03-0041	Explosion-proof Enclosure for receiver and power supply

Consult factory for information on special enclosures for systems requiring larger quantities of receiver modules in a single enclosure. Custom designs are available for any number of modules required.

ATi
ANALYTICAL TECHNOLOGY, INC
730 East Elm Street, Suite 100
Conshohocken, PA 19428
Phone: 215-828-0889, FAX: 215-828-0925
800-959-0299

Represented By

ANALYZER DATA SHEET

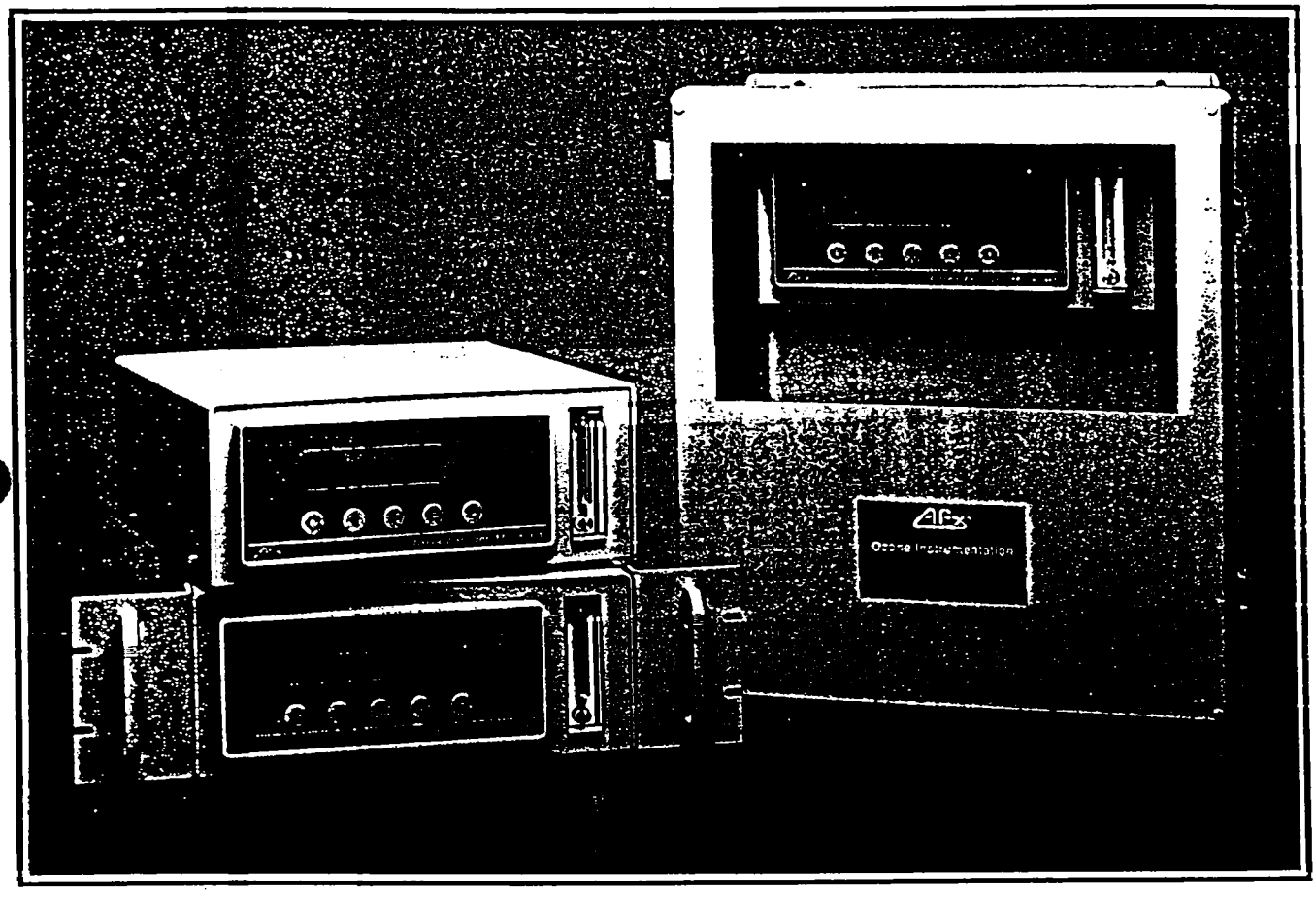
Item	High Concentration Ozone Analyzer
Location	Ozone Generator Outlet
Quantity	1
Manufacturer	IN USA
Model No.	H1-X
Scale	0 to 200 G/M^3 (0-15%)
Enclosure	NEMA 4X
Options	Ozone Scrubber
Power Supply Required	115-240 VAC 50/60 Hz
Connections	¼" Tubing

P-1 | PRV | FCV | FM
E 00063

Ozone Instrumentation

Series "H"

High Concentration Process Ozone Analyzers



- Continuous sample flow
- No solenoid valves, no external reference
- Automatic compensation for sample pressure, temperature and molecular weight
- Microprocessor controlled
- UV absorption technique
- Suitable for measurement at high pressures

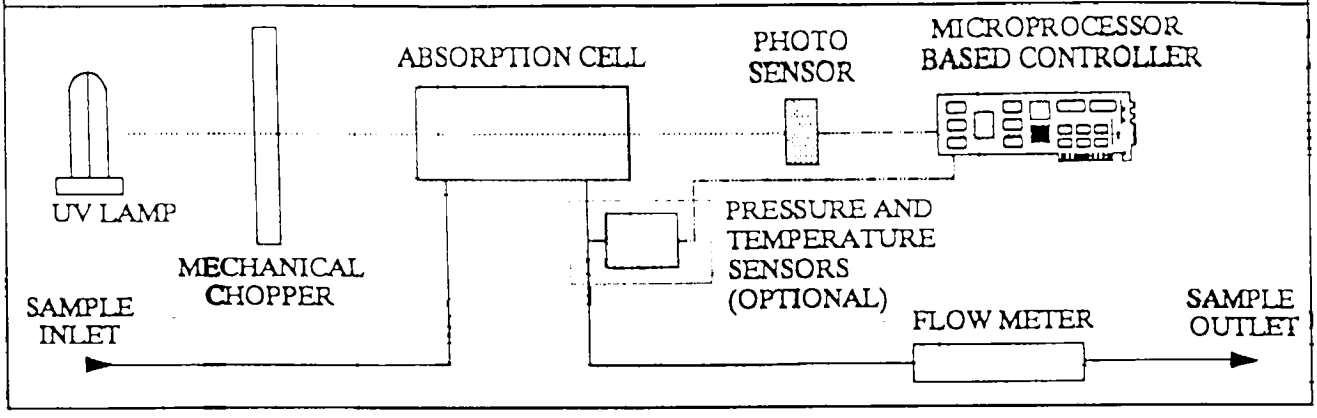
IN USA INCORPORATED

Excellence in Instrumentation™

AFX® Series "H"

High Concentration Process Ozone Analyzers

PRINCIPLE OF OPERATION



SPECIFICATIONS

Measuring Principle	Absolute determination by UV absorption through innovative optical system
Cycle Time	Continuous measurement, uninterrupted sample flow - no solenoid valves
Upper Measurement Ranges	HI-LR: 50 G/M³ (4%) – HI-S: 125 G/M³ (10%) – Hi-X: 200 G/M³ (15%) – Hi-UH: 400 G/M³ (28%)
Precision/Repeatability	0.1 G/M³ or 1% of reading (whichever is greater)
Resolution	0.1 G/M³ (0.01% W/W) in the range from 0.1-125 G/M³
Linearity	Better than 99% throughout range
Zero Drift	Less than 0.1 G/M³ per month, non cumulative
Calibration Standard	Against the International Ozone Association KI method to 1% repeatability
Ozone Concentration Units	G/M³, G/NM³, % weight, % volume (field selectable)
Sample Pressure and Temperature Sensors	Optional automatic compensation for sample pressure, temperature and molecular weight. Normalizing parameters are field selectable
Standard Alarms	2 field programmable alarms with form C relay contacts (5 A 250 VAC res.)
Diagnostic Features	Continuous internal diagnostics with error messaging & instrument error relay
Sample Flow Rate	0.5 l/min (built-in flow meter) at 30 PSIG max. Higher pressures on request
Readout	2 line by 20 character alphanumeric vacuum fluorescent display
Analog Outputs	Scalable 4-20 mA and 0-10 VDC standard. Others available on request
Digital Outputs	RS232 bi-directional interface standard
Available Configurations	NEMA 4x/IP65 non-metallic enclosure (wall mount); 19" rack; bench-top
Sample Inlet/Outlet Ports	1/8" or 1/4" compression fittings. Metric, VCR or other fittings on request
Supply Voltage	100-240 VAC 50/60 Hz

Specifications subject to change without notice

THE AFX® FAMILY OF INSTRUMENTS INCLUDES MODELS FOR ALL OZONE MEASUREMENT APPLICATIONS

Series "H"	Series "IN-2000"	Series "W"	Series "AET-030"
High concentrations - Generator output - Offgas	Low concentrations - Ambient - Safety - Stack	Dissolved and residual ozone in water	Spot-checking - Hand held operation

IN USA, Inc. • 100 Crescent Road • Needham, MA 02194 U.S.A.
Tel: 617-444-2929 • U.S. Toll Free: 800-798-4029 • Fax: 617-444-9229

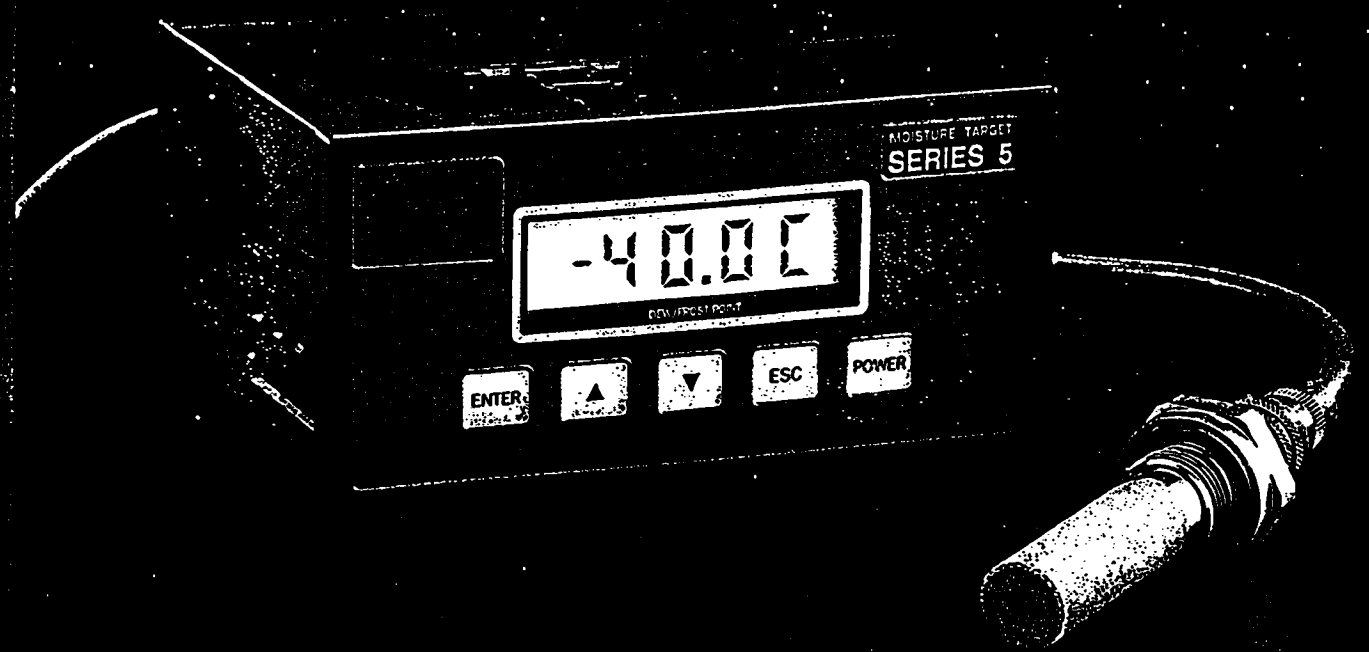
ANALYZER DATA SHEET

Item	Dewpoint Monitor
Location	Ozone Generator Room
Quantity	1
Manufacturer	Panametrics
Model No.	Receiver: Moisture Target Series 5 Sensor: M Series
Scale	-110°C to +60°C
Enclosure	Panel Mount
Options	Standard Sample Cell P017700-1
Power Supply Required	120 VAC 50/60 Hz
Connections	¼" Tubing

PANAMETRICS

Moisture Series Analyzers

Moisture Target™ Series 5



- Low cost single channel hygrometer for original equipment manufacturer applications
- Two Form C alarm relays standard or hermetically sealed for hazardous areas
- M-Series moisture probes with NIST traceable moisture calibration
- Built-in optically isolated analog outputs in current or voltage
- Weatherproof membrane front panel display/keypad
- Panel mount and DIN Rail configurations
- Fail safe fault alarm

Introducing the New Moisture Target™ Series 5 Analyzer, for OEM applications.

Low cost, real-time moisture measurement.

The Moisture Target Series 5 is an economical, single channel, aluminum oxide hygrometer in the Moisture Series line of analyzers from Panametrics. It is intended for Original Equipment Manufacturer (OEM) applications requiring low-cost, accurate, real-time moisture measurement.

Improves OEM product performance.

The Moisture Target Series 5 can significantly enhance the performance of OEM products by allowing closed-loop control of moisture. For example, in a regenerative dryer application it can improve efficiency by initiating desiccant bed regeneration when needed, rather than on an open-loop timed cycle.

Panel-mount version.

The panel-mount version of the Moisture Target Series 5 comes in a compact DIN standard meter housing for applications where space is at a premium. The case slides directly into the panel cutout, and is held in place from the rear by captive screws.

PC-board version.

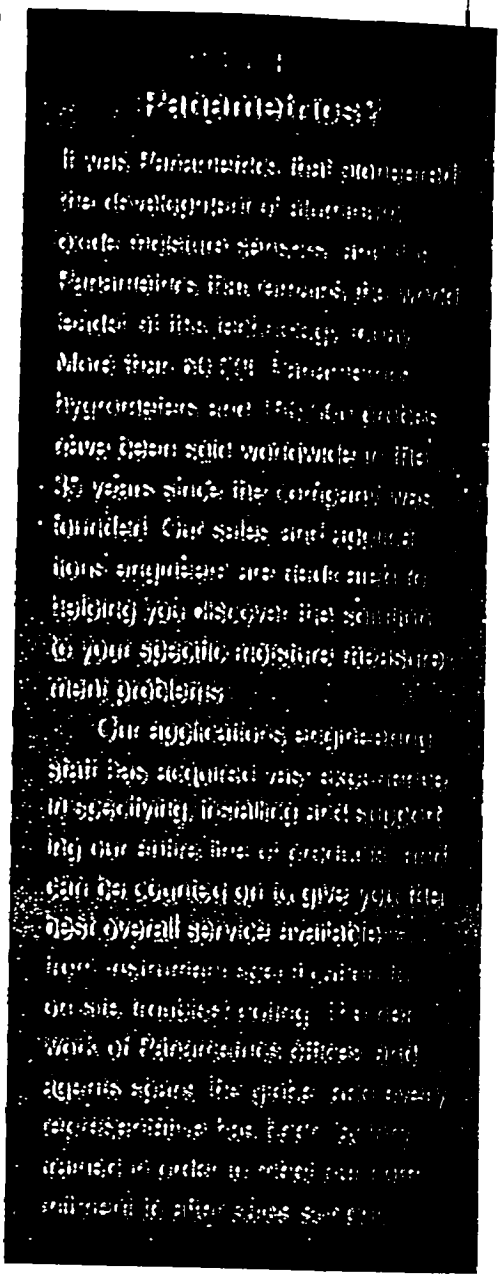
The Moisture Target Series 5 is also available in PC-board form for complete product design flexibility. The board is typically installed inside the cover of a product enclosure or cabinet, with the LCD and keypad visible through cutouts in the cabinet door.

Uses M-Series probes.

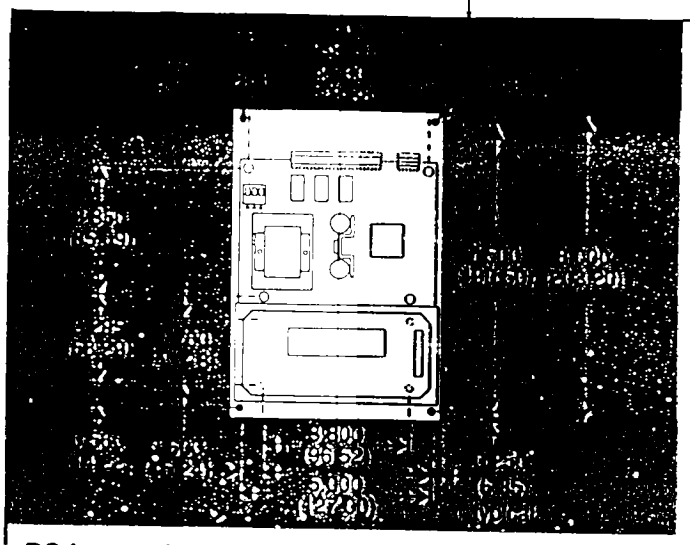
Both versions of the Moisture Target Series 5 use Panametrics M-Series aluminum oxide moisture sensor probes. M-Series probes are rugged, accurate, true absolute humidity sensors with calibration traceable to the National Institute of Standards and Technology (NIST). Exceptional dynamic range, speed of response and calibration stability have made the M-Series probe the standard for performance and value in industrial moisture measurement for more than 35 years. They are suitable for moisture measurement in gases and liquids over a wide range of process conditions.

Microprocessor-based electronics.

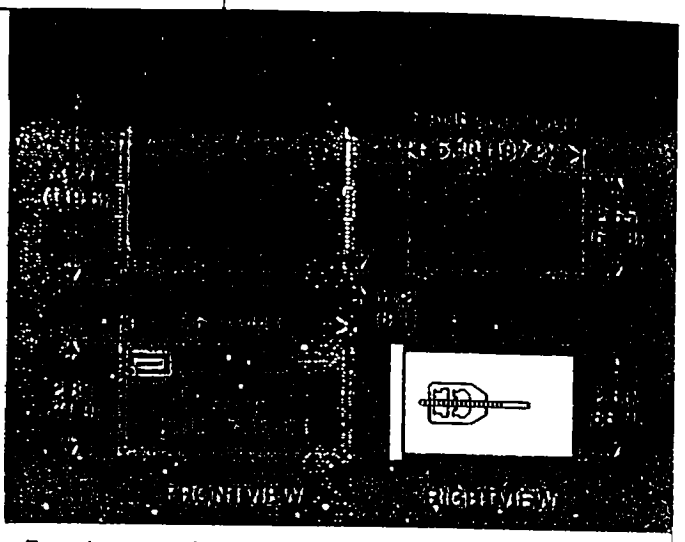
The microprocessor-based Moisture Target Series 5 accurately tracks fast-changing process conditions and displays dew/frost point temperature in °C or °F on a 6-digit LCD. Dew/frost point is also available as an analog voltage or current output, and the Moisture Target Series 5 features built-in optical isolation to ensure the integrity of signals to recorders, computers and other remote devices.



The unit also features two optional Form-C alarm relays for high and low dew/frost point limits. For applications in Division 2 hazardous areas, hermetically sealed relays are available. The microprocessor-based electronics and 5-button keypad combine to make selection of analog output zero and span, and alarm setpoints fast and easy.



PC board Moisture Target Series 5. Dimensions in inches (mm).



Panel mount Moisture Target Series 5. Dimensions in inches (mm).

Specifications:
Electronics.

Input:

Moisture signal from Panametrics M-Series thin-film aluminum oxide moisture probe.

Intrinsic safety:

External safety barrier for moisture input (optional).

Analog output:

Single internal optically-isolated recorder output for dew/frost point temperature; 10-bit (0.1%) resolution.

Standard switch-selectable outputs:

0 to 2 V, 10 kΩ minimum load resistance.

0 to 20 mA, 400 Ω max. series resistance.

4 to 20 mA, 400 Ω max. series resistance.

Zero & span are user-programmable within the range of the instrument and the corresponding sensor.

Alarm relays:

1 fail-safe fault relay.

2 standard Form-C relays SPDT, rated for 2 A at 28 VAC/28 VDC.

Hermetically-sealed relays available.

Set to any level within the range of the instrument; Programmable from front panel.

Alarm set point repeatability:

± 0.1°C dew point.

Display:

1-line, 6-digit backlit LCD.

Display functions:

Dew/frost point temperature °C or °F.

Power requirements:

100/120/230/240 VAC, 50/60 Hz. 24 VDC.

Temperature:

Operating: 0° to 60°C.

Storage: –30° to 70°C.

Warm-up time:

Meets specified accuracy within 3 minutes.

Configurations:

Panel (front panel designed to meet NEMA-4/IP66 requirements).

PC-board versions

Moisture Measurement.

Sensor type:

Thin-film aluminum oxide moisture sensor probe.

Moisture probe compatibility:

Compatible with Panametrics M-Series aluminum oxide moisture probes.

Dew/frost point temperature:

Overall calibration range capability: 60° to –110°C.

Available calibration range options:

Standard: 20° to –80°C with data to –110°C.

Extended high: 60° to –80°C with data to –110°C.

Accuracy:

± 2°C from 60° to –65°C d/f point.

± 3°C from –66° to –110°C d/f point.

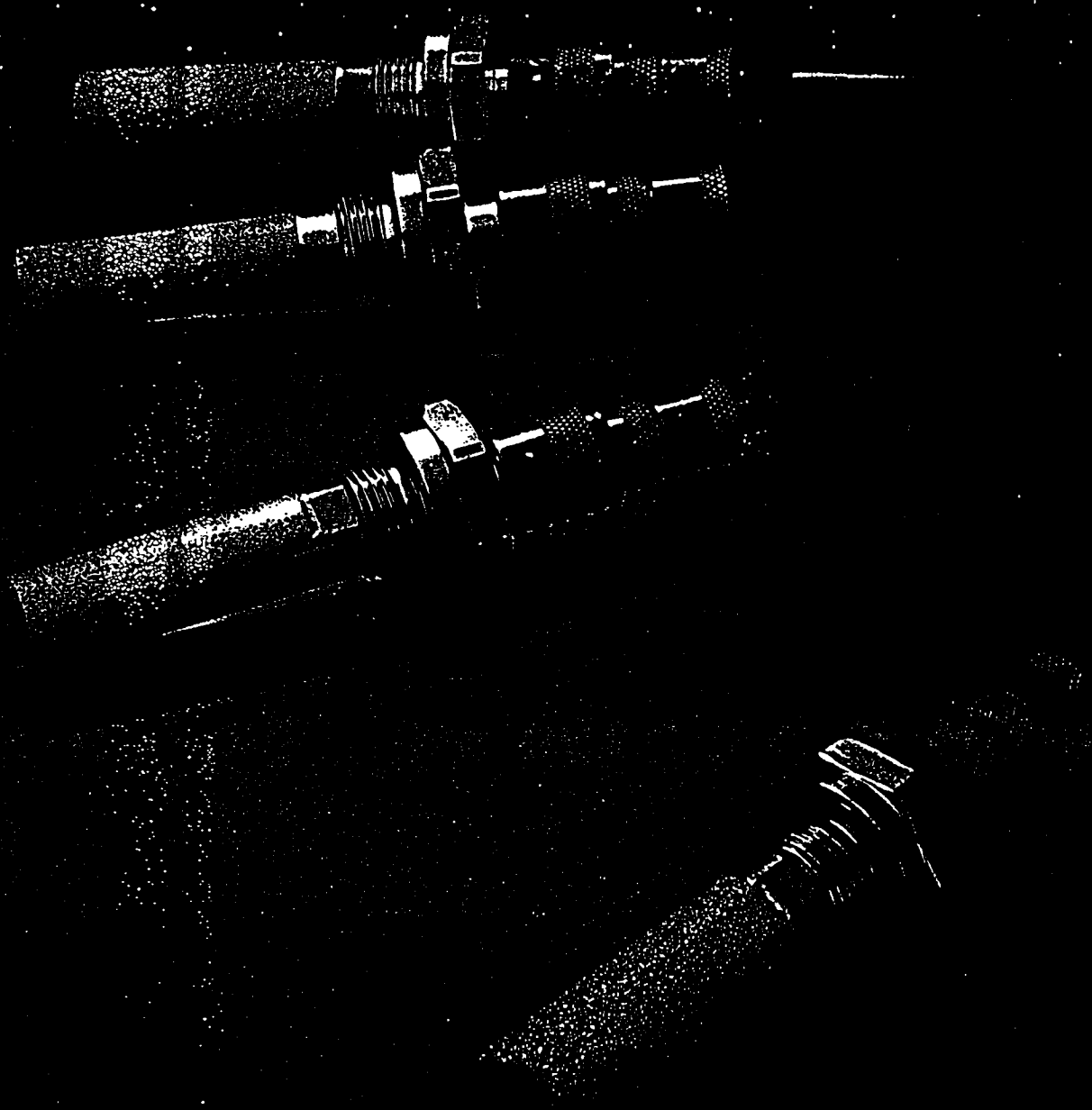
Repeatability:

± 0.5°C from 60° to –65°C d/f point.

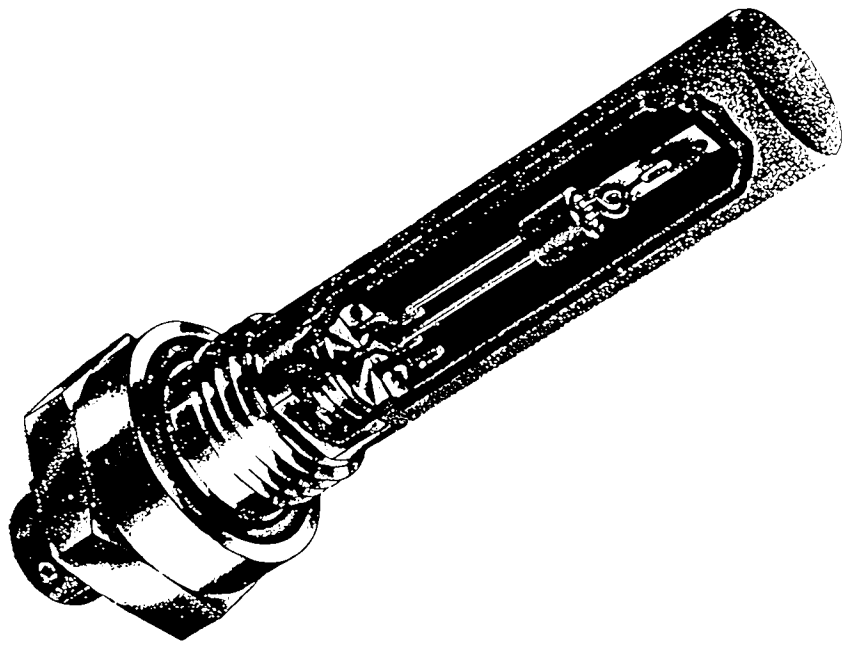
± 1.0°C from –66° to –110°C d/f point.

M Series

Aluminum Oxide Moisture Sensor for Gases and Liquids



Advanced moisture sensor technology for demanding process applications



Cutaway view of M Series moisture probe

Features

True absolute humidity sensor

Superior sensitivity, response speed and calibration stability

Wide dynamic range

Operates in both gases and liquids

Designed for on-line installation

Calibration traceable to the National Institute of Standards and Technology.

Panametrics moisture probes

For more than twenty years, the Panametrics aluminum oxide moisture sensor probe has set the standard of performance and value in industrial moisture measurement.

The aluminum oxide moisture sensor was originally developed for meteorological purposes to meet the conditions encountered during flights in the upper atmosphere and through space to other planets. Because the sensor performed so well in these extreme conditions, it was adapted for use in process streams where equally demanding conditions are frequently found. Performance of the sensor in process applications was so successful that it was quickly accepted as the true, on-line, process water vapor sensor.

Patented performance

Film thickness of the oxide layer is critical to the performance of this type of sensor. Panametrics manufactures sensors with an oxide film thickness which causes them to exhibit true absolute humidity, rather than relative humidity response, while minimizing any temperature or hysteresis effects. This critical film thickness also gives the Panametrics M Series probe quick response and exceptional calibration stability. And Panametrics thin film aluminum oxide sensors are patented around the world.

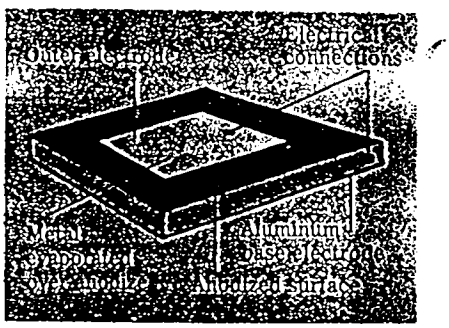
Panametrics hygrometer systems

In use, M Series moisture probes are coupled to Panametrics hygrometer consoles by an interconnecting cable. Ease of use, wide measurement range and rigorous calibration standards make these systems the preferred choice for industrial moisture measurement worldwide.

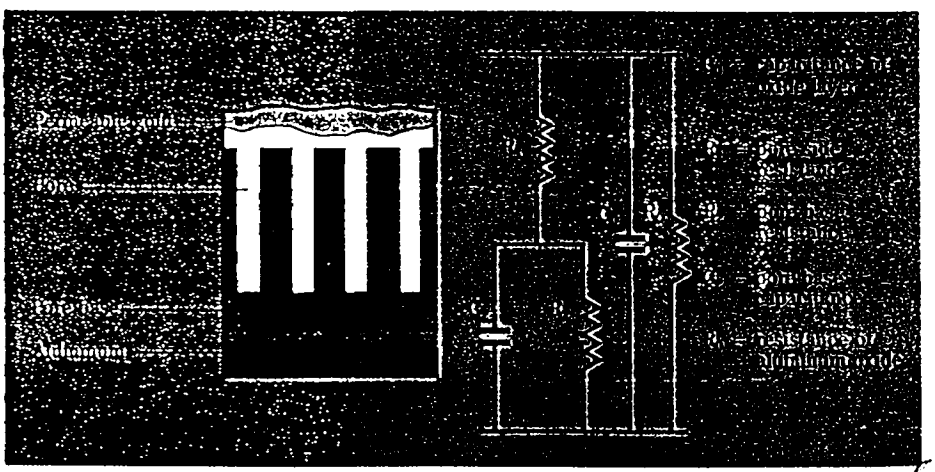
Theory of operation in gases and liquids

The direct measurement of water vapor pressure is accomplished easily and effectively in both gases and liquids by the M Series aluminum oxide moisture sensor. The sensor consists of an aluminum strip which is anodized by a special process to provide a porous oxide layer over which a very thin coating of gold is evaporated. The aluminum base and the gold layer form the two electrodes of what is essentially an aluminum oxide capacitor.

Water vapor is rapidly transported through the gold layer and equilibrates on



Mechanical construction



Aluminum oxide moisture sensor model

...ne pore walls of the oxide layer. The number of water molecules absorbed on the oxide structure determines the conductivity of the pore walls. Each value of pore wall resistance provides a distinct value of electrical impedance which in turn is functionally related to the water vapor pressure. This functional relationship holds for measurements made in either gas phase or in liquid phase.

Broadest moisture measurement range available

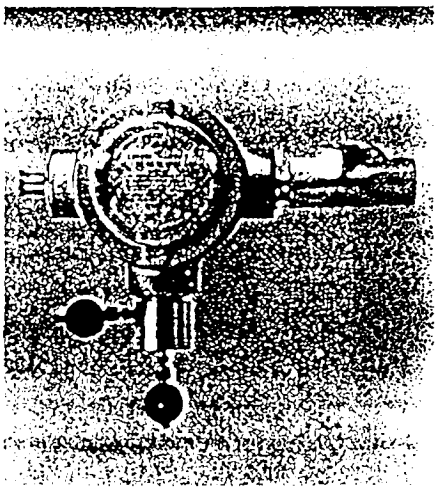
Panametrics M Series probes can measure moisture content over a calibrated range of +60°C to −110°C dew/frost point temperature, which is equivalent to 200,000 ppm_v to 0.001 ppm_v in gases at one atmosphere pressure. In principle, the same dew/frost point range may be measured in liquids. This wide dynamic range allows the user to measure dissolved moisture content with the same probe and hygrometer throughout all phases of this process, even under upset conditions. The moisture measurement system will not run out of range and the same probes may be used in either gas or liquid phase.

Most Panametrics hygrometer consoles have zero and span adjustments to maximize output resolution. Standard calibrated ranges may differ between hygrometer models. Refer to individual hygrometer brochures for details.

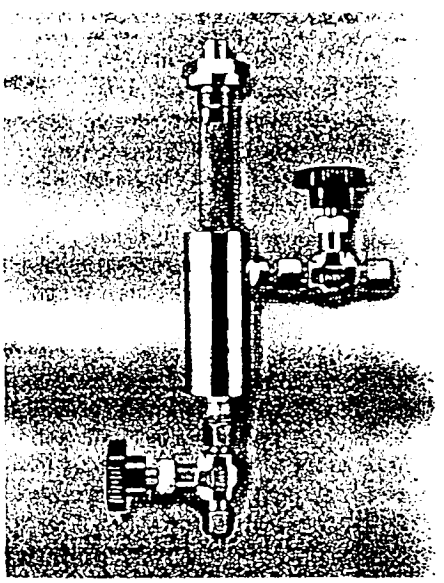
Designed for on-line installation

Panametrics M Series probes are designed to be used on-line, exactly where the measurement is needed. Cable length between the probe and the hygrometer may be 2,000 feet or more. Operating temperature range is +70°C to −110°C, pressure range is from vacuum up to 5,000 psig, and no minimum flow rate is required. Sample cells make M Series probes easy to install and are available in either general purpose or NEMA-7 explosionproof housings.

Remote installation of the probe and wide operating parameters practically eliminate the need for sample delivery or conditioning systems. Because a sample need not be brought to the analyzer, both the time lag and the potential for sample contamination associated with sample delivery systems are eliminated. This feature is extremely important in the measurement of very low moisture content or where rapid changes occur.



NEMA-7 sample cell



Standard sample cell

When a stream is contaminated by conductive or erosive particles, or when the expected dew/frost point temperature is high enough to make condensation of water in the system a possibility, sample conditioning will be required. Panametrics designs and manufactures turnkey sample-conditioning systems which maintain the integrity of the sample's moisture content while removing the contaminants. These designs have been field-tested and have proven reliable, while requiring little or no maintenance.

Rigorous calibration standards traceable to the NIST (NBS)

Each Panametrics aluminum oxide sensor is individually calibrated in one of the world's most advanced moisture calibration facilities. Developed over several decades, this facility uses flow, temperature and pressure measurement devices, which are traceable to the National Institute of Standards and Technology, to generate precisely known moisture concentrations to which each probe is exposed during the calibration process. As a final check, the generated moisture concentration is compared against an optical dew point hygrometer which is independent of the moisture generation system and which is also traceable to the National Institute of Standards and Technology.

All data is taken and stored by a dedicated computer system. Calibrations are repeated over a period of many months to determine the stability of each individual moisture probe. Only those probes which meet Panametrics' demanding specifications for accuracy and stability are shipped to our customers.

Once all criteria are met, the computer generates the appropriate calibration data medium for each probe. Depending on the model of hygrometer the probe will be used with, calibration data may be transferred to paper or to electronic EPROM's. In either case, calibration data is entered into each Panametrics hygrometer before it is shipped. When the hygrometer arrives, it is fully calibrated and functional, ready to be put into service without complicated startup procedures.

Calibration test reports performed by independent laboratories are available upon request, as is further information about moisture measurement in gases and liquids. Contact your Panametrics representative for details.

Worldwide Service

More than 10,000 Panametrics hygrometers and 50,000 probes have been sold worldwide in the 30 years since the company was founded. They are serviced by a network of Panametrics offices and agents which spans the globe. Each has been factory trained to give our customers the quality of products and service they expect from Panametrics, the leader in moisture measurement.

Specifications

Moisture sensor probe

Type:
Aluminum oxide moisture sensor probe

Construction:
Sensor: 99.99% aluminum, aluminum oxide, gold, nichrome
Back wire: 316 SS
Contact wire: Gold sponge spot-welded to 304 SS ribbon
Front wire: 316 SS spot-welded to contact wire and pins
Support: Glass, Corning 9010

Electrical connector construction:
Pins: Al 152 alloy (52% Ni)
Glass: Type 9010
Shell: 303 SS
O-ring: Viton A
End cap: 316 SS

Input voltage:
1 VAC, 77Hz

Impedance range:
50 KΩ to 2 MΩ depending on water vapor pressure

Calibration:
Each sensor is individually computer-calibrated against known moisture concentrations, traceable to the National Institute of Standards and Technology (NIST).

Dew point range:
Standard calibrated range: –80°C to +20°C
Overall capability: –110°C to +60°C (available on request)

Accuracy:
±2°C in range of –65°C to +60°C
±3°C in range of –110°C to –66°C

Repeatability:
±0.5°C in range of –65°C to +60°C
±1.0°C in range of –110°C to –66°C

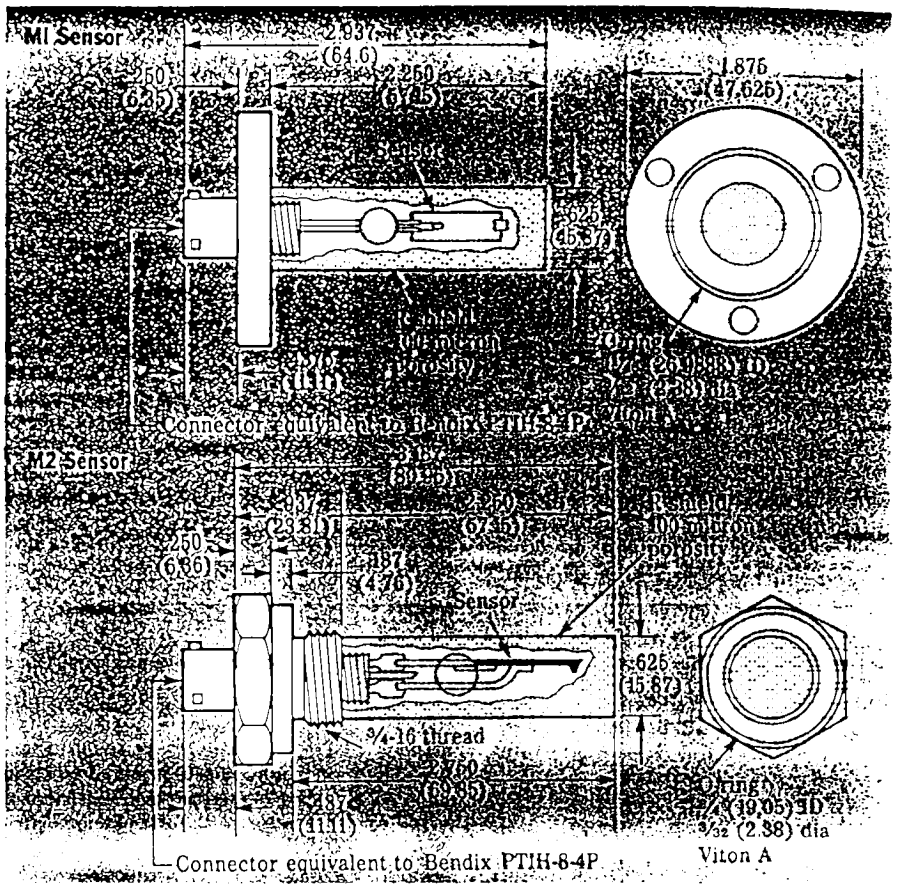
Operating temperature:
–110°C to +70°C

Storage temperature:
Maximum of +70°C

Operating pressure (depends on mount):
M1: 5 microns of Hg to 75 psig
M2: 5 microns of Hg to 5000 psig

*Patented worldwide

Dimension, Inches (mm)



Flow range:
Gases: From static to 10,000 cm/sec linear velocity at 1 atm
Liquids: From static to 10 cm/sec linear velocity at density of 1 g/cc

Response time:
Less than 5 seconds for a 63% step change in moisture content in either wet up or dry down cycle.

Consult factory for specifications of other moisture sensor probes available for special applications.

Warranty:
Calibration: six months from delivery
Materials and workmanship: one year from delivery

Optional temperature sensor

Type:
Linear thermistor network

Operating range:
–30°C to +70°C

Accuracy:
±0.5°C overall

Time constant (maximum):
1 sec. in well-stirred oil, 10 sec. in still air for a 63% step change in increasing or decreasing temperature.

PANAMETRICS

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Toll Free 800-833-9438
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Panametrics Limited
Bay 148, Shannon Airport
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Phone 353-61-471377
Fax 353-61-471359
E-Mail info@panametrics.ie

ISO 9001 Certified

ISO 9002 Certified

A 1/98

OZONIA

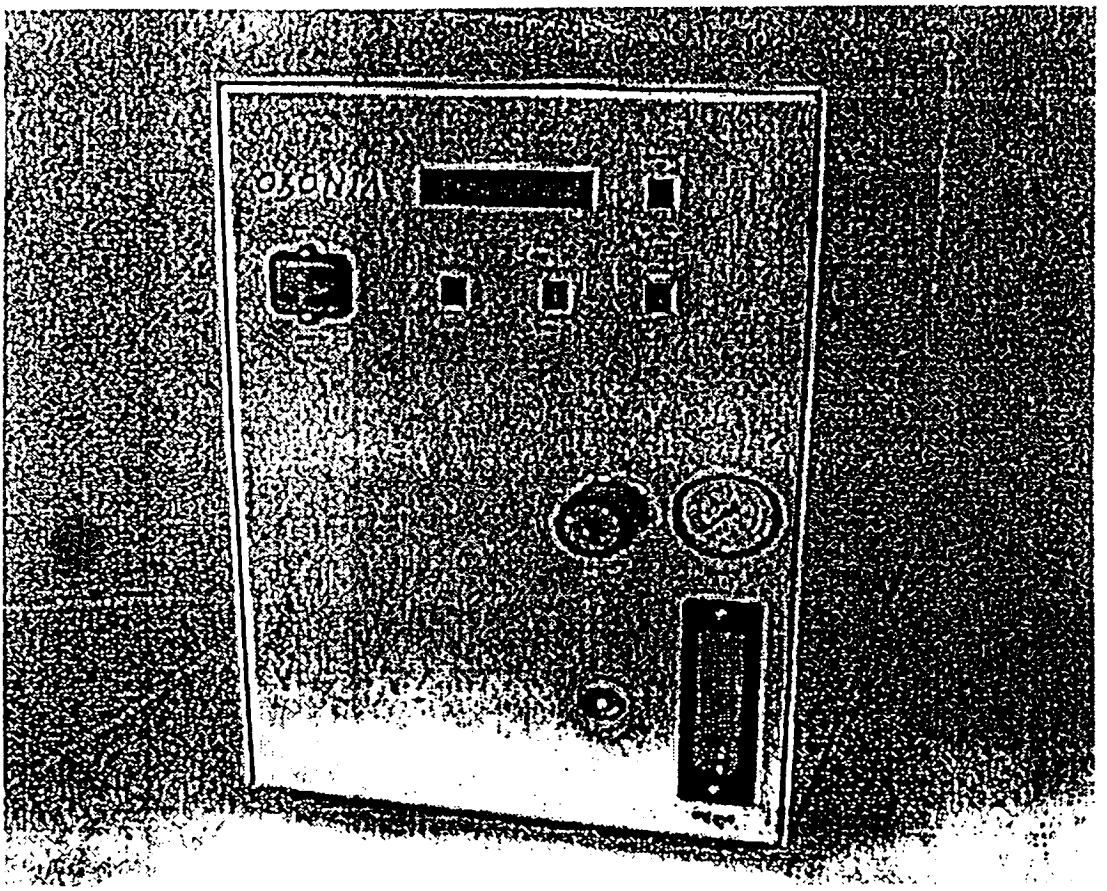
OPERATING INSTRUCTIONS

OZAT® CFS-6A

OPERATING INSTRUCTIONS

OZAT® OZONE GENERATOR

TYPE CFS-6A



INSTRUCTION:

These operating instructions contain important safety instructions. They must be carefully read by both the owner and the user before commissioning.

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	Date / Visa	Rev.	Date / Visa	Derived from: HTE 600 157	Rev.	Index
Prepared	98-08-19 / DT			Replaces :	Rev.	
Reviewed	98-09-01 / UI			Page of	Languages	No.

Captions

The following is a description of the symbols and pictograms which are used in these operating instructions:

ATTENTION:

Prohibited actions and procedures.

WARNING/INSTRUCTION:

Warning of danger. General warning that special attention should be paid. Important instruction, that must be followed.

WARNING:

Voltage or high voltage: Dangerous for persons or household pets. The valid regulations and accident prevention measures must be strictly adhered to.

WARNING:

Dangerous situation. Serious injury or death can result. The product or its surrounding can be damaged.

INFORMATION:

Information and instructions that must also be followed.

IMPORTANT:

Measures recommended by Ozonia.

PROHIBITION:

No smoking or naked flames.

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List of contents

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1. General

Please ensure that the operating instructions are carefully read by all relevant pesons before installation and before putting into operation, to ensure the safe use of the OZAT® ozone generator (from here on also referred to as the equipment) The Operating instructions contain important information for the operation and maintenance of the equipment.

The operating instructions are an integral part of the equipment supply.

Before putting into operation, all the conditions necessary for safe operation of the equipment must be fulfilled. Please refer to Chapter 3 "Safety measures and regulations".

The installation, commissioning and maintenance of the equipment should only be carried out by qualified personnel.

The equipment should only be operated by authorised personnel who have been trained accordingly.

No modifications should be made to the equipment without consulting Ozonia, as this could effect the safety. Ozonia shall not be held responsible for damage resulting from unapproved modifications.

INSTRUCTION:

The operating instructions are to be kept where they will be accessible for operating and maintenance personnel.

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2. Product description

The OZAT® ozone generator is designed to generate air or oxygen ozone gas mixture suitable for use in all types of processes, for example:

- Drinking water
- Swimming pool water
- Waste water
- Aquaculture
- Disinfection
- Oxidation processes in industry

The owner and/or user is responsible for the implementation of the ozone in the process and for the corresponding safety measures.

ATTENTION:

Bringing people or household animals into contact with, or exposing them to, gases containing ozone can endanger their lives. Gas containing ozone shall not be released in an uncontrolled manner, neither in a confined space nor to atmosphere.

PROHIBITION:

When oxygen is used as the feedgas, the relevant safety and security measures must also be complied with (Chapter 3).

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2.1 Technical data

2.1.1 Cabinet dimensions of the OZAT® ozone generator

Type			CFS-6A	
Width	378			mm
Depth	876			mm
Height	612			mm
Weight			95	kg

2.1.2 Nominal data of the OZAT® ozone generator

Type					CFS-6A		
Feedgas					Air	O_2	
Nominal production [1]					250	500	g O_3/h
Nominal ozone concentration					3	6	wt%
Oxygen requirement (98% O_2, 2% N_2)						5.84	m^3/h
Air requirement					6.44		m^3/h
Adjust. range of the ozone production	10...100						%
Cooling media requirement [1]					0.56		m^3/h
Electrical power requirement [1]					4.3		kVA

[1] with an inlet cooling temperature 12 °C

For the adjustment of the gas flow and the ozone concentration use the follow appendixes:

Type					CFS-6A		
Feedgas					Air	O_2	
Gas flow diagrams					15	17	Appendix
Setting curves					16	18	Appendix

An example for calculation see in chapter 8.1.1.

INFORMATION:

The OZAT® ozone generator requires a running-in time of minimum 400 hours from the first commissioning before it reaches nominal production. After 24 hours of operation, about 90 % of the nominal production will be reached. In order to increase the service life of the OZAT ozone generators it is not recommendable to operate the units over 80% of the nominal electrical rating for the first 100 service hours.

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2.1.3 Operational data of the OZAT® ozone generator

Feedgas: Air or Oxygen

Type					CFS-6A		
Feedgas					Air	O_2	
Oxygen purity						≥90	wt%
Dew point contents at 1 bar abs.	<-60						°C
Oil content	≤0.1						ppm
Contamination particle size	≤1						µm
Hydrocarbons	<15						ppm
Inlet pressure					4.5...8	3...8	bar g
Outlet pressure	<1.3						bar g
Temperature	5...40						°C
Nominal operational pressure					2.5	1.5	bar g
Gas flow, adjustable					0.77...7.66	0.62...6.16	Nm^3/h
Ozone concentration, adjustable	0...ca. 15						wt%

Cooling medium: Water (Drinking water quality)

Type			CFS-6A	
Chloride content	≤50			mg/l
Inlet temperature	2...30			°C
Operational pressure	2...6			bar g
Cooling media flow			0.56	m^3/h

Environmental conditions:

Type			CFS-6A	
Ambient temperature for operation	5...40 (24 h-average = 35 °C) [1]			°C
Ambient temperature for transport and storage	-25...+55 (70 °C total max. 24 h)			°C
Altitude	<1000 [1]			m.a.s.l.
Annual average air humidity - for 60 continuous days a year - occasionally	≤65 85 75			% % %
Condensation	to be avoided			
Protection class for installation	IP 42			
Vibration/Shock	installation in a vibration-free environment			
Heat dissipation to the environment			~900	W

[1] Above electrical power reduction: 1% per 1°C, 10% per 1000m

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2.2 Connection

2.2.1 Electrical data of the OZAT® ozone generator

INFORMATION:

The connection to the mains power is made using a plug and socket (L1/L2/PE). The line fuse must be sufficient to meet the local regulations and our requirements.

Type			CFS-6A	
Fuse 6.3x32 mm (fast blow)			12.5	A
Line voltage, single phase	2x 400 ±10%			V_{AC}
Line frequency	48...63			Hz
Line current			11	A_{AC}
Line power consumption			4.25	kW
Line power factor			0.99	cosφ
DC-Power measurement Pe			160...4000	W_{DC}

External set-value signal: 4...20 mA (= 0...100%), (potential free)

- Internal resistance: 150 Ω
- Max. permissible current: 25 mA
- Max. permissible common mode voltage: ≤30 V

Signals to master controller: potential free contacts (rating ≤50 $V_{AC/DC}$, 1 A)

- Supply ON
- Collective alarm
- Set-value REMOTE

Voltages in the equipment:

- In the intermediate cicuit: 650 V_{DC}
- At the ozone generator (13E1): ~5 kV, 1425 Hz

Wiring to apparatus:

- Control signals, signals to master controller (Appendix 21).
- Connection with multicore cable and plug (Appendix 22).

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2.2.2 Mechanical connections of the OZAT® ozone generator

Feedgas connection:	Bulkhead fitting Serto SO 41521-12 For hose and pipe lines Ø 12 x 1
Ozone gas connection:	Bulkhead fitting Serto SO 51521-12 For hose and pipe lines Ø 12 x 1
Cooling meduim in out:	Bulkhead fitting Serto SO 41521-15 For hose and pipe lines Ø 15 x 1

IMPORTANT:

Material recommended for the external connections.

Ozone:	Fluorised plastics (PTFE, PVDF) Stainless steel (e.g. 1.4571, 1.4435)
Oxygen:	Fluorised plastics (PTFE, PVDF) Copper, stainless steel (e.g. 1.4571, 1.4435)
Air:	Fluorised plastics(PTFE, PVDF) Stainless steel (e.g. 1.4571, 1.4435), copper, brass, galvanized steel
Water:	Plastic (PVC, PTFE, PVDF, PE, PA), copper, brass, galvanized steel

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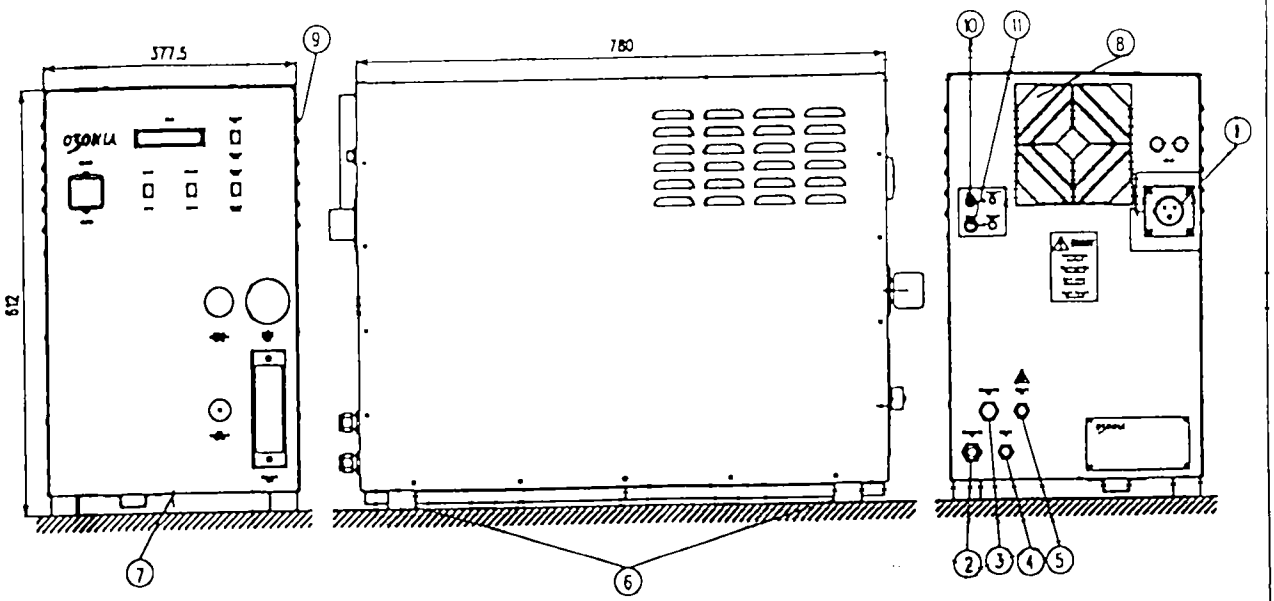
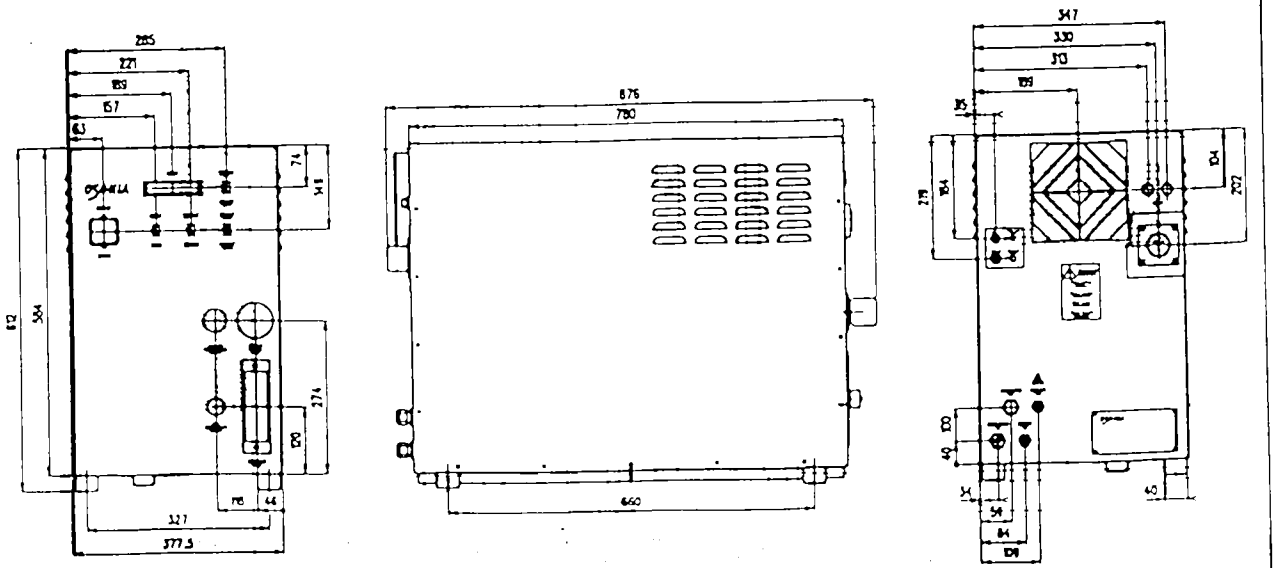
2.2.3 Dimensional drawing showing connections



Caption:

1	Mains socket
2	Cooling medium inlet
3	Cooling medium outlet
4	Feedgas inlet
5	Ozone gas outlet
6	Rubber feet
7	Condensaite drain
8	Air fan inlet (minimum clearance 200mm)
9	Air outlet (minimum clearance 200mm)
10	Plug (X2) for external set value
11	Plug (X7) for external signalisation



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3. Safety measures and regulations

The equipment must only be installed, put into operation and maintained by trained specialists. The owner and/or user must ensure that the operating personnel have been suitable instructed.

The equipment represents the state of the art. It has been subjected to a hazard analysis, corresponding precautionary measures regarding the safety of persons and domestic animals have been made. Nevertheless, it is still possible that danger could arise as a result of incorrect use, bad maintenance, material changes, etc. These dangers are associated with:

- Gaseous oxygen
- Ozone
- Electricity
- Mechanical dangers
- Air pressure

3.1 Gaseous oxygen (if used as feedgas)

Characteristics:

- Colourless, odourless, tasteless
- Heavier than air (concentration in channels, etc.)
- Supports and accelerates burning (paricularly in concentrations in air >25 % Vol./ normal concentration 21 % Vol.)

The oxygen concentration can increase in insufficiently ventilated areas and even reach dangerous levels as a result of leaks in the equipment internal or external piping, or by opening of systems containing oxygen. High oxygen concentrations will result in a significantly increased fire risk.

PROHIBITION:

Naked flames are particularly dangerous, therefore:
- Smoking is forbidden
- No welding work
- Etc.

ATTENTION:

Oil and grease are very dangerous
- No oil or grease soiled clothing
- Keep oxygen equipment free from oil and grease

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ATTENTION:

Sparks are dangerous (switching sequences, grinding, unsuitable tools, etc.)

Comprehensive information can be requested from oxygen suppliers or can be obtained from the publications of the specialist bodies (e.g.: IGC document, issued by the "European Industrial Gases Association, Brussels; can also be obtained from Ozonia (Appendix 24).

3.2 Ozone

In the OZAT® ozone generator, oxygen (feedgas) is converted into ozone.

Characteristics:

- Ozone is toxic and corrosive
- Ozone accelerates burning
- Ozone is heavier than air and oxygen (concentrations build up at ground level, in channels etc.)
- Ozone has an acrid odour
- Ozone is unstable

Ozone can be detected by humans as low as 0.003...0.02 ppm Vol. (odour threshold)

IMPORTANT:

The owner and/or user is responsible for compliance with the regulations regarding the use of ozone. comprehensive information regarding ozone can be found in the publications of various specialist bodies (Appendix 24).

The following are some of the more important points regarding the handling of ozone:

WARNING:

Modern ozone generators can produce ozone concentrations up to 15 wt%, and higher. Thits value lies well above the lethal limit. This is why even small leaks can produce dangerous concentrations of ozone in the surroundings of the ozone installation. For this reason, ozone warning devices must be installed in these areas.

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Summary of the effects of ozone at various concentrations:

Ozone concentration in inhaled air in ml/m^3	Effects
ca. 0.02	Odour awareness threshold in air.
0.1	TWA value (Time Weighted Average) [1] Concentration for an 8 hour working day and a weekly working time of 40 hours. Irritation symptoms possible in nose and throat.
ca. 0.5	Deadening o the sense of smell after about 5 minutes exposure time.
ca. 1	Strong coughing spasms, tiredness
>10	Longer periods of exposure can be lethal.
>5000	Death within a few minutes

Source: ZH 1/474 (Appendix 24)
[1] Please check, local regulations and guidelines can differ!

3.2.1 Recommended protective measures and precautions

- Observation of the regulations by the owner and/or user
- Compliance with local, national and international regulations
- Access restrictions to the "Ozone Rooms"
  - Access only for trained personnel
- Training of the authorised personnel regarding
  - Safety regulations
  - Particular dangers associated with the handling of ozone
  - Procedures in case of failures and accidents
- Identification of areas into which ozone could escape, with appropriate warning signs.
- Provision of efficient ventilation systems and well marked escape routes in areas with ozone installations.
- In order to be able to safely switch off the equipment in cases of danger, an emergency switch that disconnects the electrical supply to the equipment should be provided in a location that can be easily reached at any time.
- Areas in to which ozone can escape must be monitored with ozone warning devices (Chapter 4.2).
- Have suitable breathing apparatus avalilable on-site. Put on the breathing apparatus before entering areas into which ozone has escaped or is suspected to have escaped.

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WARNING:

Even after the OZAT® ozone generator has been switched off, ozone-generating installations still contain ozone gas. Therfore, before opening equipment or piping, flush the equipment thoroughly until no ozone can be detected.

3.3 Electricity

The equipment may only be opened if the mains plug is removed. The main plug must not be pluged in again as long as the equipment is open.

WARNING:

As the smoothing capacitors can still hold a dangerous charge for up to 3 minutes after switching off, the capacitor covers should only be removed after this time. To be absolutely certain check the line voltage with a suitable measurement instrument. Covers on the power inlet side of the mains switch should be removed if the supply to the equipment has been shut off.

WARNING:

Before starting work the ozone generator G21 ensure that the ozone generator moules have been individual discharged (Chapter 10.1.2).

3.3.1 Working on live equipment

Working on live equipment is **forbidden**.

3.4 Mechanical dangers

The equipment must be secured to prevent it moving and is to be set-up on a stable table or a similar base.

Piping to and from the equipment must be laid so that they cannot be damaged. If it is not possible to lay the lines safely, they must be covered. The lines must not transmit any vibrations.

3.4.1 Periodical maintenance

In order to maintain the highest possible safety, the equipment should be periodically checked according to the instructions in Chapter 9.

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3.5 First aid

IMPORTANT:

The owner and/or user must ensure that the necessary conditions for first aid measures are met according to local regulations. If applicable, the recommendations or guidelines from the accident prevention offices are to be observed.

3.5.1 First aid after exposure to ozone

Following exposure to ozone, the following first aid measures must be immediately carried out (Source: ZH 1/474, Appendix 24):

1. Bring the victim into the fresh air
2. Call emergency services, stating ozone exposure
3. Give Medical-Oxygen
4. Keep victim quiet
5. Check pulse, breathing, consciousness
6. If victim becomes unconscious, place in the prone position
7. If breathing stops, apply artificial respiration

3.6 Breathing apparatus

The operator must provide breathing apparatus suitable for use with ozone for every person who will be working on the OZAT® ozone generator or in an installation containing ozone. The breathing apparatus can be obtained directly from suppliers or their representitives (e.g. Dräger, Lübeck, Germany).

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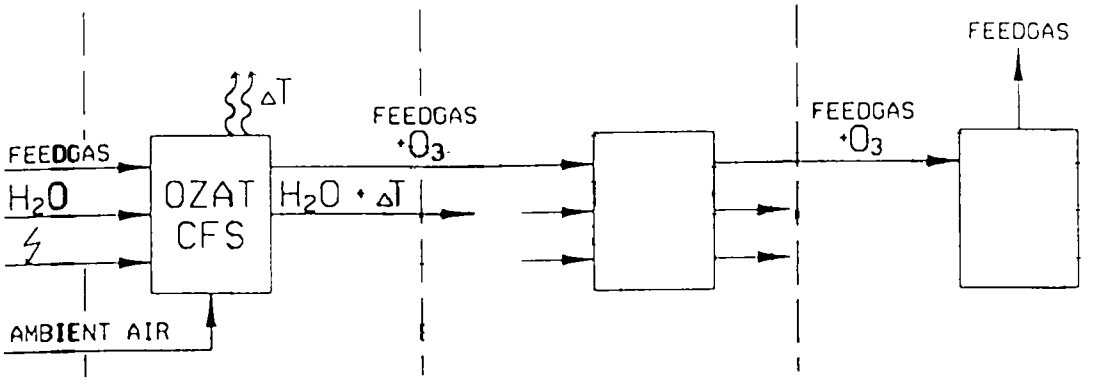
4. Construction and function

4.1 Scope of delivery and interface



Operator	OZAT® ozone generator Ozonia	Process Operator	Vent ozone destruction Possibly from Ozonia (not dealt with in these operating instructions)

4.1.1 Ozonia delivery

- OZAT® ozone generator with operating instructions
- Possibly spare parts according to Ozonia recommendations
- Possible options (e.g. vent ozone destructor)
- On request:
  - Training
  - Servicing

4.1.2 Delivery limitations

The operator will supply:

- Feedgas
- Cooling Water
- Electrical energy
- Control signals
- Emergency Stop

} according to operational data (Chapter 2.1.3)

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The equipment will produce:

- Feedgas containing ozone as given in the operational data.
- Supplied quantity of water as given in the operational data (outlet temperature 5 °C above inlet temperature).
- Signals and collective alarm.

Released to the environment:

- Heat loss through convection.
- Heat loss through forced ventilation.

The owner and/or user must supply or install:

- Adequate room ventilation.
- Ambient monitoring in all areas in which ozone can escape.

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4.2 Ambient monitoring for ozone

Depending upon local conditions, it might be necessary for several monitoring units be provided (basically one in every area in which ozone can escape). Air currents should also be taken into consideration. In very large rooms several monitoring units should be installed.

Ambient ozone monitors can be tripped by the following:

- An ozone leak in the operators plant.
- An ozone leak in the ozone generator.

When an ozone alarm has been given all personnel must be evacuated from the contaminated area. The room containing ozone should only be entered when wearing a suitable breathing apparatus. Before opening an OZAT® unit a check should be made at the cabinet's lower ventilation opening to see if the unit contains a dangerous ozone concentration. If this is the case, the doors may be opened to fascilitate a quicker dissipation of the ozone gas (breathing apparatus to be worn).

INFORMATION:

Ozonia recommends 1 ozone warning device per 50 m^2 floor area. A detection unit is to be installed within 1 metre of the lower part of equipment.

WARNING:

If the ambient monitors give a warning or fail, the feedgas supply and the electrical supply must be immediately and automatically disconnected. Simultaneously, the warning must initiate an optical and acoustic alarm, so that personnel in the respective rooms are warned. As long as the area monitors indicate a high ozone concentration, the rooms are only to be entered when wearing suitable breathing apparatus.

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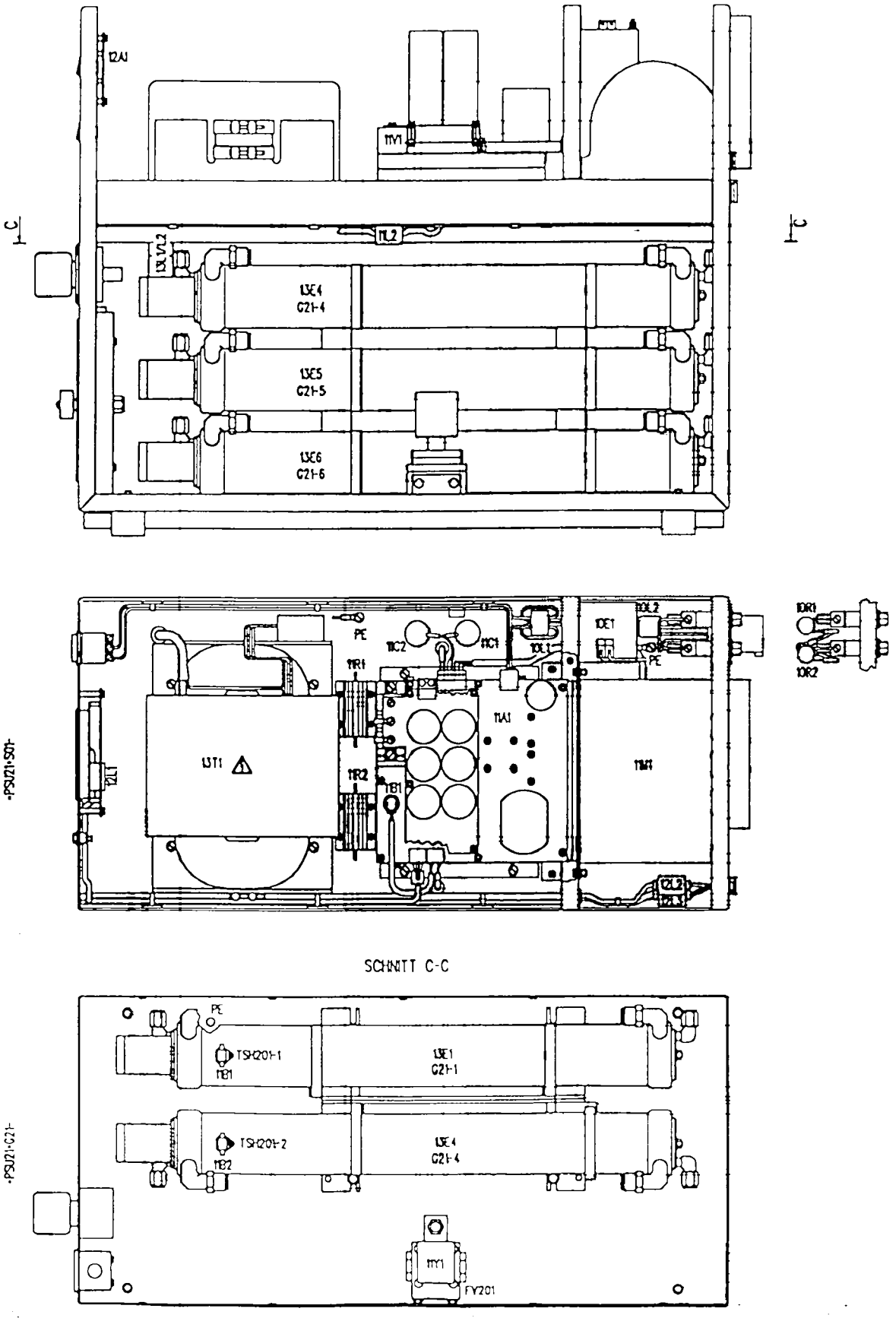
5. Layout of the OZAT® ozone generator



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Mechanical captions:

TSH201-1...2	Temperature monitor
FV201	Solenoid valve
G21-1...6	Ozone generator
PCV201	Pressure control valve

Electrical captions:

10R1/R2	Varistor
10E1	Interference suppressor filter
11A1	Converter electronics
11V1	IGBT-module
11M1	Equipment fan
11C1/C2	Capacitor for fan
11B1	Temperature monitor heat sink
11B2...3	Temperature monitor ozone generator
11Y1	Solenoid valve
12A1	Control electronics
13T1	High voltage transformer
13E1...E6	Ozone generator

(see P&I diagram, Appendix 19)

The equipment is separated into a mechanical/process part (lower level) and an electrical part (upper level).

5.1 Mechanical part

The most important mechanical parts are:

Ozone generator G21-1...6:

In the ozone generator, a part of the feedgas is converted into ozone. The ozone generator module has the following connections:

- Cooling media (inlet and outlet)
- Gas (inlet and outlet)
- Electrical connections (high voltage bushing and earth terminal on the module tube)

The ozone generator can contain one or more ozone generator modules.

TSH201-1...2 Temperature monitoring of the ozone generator:

The ozone generator is provided with a temperature monitoring system which will produce a signal to switch off the electrical supply if an excessive rise in temperature (limit value 45 °C) as a result of lack of cooling media occurs. The unit can be switched on again when the temperature drops to 30 °C.

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Cooling media circuit:

The control devices are to be supplied and installed by the owner and/or user.

Feedgas circuit:

The installed gas line is equipped with the following devices:

Pressure control valve PCV201 (equipment front):

To reduce the input pressure to the optimal operational pressure.

Solenoid valve FV201 (in the equipment):

For automatic gas flow control. It has an electrically operated override for purging procedures and maintenance work.

Gas pressure gauge PI202 (equipment front):

For monitoring the operational pressure.

Gas flow meter FI202 (equipment front):

The gas flow is indicated on the flow meter. The effective gas flow can be calculated using the corresponding appendix.

Hand operated control valve HCV201 (equipment front):

For regulating the gas flow.

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5.2 Electrical part

The electrical part is separated from the mechanical / process part by a partition, so that the electrical components are effectively protected from any possible leakages of cooling media. The layout of the individual components with captions can be seen on page 22.

The converter electronics are used to supply the ozone generator G21 with medium frequency H.V. The high voltage transformer 13T1 steps-up the output voltage from the converter electronics to the voltage required by the ozone generator module.

The most important components are:

- Mains socket 10X1.
- Converter electronics 11A1 to regulate the DC power Pe and control the IGBTs.
- Control electronics 12A1 for the surveillance of the converter electronics.
- IGBT module 11V1 consisting of two power transistors for the generation of a medium frequency H.V. for the ozone generator module.
- High voltage transformer 13T1 to step-up the output voltage from the converter to that required by the ozone generator module.

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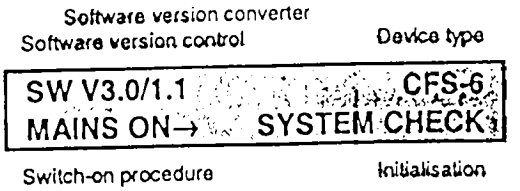
6.1 Software versions and initialisation

At switch-on proceeding (MAINS ON) of device, will initiate the control and the internal connections will be built. The LCD background color will change from; red → orange → green. At this the display indicates the corresponding software versions of control electronics resp. converter electronics and the existing device type.

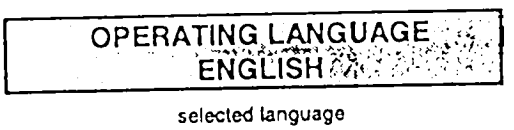
12A1 Display:
LCD background: varying



6.2 Selection of the displayed language

Five languages may be selected for the display (English, German, French, Italian, Spanish). The mains switch must be in the "MAINS OFF" position. Press the "SET POINT DOWN" switch continually and, at same time, switch on the mains. The selected language will be displayed for a short period. By continually pressing the "SET POINT UP" switch either English, German, French, Italian or Spanish can be selected. When the "SET POINT UP" is not pressed within a period of 5 seconds, the displayed language will be selected and the control will go back to the service mode.

12A1 Display:
LCD background: green



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6.3 Selection of the control location

There are 2 possibilities:

	Control command Equipment ON/OFF		Performance Pre-set value		Gas flow setting
Selector switch	LOCAL	REMOTE [1]	LOCAL	REMOTE	LOCAL [2]
Combination 1	X		X		X
Combination 2	X			X	X

[1] For remote control of the apparatus the mains feed may be switched on and off.

[2] Only "LOCAL"

12A1 Display:
LCD background: green

Control location set value

Set value	Service hour counter
100% LOCAL PSU ON	99999,9h 4000W
100% LOCAL PSU OFF	99999,9h 0000W
100% REMOTE PSU ON	99999,9h 4000W
100% REMOTE PSU OFF	99999,9h 0000W
Status	DC-Power Pe

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6.4 Ozone production

The ozone production is dependent on the gas flow and the electrical power. In addition the temperature of the cooling media has a certain effect. The combined effect of the individual values can be seen in the corresponding production diagram (Chapter 8.1.1).

The DC power Pe is set with the set value switch.

Switch position	Indication	Remote signal	DC-Power Pe W
Lower limit	0 %	4 mA	Basic power (no O_3 production)
Upper limit	100 %	20 mA	Nominal power (maximum O_3 production)

Gas flow setting (hand control valve HCV201):

The scale value for the desired gas flow is to be ascertained from the gas flow diagram in the corresponding appendix. The gas flow is altered with the valve until the corresponding scale value is reached on the gas flow meter FI202.

12A1 Display:
LCD background: green

Control location set value
Set value — Service hour counter

000% LOCAL	99999,9h
PSU ON	0000W
100% LOCAL	99999,9h
PSU ON	4000W
000% REMOTE	99999,9h
PSU ON	0000W
100% REMOTE	99999,9h
PSU ON	4000W

Status — DC-Power Pe

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6.5 Functional sequence

Precondition: Main is switched on, i.e. "MAINS ON" and the red lamp in the mains switch is illuminated.

6.5.1 Swich-on procedure

The switch-on sequence is as follows:

- On command "POWER SUPPLY ON".

12A1 Display:
LCD background: green

Control location set value
Set value
Service hour counter

100% LOCAL	99999,9h
PSU ON	0160W

Status
DC-Power Pe

- "POWER SUPPLY ON" will be displayed.
- Solenoid valve FV201 will be opened.
- Service hour counter begins to count (decimal point will blink).
- Inverter released.
- Power will increase to the LOCAL or REMOTE pre-selected value. Electrical real power will increase within about 15 seconds from the basic power to 100 %.

12A1 Display:
LCD background: green

Control location set value
Set value
Service hour counter

100% LOCAL	99999,9h
PSU ON	4000W

Status
DC-Power Pe

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6.5.2 Switch-off procedure

The switch-off procedure is as follows:

- OFF command "POWER SUPPLY OFF".

12A1 Display:
LCD background: orange

Control location set value	Service hour counter
Set value	
100% LOCAL	99999,9h
PSU OFF	PURGING 90s
Status	Purging time

- "POWER SUPPLY OFF" will be displayed.
- Service hour counter will stop.
- Electrical real power set-value is blocked.
- Inverter blocked.
- About 90 seconds later, the solenoid valve FV201 closes and the ventilator will stop. During the delay time, the equipment will be purged with feedgas, and the residual ozone fed to the process.

12A1 Display:
LCD background: green

Control location set value	Service hour counter
Set value	
100% LOCAL	99999,9h
PSU OFF	0000W
Status	DC-Power Pe

WARNING:

Even after the OZAT® ozone generator has been switched off, ozone generator and installations still contains ozone. Therfore, before opening equipment or piping, flush the equipment thoroughly until no ozone can be detected.

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6.6 Purging the system

The solenoid valve (FV201) can be opened with the switch "PURGE ON". The purging time is indicated. Purging the system to dry out is described in chapter 7.2.4.

12A1 Display:
LCD background: orange

SYSTEM PURGING 99,9h

Purging time

6.7 EMERGENCY STOP circuit

In an Emergency Stop (switching off the mains switch or interrupting the power supply), the energy supply from the mains will be interrupted and at same time the gas flow stops. Contrary to a normal operational switch-off procedure, there is no purging of the equipment with an emergency stop.

WARNING:

After an emergency stop there will still be ozone inside the components (e.g. ozone generator module, piping and, possibly, in the equipment).

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6.8 Switch-off following a fault (alarm)

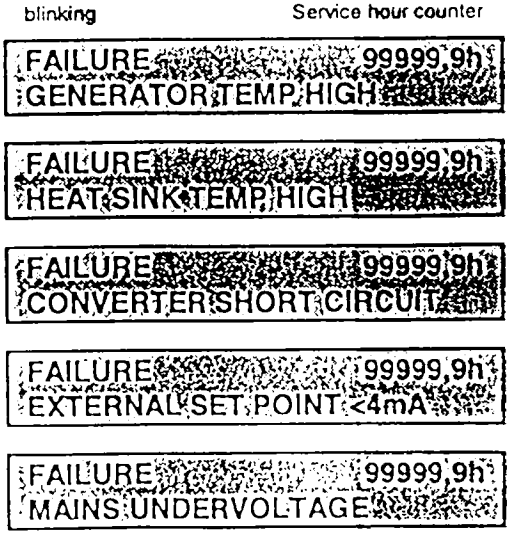
Function of the fault monitoring:

Fault	Release of the monitoring	Switch-off delay following occurrence of a fault	Remarks
Ozone generator module temperature too high	if PSU ON (with inverter release)	not delayed	On alarm status gas valve closes. After acknolege alarm purges for 90 sec.
Heat sink temperature too high	if PSU ON (with inverter release)	not delayed	On alarm status gas valve closes. After acknolege alarm purges for 90 sec.
Inverter short circuit	if PSU ON (with inverter release)	not delayed	On alarm status gas valve closes. After acknolege alarm purges for 90 sec.
Remote set-value too low	if PSU ON (with inverter release) and pre-set value is on REMOTE	approx. 1 second	On alarm status gas valve closes. After acknolege alarm purges for 90 sec.
Mains voltage too low	if PSU ON (with inverter release)	approx. 1 second	On alarm status gas valve closes. After acknolege alarm purges for 90 sec.

12A1 Display:
LCD background: red

Indication blinking

Service hour counter



Failure report

6.9 Acknowledging an alarm

An alarm remains set until the fault is corrected and the alarm signal acknowledged by operating the "SUPPLY OFF" button.

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7. Commissioning

7.1 Setting-up and installation

7.1.1 Setting-up

The equipment is to be set-up on a stable table or a similar base.

ATTENTION:

It is of utmost importance that no water enters the ozone generator module - either in the form of water vapour in the feedgas (see feedgas specification in chapter 2.1.3), or in the form of water being back-fed from the operator's process.

To prevent water being back-fed from the process the operator must install a solenoid valve and a non-return valve between the ozone generator and the ozone contacting system. The solenoid valve is to be controlled to suit operating parameters and may not be closed during the purging time of the device.

FAILURE TO OBSERVE THESE INSTRUCTIONS COULD RESULT IN IRREVERSIBLE DAMAGE TO THE OZONE GENERATOR UNIT.

7.1.2 Ambient conditions

The installation location must comply with the data given in Chapter 2:

- Ambient temperature
- Altitude
- Humidity
- Protection class
- Vibration

In addition, it should be ensured that the dissipated heat does not lead to any unacceptable temperature rise in the generator room and that the installation corresponds to the safety regulations for areas in which ozone can be present (Chapter 3).

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7.1.3 Installation of the equipment and the piping

During the whole installation period, the equipment is to be protected against dirt, dust and foreign bodies (metal swarf, screws, etc.).

IMPORTANT:

All gas lines must be kept free from dust, oil and grease. When installing the unit the correct materials (oxygen and ozone resistant) must be used for the lines, devices, seals, etc..

7.1.4 Serto Installation Instructions

All external line connections for cooling media, feedgas and ozone should be made according to the Serto installation instructions in Appendix 20.

When mounting the external connections, pay attention to the marking on the equipment (feedgas, ozone or cooling media input and output).

7.1.5 Protection of lines

Where there is the danger that the lines can be damaged or ripped away, they must be protected.

7.1.6 Electrical installation

The electrical connections must comply with local regulations. If the equipment is fitted with an instrument socket, a corresponding mains cable with a suitable plug must be used (Chapter 2.2.1).

7.2 Commissioning

Preparation:

- The commissioning personnel authorised by the owner and/or user, must read and understand the operating instructions.
- The commissioning personnel must be familiar with the safety measures and regulations, be equipped with the necessary breathing apparatus and must know the escape routes.

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7.2.1 Checking the Installation

Before the electrical feed, the feedgas and the cooling media can be connected, the following must be checked:

- Is the equipment secured against moving?
- Is the line feed protected?
- Are the lines for:
  - Feedgas (oxygen or air)
  - Ozone
  - Cooling medial

  connected to the correct unions on the equipment?

7.2.2 Further checks

The following additional points must be checked before commissioning:

- Is there adequate ventilation for normal operation and in the case of a malfunction?
- Is the feedgas and the cooling media (quantity, quality and pressure) in accordance with the technical data in Chapter 2 "Product description"?
- Have all connections been correctly made?
- Is the owner's and/or user's process, in which the ozone will be used, ready for the ozone and is the vent ozone destruction operational?

7.2.3 Tightness check

If above conditions have been fulfilled, a tightness check should be carried out. This is done as follows:

- Set the installation, including feed and return lines, under operational pressure and treat all connections on the gas side with leakage spray. Any connections where bubbles form, must be re-made.

As a leakage spray, "SNOOP LIQUID LEAK DETECTOR" from "NUPRO COMPANY" for example, can be used.

IMPORTANT:

The tightness test must be repeated until no further leaks are found.

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7.2.4 Purging the system to dry it out

Before commissioning the ozone generator, ensure that there is no moisture in the gas lines. To dry out the system, the gas flow circuit must be purged for at least 24 hours with feedgas (in accordance with the operational data). When doing this, the following sequence should be followed:

1. Operate "PURGE ON" switch until the respective display appears.
2. Slowly open the stop valve in the feedgas line. Keep to the maximum permissible pressure given in the operational data!
3. Using the hand regulating valve HCV201 set the gas flow to about 20 % (check using the gas flow display FI202).
4. Check whether the gas pressure gauge PI202 shows between 0.4 and 1 bar.
5. Purge for at least 24 hours.
6. Close the stop devices in the feed line and the hand operated regulating valve.
7. Operate "PURGE OFF" switch.

The equipment is ready for commissioning.

WARNING:

During commissioning, ozone will be produced. It must be ensured that the ozone produced can be routed to the process and that any residual ozone will be destroyed.

WARNING:

If a smell of ozone is detected, the mains switch EMERGENCY STOP must be immediately switched off and the area evacuated in accordance with the safety measures.

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7.2.5 Commissioning

1. Set the cooling media flow according to the operational data.
2. Open the stop valve in the feedgas line (owner and/or user).
3. Switch set value to "LOCAL".
4. Switch on mains (power to unit)
5. Switch on mains switch "MAINS ON" will illuminate, software version and system check will be displayed.
6. Adjust set value to 0 %.
7. Operate "POWER SUPPLY ON" switch, "POWER SUPPLY ON" will be displayed.
8. Rating display will show minimum load.
9. Increase the gas flow to maximum with the hand operated control valve HCV201.
10. Adjust load set value to 100 %.
11. Rating display will indicate maximum load.
12. Rating set value and gas flow to be set to minimum.
13. Switch off the unit with the switch "POWER SUPPLY OFF". The display must indicate minimum load and "POWER SUPPLY OFF" will appear.

IMPORTANT:

If the commissioning cannot be carried out, check in Chapter 9 for possible causes and, if necessary, contact the Ozonia service personnel.

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8. Operation

The equipment may only be operated by persons authorised by the owner and/or user. It is up to the owner and/or user how many persons he authorises to operate the installation, and whether he will instruct further persons with partial functions, e.g. "EMERGENCY STOP".

The owner and/or user must ensure that the persons authorised by him have familiarised themselves with the safety measures and regulations, and that they also comply with them, in addition to having read and understood the operating instructions.

8.1.1 Operation and setting of the equipment

The preconditions for service are:

- The process (installation) is ready for taking up ozone.
- Power supply switched on.
- Mains switch on, "MAINS ON" lamp illuminated.
- Cooling media is flowing.
- Gas feed open.

The equipment can now be switched on, to the pre-set values for gas flow and electrical real power Pe. The necessary settings are found as follows; for the setting of the equipment the "gas flow diagram" and the setting curves can be used.

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Setting the ozone production and concentration:

Example 1

Given: Ozone quantity M_{O3} and ozone concentration c

Wanted: Gas flow V_n and real power setting Pe

Procedure for a CFS-6A with oxygen:

1. Calculation of the gas flow V_n

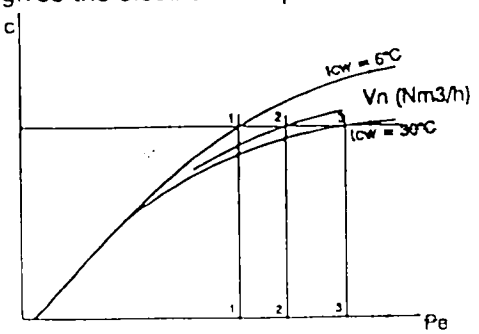
$$V_n = \frac{100}{\rho} \cdot \frac{M_{O3}}{c}$$

c	=	Ozone concentration [wt%]
M_{O3}	=	Ozone production [kg/h]
ρ	=	Density ot the feedgas [kg/Nm³] at standard conditions ρ_{Air} = 1.293 kg/Nm³ or ρ_{Oxygen} = 1.429 kg/Nm³ (t_n = 0 °C, $p_{atm.}$ = 1013 mbar)

for c = 8 wt%, M_{O3} = 0.057 kg/h and ρ = 1.429 kg/Nm³ (oxygen) it follows:

$$V_n = \frac{100}{1.429} \cdot \frac{0.057}{8} = 0.5\ Nm^3/h$$

2. The required electrical real power is determined from the setting curves.
The intersection of the horizontal line of the desired ozone concentration c with the curve of the required feedgas quantity V_n gives the electrical real power Pe.



If there is no suitable curve available for the required feedgas quantity, interpolate between the two curves (2).

For the above example (c = 8 wt%, M_{O3} = 0.057 kg/h) an electrical real power Pe of about 540 W results (12 °C cooling media inlet temperature).

3. From the gas flow diagram in the Appendix 17, the feedgas quantity for the corresponding scale value (indicated by the gas flow meter) can be found.

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Example 2

Given: Electrical real power Pe and the gas flow V_n

Wanted: Ozone production M_{O3} and ozone concentration c

Aid: Setting curves given in appendix for CFS-6A and the respective feedgas.

1. Find the intersection of the vertical line from the electrical real power with the curve for the gas flow.
2. A horizontal line gives the ozone concentration c.
3. From c and V_n (gas flow), the ozone production M_{O3} can be calculated:

$$M_{O3} = \frac{\rho \cdot V_n \cdot c}{100}$$

8.1.2 EMERGENCY STOP

In cases of danger, such as.:

- Ozone leakage
- Electrical accident
- Etc.

The mains switch of the equipment must be switched off, which also functions as an emergency stop switch. In this way, the electrical energy supply and the feedgas flow will be immediately interrupted.

8.1.3 Alarm signals

If an alarm signal is given, the equipment is switched off. After the fault has been remedied, the alarm signal can be acknowledged by operating the "SUPPLY OFF" switch, and the equipment is switched on again. If a fault repeatedly appears, the service personnel should be informed.

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8.2 Required minimum gas flow

The absolute minimum gas flow and mean feedgas pressures, at different cooling water temperatures, are given on the OZAT® model's diagram "Required minimum gas flow". When the unit is operated with a cooling water inlet temperature not shown on the diagram, operators are to use linear interpolation to create an applicable curve. The shown curves apply to 100% load. The required minimum feedgas flow is proportional to the set load, however, the actual feedgas flow should never be set to lower than 10% of the gas flow meter's scale value in order to avoid any inaccuracies due to low flow conditions.

8.3 Switching off for long periods

If the equipment is not to be used for a long period, the gas flow should be closed (hand operated control valve HCV201). This will save gas and will avoid water entering the equipment and the ozone generator from the clients process side.

INFORMATION:

The ozone generator is sensitive to moisture. for this reason the feedgas must always comply with the specification and the ingress of moisture from the process side must be prevented.

8.4 Changing from air to oxygen feedgas

IMPORTANT:

If the ozone generator was initially operated with air as the feedgas, and it is changed to oxygen, the performance data will be lower than expected in the setting curves. Therefore Ozonia recommends to replace the used ozone generator modules with new ones.

8.5 Changing from oxygen to air feedgas

If the feedgas is changed from oxygen to air, the performance data should be as given in the setting curves (but only if there was no possibility for water vapour to enter the ozone generator module).

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9.4 Terminal check

Once a year all electrical connection screws should be tightened. To do this the supply most be switched off and the mains plug removed. The covers should only be removed after waiting 3 minutes as the smoothing capacitors on the converter electronic (11A1) require time to discharge.
Before beginning work, the ozone generator modules G21 are to be discharged (Chapter 10.1.2) and the converter electronics (11A1) to be checked with a suitable measuring instrument (...750 V_{DC}).
After completing the work, replace the equipment cover.

WARNING:

If the time of 3 minutes between switching off the mains switch 10Q1 and dismanting the equipment cover is not observed, there is a danger of electrocution.

WARNING:

External signal voltages are to be switched off!

9.5 Replacing the filter mats

Depending on the environment where the equipment is installed, the filter mats must be changed at regular intervals.

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10. Overhauling

Overhaul work must only be carried out by authorised and trained personnel. The owner and/or user must ensure that his maintenance personnel are familiar with the safety measures and regulations, and that they also comply with these, in addition to having read and understood the operating instructions.

WARNING:

If work has to be carried out on the ozone generator, or on the high voltage transformer, the high-voltage terminals have to be earthed in accordance with local regulations. If work has to be carried out on the ozone generator, or on the gas lines, it must first be ensured that the parts are not under pressure and are free from ozone.

10.1 Replacement of defective fittings, lines or ozone generator modules

ATTENTION:

Before repair or service work, the complete system must first be purged (Chapter 10.1.1). The gas pressure is then to be reduced to atmospheric pressure, the cooling media and the mains switch are to be turned off and pull out the mains plug. The ozone generator modules G21 must be separately discharged directly at the high voltage bushing (Chapter 10.1.2).

Only original replacement parts from Ozonia must be used.

If in doubt contact Ozonia.

After installing a new fitting, ensure that the connections are properly made and carry out a tightness check (Chapter 9.1).

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10.1.1 Purging the systems before overhaul work

Every time overhaul (repair) or service work has to be carried out on the pipeline guides or the fittings, the residual ozone in the system must be purged with feedgas. To purge the system proceed as follows:

1. Switch to "PURGE ON".
2. Set a medium gas flow with the hand control valve HCV201 (observe the gas flow display FI202).
3. Purge for at least 15 minutes.
4. Close the shut-off device in the feedgas line.
5. When the system pressure has dropped, close the hand operated control valve HCV201. Check on the gas pressure gauge PI202.
6. Switch to "PURGE OFF".
7. Remove the cover.
8. The OZAT® ozone generator is now ready for any repair or service work that may be necessary. After completing the work, the system tightness must always be checked (Chapter 9.1) and be dried out by purging (Chapter 7.2.4).
9. Replace the cover.
10. Put the equipment into operation (Chapter 7.2.5).

PROHIBITION:

When the system is opened, a concentration of oxygen can accumulate in the clothing, with an associated increased fire risk. The corresponding safety measures should therefore be taken (Chapter 3).

10.1.2 Discharging the ozone generator module

Discharging may only take place when mains switch (10Q1) is switched off and the mains plug is diconnected. The discharging device is first connected to earth terminal and only then may the discharge rod be introduced into the opening on the upper side of the connector cover to discharge the ozone generator module (Appendix 23).

WARNING:

The discharging device must only be held by the handle. It is essential to ensure that there is a metal-to-metal contact with H.V bushing on the ozone module (Appendix 23).

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10.2 Setting the operational pressure

IMPORTANT:

Changes in the system pressure have a direct effect upon the ozone production. If the operational pressure has changed, this must be reset with the pressure control PVC201, to the values given in chapter 2.1.3.

The operational pressure is set using the pressure control valve PCV201, on the front of the unit. Proceed as follows:

1. Set the required gas flow using the hand operated control valve HCV201 (observe the gas flow meter FI202).
2. Set the gas pressure using the pressure control valve PCV201. For reasons of safety, a pressure limiter is built in. The maximum adjustable pressure is 4 bar gauge. The set operational pressure can be read from the gas pressure gauge PI202..
3. Put the equipment into operation (Chapter 7.2.5).

10.3 Correcting faults

ATTENTION:

The following described actions may only be performed with the mains plug pulled out (separated from electrical supply).

10.3.1 Temperature monitor TSH201-1...2

A temperature alarm TSH201-1...2 (11B2...3) on the ozone generator can have the following causes:

- Cooling media flow interrupted or turned off.
- Cooling media inlet temperature too high >30 °C.
- Ambient temperature >40 °C.
- Air bubbles in the ozone generator; cooling media operational pressure and/or cooling media flow too low.
- Cooling media flow too low (set-value: as in "Operational data" in Chapter 2.1.3).

After the error has been localised and corrected, the equipment can be put into operation.

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10.3.2 Temperature monitor heat sink 11B1

A temperatur alarm (11B1) on the heat sink can have the following causes:

- Filter mats dirty (blocked).
- Ambient temperature >40 °C.
- Air fan fault.
- Faulty connections of temperature monitor.
- Faulty temperature monitor.

After the error has been localised and corrected, the equipment can be put into operation.

10.3.3 Inverter short circuit

If the short-circuit monitor trips repeatedly, are to be replaced IBGT module (11V1) and the converter electronics (11A1).

10.3.4 External set point low

The detection of an external set value lower than 4mA can be caused by the following:

- External signal <3,8mA.
- Plug -X2 for external signal not connected.
- Broken wire in the external set value wiring.

10.3.5 Mains voltage low

The mains voltage monitored by the unit. As soon as the mains voltage fluctuates more than -10% for longer than 1 seconds, the unit will switch off.

If the voltage is increased within the prescribed tolerance, the unit can be taken into service.

10.3.6 Equipment short circuit

If the inlet fuse (10F1/F2) trips, there is possibly a defect in the IGBT module (11V1) or the converter electronics (11A1). Both components must be replaced one after the other.

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11. Taking out of operation, storage

There are two possibilities for taking the unit out of service:

- Shutdown of the equipment and permanently shut off the feedgas, cooling media and electricity supply.
- Dismantle the connecting lines and the equipment.

11.1 Shutdown of the equipment

Before the definitive shutdown of the equipment, all lines must be thoroughly purged so that all ozone remaining in the equipment and in the feed lines is either fed to the process or to the vent ozone destructor.

If the equipment is to be re-installed at another location, it must be purged with dry gas (dew point -60 °C or lower).

After purging, the pressure should be lowered to atmospheric pressure, the gas connection lines sealed with airtight sealing caps and the cooling media drained.

11.2 Dismantling the equipment and the connecting pipelines

Dismantling the connecting pipelines:

PROHIBITION:

If oxygen has be used as feedgas when the lines are dismantled, oxygen can escape. There is therefore an increased risk of fire and increased oxygen concentration, particularly in the clothing. It is therefore very important to observe the regulations for the handling of gaseous oxygen (Chapter 3).

Dismantling the electrical connections:

WARNING:

Before disconnecting electrical connections, the power feed to the unit must be switched off and the cable then disconnected. For equipment with plug connections, the connector plug must be pulled out external power supplies for any external signalling must be switched off. Any possible external electrical signals must also be switched off.

Dismantling the equipment:

IMPORTANT:

The equipment is to be placed on a palette, using suitable lifting equipment, and secured. Before the units fixing elements are removed, the equipment must be secured (from tipping) by using the lifting gear.

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12. Packaging, transport

When being transported, the equipment must be protected against mechanical damage and tipping, as well as against moisture and dust.

Measures:

- The equipment has to be lifted with an appropriate lifting device. Weight 95kg)
- Transport the equipment in the horizontal position.
- Seal the equipment in plastic, with a bag of silica gel to protect the equipment against moisture.
- Transport either fixed to palette or in a suitable wooden or carton container.

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13. Disposal

For disposal, proceed as follows:

- Remove the ozone generator module and return to Ozonia.
- The remaining material, such as:
  - Electronic printed circuit boards
  - Power transistors
  - Silicon rectifiers
  - Capacitors
  - Plastics such as PTFE, PVDF, PE, PVC, Plexiglas (pipelines, conduits, cable channels, electrical components)
  - Non-ferrous metals such as nickel, brass, copper (fittings, rails, cables)
  - Stainless materials etc.

  should be disposed of by the specialists in the owners company or by special disposal companies.

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14. Spare parts list

14.1 Electrical material =PSU21+S01...

Type					CFS-6A
Pcs.	Article	Tag-No.			Art-No.
1	Interference suppressor filter	-10E1			TE14247
1	Main switch	-10Q1			TE14248
1	Socket	-10X1			TE14250
1	Coupling	-10X1			TE14251
1	Converter electronics TE505	-11A1			TE14252
1	IGBT module	-11V1			TE10159
1	Control electronics TE503	-12A1			TE10102
1	HV transformer	-13T1			TE14254
1	Air fan	-11M1			TE14464
2	Capacitor for fan	-11C1/C2			TE14802
2	Power resistor	-11R1/R2			TE14465
1	Temperature sensor	-11B1			TE14729
2	Fusible cut-out, fast	-10F1/F2			TE14245
2	Fuse-holder	-10F1/F2			TE14246
1	Earthing reactor	-10L2			TE14737
2	Varistor	-10R1/R2			TE14803
3	Switch, black 0/1	-12S1...S3			TE10517
1	Switch, black I/0/I	-12S4			TE10519
1	Device plug	-X2			TE10018
1	Device plug	-X7			TE10019
1	Device connector	-X2			TE10020
1	Devise connector	-X7			TE10021

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14.2 Mechanical material =PSU21+G21...

Type					CFS-6A
Pcs.	Article	Tag-No.			Art-No.
6	Ozone generator module	-G21			TV14055
2	Temperature monitor	-TSH201			TV12388
1	Solenoid valve	-FV201			TV13950
1	Control valve	-HCV201			TV13952
1	Gas pressure display	-PI202			TV13953
1	Pressure regulaton valve	-PCV201			TV13085
1	Gas flow display	-FI202			TV13951

14.3 Other materials =PSU21...

Type					CFS-6A
Pcs.	Article	Tag-No.			Art-No.
1	Tube 10x1 PTFE				TV12308
4	Pre-formed-tube PTFE				TV14085
1	Tube 12x2 PU				TV12305
1	Set: support sleeve				TV13456
1	Set: clamping rings				TV13457
1	Set: unions				TV13954
1	Teflon tape SO841-9				TP10851
1	Grease for O_2 and O_3				TP14129
1	Tube-cutty				TV13166
1	Heat sink				TE14253
1	Input filter F150-T101				TE10354
1	Filter mats for F150-T101				TE13411
1	Front frame with acryl pane				TE13395
1	Discharging device				TE10114

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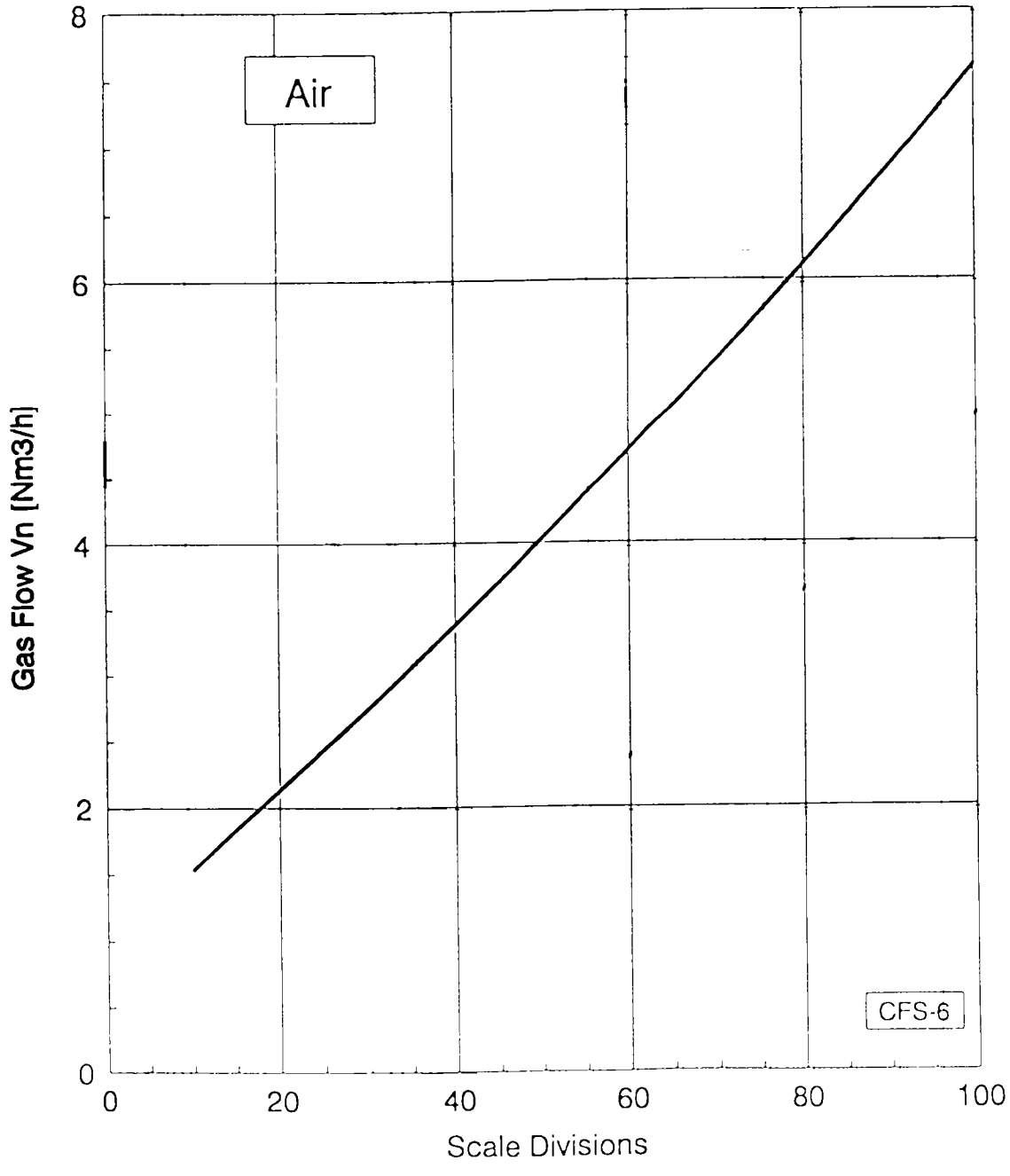
15. Appendix "Gas flow diagram CFS-6A / Air"

Gas flow display

for air

t_g = 20 °C and p_g = 2.5 bar g ($p_{atm.}$ = 1013 mbar)



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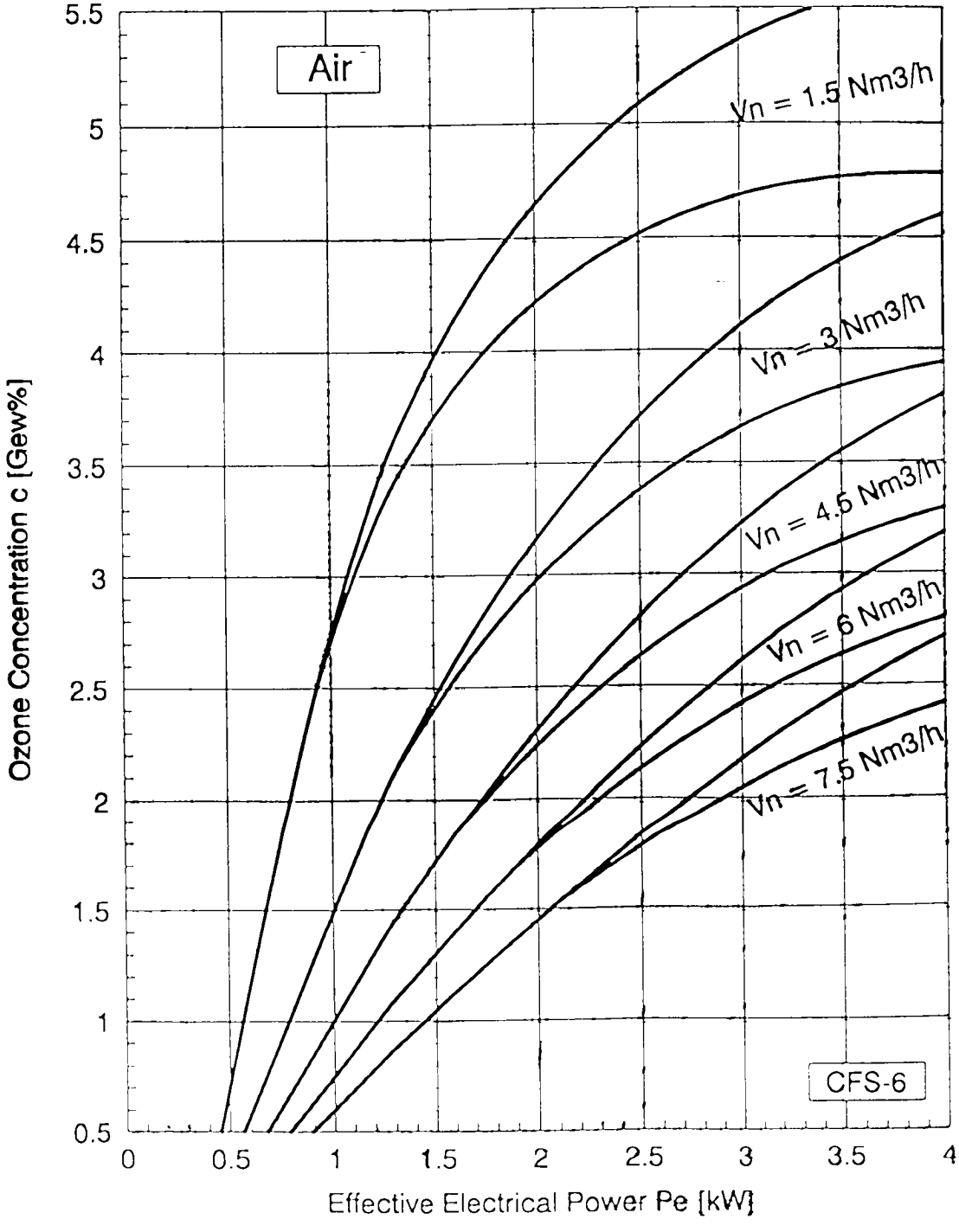
16. Appendix "Setting curves CFS-6A / Air"

Ozone concentration dependent on the electrical real power

for air

t_g = 20 °C and p_g = 2.5 bar g ($p_{atm.}$ = 1013 mbar)



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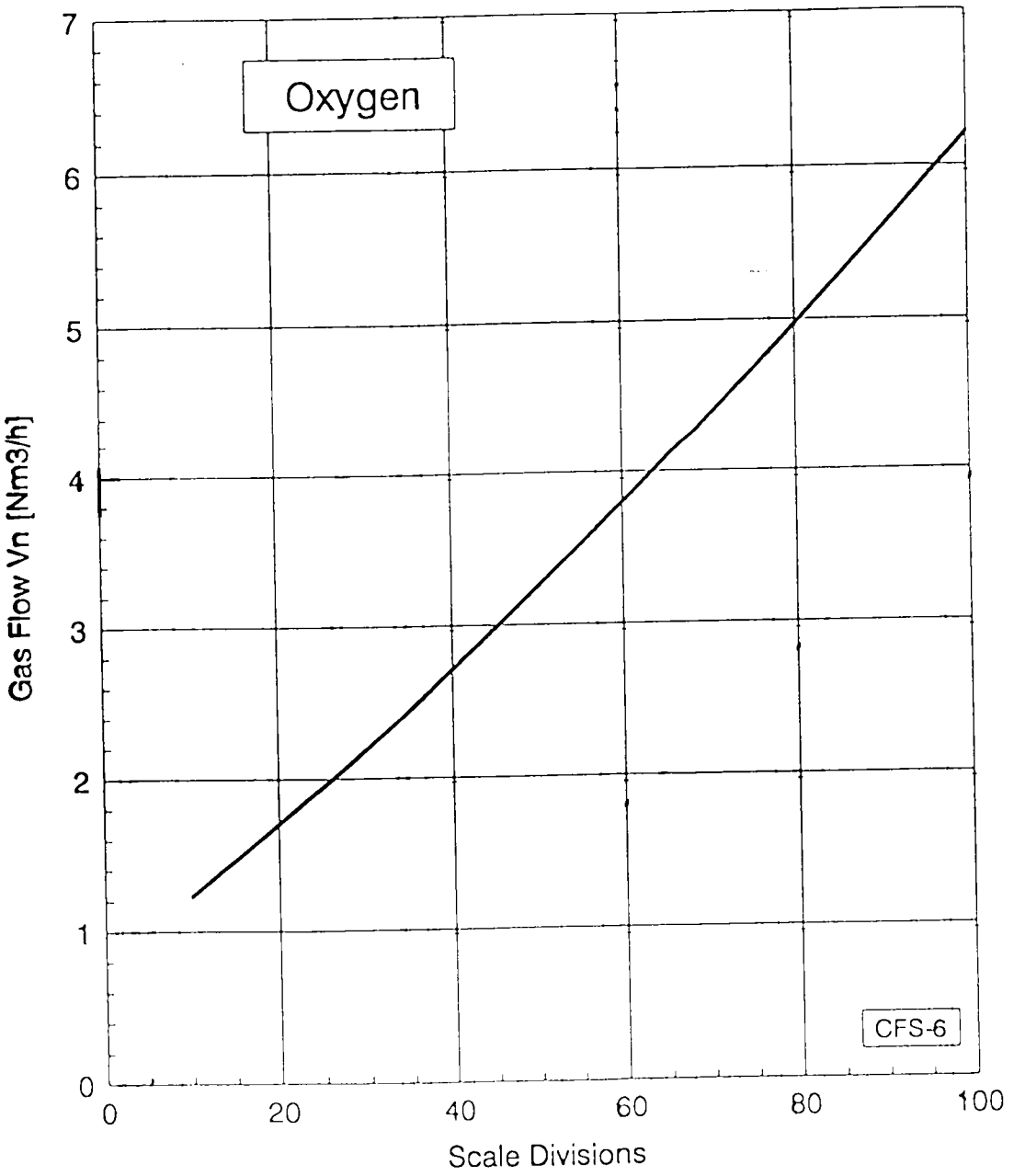
17. Appendix "Gas flow diagram CFS-6A / O_2"

Gas flow display

for oxygen with approx. 2 % nitrogen

t_g = 20 °C and p_g = 1.5 bar g ($p_{atm.}$ = 1013 mbar)



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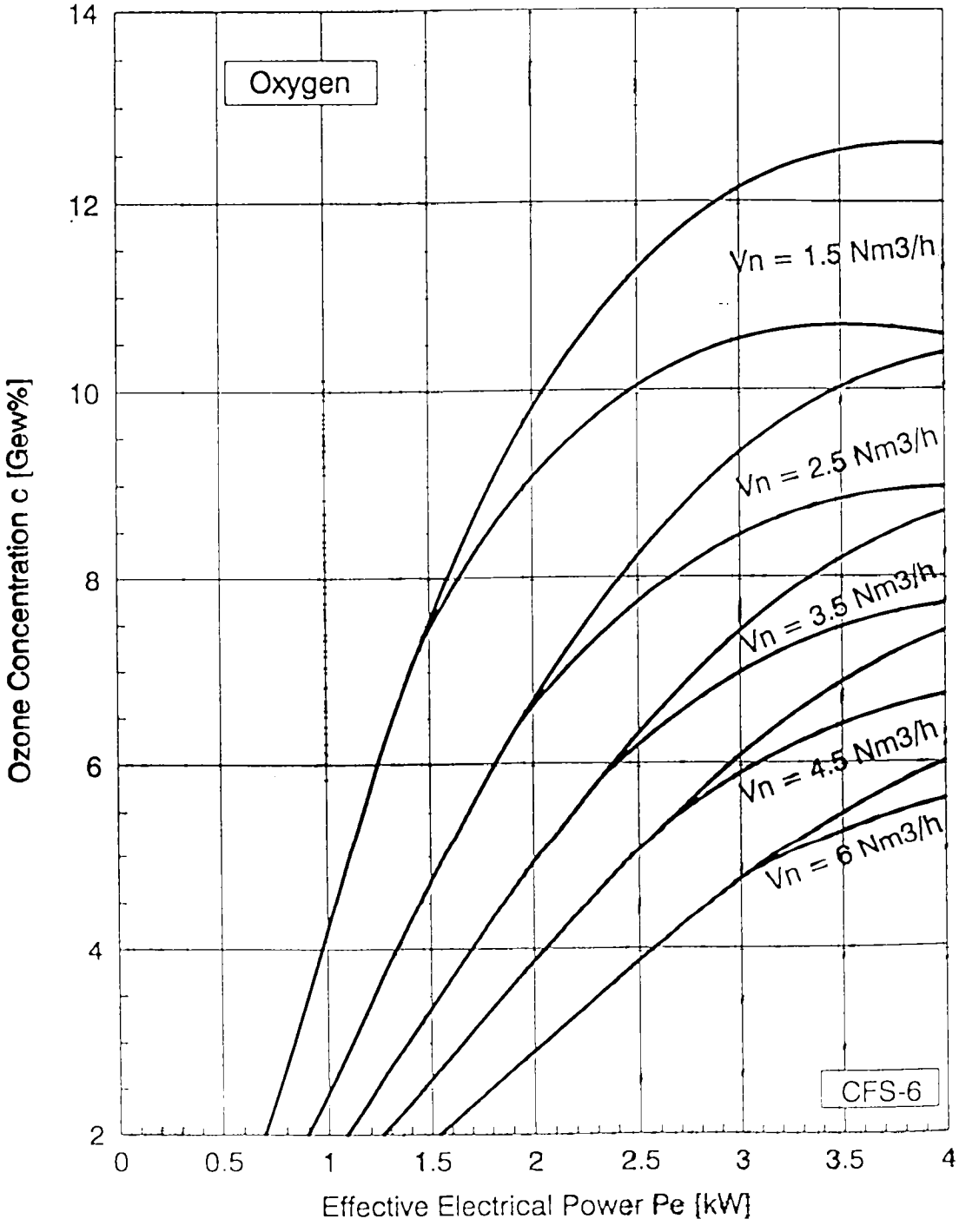
18. Appendix "Setting curves CFS-6A / O_2"

Ozone concentration dependent on the electrical real power

for oxygen with approx. 2 % nitrogen

t_g = 20 °C and p_g = 2.5 bar g ($p_{atm.}$ = 1013 mbar)



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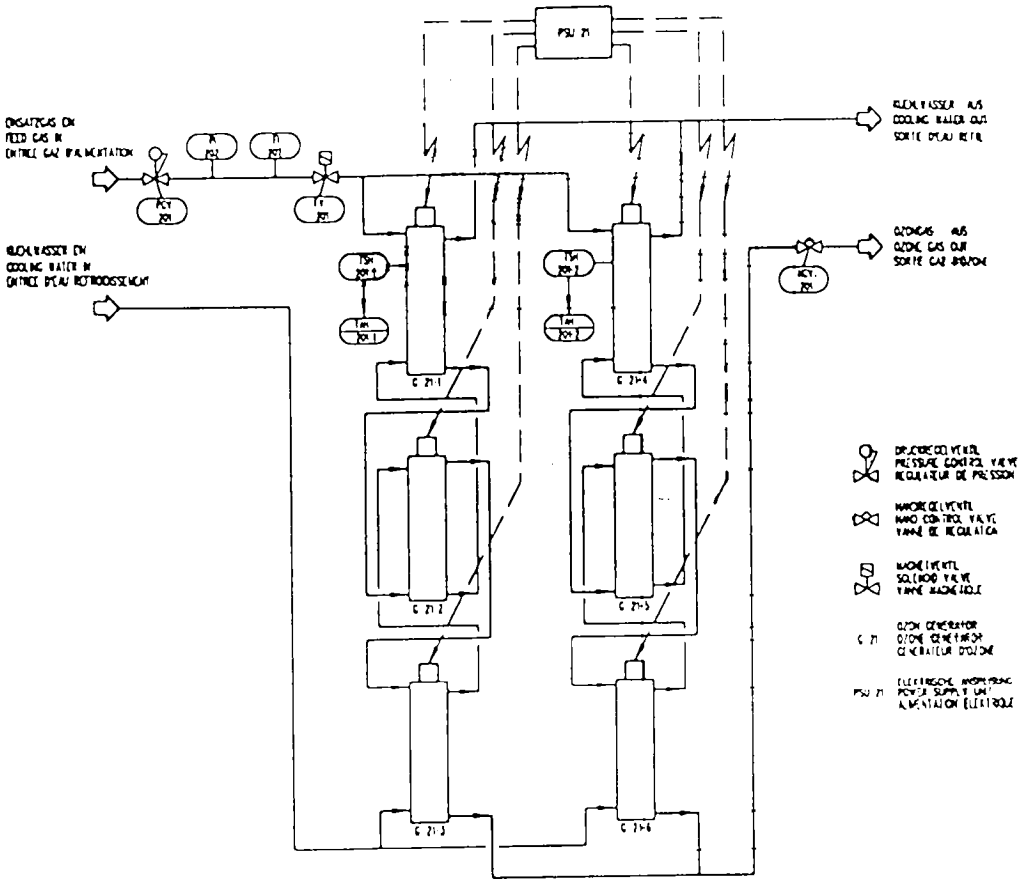
19. Appendix"P&I diagram"



Caption:

PCV201	Pressure control valve
FV201	Solenoid valve
PI202	Gas pressure display
FI202	Gas flow display
G21-1...6	Ozone generator
TSH201-1...2	Temperature monitor switch
TAH201-1...2	Temperature alarm, high
HCV201	Hand operated control valve
PSU21	Electrical power supply

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20. Appendix "Serto installation instructions"

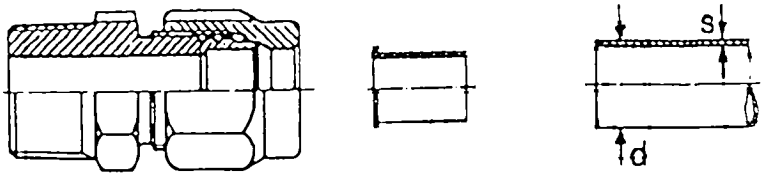
General:

- PIPING:
  Piping with a clean smooth surface is to be used, with external diameters within ± 0,1 mm.
- ROTATABLE CLAMPING RING:
  It has no effect on the quality of the connection if the clamping ring can be turned on the tube or the tube in the connection nut after assembly.
- INSTALLATION SUPPORTS FOR PRE-ASSEMBLY:
  SO 56000, stainless steel treated for Inox and brass M-programme
  SO 6000, CrNi-Steel hardened for steel.

20.1 Metal fittings

EXTENT OF DELIVERY:

- SERTO cable fittings are delivered ready for assembly:
  Base part / connection nut / clamping ring



Supporting sleeve

d = external tube diameter
S = plate thickness

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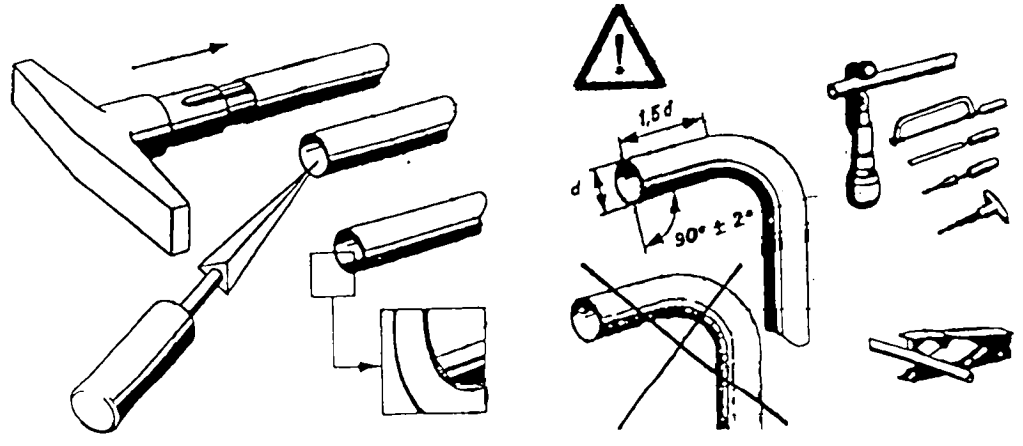
1) PREPARATION:

- Cut the pipe at right angles and remove burrs.
  The pipe end must be straight for a length of about 1.5 d, and have an undamaged surface. The fitting for the oxygen and ozone/oxygen circulation must be free from oil and grease.
- In order to prevent steel unions from seizing when tightening them up, the threads and the faces of the sealing collars are to be carefully lubricated with special grease suitable for oxygen service (e.g.: Oxigenoex S4 marketed by Klüber & Co). Special care is to be given to the sealing collar in order to ensure that the complete sealing surface is covered by a thin film of grease.

1



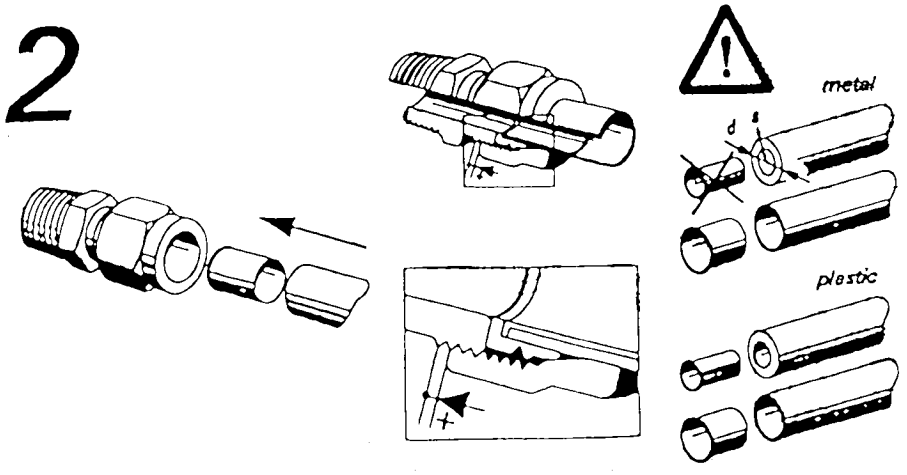
2) REINFORCE AND INSERT PIPE:

- The supporting sleeve is foreseen for thin-walled and/or soft piping, as well as for plastic pipes.

Copper pipes:	d = 10 mm & s ó 1,0 mm
	d ò 12 mm & s ó 1,5 mm
Inox pipes:	d ò 6 mm & s ó 0,5 mm
	d ò 10 mm & s ó 0,8 mm
	d ò 12 mm & s ó 1,0 mm

- Ensure alignment of the pipe and the fitting
- Insert up to the stop

2



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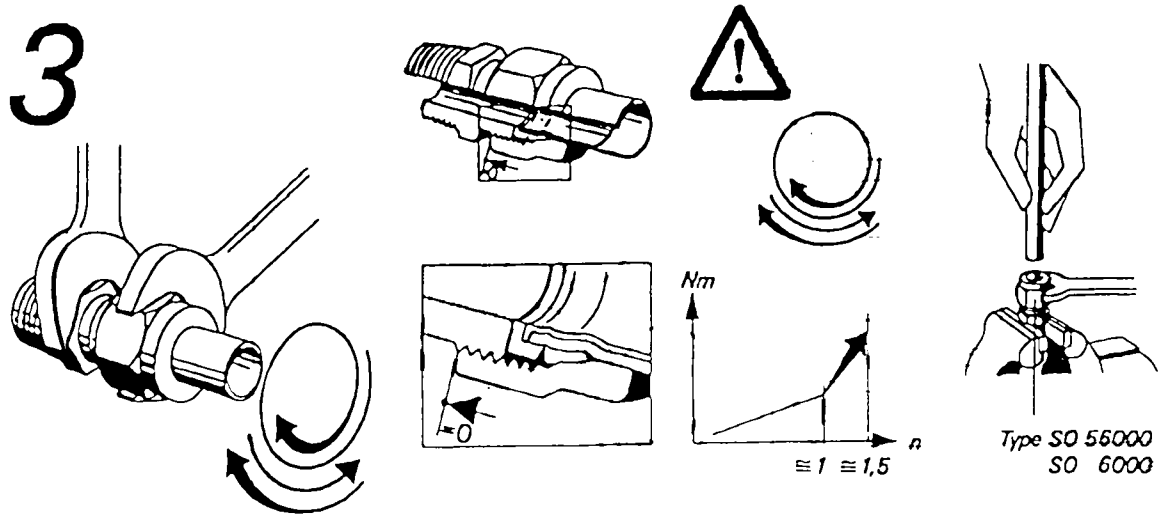
3) DEFORMATION, RELEASING TENSION, CHECKING:

- Tighten the fitting with a spanner until a strong resistance is encountered.
- Slightly loosen the nut, to relieve the piping. For the definitive installation, tighten until resistance is felt.
- Check the deformation.
  If the nut covers the connection thread, then the pipe and the clamping ring are correctly deformed..



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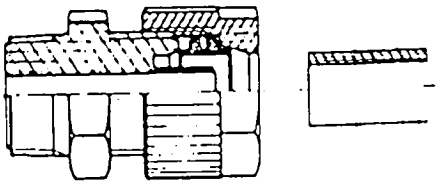
20.2 Plastic fittings

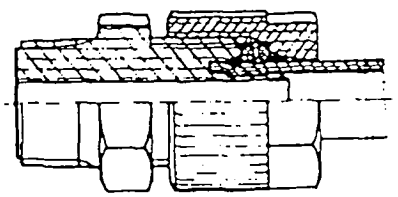
EXTENT OF DELIVERY:

- SERTO cable fittings are delivered ready for assembly:
  Base part / connection nut



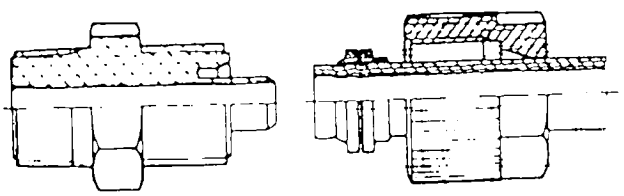
1) PREPARATION:

- Cut the pipe at right angles and remove burrs, e.g. with the "Hose-cutty" SERTO SO 835.
- The pipe end must be straight for a length of about 1.5 d, and have an undamaged surface. The fitting for the oxygen and ozone/oxygen circulation must be free from oil and grease.
- Push the tube into the union as far as the stop.
- Tighten the knurled nut hard by hand or with the special spanners SO 94441.



2) DISMANTLING, RE-ASSEMBLY:

- To disconnect, the knurled nut is unscrewed. The compression ferrule remains on the tube, however.
- Retightening of the nut produces a perfectly sealing connection, once again.



dismantled

- If a new tube is connected with an old union, the compression ferrule must be replaced by a new one.

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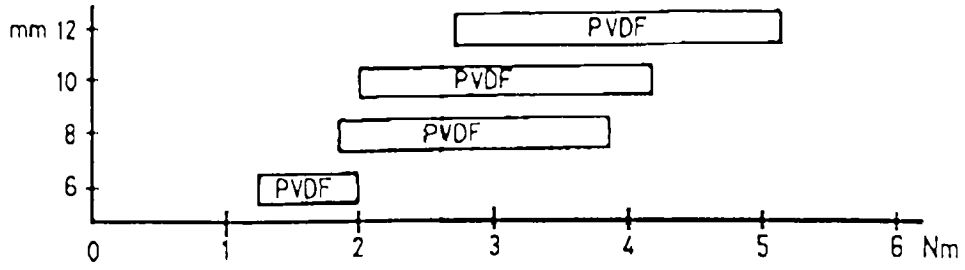
3) TORQUE:

- The design of the union ensures a reliable connection over a relatively wide range of torque. The special spanners SO 94441 improves accessibility and helps to avoid overtightening.



Tube outside diameter Torque

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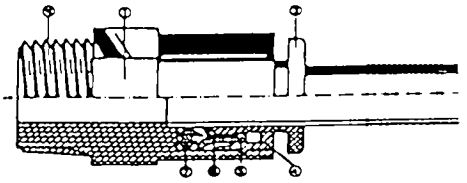
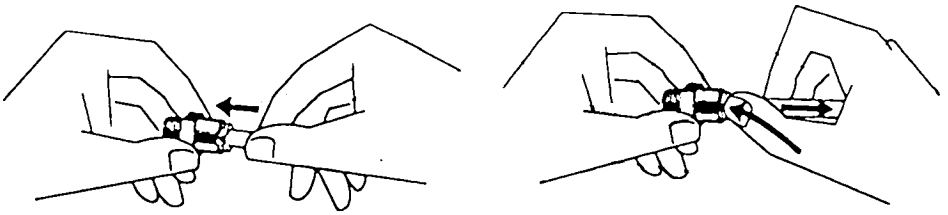
20.3 Chuck fittings FLIP

EXTENT OF DELIVERY:



1) TECHNICAL SPECIFICATION:

1. Body: Polyamid PA6.6
3. Release button: Acetal
4. Retainer: Brass
5. Collet: Acetal
6. Chuck: Stainless steel
7. Seal: NBR
10. Tapered male thread PTFE coated



2) INSTALLATION INSTRUCTIONS (Tube installation and dismantling):

1. Cut plastic tube squarely and neatly to length (preferable with tube cutty SO 835). Damage to the end of the tube can result in leaks.
2. Insert the end of tube into the SERTO flip fitting and push it until it reaches the stop. The tube is held in the cartridge by the chuck and closed with the seal.
3. To dismantle the tube press the light-grey release button slightly and withdraw end of tube from the SERTO flip fitting. The chuck is opened by the button and releases the end of the tube.

Depending on the Quality of tube used, the end may need to be recut after several dismantlings.

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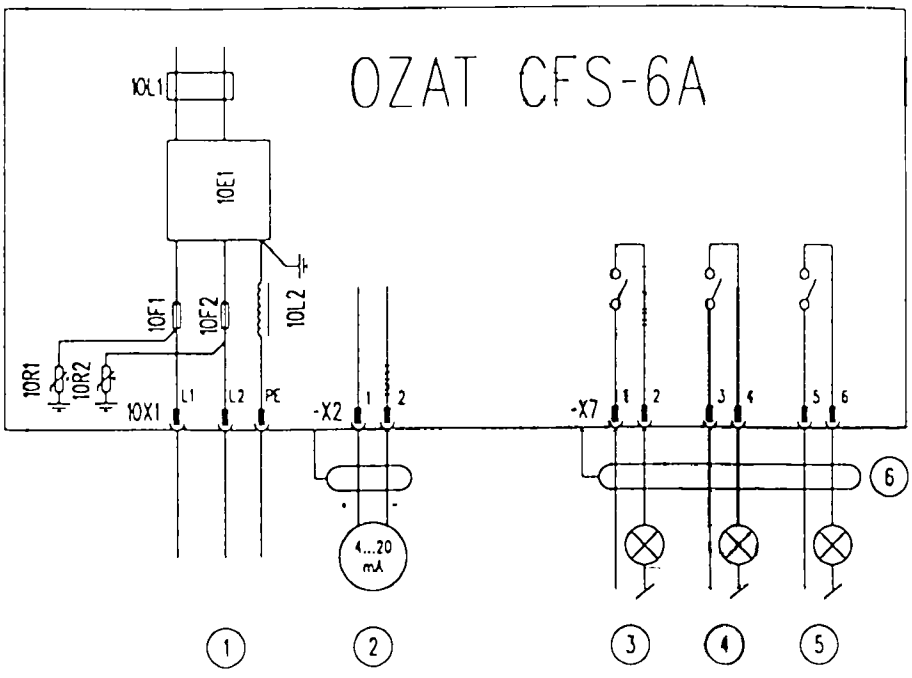
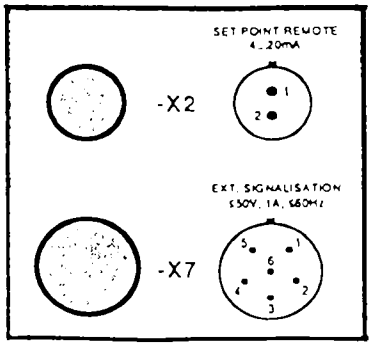
21. Appendix "Electrical connection circuit"



Caption:

1	10X1	2-phase mains connection with plug and socket
	10F1/F2	Fuse 6.3x32 mm
	10L2	Earthing reactor
	10R1/R2	Varistor
	10E1	Interference suppressor filter
	10L1	Ferrite-core
2	-X2	External set value 4...20 mA (= 0...100 %)
3	-X7	Power supply on (contact closed)
4	-X7	Collective alarm (contact closed)
5	-X7	Remote set value (contact closed)
6		Screened cable

External connection possibilities:



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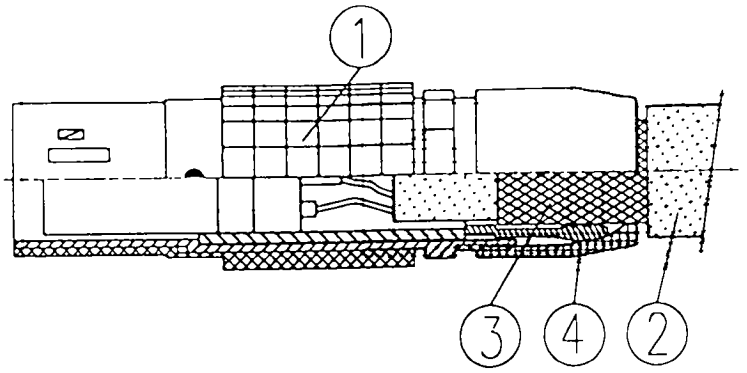
22. Appendix "EMP-Connector"



Caption:

1	EMP-Connector (Elektro-Magnetical-Pulse)
2	Screened cable
3	Screen
4	Electrical contacts

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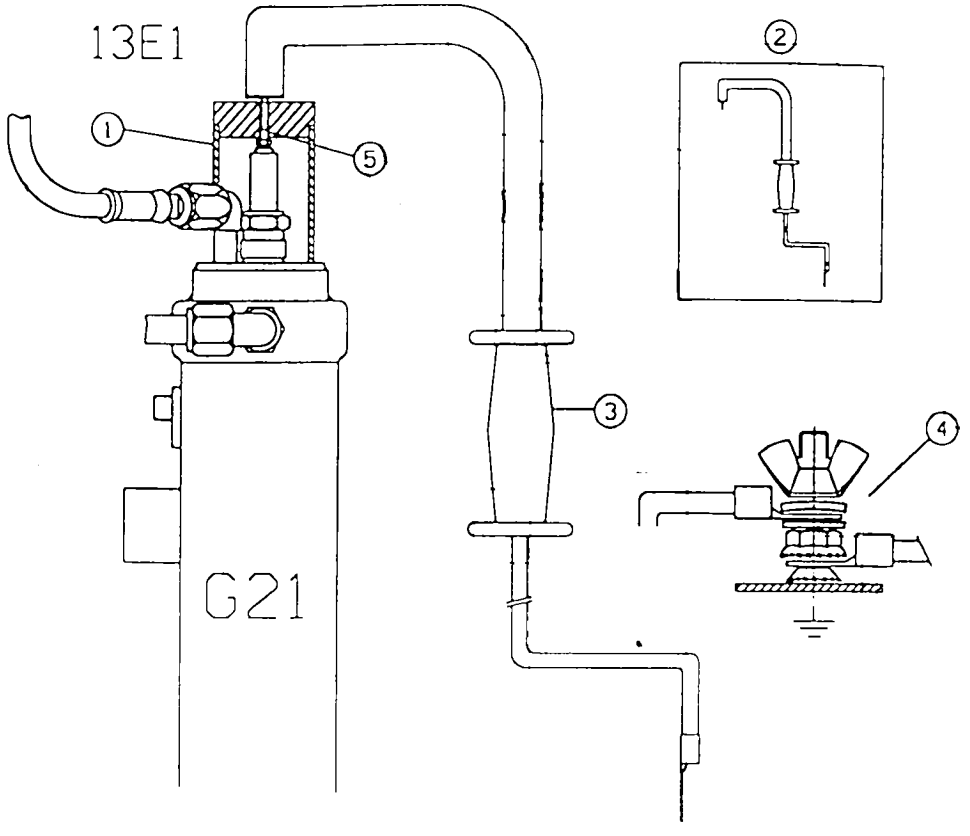
23. Appendix "Discharging the ozone generator module"



Caption:

G21	Ozone generator module
13E1	Electrical connection
1	Connection cover
2	Discharging device
3	Isolated handle
4	Earth for discharge device
5	Metal-to metal contact

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24. Appendix "Standards, regulations and guidelines"

General:

- EN 292 — Machine guidelines
- EN 60204-1 — Safety of Machines (European standard)
- prEN 1278 — Ozone

Oxygen Installations:

The regulations valid for the assembly and operation of oxygen installations must be complied with. Only the following regulations are referred to in this document:

- SVS 211.1 — Guidelines for fixed storage systems for low temperature, liquid, non-inflammable gases by the user.
- SVS 531.1 — Guidelines for oxygen lines and their fittings for operating pressures up to 40 bar.
- IGC 04/93 — Fire hazards in oxygen and concentrated oxygen atmospheres.
- VGB 62 — Accident prevention regulation No. 28. Oxygen employer's liability insurance association of the chemical industry (1.4.69 / Germany).

Ozone Installations:

The regulations valid for the assembly and operation of ozone installations must be complied with. Only the following regulations are referred to in this document:

- SBA-Nr. 143 — Swiss sheets for Safety at Work. Accident prevention with protection of health at water treatment.
- DIN 19627 — Ozone generation installations for water treatment.
- ZH 1/474 — Guidelines for the use of ozone for water treatment..
- DVGW W225 — Ozone in water treatment; Terms used, reactions, application possibilities.
- FIGAWA
  - Nr. 12 & 13 — Ozone technology in water treatment.
  - Nr. 6 — Information sheet regarding the handling of ozone and ozone generating systems in the water treatment.

The above standards, regulations and guidlines do not from a part of this service manual and should be procured separatly by the owner or user. In each and every case local regulations must be adhered to.

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APPENDIX
D

APPENDIX D

CORRECTIVE ACTION PLAN

APPENDIX D
CORRECTIVE ACTION PLAN
OZONE SPARGE/SVE TREATMENT SYSTEM
OSMOSE, INC.
BUFFALO, NEW YORK

IT Corporation Project Number: 11108061

April 28, 2000

Prepared by:

IT Engineering, P.C.
13 British American Blvd.
Latham, New York 12110

Submitted to:

Mr. David M. Kasprowicz
Osmose, Inc.
980 Ellicott Street
Buffalo, New York 14209

"Legal Notice"

This report was prepared by IT Engineering of New York, P.C., a firm certified to provide engineering services in New York State. Neither Osmose, nor any person acting on its behalf: (a) make any warranty, express or implied, with respect to the use of any information, apparatus, equipment, method, design, system, program or process disclosed in this report or that such use may not infringe privately owned rights; or (b) assumes any liability with respect to the use of, or for any damages, losses, costs, expenses or claims, resulting from or arising out of the use of any information, apparatus, equipment, method, design, system, program or process disclosed in this report.

Table of Contents

1.0 INTRODUCTION

1.1 Corrective Action Plan Objectives

This *Corrective Action Plan* focuses on the contingencies associated with the operations and maintenance (O&M) of the ozone sparge/SVE treatment system at the Osmose, Inc. (Osmose) site located at 980 Ellicott Street site in Buffalo, New York (NYSDEC Site No. 915143). The details of the remediation system design are included in the *As-Built Report* prepared by IT Engineering of New York, P.C., and the O&M procedures and equipment information included in the *Operations and Maintenance Manual.*

The objective of this *Corrective Action Plan* is to identify and standardize measures to address alarms, shutdown situations, and other questions that may arise during the O&M phase of the project. The *Corrective Action Plan* will outline the following:

1) Emergency Phone Numbers (these are also available in *the Health and Safety Plan* developed for the site)

2) Responsibility and Authority – the responsibility and authority of the key personnel involved in the O&M of the ozone sparge/SVE treatment system at the site

3) System Alarms - response procedures to alarms the indicate a fault condition

4) Third Party Inquiries – response procedures to inquiries/complaints/ communication from third parties

5) Documentation and Reporting – establish problem identification and corrective measure summaries and final documentation

2.0 EMERGENCY CONTACTS

In the event of an emergency, the following services/persons can be called. The nearest telephone is located inside the guard station in the pilot plant building.

EMERGENCY TELEPHONE NUMBERS

CONTACT	TELEPHONE NUMBER
Ambulance	911
Fire	911
Police	911
Hospital	Millard Filmore Hospital (716) 887-4880
Osmose, Inc.	Mr. David Kasprowicz (716) 882-5905 Mr. Michael Rider (716) 882-5905
IT Engineering of NY, P.C.	Ms. Gina Senia (716) 773-1801 Mr. Bruce Ahrens (518) 783-1996
NYSDEC	Mr. Jaspal Walia P.E. (716) 851-7220
Poison Control	(716) 878-7654

3.0 RESPONSIBILITY AND AUTHORITY

Responsibilities for the O&M are as follows:

Owner:
Osmose, Inc.
980 Ellicott Street
Buffalo, New York 14203
Contact: Mr. David Kasprowicz (716) 882-5905

Consultant:
IT Engineering of New York, P.C.
13 British American Blvd.
Latham, New York 12110
Contact: Ms. Gina Senia (716) 773-1801
Mr. Bruce Ahrens (518) 783-1996

State Agency:
New York State Department of Environmental Conservation
270 Michigan Avenue
Buffalo, New York 14203-2999
Contact: Mr. Jaspal Walia, P.E. (716) 851-7220

3.1 Owner's Responsibilities

The Owner is responsible for primary reporting of all corrective action procedures to the NYSDEC. The O&M consultant will immediately (within 24 hours, or as quickly as reasonable depending on the type/nature of corrective action required) notify the Owner of any situations requiring corrective action.

3.2 O & M Consultant's Responsibilities

The O&M Consultant is responsible for monitoring the remediation system and identifying any situations requiring corrective action. This identification is accomplished by on-site detection during routine or non-routine O&M visits, or by receiving a fax from the control panel autodialer. The O&M Consultant is also responsible for responding to situations identified by the Owner or State agency and communicated to the O&M Consultant.

3.3 State Agency's Responsibility

The State agency will review all reports, communications, and correspondence concerning situations requiring corrective action. The Owner will be the State agency's primary contact. Any further action required by the State agency will be communicated to the Owner.

4.0 SAFETY INTERLOCKS/ALARMS

Safety interlocks/alarms have been designed into the treatment system. A list of interlocks is presented in Table 6.0 of the *Operation and Maintenance Manual*. In all cases, when the ozone generator is shut down, an autodialer will activate and send a facsimile message to the following individuals:

- Mr. David Kasprowicz
  Plant Manager
  Osmose, Inc.
  facsimile: (716) 882-2834

- Ms. Gina Senia
  Project Engineer
  IT Corporation
  facsimile: (716) 773-2285

In the event of a SVE system shut down, once the alarm condition is cleared, the SVE will automatically restart and restart the ozone generator. However, if oxygen or ozone is detected in the treatment compound (TC-2) ambient air above critical concentrations, the ozone generator will shut down permanently, until manually reset. These alarms require corrective action on-site. To remedy these situations, consult the appropriate procedures in the manufacture's specifications included in the *Operation & Maintenance Manual*.

5.0 THIRD PARTY INQUIRIES

Any inquiry/complaint/communication received by the Owner, Consultant, or State agency by a third party will be addressed by the appropriate person(s). Any communication back to the third party will be the responsibility of the Owner.

6.0 DOCUMENTATION AND REPORTING

The value of the *Corrective Action Plan* will be assured by proper documentation and reporting techniques. The Corrective Action *Plan* team will correspond, document, and report corrective actions by completing detailed telephone logs, written letters, memorandums, and/or signed reports. The documentation of the activities will facilitate adherence to the O&M documents and maintain the level of reporting required by the NYSDEC.

7.0 REFERENCES

Final Remedial Design, January 19, 1999, IT Engineering of New York, P.C.

Health and Safety Plan, October 6, 1999, IT Engineering of New York, P.C.

Operation and Maintenance Manual, October 15, 1999, IT Engineering of New York, P.C.

APPENDIX
E

APPENDIX E

MONITORING FORMS

I Well Data Monitoring Form

II Site Monitoring Form

III Indoor Air Monitoring Form

IT Corporation
A Member of The IT Group

IT Corporation
13 British American Blvd
Latham, New York 12110
(518) 783-1996

WELL DATA MONITORING FORM

Project Name/Location:_____ Date:_____
Project Number:_____ Task Code:_____ Page ___ of ___
IT Corp Field Personnel:_____ Equipment No.:_____

Well ID	Well Depth	TOC Elev.	Depth To Water	LNAPL Thickness	Turbidity	Corrected Depth to Water	Corrected Water Elevation

Comments:

IT Corporation
13 British American Blvd
Latham, New York 12110
telephone: (518) 783-1996
facsimile: (518) 783-8397

SITE MONITORING FORM
Osmose, Inc.

Date:	Time:
Project Number:	Task Code:
IT Corp Field Personnel:	

Ambient Air Monitoring

1.0 Ozone Monitoring

Location	Result	Schedule	Activity
AA-1		bi-weekly	measure O_3 concentration with Dragger-type
AA-2		bi-weekly	tube; see figure 3-1 for sampling locations
AA-3		bi-weekly	
AA-4		bi-weekly	
AA-5		bi-weekly	
AA-6		bi-weekly	
AA-8		bi-weekly	

2.0 VOC Monitoring

Location	Result	Schedule	Activity
AA-1		bi-weekly	measure VOCs with PID
AA-8		bi-weekly	

Groundwater Dewatering and Treatment System

1.0 Flowrates and Pressures

Location	Reading	Schedule	Location	Reading	Schedule
FM-400		Monthly	PI-400		monthly
FM-401		Monthly	PI-410		monthly
FM-402		Monthly	PI-420		monthly
FM-403		Monthly	PI-430		monthly
FM-404		Monthly			
FM-405		Monthly			
FM-406		Monthly			
FM-407		Monthly			
FM-408		Monthly			
FM-409		Monthly			
FM-410		Monthly			
FM-411		Monthly			

SITE MONITORING FORM (cont.)

SVE SYSTEM / OZONE REDUCING CATALYST

1.0 VOC Concentration

Quarterly by PID

Location	Reading	Location	Reading	Location	Reading
SP-E1		SP-E9		SP-E17	
SP-E2		SP-E10		SP-E18	
SP-E3		SP-E11		SP-E19	
SP-E4		SP-E12		SP-E20	
SP-E5		SP-E13		SP-E21	
SP-E6		SP-E14		SP-E22	
SP-E7		SP-E15		SP-E23	
SP-E8		SP-E16			

Monthly

SP-7		VOCs in trunk influent line by PID
SP-8		VOCs in trunk effluent line by PID or Tedlar bag

2.0 Ozone Concentration

Monthly

SP-7		O_3 in trunk influent line monthly by Dragger-type tube
SP-8		O_3 in trunk effluent line monthly by Dragger-type tube

3.0 Pressure / Vacuum

Monthly

Location	Reading	Location	Reading	Location	Reading
PI-E001		PI-E009		PI-E017	
PI-E002		PI-E010		P-E018	
PI-E003		PI-E011		P-E019	
PI-E004		PI-E012		P-E020	
PI-E005		PI-E013		PI-E021	
PI-E006		PI-E014		PI-E022	
PI-E007		PI-E015		P-E023	
PI-E008		PI-E016			
PI-312					
PI-314					

Bi-weekly

PI-314		

SITE MONITORING FORM (cont.)

4.0 Air Flow

Monthly

Location	Reading	Location	Reading	Location	Reading
SP-E1		SP-E9		SP-E17	
SP-E2		SP-E10		SP-E18	
SP-E3		SP-E11		SP-E19	
SP-E4		SP-E12		SP-E20	
SP-E5		SP-E13		SP-E21	
SP-E6		SP-E14		SP-E22	
SP-E7		SP-E15		SP-E23	
SP-E8		SP-E16			
SP-8					

OZONE SPARGE SYSTEM

1.0 Pressure

Bi-weekly

Location	Reading	Location	Reading	Location	Reading
PI-O-1		PI-O-8		PI-O-15	
PI-O-2		PI-O-9		PI-O-16	
PI-O-3		PI-O-10		PI-O-17	
PI-O-4		PI-O-11		PI-O-18	
PI-O-5		PI-O-12		PI-O-19	
PI-O-6		PI-O-13		PI-O-20	
PI-O-7		PI-O-14			

2.0 Flow Characteristics

Characteristic	Location	Reading (bi-weekly)
Dew Point	R-200 (display panel)	
DC-Power (Pe)	R-200 (display panel)	
Run Time	R-200 (display panel)	
Pressure	R-200 (display gauge)	
Gas Flow Rate (Vn)	R-200 (display gauge)	

2.0 Ozone Injection Rate

Location	Reading	
FM-200		Monthly: Record flow, adjust needle valve at each sparge point to desired flow

IT Corporation
13 British American Blvd.
Latham, New York 12110
Telephone: (518) 783-1996
Facsimile: (518) 783-8397

IT Corporation
A Member of The IT Group

morning: 7:30am – 8:00am
noon: 11:30am – 12:00pm
end of day: 4:30pm – 5:00pm

INDOOR AIR MONITORING FORM
Sampling Location AA-7

Date	Time (record)	Reading (ppb)	Date	Time	Reading (ppb)
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	
	morning am			morning am	
	Noon			Noon	
	end of day pm			end of day pm	

APPENDIX
F

APPENDIX F

HEALTH AND SAFETY PLAN

SAFETY - FIRST AND ALWAYS

APPENDIX A
HEALTH AND SAFETY PLAN

FOR SITE ACTIVITIES AT

OSMOSE, INC.
980 ELLICOTT STREET
BUFFALO, NEW YORK 14209
NYSDEC SITE # 915143

PROJECT NO. 01110-8061

BRUCE W. AHRENS
SENIOR PROJECT MANAGER

10/6/99

JOHN R. REINEMANN, CIH
HEALTH AND SAFETY REPRESENTATIVE

The information in this HASP is provided solely for the protection of the health and safety of Fluor Daniel, GTI employees and subcontractors working under the direct supervision and control of Fluor Daniel, GTI on this project. Fluor Daniel, GTI assumes no liability for, or responsibility to, any other parties for the accuracy or completeness of the information contained herein for any use or reliance upon this HASP by any other party.

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IT Corporation

Project Name: Osmose, Inc.

Project Number: 11108061

PM: Bruce Ahrens, CHMM

Location: 980 Ellicott Street, Buffalo, NY 14209

Changes in field activities or hazards: There has been no changes in hazards since the Health and Safety Plan was revised on January 6, 1999. However, the following minor changes should be noted in the HASP:

1. The previous HASP referenced Fluor Daniel GTI personnel performing the services. IT Corporation has since acquired Fluor Daniel GTI. Any reference to Fluor Daniel GTI in the HASP means IT Corporation.

2. The previous HASP was written in the future tense. Construction activities have been completed and now the project is in an operation and maintenance (o & M) phase on the ozone sparging and soil vapor extraction systems.

3. The Technical Advisors in Section 1.2, Project Personnel and Responsibilities, and the Medical/Technical Advisors in Section 7.1 of the HASP have changed since the original HASP. John Reinemann, CIH and David Crowley, CSP, CET, CHMM, have been replaced by Jeff Hutchens, CSP and Leo Hearn, CIH, CSP, respectively.

   Jeff Hutchens, CSP: 518-783-1996
   Leo Hearn, CSP, CIH: 904-636-9360

Approved by: Bruce W Ahrens
Project Manager: Bruce Ahrens, CHMM

Date: 11/9/99

TABLE OF CONTENTS

TABLES

EXHIBITS

LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
BP	Breath pipe
BT	Body temperature
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
BWL	Body water loss
BWT	Body water temperature
CET	Certified Environmental Trainer
CFR	Code of Federal Regulations
CGI	Combustible gas indicator
CHMM	Certified Hazardous Materials Manager
CIH	Certified Industrial Hygienist
COHN	Certified Occupational Health Nurse
CNS	Central nervous system
CPR	Cardio-pulmonary resuscitation
CRZ	Contaminant reduction zone
CSE	Confined space entry
CSP	Certified Safety Professional
CZ	Clean zone
DM	Dust-particulate monitor
DOT	Department of Transportation
DT	Detector tube
DZ	Decontamination zone
EKG	Electrocardiogram
EMR	Environmental Medical Resources
EMS	Emergency Medical Services
EPA	Environmental Protection Agency
EZ	Exclusion zone
FID	Flame ionization detector
FP	Flashpoint
GFCI	Ground fault circuit interrupter
GM	Geiger-Mueller
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HBV	Hepatitis B-virus
HEPA	High efficiency particulate air-purifying
HR	Heart rate
HSM	Health and Safety Manager
HSR	Health and Safety Representative
HSS	Health and Safety Specialist

LIST OF ACRONYMS (continued)

HVDPE	High vacuum dual-phase extraction
HZ	Hot zone
IDLH	Immediately dangerous to life or health
ILO	International Labor Organization
IP	Ionization potential
JSA	Job safety analysis
LEL	Lower explosive limit
LO/TO	Lockout/tagout
mg/M_3	Milligrams per cubic meter
mg/L	Milligrams per liter
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
N	NIDA drug screen
NA	Not available
NBR	Nitrile butyl rubber
NEC	National Electrical Code
NIDA	National Institution on Drug Abuse
NIOSH	National Institute for Occupational Safety and Health
NFPA	National Fire Prevention Association
NL	NIDA-like drug screen
NRR	Noise reduction rating
O_2	Oxygen
O_3	Ozone
OM	Operations Manager
OJT	On the job training
OT	Oral temperature
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
PID	Photoionization detector
PIR	Preliminary incident report
PM	Project Manager
ppb	Parts per billion
PPE	Personal protective equipment
ppm	Parts per million
RB	Random breathalyser
RBP	Random breath pipe
RCRA	Resource Conservation and Recovery Act of 1976
REL	Recommended exposure limit
RN	Registered Nurse

LIST OF ACRONYMS (continued)

RR	Relative responses
RT	Random ten panel drug screen
SHSO	Site Health and Safety Officer
SLM	Sound level meter
SOW	Scope of work
SPL	Sound pressure level
STEL	Short-term exposure limit
SZ	Support zone
TLV	Threshold limit value
TP	Fluor Daniel GTI ten panel drug screen
TSF	Tons per square foot
TWA	8-hour time-weighted average
UEL	Upper explosive limit
ug/L	Micrograms per liter
UST	Underground storage tank
VP	Vapor pressure
WBGT	Wet bulb globe temperature

SITE EMERGENCY FORM

Chemicals of Concern: Polynuclear aromatic hydrocarbons (PAH) from Brushing Grade Creosote, volatile organic compounds (VOC) from No.2 Fuel Oil and ozone from remediation system.
Minimum Level of Protection: Level D
Hazard Determination: Serious_____ Moderate XXXXX Low_____

Do not endanger your own life. Survey the situation before taking any action.

Fluor Daniel GTI Office Telephone	518-783-1996
Site Location Address	980 Ellicott St., Buffalo, NY 14209
Telephone Located at	Osmose Facility

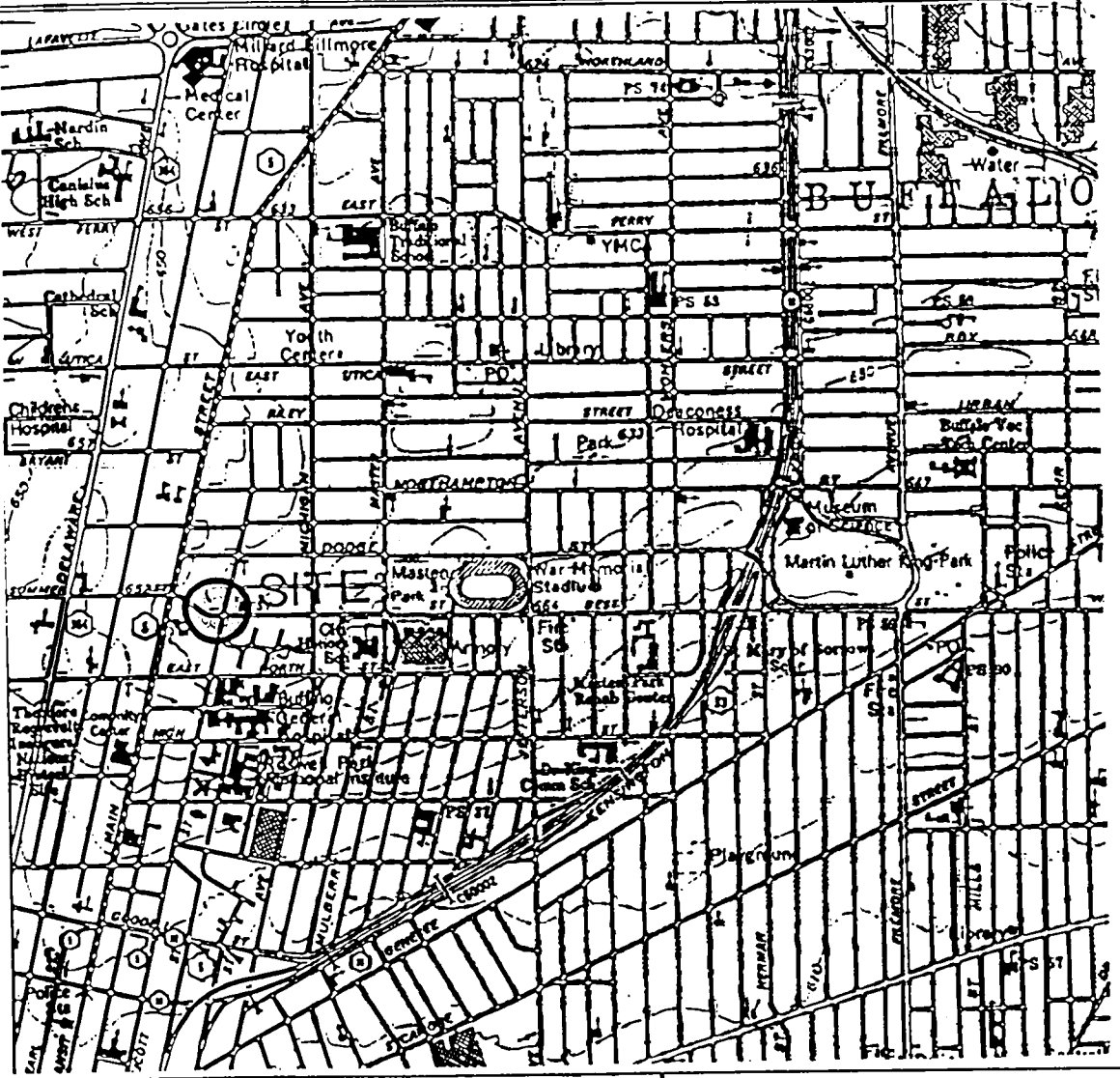
EMERGENCY PHONE NUMBERS **IN THE EVENT OF ANY EMERGENCY CONTACT PROJECT MANAGER (PM) OR HEALTH AND SAFETY REPRESENTATIVE**

Ambulance	911
Fire	911
Police	911
Poison Control	716-878-7654
Hospital Name	Millard-Fillmore Hospital
Hospital Phone Number	716-887-4880
Project Manager	Bruce W. Ahrens, 518-783-1996
Site Safety Officer	To be announced
District Health and Safety Mgr.	John Reinemann, CIH, 518-783-1996
Client Contact	Michael E. Rider, 716-882-5905
NYSDEC	Region, 716-851-7220; 24 Hr Emergency, 800-457-7362

UTILITY MARKER EMERGENCY TELEPHONE NUMBERS

Utility	Color Code	Telephone Number
Water Gas Electric Telephone/Cable Sewer	Blue Yellow Red Orange Green	800-962-7962 for all utilities
Underground Facilities Protection Organization (UFPO) Telephone Number: 800-962-7962		

HOSPITAL LOCATION MAP



HOSPITAL DIRECTIONS:

From the site, take Best St. west two blocks to the intersection of Delaware Avenue. Take a right (north) onto Delaware Avenue and go approximately five blocks to Gate Circle. The hospital is located on the right hand side at 3 Gate Circle.

HOSPITAL INFORMATION:

Name: Millard-Fillmore Hospital
Address: 3 Gate Circle
City, State Buffalo, NY

Phone: Emergency: 716-887-4880
General: 7165-887-4880

EMERGENCY FIRST AID

FIRST AID

Ingestion:	DO NOT INDUCE VOMITING. Call Poison Control - follow instructions. Administer cardiopulmonary resuscitation (CPR), if necessary. Seek medical attention.
Inhalation:	Remove person from contaminated environment. Administer CPR if necessary. Seek medical attention. DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME UNLESS PROPERLY EQUIPPED AND A STANDBY PERSON IS PRESENT.
Skin Contact:	Brush off dry material, remove wet or contaminated clothing. Flush skin thoroughly with water. Seek medical attention if irritation persists.
Eye Contact:	Flush eyes with water for 15 minutes. Seek medical attention.
Exposure Symptoms:	Headache, dizziness, nausea, drowsiness, irritation of eyes, nose, throat, breathing difficulties.
Contingency Plan:	Report incident to PM and Health and Safety Specialist (HSS) after emergency procedures have been implemented.

RESPONDER MUST HAVE A CURRENT CERTIFICATE TO ADMINISTER FIRST AID OR CPR

1. Survey the situation. Do not endanger your own life. DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME UNLESS PROPERLY EQUIPPED AND TRAINED. ENSURE ALL PROTOCOLS ARE FOLLOWED INCLUDING THAT A STANDBY PERSON IS PRESENT.

2. Call 911 (if available) or the fire department IMMEDIATELY. Explain the physical injury, chemical exposure, fire, or release.

3. Decontaminate the victim without delaying life-saving procedures.

4. If the victim's condition appears to be noncritical, but seems to be more severe than minor cuts, he/she should be transported to the nearest hospital by trained Emergency Medical Services (EMS) personnel: let the doctor assume the responsibility for determining the severity of the injury. If the condition is obviously serious, EMS must transport the victim.

5. Notify the PM and the HSS. Complete the Fluor Daniel GTI Preliminary Incident Report (PIR) within 24 hours.

EMERGENCY FIRST AID PROCEDURES	
To Stop Bleeding	**CPR**
1. Give medical statement.	1. Give medical statement.
2. Assure airway, breathing, circulation.	2. Arousal: Check for consciousness.
3. Use DIRECT PRESSURE over the wound with clean dressing or your hand (use nonpermeable gloves). Direct pressure will control most bleeding.	3. Open airway with chin-lift.
	4. Look, listen, and feel for breathing.
	5. If breathing is absent, give 2 slow, full rescue breaths.
4. Bleeding from an artery or several injury sites may require DIRECT PRESSURE on a PRESSURE POINT. Use pressure points for 30 - 60 seconds to help control severe bleeding.	6. Check the pulse for 5 to 10 seconds.
	7. If pulse is present, continue rescue breathing: 1 breath every 5 seconds.
5. Continue primary care and seek medical aid as needed.	8. If pulse is absent, initiate CPR; 15 compressions for each two breaths.

1.0 INTRODUCTION

Osmose, Inc. (Osmose) has retained Fluor Daniel GTI, Inc. (Fluor Daniel GTI) to perform environmental services at the Osmose facility located at 980 Ellicott Street in Buffalo, New York. The Ellicott Street facility serves as the executive and accounting headquarters and also includes research and product production at the site. This facility manufactures a variety of preservatives used in the treatment of lumber and wood products.

This Health and Safety Plan (HASP) is a revision of the plan written October 9, 1992. This plan includes the same general information as the previous plan but format has been updated since the original version.

The Health and Safety Plan (HASP) is written to ensure the well-being of all field personnel and the community surrounding the site. Accordingly, project staff and approved Fluor Daniel GTI subcontractors must follow the policies and procedures established in the HASP. All Fluor Daniel GTI personnel and subcontractors assigned to this project must sign the Agreement and Acknowledgment Sheet (Exhibit B) to confirm that they understand and agree to abide by the provisions of the plan.

All work will comply with Fluor Daniel GTI health and safety guidelines in concurrence with all applicable sections of the Occupational Safety and Health Act (OSHA), 29 Code of Federal Regulations (CFR) 1910 and 1926; specifically 29 CFR 1910.120 and 1926.65 Standards, "Hazardous Waste Operations and Emergency Response," (29 CFR 1910.120) as well as other federal, state, and local regulations that require the development and implementation of a HASP. Generation of this document certifies that the workplace has been evaluated for the hazards as described. A hazard assessment has been performed and the adequacy of the personal protective equipment (PPE) selected is hereby certified per 29 CFR 1910.132(d) and is duly noted by the signature(s) and date appearing on the cover page of this document.

This HASP addresses the safety issues associated with the construction and operation of an ozone sparge, soil vapor extraction (SVE), and ground water recovery/treatment systems. The HASP addresses safety issues that may be associated with performing installation operation and maintenance on the remediation system over a projected one to two year period. The HASP addresses site and surrounding property safety. Preliminary design on remediation systems has been completed. This HASP has been prepared in conjunction with and submitted as part of, the final remedial design. The remediation systems are expected to be procured and installed in a November 1998 through January, 1999 time frame. In general, the work to be performed involves the following site tasks:

- Excavation and trenching;
- Upgrading of an existing LNAPL recovery system;
- Installation of a soil vapor extraction system;
- Installation of a vapor treatment system;

- Installation of ozone generating equipment;
- Installation of an ozone sparging system;
- Performing equipment operation and maintenance including lockout/tagout;
- Gauging existing monitoring wells;
- Sampling existing monitoring wells; and,
- Abandonment of wells.

The minimum level of protection for this site is Level D. For each task, the potential hazards for employee exposure to site chemicals and/or air monitoring results, will determine the level of protection. Modified Level D will be worn during tasks that may have the potential for skin contact with impacted media (soil or water). Upgrade to Level C and/or B will occur when the possibility of exposure exists from the onset of site-specific tasks or results of real-time monitoring exceed established action levels listed in Table 7, Air Monitoring Action Levels. This HASP must be modified or amended when circumstances or conditions develop that are beyond the scope of this plan.

Any changes in project work scope and/or site conditions as described must be amended in writing by the Health and Safety Representative (HSR) on the HASP Amendment Sheet (Exhibit A).

Table 1, Responsibilities of On-Site Personnel, lists those accountable and responsible for the implementation of the HASP. Table 2, Hazard Analysis Matrix, presents an overview of site-specific job tasks and the associated hazards. Table 3, Chemicals of Concern Profile presents an overview of the hazards and control measures associated with the site chemicals of concern. Lastly, Table 4, presents an overview of the Fluor Daniel GTI health and safety programs in which all field personnel are required to participate. These include the medical surveillance and comprehensive training programs in accordance with OSHA Hazardous Waste Operations and Emergency Response standard, 29 CFR 1910.120.

1.1 Site Description/Background Information

The Osmose site is located on the corner of Best Street and Ellicott Street. Soil in one area of the site possesses elevated concentrations of PAHs from historic releases of brushing grade creosote and VOCs associated with No. 2 fuel oil. PAHs have been detected in soils at levels up to 650 mg/kg (ppm). VOCs in soil have ranged from non-detectable to 9.1 mg/kg. The maximum level of dissolved VOCs in groundwater was 2.2 milligram/liter (mg/l) and the maximum level of PAHs in groundwater was 12 mg/l (or ppm).

Laboratory and field treatability studies have indicated that PAHs may be degraded in situ through injection of ozone into the subsurface. Fluor Daniel GTI or its subcontractors will conduct installation and operation of an ozone injection/SVE treatment system as required by the New York State

Department of Environmental Conservation's (NYSDEC) Record of Decision (ROD) and as specified in the final design.

1.2 Project Personnel and Responsibilities

Fluor Daniel GTI will oversee and act accordingly during all phases of the project. The following management structure will be instituted for the purpose of successfully and safely completing this project.

Technical Advisors

John Reinemann, CIH District Health and Safety Manager	Fluor Daniel GTI, Albany, NY	(518) 783-1996
David Crowley, CSP, CET, CHMM Fluor Daniel GTI, Norwood, MA		(781) 769-7600

The specific duties of the technical advisors include:

- providing technical input into the design and implementation of the site HASP,
- advising on potential for worker exposure to project hazards along with appropriate methods and/or controls to eliminate site hazards.

A site health and safety officer (SHSO) will be assigned on a full time basis during site activities and shall assist and represent the Health and Safety Manager (HSM). The SHSO shall have the responsibility and authority to implement and enforce the approved HASP; this includes modifying/halting work, and removal of personnel from the site if work conditions change and effect on-site/off-site health and safety matters. The SHSO will serve as the main contact for any on-site emergency situation.

Table 1. Responsibilities of On-Site Personnel

Table 1. Responsibilities of On-Site Personnel (continued)

Title	General Description	Responsibilities
Project Manager (PM) Bruce Ahrens	Reports to upper-level management. Has authority to direct response operations. Assume total control over site activities.	■ Prepares and organizes background review of the project, the work plan, the HASP, and the field team. ■ Obtains permission for site access and coordinates activities with appropriate officials. ■ Sees that the work plan is properly carried out and on schedule. ■ Briefs the field personnel on specific assignments. ■ Together with the SHSO sees that health and safety requirements are met. ■ Prepares final report and follow up on Preliminary Incident Report (PIR) events.
SHSO To be assigned	Advises the PM on all aspects of health and safety on site. Stops work if site operations threaten worker or public health and safety. Informs health and safety specialist of any changes in site conditions or project status.	■ Periodically inspects protective clothing and equipment. ■ Sees that protective clothing and equipment are properly stored and maintained. ■ Controls entry and exit at the access control points. ■ Monitors the workers for signs of stress, including heat stress, cold exposure, and fatigue. ■ Implements the HASP. ■ Conducts periodic inspections to assess whether the HASP is being followed. ■ Enforces the "buddy" system. ■ Informed of emergency procedures, evacuation routes, and telephone number of local hospital, poison control center, fire department, and police department. ■ Notifies, when necessary, local public emergency officials. ■ Submits PIRs promptly to site supervisor and PM. ■ Maintains communication with health and safety representative on site activities.

Table 1. Responsibilities of On-Site Personnel (continued)

Title	General Description	Responsibilities
SHSO (continued)		■ Coordinates emergency medical care. ■ Sets up decontamination lines and decontamination solutions appropriate for the chemical contaminants encountered. ■ Controls the decontamination of equipment, personnel, and samples from contaminated areas. ■ Facilitates the proper disposal of contaminated clothing and materials. ■ Maintains the availability of required equipment. ■ Advises Fluor Daniel GTI Technology health services and medical personnel of potential exposures. ■ Notifies emergency response personnel in the event of an emergency. ■ Maintains and oversees operation of monitoring equipment and interpretation of data from the monitoring equipment.
Project Supervisor To be assigned	Reports to PM. Has authority to direct response operations. Assumes total control over site activities.	■ Conducts Daily Safety Tailgate Meeting and documents attendance (Exhibit M). ■ Conducts periodic field health and safety inspections (Exhibit L). ■ Manages field operations. ■ Executes the work plan and schedule. ■ Enforces safety procedures. ■ Coordinates with the SHSO in enforcing worker protection levels. ■ Enforces site control. ■ Documents field activities and sample collection. ■ Notifies when necessary, local public emergency officials. ■ Submits PIRS and initiates follow up with PM and SHSO.
Work Team	Reports to project supervisor for on-site activities. Work parties must comprise at least two people for high hazard operations.	■ Safely completes on-site tasks required to fulfill the work plan. ■ Complies with the HASP. ■ Attends and participates in Daily Safety Tailgate Meetings. ■ Notifies SHSO or supervisor of suspected unsafe conditions. ■ Submits PIRs to SHSO and Project Supervisor.

1.3 Hazard Analysis and Site-Specific Health and Safety Program Requirements

Site-specific job tasks and the associated hazards are identified in Table 2, Hazard Analysis Matrix. For each task involved with the project are the type of hazards that may be encountered. Utilize the hazard analysis table as a guide for implementing specific health and safety programs. Table 5, Potential Hazards and Controls provide guidelines to follow when conducting the tasks involved with this project.

Table 2. Hazard Analysis Matrix

Hazards	Tasks						
	Excavate and Trench Work	Upgrade LNAPL Recov. System	Install Vapor Treat. And Extr. Systems	Coll. Envir. Sam-ples	Air Sparg-ing	Gauge/ Aband. Wells	System O & M/ LOTO
Chemicals of Concern Exposure	X		X	X	X	X	X
OSHA Chemicals Exposure	X	X	X	X	X	X	X
Mechanical Equipment/ Construction	X	X	X		X		X
Electrical	X	X	X		X		X
Fire and Explosion	X	X	X	X	X		X
Heat/Cold Stress	X	X	X	X	X	X	X
Vehicular Traffic	X		X	X		X	X
Pedestrian Traffic	X					X	
Overhead Utilities	X		X	X			
Underground Utilities	X	X	X			X	
Noise	X	X	X		X		X
Confined Space Entry (CSE)			X	X			
Poisonous Plants							
Snakes/Spiders/ Insects	X	X	X	X		X	X

Site-Specific Health and Safety Program Requirements

Based upon the site-specific hazard analysis, the following programs must be implemented and the accompanying forms, found in the Exhibits section of the HASP, completed. The completed forms can then be attached to this document.

SITE-SPECIFIC PROGRAM	HASP EXHIBIT
Air Monitoring Program	E
Noise Monitoring Program	E
Site-Specific Lockout/Tagout (LO/TO) Procedures	C
Excavation/Trenching	F
Underground Utility Contact Prevention and Management Plan	F
Heat/Cold Stress Procedure	I
Hot Work Permit	H
Daily Safety Tailgate Meeting	M

1.4 Chemicals of Concern Profile

Based upon data obtained from the background information, site history, and site characterization a summary profile of the hazards and control measures to follow for the chemicals of concern is presented. Summarized in Table 3, the profile provides an overview of the hazards associated with potential exposure to the chemicals of concern and the preventative measures. For more detailed and specific information, always refer to the Material Safety Data Sheet (MSDS) or equivalent information for the compound located in Exhibit D.

Table 3. Chemicals of Concern Profile

Chemical of Concern	Profile of Hazards and Control Measures to Follow
No. 2 Fuel Oil	Contains a mixture of petroleum hydrocarbons including paraffinic, olefinic, naphthenic and aromatic hydrocarbons including less than 100 ppm benzene, a human carcinogen. A flammable liquid. A skin irritant and central nervous system (CNS) depressant. Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, stupor, convulsions, or unconsciousness. Primary target organs include the CNS, skin and mucous membranes. Excessive contact with skin may cause dermatitis. Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety. Wear protective eyeglasses and gloves when handling. No OSHA permissible exposure limit (PEL) has been established. However, benzene, a minor contaminant, has a PEL of 1.0 ppm. See generic MSDS in Exhibit D for additional hazards and control measures.

Chemical of Concern	Profile of Hazards and Control Measures to Follow
Brushing Grade Creosote	Contains coal tar pitch volatiles, a human carcinogen. Combustible liquid. Toxic by inhalation, ingestion, and skin contact. OSHA PEL is 0.2 mg/M3. Photosensitization from skin contact can occur. Coal tars contain a variety of polynuclear aromatic hydrocarbons such as benzo[a]pyrene, benzanthracene, and other polycyclic compound derivatives. Effects of overexposure includes skin irritation, dermatitis, skin cancer. Target organs include eyes, skin, bladder, kidneys and respiratory system. Avoid ingestion. Systemic absorption by any route may cause trouble breathing, thready pulse, dizziness, headache, nausea, vomiting, salivation and convulsions. Exposure to large doses may be fatal. Wear chemical impervious gloves and coveralls when handling in addition to other PPE specified in the HASP or on the MSDS. See the attached MSDSs for brushing grade creosote, coal tar, and other polycyclic aromatic hydrocarbons located in Exhibit D for additional information on hazards and control measures to follow.
Ozone (Treatment Chemical)	Powerful oxidizing agent. Highly chemically reactive and extremely shock sensitive as a liquid or solid. Inhalation produces various degrees of respiratory effects from irritation to pulmonary edema as well as affecting the eyes, blood, and CNS. Ozone accelerates decomposition of rubber and reacts with non-saturated organic compounds to produce ozonides which are unstable and may decompose with explosive violence. Not readily water soluble so inhalation of gas will irritate the bronchioles and alveoli of the lungs. Inhalation can cause nose, throat, and respiratory tract irritation, cough, difficulty breathing, visual disturbances, watering eyes, headache, decreased pulse rate with a fall in blood pressure, incoordination, chest pain, substernal soreness, and fatigue. Acute inhalation exposure has resulted in reproductive effects, blood changes and chromosomal changes. Inhalation of around 2 ppm caused watering eyes, decreased pulse rate, drop in blood pressure and coughing. Exposure to 1 ppm has resulted in coughing and difficulty breathing. (see attached MSDS). Repeated exposure may cause breathing disorders though respiratory tract scarring or premature aging. OSHA PEL is 0.1 ppm; IDLH is 10 ppm. NIOSH and ACGIH recommend a ceiling concentration of 0.1 ppm. Odor threshold ranges between 0.0076 and 0.25 ppm. A bluish gas with a pungent, bleach-like odor. See attached MSDS in Exhibit D for additional hazards information and special protection data and special precautions to follow.

Table 4. Fluor Daniel GTI Health and Safety Training Programs

Training Program	Requirement/Action
■ Specific training program requirements are described in Fluor Daniel GTI's Health and Safety Procedure Manual, Policy and Procedure #8, "Safety Training." ■ Training requirements and programs comply with the OSHA Hazardous Waste Operations and Emergency Response standard, 29 CFR 1910.120.	■ Field personnel must complete a minimum of 40 hours of hazardous waste activity instruction. ■ Field personnel must complete a minimum of 3 days supervised field instruction. ■ Field personnel assigned to the site will also receive 8 hours of refresher training each year. ■ On-site managers and supervisors directly responsible for employees engaged in hazardous waste operations receive an additional 8 hours of supervisory training. ■ Field personnel assigned to site also receive first aid/Cardio-pulmonary resuscitation (CPR) and blood borne pathogen training. ■ Field personnel and subcontractors assigned to site must participate in "Daily Safety Tailgate Meeting" and document their attendance.
■ Regulatory compliance training for excavation/trenching operations meet requirements outlined in 29 CFR 1926, Subpart P.	■ On-site managers and supervisors directly responsible for employees engaged in excavation/trenching operations receive the Fluor Daniel GTI 4-hour " Regulatory Compliance Training Seminar."
■ Authorized supervisor, attendant, and entrant training for permit required confined space entry meet requirements outlined in 29 CFR 1910.146.	■ Field personnel assigned to site who must supervise, watch over and/or enter permit required confined spaces receive the Fluor Daniel GTI 8-hour (or equivalent) "Confined Space Entry" course.
■ Fall protection training that meets requirements in 29 CFR 1926.503	■ Field personnel assigned to site who must work in areas with fall hazards six feet or greater must receive the Fluor Daniel GTI 2-hour "Fall Protection" course.
■ Fluor Daniel GTI requirement for removing underground storage tanks (UST).	■ Field personnel assigned to site who are tasked with the assessment and removal of USTs must complete the 4-hour Fluor Daniel GTI "Underground Storage Tank Removal" course.

Training Program	Requirement/Action
■ Orientation of plant operations, hazards, safe work practices, and emergency procedures to follow that meets the requirements of the OSHA Process Safety Standard, 29 CFR 1910.119.	■ Project personnel who are on the project site that falls under the Process Safety Standard will receive orientation by a company representative.

2.0 HAZARD IDENTIFICATION AND CONTROL

Based upon the hazard analysis of the tasks that will be conducted for the project, Table 5 lists the general procedures and practices to follow to prevent injury or illness. Appropriate training for specific hazards must be completed by field personnel prior to initiating work activities. Precautions must be taken to prevent injuries and exposures to the following potential hazards. For additional information, refer to the Fluor Daniel Health and Safety Policies and Procedures, or consult with your health and safety professional.

Table 5. Potential Hazards and Control

Potential Hazard	Control
Exposure to Chemical Products (See Exhibit D: MSDS Definitions and MSDSs)	1. Stand up-wind of chemical products whenever possible. 2. Minimize direct contact and contact time with contaminated media to prevent exposure. 3. Avoid walking through discolored areas, puddles, leaning on drums, or contacting anything that is likely to be contaminated, unless wearing the appropriate PPE. 4. Do not eat, drink, smoke and/or apply cosmetics in the hot or warm zones. 5. Wear appropriate PPE when it is required to come in contact with contaminated media or surfaces. 6. Level D PPE must be worn as a minimum when on project site. 7. > 2 parts per million (ppm) organic vapors, sustained for 5 minutes, in breathing zone requires monitoring for benzene using colorimetric indicator tubes; Benzene concentrations above 0.5 ppm requires an upgrade to Level C. 8. 20 ppm to 100 ppm organic vapors, sustained for 5 minutes, in breathing zone requires upgrade from Level D to Level C. 9. > 100 ppm organic vapors, or If unknown materials are encountered, call the HSR.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Exposure to OSHA Defined Hazardous Materials (See Exhibit D: MSDS Definitions and MSDSs)	1. All chemicals brought on-site by Fluor Daniel GTI personnel or their subcontractors, such as pipe glues, solvents, reagents, decontamination solutions, or any other OSHA defined hazardous material must be adequately labeled and the MSDSs available on-site. 2. MSDSs brought on-site can be attached in Appendix D or in the MSDS binder that is kept in the company vehicle. 3. Training on OSHA defined hazardous materials must be completed and documented. Use the Daily Safety Tailgate Meeting Form in Exhibit M to record training attendance.
Erecting Temporary Structure or Working From Aerial Lift	1. Wear leather gloves while attaching support members to protect against pinching injuries. 2. While working from elevated levels greater than 6 feet, ensure that all employees have 100% fall protection with full body harnesses and guardrails. 3. Do not stand under loads that are being raised or lowered with cranes or aerial lifts. 4. Conduct pre-operational inspection of aerial lifts to include: tire air pressure, hydraulic fuel level and pressure check, make sure pivot pins are secured, check hoses for worn areas, check for cracks or deviations in welded parts, the safety limit switch should work freely, security of the guardrail system on the platform, check both ground and platform control functions, raise and lower each boom system separately, listen for any unusual noises, vibrations, or uneven operations. 5. Maintain a safe distance of 20 feet from unguarded overhead power lines. 6. Conduct site evaluation to determine proper positioning for the unit. Make sure surface is level. Cordon off holes, drop-offs, bumps or weak ground surfaces. 7. Never climb a raised platform or stand on the mid-rail or top-rail. 8. Tools should always be hung or put into a belt whenever possible.
Exposure to Surface/ Subsurface Airborne Dust in the Work Zone	1. Stand up-wind whenever intrusive activities occur and generate visible signs of airborne dust. 2. Monitor air for airborne soil dust (surface or subsurface soil) with portable aerosol dust-direct reading instrument. 3. >0.15 mg/M^3 above background in the breathing zone, sustained for 5 minutes, requires upgrade to Level C and use of dust suppression. 4. > 50 mg/M^3 in breathing zone requires upgrade to Level B. Approval for Level B must first be approved by HSR. 5. Utilize wet methods (spraying ground, wet drilling, etc.) when visible signs of airborne dust are generated. Reference NYSDEC TAGM-4031.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Exposure to OSHA Defined Hazardous Materials (See Exhibit D: MSDS Definitions and MSDSs)	1. All chemicals brought on-site by Fluor Daniel GTI personnel or their subcontractors, such as pipe glues, solvents, reagents, decontamination solutions, or any other OSHA defined hazardous material must be adequately labeled and the MSDSs available on-site. 2. MSDSs brought on-site can be attached in Appendix D or in the MSDS binder that is kept in the company vehicle. 3. Training on OSHA defined hazardous materials must be completed and documented. Use the Daily Safety Tailgate Meeting Form in Exhibit M to record training attendance.
Erecting Temporary Structure or Working From Aerial Lift	1. Wear leather gloves while attaching support members to protect against pinching injuries. 2. While working from elevated levels greater than 6 feet, ensure that all employees have 100% fall protection with full body harnesses and guardrails. 3. Do not stand under loads that are being raised or lowered with cranes or aerial lifts. 4. Conduct pre-operational inspection of aerial lifts to include: tire air pressure, hydraulic fuel level and pressure check, make sure pivot pins are secured, check hoses for worn areas, check for cracks or deviations in welded parts, the safety limit switch should work freely, security of the guardrail system on the platform, check both ground and platform control functions, raise and lower each boom system separately, listen for any unusual noises, vibrations, or uneven operations. 5. Maintain a safe distance of 20 feet from unguarded overhead power lines. 6. Conduct site evaluation to determine proper positioning for the unit. Make sure surface is level. Cordon off holes, drop-offs, bumps or weak ground surfaces. 7. Never climb a raised platform or stand on the mid-rail or top-rail. 8. Tools should always be hung or put into a belt whenever possible.
Exposure to Surface/ Subsurface Airborne Dust in the Work Zone	1. Stand up-wind whenever intrusive activities occur and generate visible signs of airborne dust. 2. Monitor air for airborne soil dust (surface or subsurface soil) with portable aerosol dust-direct reading instrument. 3. >0.15 mg/M^3 above background in the breathing zone, sustained for 5 minutes, requires upgrade to Level C and use of dust suppression. 4. > 50 mg/M^3 in breathing zone requires upgrade to Level B. Approval for Level B must first be approved by HSR. 5. Utilize wet methods (spraying ground, wet drilling, etc.) when visible signs of airborne dust are generated. Reference NYSDEC TAGM-4031.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Vehicular Traffic	1. Wear traffic safety vest when vehicle hazard exists. 2. Use cones, flags, barricades, and caution tape to define work area. 3. Use vehicle to block work area. 4. Engage police detail for high-traffic situations. 5. Refer to section 5.3 for specific details and guidance.
Fall Protection	1. Assess the work to determine if there is a potential for falling. 2. Make a determination of the distance of the potential fall. 3. A fall protection system must be used for potential falls greater than 6 feet. 4. Consult a competent person, such as the HSR, regarding the applicability requiring fall protection and what type of protection systems should be used. 5. Inspect all fall protection equipment and anchoring points prior to their use. 6. Ensure Fall Protection training for applicable employees is completed prior to initiating work activities.
CSE (Note: not anticipated for this work. However, these control measures must be used should confined space entry situations develop)	1. Ensure personnel assigned meet CSE training requirements. 2. Complete CSE Hazard Analysis Form in Exhibit G. 3. Complete CSE permit. Post sign. 4. Ensure pre-entry CSE safety meeting is conducted. 5. Remove vault cover using proper lifting techniques. 6. Promote natural ventilation by opening the space to fresh air, if needed utilize mechanical purge ventilation. 7. Conduct remote air monitoring prior to entry. 8. Attendant can act as CSE Supervisor and must be present at CSE entry point all times when entrant is in CSE. 9. Access work for fall hazards and ensure provisions for non-entry rescue have been met. 10. Enter only when safe; conduct continuous air monitoring.
Installation and Operation of Soil Vapor Extraction (SVE) System	1. Competent person must be present during excavation/trenching activities; follow procedures in Exhibit F. 2. SVE effluent pipe and galvanized steel SVE pipes from thermal SVE wells are "HOT" and must be labeled to prevent skin burns. 3. LO/TO points must be identified for blower motors and specific LO/TO procedures followed as listed in Exhibit C. 4. Monitor for benzene, phenol and ozone using colorimetric indicator tubes (low level) when possibility of exposure occurs such as during emission monitoring activities or system maintenance. Follow air monitoring schedule and action levels in Table 7 of this HASP.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Upgrade, Operation, and Maintenance of High Vacuum Dual Phase Extraction (HVDPE) System	1. Competent person must be present during excavation/trenching activities. Follow procedures in Exhibit F. 2. Fall protection equipment (harness and lifeline) must be used during construction of remediation shed which will requires work above 6 feet in height. 3. LOTO points must be identified for vacuum motors and specific LOTO procedures followed as listed in Exhibit G. 4. Monitor for aromatic and chlorinated organic compounds with a photoiionization detector (PID) (10.2 and 11.7 eV lamp, respectively)/flame ionization detector (FID) when possibility of exposure occurs such as during emission monitoring or system maintenance activities. Follow air monitoring schedule and action levels listed in Table 7. 5. Conduct noise monitoring during HVDPE operation to determine hearing conservation program requirements. 6. Ensure product recovery vessels are labeled for hazard communication requirements..
Inclement Weather	1. Stop outdoor work during electrical storms and other extreme weather conditions such as extreme heat or cold temperatures. 2. Take cover indoors or in vehicle. 3. Listen to local forecasts for warnings about specific weather hazards such as tornados, hurricanes, and flash floods.
Utility Lines Contact	1. Contact Dig Safe to have utility lines marked prior to excavation/trenching 2. Refer to site drawings or customer interviews if on private property for utility locations. 3. Hand dig 3 to 5 feet down to avoid breaking utility lines. 4. Refer to Exhibit F for Underground Utility Contact Prevention Management Plan.
Noise	1. Wear hearing protection when equipment such as a drill rig, jackhammer, cut saw, air compressor, blower or other heavy equipment is operating on the site. 2. Wear hearing protection whenever you need to raise your voice above normal conversational speech due to a loud noise source; this much noise indicates the need for protection. 3. Hearing protection is required when measured sound pressure levels (SPL) exceed 85 dB(A) where employees stand or conduct work. 4. Conduct noise monitoring of suspected high noise operations at the beginning of the workday or start up of new operations to verify noise control/hearing protection requirements. 5. Refer to Section 3.2, Noise Monitoring for guidance.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Electric Shock	1. Maintain appropriate distance from overhead utilities; **20-foot minimum clearance from power lines required; 10-foot minimum clearance from shielded power lines.** 2. Use ground-fault circuit interrupters as required. 3. Perform LO/TO procedures (Exhibit C). 4. Use three-pronged plugs and extension cords. 5. Contact your local underground utility-locating service. 6. Follow code requirements for electrical installations in hazardous locations.
Physical Injury	1. Wear hard hats and safety glasses when on-site. 2. Maintain visual contact with the equipment operator and wear orange safety vest when heavy equipment is used on-site. 3. Avoid loose-fitting clothing (driller and driller's helper). 4. Prevent slips, trips, and falls; keep work area uncluttered. 5. Keep your hands away from moving parts (i.e., augers). 6. Test the emergency shut-off switch on the drill rig daily.
Back Injury	1. Use a mechanical lifting device or a lifting aid where appropriate. 2. If you must lift, plan the lift before doing it. 3. Check your route for clearance. 4. Bend at the knees and use leg muscles when lifting. 5. Use the buddy system when lifting heavy or awkward objects. 6. Do not twist or jerk your body while lifting.
Heat Stress	1. Increase water intake while working. 2. Minimize and/or avoid alcohol intake the night before working in heat stress situations. 3. Increase number of rest breaks and/or rotate workers in shorter work shifts; take breaks in shaded areas. 4. Watch for signs and symptoms of heat exhaustion and fatigue. 5. Plan work for early morning or evening during hot months. 6. Use ice vests when necessary. 7. Rest in cool, dry areas. 8. In the event of heat stroke, bring the victim to a cool environment and initiate first aid procedures. Refer to Appendix I.
Cold Stress (For winter operations)	1. Take breaks in heated shelters when working in extremely cold temperatures. 2. Remove the outer layer of clothing and loosen other layers to promote evaporation of perspiration, upon entering the shelter. 3 Be aware of cold stress symptoms such as shivering, numbness in the extremities, and sluggishness. 4. Drink warm liquids to reduce the susceptibility to cold stress. Refer to Appendix I.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
High Crime Areas	1. Be aware of surroundings. 2. Use the buddy system. 3. Request police detail when appropriate.
Insects	1. Tuck pants into socks. 2. Wear long sleeves. 3. Use insect repellent. 4. Avoid contact by always looking ahead to where walking, standing, sitting, leaning, grabbing, lifting or reaching-in-to. 5. Check for signs of insect/spider bites, such as redness, swelling, and flu-like symptoms. 6. Use buddy system to check each other for signs of insect/spider bites. 7. Remove ticks immediately with fine tipped tweezers by grasping the tick as close to your skin as possible and gently pulling straight out. Do not squeeze the tick's body as this may inject fluids into you. Wash the bite area of skin and apply antiseptic.
Poisonous Plants (Such as Poison Ivy, Oak or Sumac)	1. Don't enter areas infested with poisonous plants. 2. Immediately wash any areas that come into contact with poisonous plants. 3. Protect exposed skin area with gloves and Tyvek® suits. 4. Be aware that the oil from the plant can be carried on boots, clothes and equipment. Always protect skin from contact. 5. If you have known or suspected allergies, carry an Epi-Pen at all times and notify co-workers that you are allergic.
Poisonous Snakes (If in areas of known habitat)	1. Avoid walking in areas where snake may nest or hide. Always look ahead to where walking for signs of snakes. 2. Use extreme caution when moving or lifting objects which could be used by snakes as cover. 3. Never reach under or behind objects or into other areas where snakes may hide. 4. Wear sturdy leather boots.
Ladders	1. Assess work areas for fall hazards. 2. Make sure ladder rungs are sturdy and free of cracks. 3. Use ladders with secure safety feet. 4. Pitch ladders at a 4:1 ratio. 5. Secure ladder at the top or have another person at the bottom to help stabilize it. 6. Do not use ladders for access to air stripper towers. 7. Use non-conductive ladders near electrical wires.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Fire Control	1. Smoke only in designated areas. 2. Keep flammable liquids in closed containers. 3. Keep site clean; avoid accumulating combustible debris such as paper. 4. Follow Hot Work Safety Procedures when welding or performing other activities requiring an open flame. 5. Isolate flammable and combustible materials from ignition sources. 6. Ensure fire safety integrity of equipment installations.
Static Electricity	1. Do not create static discharge in flammable atmospheres. 2. Electrically bond and ground pumps transfer vessels, tanks, drums, bailers and probes, when moving liquids. 3. Electrically bond and ground vacuum trucks and the tanks they are emptying. 4. Do not splash fill containers with flammable liquids.
Rapid Response	1. Ensure emergency response activities have been completed prior to beginning rapid response field activities. 2. Conduct hazard assessment of project site and communicate findings through a "Daily Tailgate Safety Meeting" to all Fluor Daniel GTI employees and subcontractors prior to beginning rapid response field activities. 3. Communicate applicable Fluor Daniel GTI health and safety programs to other contractors on site that may be impacted and coordinate field activities with them.
Welding, Cutting, Brazing	1. Conduct fire safety evaluation. 2. Complete Hot Work Permit (Exhibit H). 3. Ensure flammable materials are protected from hot work, sources of ignition. 4. Ensure fire watch/fire extinguisher is on standby by hot work location.
Cleaning Equipment	1. Wear appropriate PPE to avoid skin and eye contact with isopropyl alcohol, alconox, or other cleaning materials. 2. Stand upwind to minimize any potential inhalation exposure. 3. Dispose of spent cleaning solutions and rinses accordingly.
Installation and Operation of Ozone Sparge System	1. Competent person must be persent during excavation/trenching actities. Follow procedures in Exhibit F. 2. Use hot work permit and procedures in Exhibit H when welding, cutting or torching. 3. Ensure ozone delivery piping system has been leak tested with helium prior to generationg ozone. 4. Conduct real time air monitoring for ozone during activites where employees are in close proximity to ozone generator or discharge points. Follow air monitoring guidelines and action levels in Table 7. 5. Review job safety analysis (JSA) listed in Exhibit J.

Potential Hazard	Control
	First aid kit, blood borne pathogen kit, emergency eye wash/shower station, fire extinguisher and absorbent pads will be located on-site, either in the decontamination zone, or in the Fluor Daniel GTI company vehicle.

3.0 AIR MONITORING AND NOISE MONITORING

3.1 Air Monitoring

Air monitoring must be performed on all sites in accordance with Fluor Daniel GTI practices. Organic vapor and/or concentrations are monitored in the field with a FID or PID with an 10.2 eV or 11.7 eV lamp. Flammable vapor and/or gas are monitored with an oxygen/combustimeter (O_2/LEL) real-time instrument. Airborne dust/particulate concentrations are measured with a real-time aerosol monitor (using a scattered light photometric sensing cell) when there are visible signs of airborne dust. Specific real-time air monitors, or colorimetric indicator tubes can be used for ozone and carbon monoxide monitoring during O_3 sparging or checking levels of excessive combustion engine exhaust, if a problem. Detector tube grab sampling is conducted for benzene and ozone, when results of non-specific real-time monitor action levels are reached or when their presence is suspected. Note that ozone has a relatively low odor threshold value (good warning properties). Both area and personal air monitoring readings are to be taken to characterize site activities. Air monitoring results must be documented on the Air Monitoring Form (Exhibit E).

ATTENTION:

SITE PERSONNEL ASSIGNED RESPONSIBILITY TO CONDUCT AIR MONITORING MUST HAVE BEEN TRAINED IN AIR MONITORING EQUIPMENT OPERATION AND CALIBRATION PRIOR TO ITS USE.

Calibration and maintenance of air monitoring equipment must follow manufacture specifications and be documented. Recalibration and adjustment of air monitoring equipment must be completed when site conditions and equipment operation reveal the need. Record all air monitoring equipment calibration and adjustment information on form in Exhibit E.

Air monitoring action levels (Table 7) have been developed by the Fluor Daniel GTI HSM, to indicate the chemical concentrations in the breathing zone that require an upgrade in level of PPE. Action levels are typically set at either one-half the OSHA Permissible Exposure Limit (PEL), National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limits (REL), or the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV). Rationale for establishing action levels is based upon the data available that characterizes contaminants of concern in soil or water. Calculation for estimating action levels is then completed using the principles of Henry's Law (volatiles in water), fugacity (volatiles in soil), and proportionality

(particulates in soil). When analytical data is not available, a qualitative assessment is conducted based on knowing the contaminants of concern and then setting action levels based on the compound(s) with the lowest OSHA PEL, NIOSH REL or ACGIH TLV, and following an air monitoring schedule that will minimize any potential for over exposure.

All workers on-site must have been properly fitted with PPE (i.e., respirators) and have been trained in their use (i.e., donning and doffing). Air monitoring measurements will be taken in the breathing zone of the worker most likely to have the highest exposure. Transient peaks will not automatically trigger action. Action will be taken when levels are consistently exceeded in a 5-minute period. Similarly, if chemical odors are detected that are a nuisance, bothersome, or irritating, an upgrade in respiratory protection can provide an extra level of comfort or protection when conducting site activities. Guidelines for frequency of air monitoring are presented in Table 6. Job tasks that require air monitoring, the applicable action levels that apply for those tasks, and the frequency of air monitoring are described in Table 6 and Table 7 respectively.

Engineering controls such as the venturi air mover (supplied by compressed air) to exhaust or dilute solvent vapors emanating from monitoring wells or when conducting intrusive activities can be utilized as a means to downgrade PPE requirements (Level B to C, Level C to D).

Table 6. Air Monitoring Frequency Guidelines

Conduct periodic monitoring when:

1. It is possible that an immediately dangerous to life or health (IDLH) condition or a flammable atmosphere has developed, or

2. There is an indication that exposures may have risen over established action levels, permissible exposure limits or published exposure levels since the last monitoring. Look for a possible rise in exposures associated with these situations:

   - **Change in site area** - work begins on a different section of the site.
   - **Change in contaminants** - handling contaminants other than those first identified.
   - **Visible signs of particulate exposure from intrusive activities such as drilling/boring and excavation.**
   - **Perceptible chemical odors or symptoms of exposure.**
   - Change in on-site activity - one operation ends and another begins.
   - Handling leaking drums or containers.
   - Working with obvious liquid contamination (e.g., a spill or lagoon).

Conduct air monitoring when the possibility of volatilization exists (such as with a new monitoring well or a well containing known product).

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Table 7. Air Monitoring Action Levels

Instrument*	Function	Measurement	Action
FID or PID (10.2/11.7eV lamp) - Measures Total Organic Vapors			
	Conduct air monitoring for volatile organic compounds during activities where impacted media are present.	0 - 2 ppm	Level D/Modified Level D required. Check for benzene with detector tubes.
		>2 - 50 ppm	Upgrade to Level C.
		>50 - 1,000 ppm	Upgrade to Level B. Coordinate with PM and HSR for guidance.
		>1,000 ppm	Stop work required. Leave work area, contact PM and HSR for guidance.
Benzene Detector Tubes			
	Conduct grab sampling for benzene when sustained PID/FID readings are detected in the breathing zone.	0 - 0.5 ppm	Level D/Modified Level D required.
		>0.5 - 50 ppm	Upgrade to Level C required.
		>50 - 1,000 ppm	Upgrade to Level B required.
		>1,000 ppm	Stop work required. Contact PM and HSR for guidance.
Ozone Real-Time Monitor/Detector Tubes			
	Conduct air monitoring when performing O & M on remediation equipment, or whenever exposure to ozone is suspected. Upgrade will be required whenever readings are sustained for > 5 minutes in breathing zone.	0 - 0.05 ppm	Level D/Modified Level D required
		>0.05 to 5 ppm	Upgrade to Level C required.
		>5.0 ppm	Upgrade to Level B required with approval from HSR.
Dust/Particulate Monitor			
	Conduct air monitoring for dust particulate when sustained (> 5 minute) levels of visible dust are generated and engineering controls such as wet methods are ineffective.	0 - 0.15 mg/M^3	Level D/Modified Level D required.
		>0.15 - 50 mg/M^3	Upgrade to Level C. Use dust supression measures to mitigate. If levels remain above 0.15 mg/M3 stop work until levels drop below 0.15 mg/M3. Follow guidance in NYSDEC TAGM # 4031," Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites."

Table 7. Air Monitoring Action Levels (continued)

Instrument*	Function	Measurement	Action
Oxygen/Combustimeter (O_2/LEL) Measures oxygen level (O_2) and lower explosive limit (LEL)			
Conduct air monitoring for O_2/LEL when conditions exist where flammable vapors/gases and/or oxygen deficiency or enrichment can occur. A decreased O_2 reading of 0.1% (e.g., 20.9% to 20.8%) actually represents a change in the total air envelope of approximately 0.5% or 5,000 ppm. This represents little hazard if the displacing gas is inert; if the displacing gas is toxic/flammable/reactive, such a concentration represents a real hazard. Verify reasons for O_2 depletion by conducting air monitoring with instruments that can measure suspected contaminants (PID/FID) or that can confirm presence of contaminants (detector tubes or chemical specific real-time air monitors).		O_2 = 20.9 %	Acceptable
		O_2 >19.5 - 20.8%	Verify reasons for O_2 depletion with appropriate air monitoring instrumentation before work continues. Utilize appropriate engineering controls/PPE once atmospheric contaminants have been verified.
		O_2 >20.9 % - 22 %	Verify reasons for O_2 enrichment before entering area. Utilize appropriate engineering controls/PPE to control O_2 enriched atmosphere.
		O_2 >22 %	Leave area immediately; this atmosphere is extremely flammable. Notify PM or HSR for guidance.
		O_2 <19.5%	Leave area immediately; this atmosphere is oxygen deficient. Verify reasons for O_2 depletion with appropriate air monitoring instrumentation before work continues. Utilize appropriate engineering controls/PPE once atmospheric contaminants have been verified.
		LEL <10%	Acceptable conditions. Continue normal activity.
		LEL >10%	Leave area immediately. Contact PM or HSR for guidance on venting and other safety measures.
*Note: Instruments must be calibrated according to manufacturer's recommendations.			

Table 8. Hazard Summary

AIR MONITORING SUMMARY			
Job Task	Level PPE	Instrument	Frequency
Excavation and trenching activities	Modified Level D (See Table 11)	PID[1] or FID[2], O_2/LEL[3], DT[4], DM[5]	Start up of work, then 30 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded. May be reduced to once per hour based on previous data collected.
Installation of remediation systems	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT, DM	For below ground installations: Start up of work, then 30 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded. For above ground installations: Start up of work only; however, if work activities expose workers to chemicals, monitor every 30 minutes or more frequently, if action level is exceeded. May be reduced to once per hour based on previous data collected.
Perform O&M and LOTO	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT	Start up of work, then 30 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded. May be reduced to once per hour based on previous data collected.
Air sparging	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT	Start up of work, then 30 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded. May be reduced to once per hour based on previous data collected.
Gauging wells	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT	Start up of work. Continuously if action level is exceeded. May be reduced to once per hour based on previous data collected.
Sampling wells, soils	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT, DM	Start up of work. Continuously if action level is exceeded. May be reduced to once per hour based on previous data collected.
Abandon wells	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT, DM	Start up of work, then 15 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded.

[1] PID, Photoionization Detector
[2] FID, Flame Ionization Detector
[3] O_2/LEL, Oxygen Level and Combustible Gas Meter
[4] DT, Benzene Detector Tube
[5] DM, Dust/ Particulate Monitor

Note: "Start up of work at each new task location" means to monitor the air quality at each new operation on the site. The breathing zone is the area inside a 1-foot radius around the head.

3.2 Noise Monitoring

Noise monitoring must be performed in accordance with Fluor Daniel GTI practices. Noise levels are monitored in the field with either a Type I or Type II Sound Level Meter (SLM). Noise dosemeter readings can also be obtained to determine the percent (%) noise dose. Noise levels and % dose measured are then compared to limits listed in OSHA standard 29 CFR 1910.95, Hearing Conservation.

Action levels listed in Table 9 will trigger upgrade in PPE to include appropriate hearing protectors (muffs or plugs) or initiate possible noise control engineering. Noise monitoring equipment must be calibrated prior to use each shift and checked at the end of the shift to determine accuracy. Noise readings must be recorded on data form in Exhibit E, Noise Monitoring Form.

Selection of hearing protection must match the employees needs and the ability to attenuate noise below 90 dB(A). Each hearing protection device (muff or plugs) has a Noise Reduction Rating (NRR) assigned by the U.S. Environmental Protection Agency (EPA). To calculate the hearing protector's effectiveness use the following formula:

$$\text{Noise Reading dB(A)} - (\text{NRR} - 7\text{dB}) < 90 \text{ dB(A)}$$

Table 9. Noise Monitoring

Instrument	Measurement	Action
Type I or Type II SLM - Calibrate Before Use		
	>80 dB(A) - 85 dB(A)	Hearing protection recommended. Limit work duration to 8-hour shifts.
	>85 dB(A) - 90 dB(A)	Hearing protection required. Limit work duration to 8-hour shifts.
	>90 dB(A) - 115 dB(A)	Hearing protection required. Investigate use of engineering controls. Limit work duration to 8-hour shifts.
	> 115 dB(A)	Stop work. Contact HSR and PM.

4.0 CSE PROCEDURES

Although not currently anticipated, in the event site work may require personnel to enter confined spaces, **No Fluor Daniel GTI employee or subcontractor shall enter an area identified as a confined space without using the CSE procedures described in Exhibit G and the site-specific entry procedures presented in this Exhibit**. The purpose of the CSE procedure is to protect

employees from potentially hazardous environments and to facilitate immediate rescue in an emergency situation. A CSE Permit must be posted at the entrance to each confined space. Permit required confined spaces identified for this project may include vaults associated with remediation systems at this site.

5.0 CHEMICAL HAZARD CONTROL

5.1 Chemical Handling Procedures

Personnel must practice the chemical-specific handling procedures outlined below.

Table 10. Chemical Handling Procedures

Chemical	Description	Procedures
Acids and Bases Acids: including hydrochloric, nitric, and sulfuric acids Bases: including sodium hydroxide	Extremely corrosive materials with a variety of uses.	■ Wear gloves and eye-splash protection while using acid dispensed from a small dropper bottle during water sampling. ■ Wear a full-face, air-purifying respirator equipped with combination cartridges (organic vapor/acid gas) as well as Tyvek® coveralls and nitrile and/or nitrile butyl rubber (NBR) gloves for large volume applications. ■ Have an eye wash bottle or portable eye wash station on-site. ■ Cap all drums after dispensing chemicals. ■ Do not add anything into a virgin chemical drum, including unused product. ■ Avoid mixing strong acids and bases. Consult HSR for task-specific evaluation. If mixing is absolutely necessary, do it slowly. Avoid vapors or fumes that are generated. ■ When diluting acids, add the acid to water in small quantities and mix cautiously. ■ When diluting bases, add water to the base in small quantities and mix cautiously.
Activated Carbon	Granular adsorbent medium used to remove residual hydrocarbons from water and/or air.	■ Use respiratory protection when activated carbon creates a dusty environment. ■ Avoid using Activated Carbon Filter Beds for Ketone Solvents - an exothermic reaction can develop over time and result in possible explosion. ■ Contact HSR for task-specific evaluation.

5.2 PPE

Based upon the hazards that may be encountered during site activities, PPE as follows was selected. Only PPE that meets the following American National Standards Institute (ANSI) standards are to be worn.

- Eye protection - ANSI Z87.1-1989
- Head protection - ANSI Z89.1-1986
- Foot protection - ANSI Z41-1991

Employees must maintain proficiency in the use and care of PPE that is to be worn. Typically this is covered during formal and informal refresher training sessions presented by Fluor Daniel GTI.

Level D is the minimum acceptable level of protection for this project site. Upgrade to Modified Level D occurs when the possibility of contact to the skin or work uniform can occur from contaminated media. Upgrade to Level C will occur when results of air monitoring reveals action levels have been exceeded. Upgrade to Level B occurs when results of air monitoring reveals action levels have been exceeded, and site personnel meet training requirements. Wear hearing protection when in areas where high noise levels are generated.

Table 11. PPE

Level	Requirements
Level D	■ Work uniform ■ Steel-toed boots ■ Approved safety glasses or goggles ■ Hard hat ■ Fluorescent vest, when vehicular traffic is on or adjacent to the site ■ Nitrile gloves for water sampling handling
Modified Level D	**One or more of the following:** ■ Chemical resistance (acid or solvent) boot covers ■ PE-coated Tyvek® suit, NBR outer and nitrile inner gloves if skin contact with contaminants is possible. ■ Hearing protection (muffs and/or plugs).
Level C	■ Level D and Modified Level D ■ Cooling vests and thermal protection, if needed ■ NIOSH/MSHA-approved full-face respirator with organic vapor/acid gas high efficiency particulate air-purifying (HEPA) cartridges.
Level B	■ Level D and Modified Level D ■ Cooling vests, and thermal protection, if needed ■ NIOSH/MSHA approved full face positive pressure demand supplied air respirator, either airline or self contained.
Prior to use, all equipment must be inspected to ensure proper working condition.	

5.3 Site Control: Work Zones

Work zones will be established in order to:

- Delineate high-traffic locations,
- Identify hazardous locations, and
- Contain contamination within the smallest area possible.

Employees entering the work zone must wear the proper PPE for that area. Work and support zones will be established based on ambient air monitoring data, necessary security measures, and site-specific conditions. Work zones will be identified as either Hot Zone (HZ)/Exclusion Zone (EZ); Decontamination Zone (DZ)/Contamination Reduction Zone (CRZ); or Clean Zone (CZ)/Support Zone (SZ).

The following PPE requirements apply for Work Zones:

- HZs/EZs requires Level Modified Level D or Level C PPE
- DZs/CRZs require Modified Level D PPE
- SZs/CZs require Level D PPE

Specific work zones for this project have been identified and shown on the site map in Appendix I.

Listed are general guidelines for delineation of work zones. CRZs will be developed for decontamination procedures listed in Section 4.5.

1. The HZ/EZ is identified to contain areas where excavation is occurring that exposes workers to contaminated soils. A minimum ten-foot distance surrounding this area will be demarcated with cones, barricades and/or caution tape depending on location to employees, general public, and high traffic areas. The area inside the ozone remediation shed may also be considered a hot zone since workers may be exposed to substantial levels of ozone if leaks in the system occur. Monitoring should always be done in the HZ/EZ to determine employee exposure.

2. The DZ/CRZ will be a corridor connecting the HZ/EZ and the support zone and can include the back-end of the company pick-up truck. The DZ/CRZ will be demarcated at its boundaries with barricades, cones, and/or caution tape depending on location to employees, general public, and high traffic areas.

3. Support areas are all areas outside the hot zone or contamination reduction zones which do not pose chemical exposure potential to workers.

Table 12. Site Security and Work Zone Definition

WORKING IN STREET OR ROADWAY ■ Wear traffic vest and hardhat when vehicle hazard exists. ■ Use cones, flag-mounted cones, caution tape and/or barricades. ■ Use vehicle strobe light and block area with truck. ■ Develop traffic patternization plan for high traffic situations: • use flag person, • use flashing arrow sign, • use "MEN WORKING" signs liberally, • obtain lane closing permits, and • engage police details.
WORKING AT EXCAVATION/TRENCHING SITES ■ "Competent person" is required per OSHA 29 CFR 1926 Subpart P. ■ Safety guard open excavations by restricting unauthorized access. ■ Highlight work area using prominent warning signs (cones, saw horses/barricades and signage) placed a minimum of 10' back from excavation opening. ■ Maintain zone definition along perimeter with continuous string of yellow orange caution tape.
EXCAVATIONS LEFT UNATTENDED OR OVERNIGHT **Use one of the following methods to address these situations:** ■ Surround entire perimeter with plastic or cloth construction net fencing. Anchor fence to ground using steel posts driven into ground. Space out posts no greater than 8 feet apart. Fence height minimum 4-feet high. Fence material must be of a quality capable of withstanding a pressure of 200 pounds. Place fence a minimum of 10 feet back from excavation opening. ■ Place 8-foot long barricades affixed with flashing lights end to end with 4-foot high construction net fence attached to barricades. ■ Utilize temporary curbing or concrete "jersey" barriers affixed with flashing signal lights or other effective warning signs.

5.4 Decontamination Procedures

Operations conducted at this site have the potential to contaminate field equipment and PPE. To prevent the transfer of contamination to vehicles, administrative offices and personnel, the procedures presented in Table 13 must be followed. Specific decontamination requirements will be followed by utilizing the equipment for that purpose. Work uniforms and Level D PPE must not be brought to employee residences and left either on-site, at the office location, or in the company vehicle. Laundering of company uniforms must be by Fluor Daniel GTI approved laundering services and not done at employees residence.

Table 13. Decontamination Procedures

Item	Examples	Procedure
Field equipment	Bailers, interface probes, hand tools, drill augers, and miscellaneous sampling equipment	■ Decontaminate with a solution of detergent and water; rinse with water prior to leaving the site. ■ Protect from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.
Disposable PPE	Tyvek® suits, inner latex gloves, respirator cartridges	■ Dispose of according to the requirements of the client and state and federal agencies. ■ Change out respirator cartridges on a daily basis and dispose accordingly.
Nondisposable PPE	Respirators	■ Wipe out respirator with disinfecting pad prior to donning. ■ Decontaminate respirator on-site at the close of each day based upon extent of contamination. This procedure could include disassembling the respirator and cleaning, rinsing, sanitizing, and drying all parts with approved powders and solutions.
	Boots and gloves	■ Decontaminate outside with a solution of detergent and water; rinse with water prior to leaving the site. ■ Protect from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.

All water used in decontamination procedures should be stored in portable storage tanks until sufficient amount are stockpiled to facilitate disposal treatment. Disposable sampling and PPE will be place in plastic bags and temporarily stored in designated drums. These drums shall be disposed of according to regulatory guidelines, if necessary.

5.5 Example Decontamination Diagram

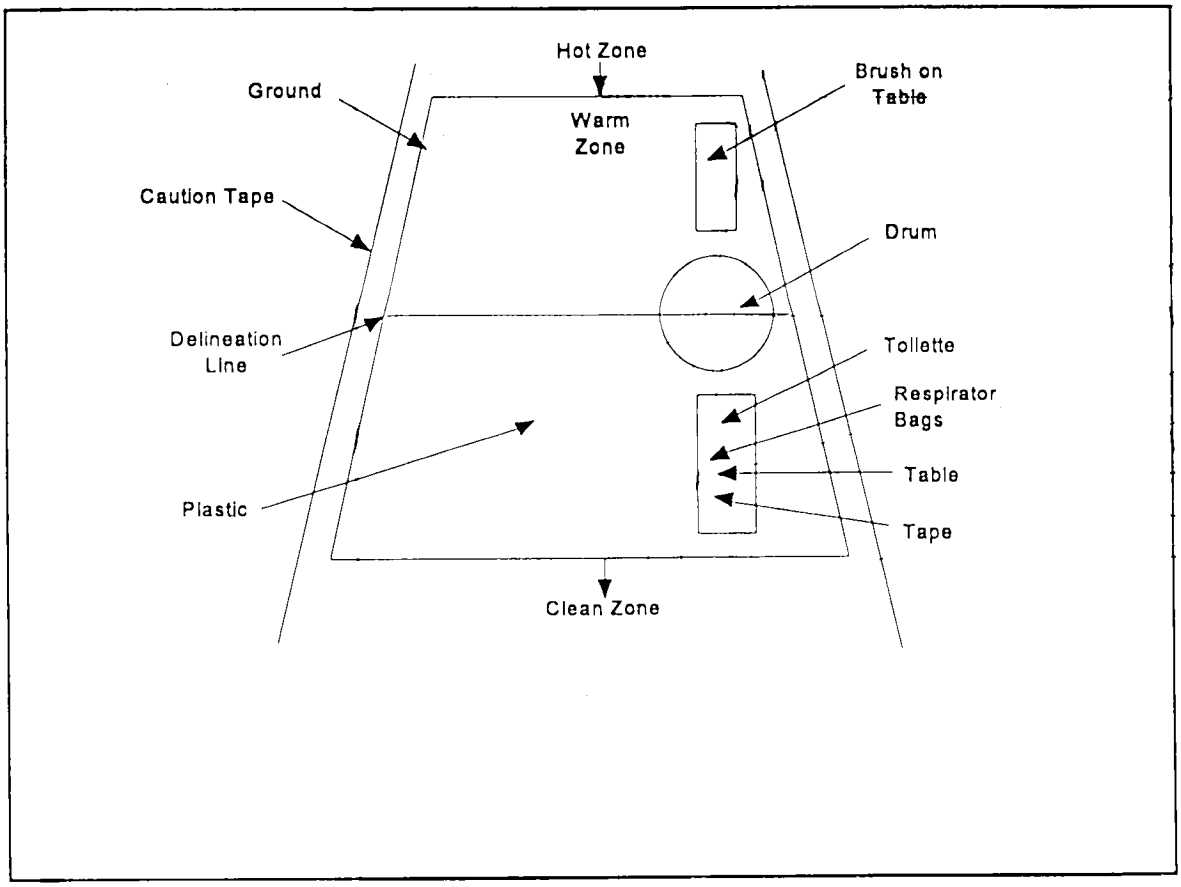
If Level C or Level B PPE is required, a CRZ will be constructed in a centralized common area with a travel path from the EZ demarcated with caution tape, or four-foot high cones. The decontamination procedure for this project site is a two stage process.

STAGE 1 ■ Gross contamination removal with a brush.

- Remove outer boots and dispose in a drum.
- Remove Tyvek® suit and dispose in a drum.
- Remove outer gloves and dispose in a drum.
- Walk to Stage 2.

STAGE 2

- Remove respirator.
- Remove cartridge and dispose in a drum.
- Clean respirator and insert into a bag.
- Remove inner gloves and dispose.
- Wipe hands with a toilette and dispose.
- Walk out of decontamination area.



6.0 CONTINGENCY PLANS

Table 14 presents contingency plans for potential emergency situations. Ensure that the information in the contingency plans have been clearly communicated to all project personnel and those within the vicinity that may be affected, such as plant personnel and other contractors on site.

Table 14. Contingency Plans for Site Emergencies

Situation	Action
Evacuation	1. Immediately notify all on-site personnel of an emergency requiring evacuation. 2. Leave the dangerous area and report to a designated rally point. 3. Notify emergency medical service (EMS), as appropriate. 4. Account for all personnel. 5. Contact the PM and the HSR as soon as possible. 6. Maintain site security and control measures for community safety until emergency responders arrive.
Medical Emergency	1. Survey the situation: **Do not enter an area that may jeopardize your safety.** ■ Establish the patient's level of consciousness. ■ Call for help. ■ Contact EMS and inform them of patient's condition. 2. Primary assessment (patient unconscious) ■ Arousal ■ Airway ■ Breathing ■ Circulation **Only trained personnel should perform CPR or First Aid - State you are medically trained** 3. Secondary assessment (patient conscious) ■ Check for bleeding: Control with direct pressure. ■ Do not move patient (unless location is not secure). ■ Monitor vital signs. ■ Provide First Aid to the level of your training. ■ Contact the PM and HSR as soon as possible. ■ Document the incident on Fluor Daniel GTI's PIR form.
Fire Emergency	1. **Evacuate the area.** 2. Notify the EMS. 3. Extinguish small fires with an all-purpose extinguisher. 4. Contact the PM and HSR. 5. Document the incident using the PIR form.

Situation	Action
Spill/ Release	Prevent problems by documenting the location of underground lines (e.g., product, sewer, telephone) before starting site work. If you drill through a line or tank or another leak occurs, document the spill/release in writing. Include dates, times, actions taken, agreements reached and names of people involved. In the event of a spill/release, follow this plan. 1. Wear appropriate PPE; stay upwind of the spill/release. 2. Turn off equipment and other sources of ignition. 3. Turn off pumps and shut valves to stop the flow/leak. 4. Plug the leak or collect drippings in a bucket, when possible. 5. Place sorbent pads to collect product, if possible. 6. Call Fire Department immediately if fire emergency develops. 7. Inform Fluor Daniel GTI PM about the situation. 8. Determine if the client wants to repair the damage of if the client will use an emergency repair contractor. 9. Based on agreements, contact emergency spill contractor for containment of free product. 10. Advise the client of spill discharge notification requirements and determine who will complete and submit forms. Do not submit or report to agencies without the client's consent. Document each interaction with the client and regulators and note, in writing; name, title authorizations, refusals, decisions, and commitments to actions. 11. Do not transport or approve transportation of contaminated soils or product until proper manifests have been completed and approve. Be aware that soils/product may meet criteria for hazardous waste. 12. Do not sign manifests as generator of wastes; contact the regional compliance manager to discuss waste transportation.
*Notifications - **a spill/release requires completion of a PIR and Class III notification.*** The PM must contact the client or generator. The generator is under obligation to report to the proper government agencies. If the spill extends into waterways, the Coast Guard and the National Response Center ([800] 424-8802) must be notified immediately by the client or with their permission.	

6.1 Field Communications

Communications at the work site can be accomplished by verbal and/or non-verbal means to ensure contact with all Fluor Daniel GTI and subcontractors. Verbal communication can be impacted by the on-site background noise and while wearing respiratory protection. Table 15 lists the type of communication methods and equipment to use, depending on site conditions. Communication equipment must be checked daily to ensure proper operation and all project personnel must be initially briefed on the communication methods prior to starting work and reviewed in Daily Safety Tailgate Meetings as a reminder.

Table 15. Field Communication Methods

COMMUNICATION DEVICE	TYPE OF COMMUNICATIONS	SIGNAL
Telephone On-Site or Cellular Telephone	Emergency notification	Initiate phone call using applicable emergency numbers
Two-Way Radio	Emergency notification among site personnel	Initiate radio communication with Code Red message
Compressed Air Horn	Hailing site personnel for non-emergency	One long blast, one short blast
Compressed Air Horn	Hailing site personnel for emergency evacuation	Three long continuous blasts
Visual	Hailing site personnel for distress, need help	Arms waved in circle overhead
Visual	Hailing site personnel for emergency evacuation	Arms waved in cris-cross over head
Visual	Contaminated air/strong odor	Hands clutching throat
Visual	Break, lunch, end of day	Two hands together, break apart

7.0 MEDICAL MONITORING PROGRAM

Fluor Daniel GTI, under the oversight of the company's consulting physician, has developed a medical monitoring program to track the physical conditions of it's employees on a routine basis; starting with a baseline assessment, then periodic follow-up (annual or biennial) or specific project requirements based upon site contaminants or as assessment tool to aid in determining possible exposure.

7.1 Medical/Technical Advisors

Elayne Theriault, MD
Fluor Daniel GTI, CONSULTING PHYSICIAN (800) 229-3674 x 326

John Reinemann, CIH
Fluor Daniel GTI, District Health & Safety Manager
Schenectady, NY (518) 783-1996

David Crowley, CSP, CET, CHMM
Fluor Daniel GTI, Corporate Health and Safety Director

FLUOR DANIEL GTI

Norwood, MA (781) 769-7600

The specific duties of the medical/technical advisors include:

- recommending a suitable medical monitoring program for the site workers by the occupational health physician in conjunction with consultation of the above listed personnel,
- providing interpretation of medical monitoring requirements and technical guidance for developing project specific medical monitoring requirements, and
- advising worker exposure potential along with appropriate hazard reduction methods.

Table 16. Medical Monitoring Program

Module	Hst. Phys. W/Dipstick UA, Vision, Vital Signs	Spiro	Audio	EKG	Chest X-Ray	Bio Chem W/Diff	Shipping Fee	Substance Abuse Screen	Random Substance Abuse	Tetanus Diphtheria
BASELINE										
Regular	•	•	•		•	•	•	NL/BP		(10Y)
Regular/DOT	•	•	•		•	•	•	N/BP		(10Y)
ANNUAL/PERIODIC										
Regular	•	•	•		5Y	•	•	NL/BP	RT/RBP	(10Y)
Regular/DOT	•	•	•		5Y	•	•	N/BP	RT/RN/RB	(10Y)
BIENNIAL										
Regular	•	•	•		5Y	•	•	NL/BP	RT/RBP	(10Y)

>40 years of age or for medial indications (pre-approved by EMR)
\# X-ray film sent to EMR for International Labor Organization (ILO) reading
1Y - 5Y Yearly frequency
( ) If not done within
TP Fluor Daniel GTI ten panel drug screen
BP Breath pipe
N National Institution of Drug Abuse (NIDA) drug screen
NL NIDA-like drug screen
RT Random ten panel drug screen
RBP Random breath pipe
RB Random breathalyser

An EKG is required on a baseline exam. Thereafter, an EKG is performed annually for anyone over 40 years of age or for medical indications. A chest x-ray is required on a baseline exam, and then once every 5 years thereafter. A chest x-ray is also required upon termination (if it has been more than 1 year since the previous x-ray). Random drug screens and tetanus are variable components; therefore, they are not included in the total examination price. These variable components will only be billed at the time they are included in the exam.

Examination price is based on the utilization of the EMR medical facility network. Should Fluor Daniel GTI wish to choose the facilities at which some or all of the services are provided, it is agreed that Fluor Daniel GTI will pay any difference between these component prices and those charged by those facilities designated by the client. In the event an EMR medical facility increases fees substantially over those component prices, Fluor Daniel GTI has agreed to pay any reasonable difference or to change to an alternative EMR-qualified facility.

EXHIBIT A-A

AGREEMENT AND ACKNOWLEDGEMENT FORM
HASP AMENDMENT SHEET
VISITOR/TRAINEE GUIDELINES
TRAINEE/OBSERVER AGREEMENT FORM

AGREEMENT AND ACKNOWLEDGEMENT SHEET

Fluor Daniel GTI personnel have the authority to stop field activities at this site if any activity is not performed in accordance with the requirements of the HASP. All Fluor Daniel GTI project personnel, subcontractor personnel, and visitors are required to sign the Agreement and Acknowledgement Sheet prior to conducting field activities at this site.

FLUOR DANIEL GTI

AGREEMENT AND ACKNOWLEDGEMENT STATEMENT

1. I have read and fully understand the HASP and my responsibilities.
2. I agree to abide by the provisions of the HASP.

Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date

FLUOR DANIEL GTI, INC.

Project Name:

Project Number:

PM:

Location:

Changes in field activities or hazards:

Approved by:_____ _____
Project Manager Date

FLUOR DANIEL GTI

VISITOR/TRAINEE GUIDELINES

Fluor Daniel GTI is committed to providing a safe environment on all work sites for visitors, trainees, employees and/or passersby. In order to accomplish this, the following guidelines must be followed. Infractions of the listed requirements agreement will be viewed as extremely serious and will be subject to discipline up to and including termination for either the trainee and/or supervisor.

1. VISITORS

Any person not actively participating in the work at the site is regarded as a "visitor" and must follow Fluor Daniel GTI's visitor/trainee guidelines while on-site. Visitors must be accompanied by a representative at all times.

Visitors will attend and sign-off on a site orientation. The orientation will cover specific areas that visitors will not be allowed to access during certain work activity. Visitors are required to wear appropriate PPE on-site. Required PPE for visitors include:

closed toed shoes,
hard hat,
safety glasses with side shields, and
other as required by SHSO (i.e., gloves, hearing protection, Tyvek® suit, etc.)

2. TRAINEES

Trainees are employees of Fluor Daniel GTI who have not yet completed Fluor Daniel GTI's required safety training program. New hires and in-house company transfers will be considered trainees until safety training requirements are met.

Trainees will be informed of restrictions by their supervisor and must abide by them on-site.

Trainees will be permitted to visit Fluor Daniel GTI sites to obtain three days on the job (OJT) training as observers as long as the following conditions are met:

Trainees are supervised at all times while on-site.
Trainees do not perform work functions of any type while on-site unless under direct supervision.
Trainees do not handle any equipment, tools and/or supplies while on-site unless under direct supervision.
Trainees do not enter any hazardous or HZ or confined space areas while on-site unless under direct supervision.

Supervisors will be responsible for informing trainees of the above conditions and for ensuring that the conditions are met. Supervisors will also ensure that trainees will not be asked to violate the conditions listed above.

A Trainee/Observer Agreement Form must be signed by both the trainee and the supervisor and placed on file in the Regional Human Resources department.

TRAINEE/OBSERVER AGREEMENT FORM

The following section is to be filled out by trainee.

Agreement between:

_____ _____ and Fluor Daniel GTI.

Name (print/type) SS#

Because we have your safety in mind, you will be considered a trainee until all training criteria are met. This means you must complete all training requirements prior to performing work activities on-site.

Training requirements include:

Up to date medical clearance documentation, successful completion and documentation or 40-hour HAZWOPER.

Trainees also must attend an orientation of the HASP including specific training on hazards that there is a likelihood the worker would be exposed to.

Prior to a trainee becoming a worker, the trainee must successfully complete three days of OJT. This three day OJT must be performed under direct supervision of a qualified supervisor.

I agree to adhere to the above conditions in all instances while on-site as a trainee/observer.

_____ _____

Signature Date

This section is to be filled out by supervisor.
As supervisor to the above trainee, I agree to the above restrictions and agree not to request him/her to perform activities contrary to those restrictions.

_____ _____

Signature Date

AGREEMENT AND ACKNOWLEDGEMENT SHEET

Fluor Daniel GTI personnel have the authority to stop field activities at this site if any activity is not performed in accordance with the requirements of the HASP. All Fluor Daniel GTI project personnel, subcontractor personnel, and visitors are required to sign the Agreement and Acknowledgement Sheet prior to conducting field activities at this site.

FLUOR DANIEL GTI
AGREEMENT AND ACKNOWLEDGEMENT STATEMENT

1. I have read and fully understand the HASP and my responsibilities.
2. I agree to abide by the provisions of the HASP.

Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date

FLUOR DANIEL GTI, INC.

Project Name:

Project Number:

PM:

Location:

Changes in field activities or hazards:

Approved by:_____ _____
Project Manager Date

FLUOR DANIEL GTI

VISITOR/TRAINEE GUIDELINES

Fluor Daniel GTI is committed to providing a safe environment on all work sites for visitors, trainees, employees and/or passersby. In order to accomplish this, the following guidelines must be followed. Infractions of the listed requirements agreement will be viewed as extremely serious and will be subject to discipline up to and including termination for either the trainee and/or supervisor.

1. VISITORS

Any person not actively participating in the work at the site is regarded as a "visitor" and must follow Fluor Daniel GTI's visitor/trainee guidelines while on-site. Visitors must be accompanied by a representative at all times.

Visitors will attend and sign-off on a site orientation. The orientation will cover specific areas that visitors will not be allowed to access during certain work activity. Visitors are required to wear appropriate PPE on-site. Required PPE for visitors include:

closed toed shoes,
hard hat,
safety glasses with side shields, and
other as required by SHSO (i.e., gloves, hearing protection, Tyvek® suit, etc.)

2. TRAINEES

Trainees are employees of Fluor Daniel GTI who have not yet completed Fluor Daniel GTI's required safety training program. New hires and in-house company transfers will be considered trainees until safety training requirements are met.

Trainees will be informed of restrictions by their supervisor and must abide by them on-site.

Trainees will be permitted to visit Fluor Daniel GTI sites to obtain three days on the job (OJT) training as observers as long as the following conditions are met:

Trainees are supervised at all times while on-site.
Trainees do not perform work functions of any type while on-site unless under direct supervision.
Trainees do not handle any equipment, tools and/or supplies while on-site unless under direct supervision.
Trainees do not enter any hazardous or HZ or confined space areas while on-site unless under direct supervision.

Supervisors will be responsible for informing trainees of the above conditions and for ensuring that the conditions are met. Supervisors will also ensure that trainees will not be asked to violate the conditions listed above.

A Trainee/Observer Agreement Form must be signed by both the trainee and the supervisor and placed on file in the Regional Human Resources department.

TRAINEE/OBSERVER AGREEMENT FORM

The following section is to be filled out by trainee.

Agreement between:

_____ _____ and Fluor Daniel GTI.

Name (print/type) SS#

Because we have your safety in mind, you will be considered a trainee until all training criteria are met. This means you must complete all training requirements prior to performing work activities on-site.

Training requirements include:

Up to date medical clearance documentation, successful completion and documentation or 40-hour HAZWOPER.

Trainees also must attend an orientation of the HASP including specific training on hazards that there is a likelihood the worker would be exposed to.

Prior to a trainee becoming a worker, the trainee must successfully complete three days of OJT. This three day OJT must be performed under direct supervision of a qualified supervisor.

I agree to adhere to the above conditions in all instances while on-site as a trainee/observer.

_____ _____

Signature Date

This section is to be filled out by supervisor.
As supervisor to the above trainee, I agree to the above restrictions and agree not to request him/her to perform activities contrary to those restrictions.

_____ _____

Signature Date

EXHIBIT A-B

PIR
INCIDENT REPORTING GUIDE

Line Manager must check incident type:

Class I _____

Class II _____

Class III _____

PRELIMINARY INCIDENT REPORT

Person Completing Report _____ Office _____ Date _____ Incident Date _____

Incident Time: _____ Location _____ Home Dept. # _ _ _ _ _ Visiting Dept. # _ _ _ _ _

Person Involved in Incident _____ Telephone _ _ _ - _ _ _ - _ _ _ _

Driver Name (if motor vehicle accident) _____ Telephone _ _ _ - _ _ _ - _ _ _ _

Type of Incident:

Personal Injury/Illness
Chemical Exposure
Equipment Damage
Theft
Property Damage
Permit/Code Compliance

Near Miss Event
Unsafe Condition/Action
Fire/Explosion
Spill/Release
Customer Incident
Newspaper/Radio/TV

Other
Motor Vehicle Accident
Assoc. Leasing Vehicle #: _ _ _ _ _ _ _ _ - _ _
VIN # _____
If FDGTI vehicle, call Associates Leasing at 800-255-2607.
Circle one based on initial findings: Preventable/Non-preventable

---

Personal Injury Yes No (If no, go to next section)

First Aid Only
Hospitalization
Medical Treatment
Possible Injury, Not Confirmed

Person Injured:
Fluor Daniel GTI Employee (If so, complete First Report of Injury)
Subcontractor
Customer/Public/Other

Nature of Injury, Illness or Exposure: _____

Describe nature of incident, how it occurred, who was involved, witnesses and possible causal factors: (Attach additional sheets if necessary)

First Report of Injury Attached Police Report Attached

Describe immediate actions taken and persons notified: (Attach additional sheets if necessary)

Line Manager (responsible for follow-up) _____ Office _____

DISTRIBUTION

Provide this report to the line manager immediately. The line manager is responsible for the proper distribution of the PIR form per the Incident Reporting Guide (see reverse side). Notify the Norwood Health and Safety Department of all Class II and III incidents immediately by phone at (800) 876-0647, Mailbox *11911, and fax a copy of the PIR to (617) 769-9861 .

Rev. 9/96

Line Manager must check incident type:

Class I_____

Class II_____

Class III_____

PRELIMINARY INCIDENT REPORT

Person Completing Report _____ Office_____ Date_____ Incident Date_____ _____

Incident Time: _____ Location _____ Home Dept. # _ _ _ _ _ _ Visiting Dept. # _ _ _ _ _ _

Person Involved in Incident _____ Telephone _ _ _ -_ _ _ -_ _ _ _

Driver Name (if motor vehicle accident) _____ Telephone _ _ _ -_ _ _ -_ _ _ _

Type of Incident:

Personal Injury/Illness
Chemical Exposure
Equipment Damage
Theft
Property Damage
Permit/Code Compliance

Near Miss Event
Unsafe Condition/Action
Fire/Explosion
Spill/Release
Customer Incident
Newspaper/Radio/TV

Other
Motor Vehicle Accident
Assoc. Leasing Vehicle #: _ _ _ _ _ _ _ _ _ _ _ _
VIN #_____

If FDGTI vehicle, call Associates Leasing at 800-255-2607.
Circle one based on initial findings: Preventable/Non-preventable

---

Personal Injury Yes No (If no, go to next section)

First Aid Only
Hospitalization
Medical Treatment
Possible Injury, Not Confirmed

Person Injured:
Fluor Daniel GTI Employee (If so, complete First Report of Injury)
Subcontractor
Customer/Public/Other

Nature of Injury, Illness or Exposure: _____

Describe nature of incident, how it occurred, who was involved, witnesses and possible causal factors: (Attach additional sheets if necessary)

First Report of Injury Attached Police Report Attached

Describe immediate actions taken and persons notified: (Attach additional sheets if necessary)

Line Manager (responsible for follow-up)_____ Office _____

DISTRIBUTION

Provide this report to the line manager immediately. The line manager is responsible for the proper distribution of the PIR form per the Incident Reporting Guide (see reverse side). Notify the Norwood Health and Safety Department of all Class II and III incidents immediately by phone at (800) 876-0647, Mailbox #11911, and fax a copy of the PIR to (617) 769-9861 .

Rev. 9/96

INCIDENT REPORTING GUIDE

Incident Class	Class I: A minor incident that is dealt with at the local level	Class II: A serious incident requiring immediate distribution and notification as described below and on the first page.	Class III: A highly significant incident requiring immediate notification and assistance from Regional Manager and Corporate
Examples of Incidents	First Aid injury Minor damage <$200 Non-reportable quantity spill Near miss event Unsafe condition or action	Personal injury (more than first aid to employee, subcontractor or public) Any motor vehicle accident Damage to property greater than $200 but less than $10,000 Near miss incident that could have been very serious Fire/Explosion Non-emergency notification of regulatory agency is required Served with subpoena (DO NOT ACCEPT; have subpoena delivered to CT Corporation System, our Registered Agent at 800-336-3376 or contact Legal Dept. in Norwood for additional assistance; no written investigation report is required for a subpoena.)	Possible Lost Work Day injury Hospitalization (of one or more persons) Multiple injury of employees, subcontractors or public Unprotected chemical exposure Death Damage to property greater than $10,000 Reportable quantity spill release Emergency notification of regulatory agency Regulatory agency response to incident site (inspection) Contact or appearance of news or public media
Notification Actions	1. On-scene person notifies Line Manager* immediately by phone. 2. Provide PIR form to Line Manager and H&S Representative(s)** immediately following the incident. 3. Line Manager investigates and follows up within 48 hours.	1. On-scene person notifies Line Manager* immediately by phone. 2. Line Manager notifies the District Manager; Regional Manager, H&S Representative(s)**, Human Resources Representative, Corporate H&S Director and CEO with PIR form immediately following the incident. 3. Line Manager provides a detailed final investigation report within 48 hours after the original PIR is submitted. The final report must be submitted to District Manager, Regional Manager, H&S Representative(s), Human Resources Representative, Corporate Director H&S and CEO.	1. On-scene person notifies Line Manager* immediately by phone. 2. Line Manager immediately notifies District Manager, Regional Manager, H&S Representative(s)**, Human Resources and Corporate Director H&S. PIR form is provided by fax immediately to (617-769-9861) addressed to Corporate Director H&S. 3. Incident management team conferences by phone and formulates an action plan.

Notes: If there is a question as to Class I or II, follow Class II notification actions. Rev. 9/96

All Class II and III incidents must be communicated to the Norwood Health and Safety Department immediately by phone at (800) 876-0647, Mailbox *11911; leave a voice message. This will activate a digital pager which is carried by a company health and safety professional 24 hours a day.

All lost-time injury events will be investigated by the respective Regional Manager with a final report to the CEO.

*Line management = reporting manager, project manager, or operations/office manager.
**H&S representative = includes District H&S representatives and Regional H&S manager

INCIDENT REPORTING GUIDE

Incident Class	Class I: A minor incident that is dealt with at the local level	Class II: A serious incident requiring immediate distribution and notification as described below and on the first page.	Class III: A highly significant incident requiring immediate notification and assistance from Regional Manager and Corporate
Examples of Incidents	First Aid injury Minor damage <$200 Non-reportable quantity spill Near miss event Unsafe condition or action	Personal injury (more than first aid to employee, subcontractor or public) Any motor vehicle accident Damage to property greater than $200 but less than $10,000 Near miss incident that could have been very serious Fire/Explosion Non-emergency notification of regulatory agency is required Served with subpoena (DO NOT ACCEPT; have subpoena delivered to CT Corporation System, our Registered Agent at 800-336-3376 or contact Legal Dept. in Norwood for additional assistance; no written investigation report is required for a subpoena.)	Possible Lost Work Day Injury Hospitalization (of one or more persons) Multiple injury of employees, subcontractors or public Unprotected chemical exposure Death Damage to property greater than $10,000 Reportable quantity spill release Emergency notification of regulatory agency Regulatory agency response to incident site (inspection) Contact or appearance of news or public media
Notification Actions	1. On-scene person notifies Line Manager* immediately by phone. 2. Provide PIR form to Line Manager and H&S Representative(s)** immediately following the incident. 3. Line Manager investigates and follows up within 48 hours.	1. On-scene person notifies Line Manager* immediately by phone. 2. Line Manager notifies the District Manager; Regional Manager, H&S Representative(s)**, Human Resources Representative, Corporate H&S Director and CEO with PIR form immediately following the incident. 3. Line Manager provides a detailed final investigation report within 48 hours after the original PIR is submitted. The final report must be submitted to District Manager, Regional Manager, H&S Representative(s), Human Resources Representative, Corporate Director H&S and CEO.	1. On-scene person notifies Line Manager* immediately by phone. 2. Line Manager immediately notifies District Manager, Regional Manager, H&S Representative(s)**, Human Resources and Corporate Director H&S. PIR form is provided by fax immediately to (617-769-9861) addressed to Corporate Director H&S. 3. Incident management team conferences by phone and formulates an action plan.

Notes: If there is a question as to Class I or II, follow Class II notification actions. Rev. 9/96

All Class II and III incidents must be communicated to the Norwood Health and Safety Department immediately by phone at (800) 876-0647, Mailbox *11911; leave a voice message. This will activate a digital pager which is carried by a company health and safety professional 24 hours a day.

All lost-time injury events will be investigated by the respective Regional Manager with a final report to the CEO.

*Line management = reporting manager, project manager, or operations/office manager.
**H&S representative = includes District H&S representatives and Regional H&S manager

EXHIBIT A-C

LO/TO PROCEDURES

This form is required to be completed when equipment (i.e. electrical, mechanical, pneumatic, chemical, thermal) that requires maintenance, which has stored energy, could be set in motion, thereby causing an injury. To complete the form:

Identify all equipment (i.e. blower motor, recovery pump, etc);
Describe the operation to be conducted (i.e. change fuse, change motor brushes, etc.)
Describe the lockout method/location (i.e. circuit breaker panel outside remediation compound shed, using a single-pole, red plastic lockout clip)

SITE-SPECIFIC LO/TO PROCEDURES		
Equipment	Operation	Lockout Method/Location

This form is required to be completed when equipment (i.e. electrical, mechanical, pneumatic, chemical, thermal) that requires maintenance, which has stored energy, could be set in motion, thereby causing an injury. To complete the form:

Identify all equipment (i.e. blower motor, recovery pump, etc);
Describe the operation to be conducted (i.e. change fuse, change motor brushes, etc.)
Describe the lockout method/location (i.e. circuit breaker panel outside remediation compound shed, using a single-pole, red plastic lockout clip)

SITE-SPECIFIC LO/TO PROCEDURES		
Equipment	**Operation**	**Lockout Method/Location**

EXHIBIT A-D

MSDS DEFINITIONS
MSDS

EXHIBIT A-F

EXCAVATION/TRENCHING SAFETY PROCEDURES
TRENCH SAFETY DAILY FIELD REPORT
SOILS CLASSIFICATION CHECKLIST
SOILS ANALYSIS CHECKLIST
EXCAVATION/TRENCHING - UNDERGROUND UTILITIES
UNDERGROUND UTILITY CONTACT PREVENTION AND MANAGEMENT PLAN
EXCAVATION/TRENCHING - USTs
UST REMOVALS

ATTENTION:

THE TRENCH SAFETY DAILY FIELD REPORT FORM
MUST BE COMPLETED AT LEAST DAILY DURING EXCAVATION/TRENCHING OPERATIONS
AND MORE FREQUENTLY IF CONDITIONS CHANGE.

EXCAVATION/TRENCHING SAFETY PROCEDURES

Evaluation: Conducted by **Competent Person 29 CFR 1926.**

Two soil classifications must be completed to determine sloping/shoring requirements. Conduct daily inspections of all open excavations prior to entry.

Egress: Excavation areas **4 feet (1.22 meters) or more deep**

Ladders must be spaced no more than 25 feet (7.62 meters) apart so that a person in the trench is always within 25 feet (7.62 meters) of a ladder for egress.

Shoring: Excavation areas **5 feet (1.52 meters) or more deep**

Excavations must be sloped or shored if personnel will be entering the excavation. Soil classification may be done only by a competent person using both a visual and manual test.

WARNING: One soil classification may not be enough. Outside disturbances during excavation may change even the best classification.
Inspect the soil after any condition change.

Storage: All excavations

Spoils and heavy equipment must be stored a minimum of 2 feet (0.61 meters) from the edge of the excavation.
Store spoils on the downhill side.

Maximum Allowable Slopes

Soil or Rock Type	Maximum allowable slopes (H:V)[1] for excavations less than 20 feet (6.10 meters) deep[2]
Stable Rock[3]	Vertical (90°)
Type **A** - highly cohesive soil	3/4:1 (53°)
Type **B** - cohesive soil with some sand	1:1 (45°)
Type **C** - loose, wet, or sandy soil	1½:1 (34°)

Notes:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

2. Sloping or benching for excavations greater than 20 feet (6.10 meters) deep shall be designed by a registered professional engineer.

3. A short-term maximum allowable slope of ½ H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 meters) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 meters) in depth shall be 3/4 H:1V (53°)

TRENCH SAFETY DAILY FIELD REPORT

DATE:_____

Project Name:_____
Project Manager:_____
Weather Conditions:

I hereby attest that the following conditions existed and that the following items were checked or reviewed during this inspection.

INSPECTION ITEM	YES	NO	NA
All open trenches were inspected.			
Were any tension cracks observed along top of any slopes?			
Was any water seepage noted on trench walls or trench bottom?			
Was bracing system installed in accordance with design?			
Type shoring being used_____.			
Is shoring secure?			
Was there evidence of shrinkage cracks in trench walls?			
Was there any evidence of caving since the last field inspection?			
Trench box(s) certified with tabulated data?			
Traffic in area adequately away from trenching operations with barricades			
Surface encumbrances and other hazards in area accounted for?			
Protective measures taken for standing water in trench.			
All site personnel wearing reflective vest.			
Atmospheric testing conducted in trenched < 4 feet deep.			
Vibrations from equipment or traffic too close to trenching operation?			

Observations:_____

Competent Person signature_____

Soils Analysis Checklist

This checklist must be completed when soil analysis is conducted to determine the excavation soil type. A separate analysis must be performed on each layer of soil excavation walls. Additional soil analysis must also be performed for the excavation (trench) when it stretches over a distance where soil type may change.

Name:_____ Date:_____ Time:_____

Competent person:_____

Where was the sample taken from?_____

Excavation: Depth_____ Width_____ Length_____

SOIL CLASSIFICATION - VISUAL TEST				
ITEM	TEST PROTOCOL	YES	NO	COMMENTS/ACTIONS
1	**Soil Particle Type** Fine Grained/Cohesive Course Grained(Sand or Gravel)			
2	**Excavation Water Conditions** Dry Surface Water Present Submerged Water Present			
3	**Soil Condition** Undisturbed Disturbed Layered Soil Dipping into Excavation Excavation Exposed to Vibrations Cracked/Fissures/Spalling Observed			
4	**Additional Excavation Hazards** Surface Encumbrances(If YES - What Type) Hazardous Atmosphere in Excavation (If YES - List Source and Conditions)			

SOIL ANALYSIS - MANUAL TEST		
RESULTS	THUMB TEST	Check here if conducted
	Type A - Soil identified by thumb with great degree of effort	
	Type B - Soil identified by thumb with some degree of effort	
	Type C - Soil identified by thumb with little degree or no effort	
RESULTS	PENETROMETER OR SHEARVANE - Circle which used	Write in brand/model
	Type A - Soil with unconfined compressive strength of 1.5 tons per square foot (tsf) or greater	
	Type B - Soil with unconfined compressive strength > 0.5 to 1.5 tsf	
	Type C - Soil with unconfined compressive strength < 0.5 tsf or soil that is submerged or exposed to water	

Soil Classification		
Type A	Type B	Type C

Selection of Protective System (Appendix F)	
PROTECTIVE SYSTEM	Sloping Specify angle_____ _____ Timber shoring _____ Aluminum hydraulic shoring _____ Trench Shield Max Depth in this soil _____

Note: Although OSHA will accept the above tests in most cases, some states do not - check your state safety requirements for trenching regulations.

EXCAVATION/TRENCHING - UNDERGROUND UTILITIES

REFERENCES

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Wynder, E.L. and Hoffmann, D. (1959) *The carcinogenicity of benzofluoranthenes*. Cancer 12:1194-1199.

BENZO[k]FLUORANTHENE

GENERAL BACKGROUND INFORMATION

Benzo[k]fluoranthene (BkF) is a member of the class of compounds referred to as polycyclic aromatic hydrocarbons (PAHs). PAHs contain two or more aromatic rings. PAHs are ubiquitous in nature and are both naturally occurring and man-made. Exposure to BkF can come from air, water, or soil. As a PAH, BkF is present in the emissions from industrial plants that produce coal tar, cooking plants, asphalt production plants, and home heating with wood and coal. BkF is also present in charcoal-broiled foods and cigarette smoke (ATSDR, 1990).

PHARMACOKINETICS

No data on the absorption, distribution or excretion of BkF were identified. BkF is believed to be metabolized to phenol and dihydrodiol metabolites (ATSDR, 1990). The general metabolic pathways elucidated for benzo[a]pyrene are believed to be active on BkF. As for the other PAHs, the material excreted is expected to consist primarily of dihydrodiol and phenol conjugates (Levin et al., 1982; Cooper et al., 1983; Grover et al., 1986).

HUMAN TOXICOLOGICAL PROFILE

The database for human toxicity is very limited. There are no studies correlating exposure to BkF and cancer or systemic toxicity. The only data implicating BkF as a carcinogen come from carcinogenicity studies using a mixture of PAHs.

MAMMALIAN TOXICOLOGICAL PROFILE

The database on the toxicity of BkF is limited. The skin tumor initiating ability of BkF has been demonstrated in mice using a standard initiation/promotion protocol with either croton resin or phorbol myristate acetate as tumor promotors (Van Duuren et al., 1966; LaVoie et al., 1982). Chronic dermal application of benzo[k]fluoranthene to mice resulted in no skin tumors, suggesting that BkF alone is not a complete carcinogen (Wynder and Hoffman, 1959).

GENOTOXICITY

The genotoxicity of BkF has not been documented in *in vitro* studies. In vivo, a single topical application of BkF was reported to bind to DNA in CD-1 mouse skin (Weyland et al., 1987). Covalent binding of chemicals to DNA can result in strand breaks and DNA damage, ultimately leading to mutations (ATSDR, 1990).

CHRYSENE

GENERAL BACKGROUND INFORMATION

Chrysene is one of the polycyclic aromatic hydrocarbon (PAH) compounds which are formed during the combustion of organic material. Chrysene often exists in particulate form, adsorbing to existing particulate material in air. Human exposure can occur in the workplace (coal and asphalt production plants, cooking plants, smoke houses) or in the environment due to chrysene contamination of air, food, soil and water (ATSDR, 1990).

PHARMACOKINETICS

Chrysene can be absorbed by all routes of exposure (see section on Relative Absorption Factors). Its absorption is believed to be qualitatively similar to benzo[a]pyrene (ATSDR, 1990). Following absorption, chrysene distributes to all organs, reaching the highest concentration in tissues with large fat content (adipose tissue, mammary tissue, brain) (Modica et al., 1983). Chrysene undergoes metabolic biotransformation mediated by the mixed function oxidase enzyme system to form reactive intermediates hypothesized to be responsible for its toxicity. The major metabolites include trans-dihydrodiols, phenols, diol epoxides and triol epoxides (Thakker et al., 1985). The reactive metabolites are conjugated and excreted primarily in feces (Schlede et al., 1970).

HUMAN TOXICOLOGICAL PROFILE

There is no information available on threshold toxic effects of chrysene in humans. Since it is structurally similar to benzo[a]pyrene, it would be expected to produce effects similar to B[a]P following acute or chronic exposure (see Toxicity Profile on Benzo[a]pyrene).

MAMMALIAN TOXICOLOGICAL PROFILE

There is no information available on threshold toxic effects of chrysene in animals. Since it is structurally similar to benzo[a]pyrene, it would be expected to produce effects similar to B[a]P following acute or chronic exposure (see Toxicity Profile for Benzo[a]pyrene).

GENOTOXICITY

The genotoxicity of chrysene has been evaluated in in vivo and in vitro cytogenetic tests. Chrysene produced weak positive results in bacterial mutation assays, human epithelial mutation studies, cell transformation assays and in vivo cytogenetic studies (Waters et al., 1987). Metabolism of chrysene is essential to produce the observed positive responses. Chrysene is not genotoxic in all test systems, however, it is believed to be a weak mutagen (ATSDR, 1990). The carcinogenicity of chrysene has not been adequately studied. There are no reports directly correlating human chrysene exposure and tumor development. There is limited evidence that chryesene is a skin carcinogen in animals following long-term dermal application (Wynder and Hoffmann, 1959; Hecht et al., 1974).

DIBENZO[a,h]ANTHRACENE

GENERAL BACKGROUND INFORMATION

Dibenzo[a,h]anthracene is a member of the polycyclic aromatic hydrocarbons (PAH). PAHs are a class of compounds which are non-polar and contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. The data regarding dibenzo[a,h]anthracene are very limited. As a PAH, it is found in tobacco smoke, food, and the emissions from industrial or natural burning.

PHARMACOKINETICS

Dibenzo[a,h]anthracene is metabolized similarly to benzo(a)pyrene (ATSDR, 1990). However, while the metabolic profiles of these two compounds (and other alternant PAHs) are qualitatively similar, there are differences in the levels and rates of formation of specific metabolites among tissues and cell preparations used. Sanders et al (1986) applied ^{14}C - dibenzo[a,h]anthracene to the shaved backs of mice. After 24 hours, the majority of activity was recovered from the application site, with the remainder from body tissues and excreta. In comparison, benzo(a)pyrene similarly applied was found predominantly in the excreta and body tissues, with the remainder at the application site.

HUMAN TOXICOLOGICAL PROFILE

The database for the toxicological effects of dibenzo[a,h]anthracene on humans, separate from other PAHs, is limited. Toxic effects attributable to mixtures of PAHs include a variety of skin lesions and non-cancer lung diseases such as bronchitis (IARC, 1973).

MAMMALIAN TOXICOLOGICAL PROFILE

Dibenzo[a,h]anthracene has been shown to induce skin tumors in lab animals (i.e. it is a complete carcinogen) following dermal exposure (Wyndner and Hoffman, 1959; Van Duuren et al, 1967; and Lijinsky et al, 1965). Dibenzo[a,h]anthracene ahs also demonstrated tumor initiation activity (Slaga et al. 1980).

Carcinogenic PAHs as a group has immunosupprssive effects, with the degree of immunosuppression correlated with carcinogenic potency (ATSDR, 1990). Dibenzo[a,h]anthracene was also tested for developmental effects via parenteral routes and was found to produce fetolethal effects in rats (Wolfe and Bryan, 1939).

GENOTOXICITY

Dibenzo[a,h]anthracene is mutagenic (Barfknecht et al, 1982; Rocchi et al, 1980) and produces DNA damage (Martin et al, 1978) in cultured human cells. Test results in nonhuman systems were also positve (ATSDR, 1990).

FLUORANTHENE

GENERAL BACKGROUND INFORMATION

Fluoranthene is a member of the polyaromatic hydrocarbons (PAH). PAHs constitute a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. Fluoranthene has been detected in food, cigarette smoke, and smoke from industrial and natural burning.

PHARMACOKINETICS

No data were found regarding the pharmacokinetics of fluoranthene.

HUMAN TOXICOLOGICAL PROFILE

The database for the toxicological effects of fluoranthene on humans, separate from other PAHs, is limited. Toxic effects attributable to mixtures of PAHs include a variety of skin lesions and non-cancer lung diseases such as bronchitis (IARC, 1973).

MAMMALIAN TOXICOLOGICAL PROFILE

The database on the toxicity of fluoranthene is limited. A 13 week subchronic study where CD-1 mice were gavaged with up to 500 mg/kg-day of fluoranthene indicated nephropathy, increased liver weights, hematological alterations and clinical effects (EPA, 1988). A developmental study in which fluoranthene was administered once via intraperitoneal injection to pregnant mice reported only an increased rate of embryo resorption (Irvin and Martin, 1987).

Chronic dermal application of up to 1 percent fluoranthene to the backs of mice did not induce skin tumors following lifetime application (Hoffman et al, 1972; Horton and Christian, 1974; and Wydner and Hoffman, 1959a). Fluoranthene is not a complete carcinogen (ATSDR, 1990) and does not exhibit iniation activity (Hoffman et al, 1972).

GENOTOXICITY

There is some evidence that fluoranthene is genotoxic (ATSDR, 1990). Genotoxic effects have been reported in human cells with exogenous metabolic activation, but negative results were recorded without metabolic activation.

FLUORENE

GENERAL BACKGROUND INFORMATION

Fluorene is a member of the polyaromatic hydrocarbons (PAH). PAHs constitute a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. The data on fluorene are very limited. Low levels of (5 to 67 ug/kg) have been detected in smoked meats (U.S. EPA, 1982).

PHARMACOKINETICS

No data were found regarding the pharmacokinetics of fluorene.

HUMAN TOXICOLOGICAL PROFILE

The database for the toxicological effects of fluoranthene on humans, separate from other PAHs, is limited. Toxic effects attributable to mixtures of PAHs include a variety of skin lesions and non-cancer lung diseases such as bronchitis (IARC, 1973).

MAMMALIAN TOXICOLOGICAL PROFILE

Limited information is available on the threshold effects of fluorene. An EPA study (EPA,1989) indicated that CD-1 mice exposed by gavage to up to 500 mg/kg-day of fluorene showed hypoactivity as well as a decrease in red blood cell count and packed cell volume and hemoglobin. Increases in absolute and relative liver, spleen and kidney weights was also observed. Gershbein (1975) reported that partially hepatectomized rats fed a diet of 180 mg/kg-day of fluorene for 10 days showed a statistically significant increase in liver regeneration, which is indicative of the ability to induce a proliferative response.

Fluorene is not reported to be a complete skin carcinogen (ATSDR, 1990). It was inactive as a tumor initiator when an estimated total dose of 1.0 mg was applied prior to the application of tetradecanoyl phorbol acetate (LaVoie et al, 1980).

GENOTOXICITY

There is no evidence that fluorene is genotoxic, but genotoxicity has been studied only in a few in vitro assays (ATSDR, 1990).

INDENO[1,2,3-cd]PYRENE

GENERAL BACKGROUND INFORMATION

Indeno[1,2,3,-cd]pyrene is a member of the polyaromatic hydrocarbons (PAH). PAHs constitute a class of non-polar compounds that contain two or more aromatic rings. They are ubiquitous in nature and are both naturally occurring and man-made. Indeno[1,2,3-cd]pyrene is present in cigarette smoke (IARC, 1983) as well as emissions from industrial stacks.

PHARMACOKINETICS

No data were found regarding the pharmacokinetics of indeno[1,2,3-cd]pyrene. However, its metabolism should be similar to another non-alternant PAH, benzo(b)fluoranthene (ATSDR, 1990).

HUMAN TOXICOLOGICAL PROFILE

The database for the toxicological effects of indeno[1,2,3-cd]pyrene on humans, separate from other PAHs, is limited. Toxic effects attributable to mixtures of PAHs include a variety of skin lesions and non-cancer lung diseases such as bronchitis (IARC, 1973).

MAMMALIAN TOXICOLOGICAL PROFILE

Studies on laboratoyr animals have demonstrated that indeno[1,2,3-cd]pyrene can induce skin tumors (i.e. it is a complete carcinogen) following dermal exposure (ATSDR, 1990).
It has tumor initiating activity, but is not as potent as benzo(b)fluoranthene (Rice et al, 1985).

Carcinogenic PAHs as a group are immunosuppressant, with the degree of suppression correlated with the degree of potency (ATSDR, 1990)

GENOTOXICITY

In test systems using non-human cells, indeno[1,2,3-cd]pyrene was found to be genotoxic (ATSDR, 1990).

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NAPHTHALENE

GENERAL BACKGROUND INFORMATION

Naphthalene is a white solid substance at room temperature. It has a distinct odor of mothballs or tar. Humidity and sunshine cause evaporation into the air within a few hours. When placed in water or soil, bacteria will destroy naphthalene, or will render it airborne within a few hours (ATSDR, 1990). Tobacco smoke is known to release 3 ug of naphthalene per cigarette (U.S. EPA, 1982). The compound is used in the production of dyes, solvents, lubricants, motor fuels (U.S. EPA, 1980) and is a major component of many moth ball preparations.

PHARMACOKINETICS

Humans can absorb naphthalene by dermal, inhalation and oral routes (see section on Relative Absorption Factors). Metabolism occurs via the P450 mixed function oxidase enzyme system to yield multiple intermediates which are then conjugated. Key metabolites are responsible for each toxicity endpoint following intraperitoneal administration: 2-naphthoquinones --> hemolysis; 1,2-naphthoquinones --> cataracts; 3-GSH adducts --> pulmonary toxicity (Buckpitt et al., 1984). Excretion of metabolites occurs via urine and feces (ATSDR, 1990).

HUMAN TOXICOLOGICAL PROFILE

Adults and children exposed to airborne naphthalene experience vomiting, abdominal pain and anemia (ATSDR, 1990). Most of the data is for inhalation of naphthalene from mothballs. The primary site of toxicity is the erythrocyte resulting in hemolytic crisis (hemolytic anemia). Jaundice is seen upon dermal, inhalation, and oral exposures, as are kidney effects (ATSDR, 1990). Near-blindness resulted in male and female subjects with 5 gram ingestion (ATSDR, 1990).

MAMMALIAN TOXICOLOGY PROFILE

Oral doses in rats have hepatic effects. Dogs (1800 mg/kg) for 5 days of exposure showed signs of lethargy and ataxia, and decreased hemoglobin levels (ATSDR, 1990)

GENOTOXICITY

No studies of genotoxic effects in humans or laboratory animals were located. No human epidemiological evidence for cancer.
Inconclusive evidence for cancer in rats and mice were found (ATSDR, 1990).

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Material Safety Data Sheets Collection

Benzo(a)pyrene

MSDS No. 164

Date of Preparation: 2/94

Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Benzo(a)pyrene
Chemical Formula: $C_{20}H_{12}$; a polynuclear aromatic hydrocarbon
CAS No.: 50-32-8
Synonyms: BaP; 3,4-benz(a)pyrene; BP; 3,4-benzopyrene; 3,4-benzpyrene. Formerly called 1,2-benzpyrene.
Derivation: Synthesized from pyrene and succinic anhydride.
General Use: Benzo(a)pyrene is no longer used or produced commercially in the US. In its pure form, benzo(a)pyrene may be used as a research laboratory reagent. It also occurs in combustion products of coal, oil, petroleum, wood and other biological matter; in motor vehicle and other gasoline and diesel engine exhaust; in charcoal-broiled foods; in cigarette smoke and general soot and smoke of industrial, municipal, and domestic origin. It occurs naturally in crude oils, shale oils, coal tars, gases and fly ash from active volcanoes and forest fires. Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition/Information on Ingredients

Benzo(a)pyrene, ca 100 %wt; except in laboratories, benzo(a)pyrene is usually mixed with other coal tar pitch chemicals. Consider exposure limits for coal tar pitch volatiles as a guideline. However, because benzo(a)pyrene is considered a probable carcinogen to humans, it is recommended that exposures to carcinogens be limited to the lowest feasible concentration.

OSHA PELs
Coal tar pitch volatiles
8-hr TWA: 0.2 mg/m^3

ACGIH TLVs
A2: Suspected Human Carcinogen

NIOSH REL
10-hr TWA: 0.1 mg/m^3
Carcinogen; coal tar pitch volatile, cyclohexane extractable fraction.

DFG (Germany) MAK
None established

IDLH Level
700 mg/m^3
Coal tar pitch volatiles (benzene soluble fraction)

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Benzo(a)pyrene is a pale yellow, crystalline solid or powder that is irritating to the skin, eyes, and respiratory tract. It is a carcinogen and mutagen. Handle with extreme caution!

Wilson Risk Scale	
R	1
I	4
S	4
K	1

HMIS	
H	2*
F	1
R	0

* Chronic Effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion. Target Organs: Respiratory system, bladder, kidneys, skin.
Acute Effects: Inhalation: Respiratory tract irritation. Eye: Irritation and/or burns on contact. Skin: Irritation with burning sensation, rash, and redness; dermatitis on prolonged exposure. Sunlight enhances effects (photosensitization). Ingestion: None reported.
Carcinogenicity: IARC, NTP, NIOSH, ACGIH, EPA, and MAK list benzo(a)pyrene as: an IARC 2A (probably carcinogenic to humans: limited human evidence, sufficient evidence in experimental animals), an NTP-2 (reasonably anticipated to be a carcinogen: limited evidence from studies in humans or sufficient evidence from studies in experimental animals), a NIOSH-X (carcinogen defined with no further categorization); an ACGIH TLV-A2 (suspected human carcinogen: carcinogenic in experimental animals, but available epidemiological studies are conflicting or insufficient to confirm an increased risk of cancer in exposed humans); an EPA-B2 (sufficient evidence from animal studies, inadequate evidence or no data from epidemiological studies); and an MAK-A1 (capable of inducing malignant tumors as shown by experience with humans) carcinogen, respectively.
Medical Conditions Aggravated by Long-Term Exposure: Respiratory system, bladder, kidney, and skin disorders.
Chronic Effects: Inhalation: Cough and bronchitis. Eye: Photosensitivity and irritation. Skin: Skin changes such as thickening, darkening, pimples, loss of color, reddish areas, thinning of the skin, and warts. Sunlight enhances effects (photosensitization). Other: Gastrointestinal (GI) effects include leukoplakia (a pre-cancerous condition characterized by thickened white patches of epithelium on mucous membranes, especially of the mouth). Cancer of the lung, skin, kidneys, bladder, or GI tract is also possible. Smoking in combination with exposure to benzo(a)pyrene increases the chances of developing lung cancer. Persons with a high degree of inducibility of the enzyme aryl hydrocarbon hydroxylase may be a high risk population.
Comments: Pregnant women may be especially susceptible to exposure effects of benzo(a)pyrene; exposure may damage the fetus. In general, polyaromatic hydrocarbons such as benzo(a)pyrene tend to localize primarily in body fat and fatty tissues (for ex. breasts) and are excreted in breast milk. Benzo(a)pyrene may also affect the male reproductive system (testes and sperm).

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

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annual basis for employees 45 yr of age or older or with 10 or more years of exposure to coal tar pitch volatiles. Train workers about the hazards of benzo(a)pyrene and the necessary protective measures to prevent exposure. Periodically inspect lab atmospheres, surfaces such as walls, floors, and benches, and interior of fume hoods and air ducts for contamination. Post appropriate signs and labels on doors leading into areas where benzo(a)pyrene is used.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. The following respirator recommendations are for coal tar pitch volatiles. For any unknown concentration, wear any SCBA with a full facepiece and operated in a pressure-demand or other positive pressure mode, or any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive pressure mode. For escape, wear any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter, or any appropriate escape-type SCBA. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. In animal laboratories, wear protective suits (disposable, one-piece and close-fitting at ankles and wrists), gloves, hair covering, and overshoes. In chemical laboratories, wear gloves and gowns. Wear protective eyeglasses or chemical safety, gas-proof goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Shower and change clothes after exposure or at the end of the workshift. Separate contaminated work clothes from street clothes. Launder before reuse. Remove benzo(a)pyrene from your shoes and clean personal protective equipment. Use procedures to ensure laundry personnel are not exposed.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: Pale yellow monoclinic needles with a faint, aromatic odor.

Vapor Pressure: >1 mm Hg at 68 °F (20 °C)

Formula Weight: 252.30

Specific Gravity (H_2O=1, at 4 °C): 1.351

Water Solubility: Insoluble; 0.0038 mg (+/- 0.00031 mg) in 1 L at 77 °F (25 °C)

Other Solubilities: Ether, benzene, toluene, xylene, concentrated hydrosulfuric acid; sparingly soluble in alcohol, methanol.

Boiling Point: >680 °F (>360 °C); 540 °F (310 °C) at 10 mm Hg

Melting Point: 354 °F (179 °C)

Octanol/Water Partition Coefficient: log Kow= 6.04

Section 10 - Stability and Reactivity

Stability: Benzo(a)pyrene is stable at room temperature in closed containers under normal storage and handling conditions. It undergoes photo-oxidation when exposed to sunlight or light in organic solvents and is also oxidized by chromic acid and ozone.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Strong oxidizers (chlorine, bromine, fluorine) and oxidizing chemicals (chlorates, perchlorates, permanganates, and nitrates).

Conditions to Avoid: Avoid heat and ignition sources and incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of benzo(a)pyrene can produce carbon monoxide and carbon dioxide.

Section 11 - Toxicological Information

Toxicity Data:*

Tumorigenic Effects:

Rat, oral: 15 mg/kg produced gastrointestinal and musculoskeletal tumors.

Mouse, inhalation: 200 ng/m^3/6 hr administered intermittently over 13 weeks produced tumors of the lungs.

Rabbit, skin: 17 mg/kg administered intermittently over 57 weeks produced tumors of the skin and appendages.

Teratogenicity:

Rat, oral: 2 g/kg administered 28 days prior to mating and 1-22 days of pregnancy produced a stillbirth.

Rat, oral: 40 mg/kg on the 14th day of pregnancy caused changes in the extra embryonic structures.

Mouse, oral: 75 mg/kg administered to the female during the 12-14 day of pregnancy produced biochemical and metabolic effects on the newborn.

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Sheet No. 757
Coal Tar Creosote

Issued: 7/91

Section 1. Material Identification

Coal Tar Creosote (molecular formula varies with purity) **Description:** Three main derivations: by distillation of coal tar produced by high-temperature carbonization of bituminous coal; by mixing strained naphthalene oil, wash oil, and strained or light anthracene oil; as a by-product of conventional coal coking. It typically contains up to 160 chemicals, mainly aromatic compounds such as phenol, pyrol and pyridine. Used mainly as a wood preservative for railroad ties, poles, fence posts, marine pilings, and other lumber for outdoor use; as a water-proofing agent, fuel oil constituent, frothing agent for mineral separation, hop defoliant, and lubricant for die molds; in manufacturing chemicals; and in medicine as an antiseptic, disinfectant, antipyretic, astringent, germicide, and styptic.
Other Designations: CAS No. 8001-58-9, Awpa,® brick oil, Caswell No. 225,® coal tar oil, creosote, creosote oil, creosotum, cresylic creosote, heavy oil, liquid pitch oil, naphthalene oil, Preserv-o-sote,® Sakresote,® tar oil, wash oil.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.
Cautions: Flammable, liquid coal tar creosote is toxic by inhalation, ingestion, and skin contact. The IARC and NTP† classify it as *a human carcinogen.*

R 1
I 4
S 4*
K 2
* Skin absorption

NFPA
2 / 2 0 / -

HMIS
H 2
F 2
R 0
PPG†
† Sec. 8

* Skin absorption can occur with phenol, a major component of coal tar creosote.

Section 2. Ingredients and Occupational Exposure Limits

Coal tar creosote, ca 100%

1990 OSHA PEL
8-hr TWA: 0.2 mg/m³*

1990-91 ACGIH TLV
TWA: 0.2 mg/m³*

1987 IDLH Level
700 mg/m³

1990 NIOSH REL
0.1 mg/m³ (cyclohexane extractable portion)

1985-86 Toxicity Data†
Rat, oral, LD_{50}: 725 mg/kg; toxic effects not yet reviewed
Dog, oral, LD_{Lo}: 600 mg/kg; toxic effects not yet reviewed
Rat, TD_{Lo}: 52,416 mg/kg administered during 91 days prior to mating produces reproductive effects on fallopian tubes and ovaries
Mouse, skin, TD_{Lo}: 99 g/kg produces tumors in skin and appendages

* As coal tar pitch volatiles.
† See NIOSH, *RTECS* (GF8615000), for additional mutation, reproductive, tumorigenic, and other toxicity data.

Section 3. Physical Data

Boiling Point: 381 to 752 °F (194 to 400 °C)
Distillation Range: 446 to 554 °F (230 to 290 °C)
Heat of Combustion: -12,500 Btu/lb
Heat of Vaporization: 107 Btu/lb
Molecular Weight: Varies with purity
Density/Specific Gravity: 1.07 to 1.08 at 68 °F (20 °C)
Water Solubility: Slightly soluble

Appearance and Odor: Pure coal tar creosote is colorless, but the industrial product is a yellow to black oily liquid with an aromatic smoky smell and a burning caustic taste.

Section 4. Fire and Explosion Data

Flash Point: 165.2 °F (74 °C), CC	Autoignition Temperature: 637 °F (336 °C)	LEL: None reported	UEL: None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), or regular foam. For large fires, use fog or regular foam. Since water is least effective, use it as an extinguishing agent only when the preferred measures are unavailable. However, use water spray to cool fire-exposed containers.
Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. Containers may explode in heat of fire. Coal tar creosote presents a vapor explosion hazard indoors, outdoors, and in sewers.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear full protective clothing. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Immediately leave area if you hear a rising sound from venting safety device or notice any fire-caused tank discoloration. Isolate area for 1/2 mile in all directions if fire involves tank, rail car or tank truck. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Fully decontaminate or properly dispose of personal protective clothing.

Section 5. Reactivity Data

Stability/Polymerization: Coal tar creosote is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Creosote oil mixed with chlorosulfonic acid in a closed container causes an increase in temperature and pressure.
Conditions to Avoid: Avoid excessive heat and contact with chlorosulfonic acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of coal tar creosote can produce oxides of carbon and thick, black, acrid smoke.

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Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA list coal tar creosote as a carcinogen.
Summary of Risks: Coal tar creosote is toxic by inhalation, ingestion, and skin contact. It contains a variety of hydrocarbons such as phenol and polycyclic aromatic hydrocarbons such as benzo[a]pyrene, benzanthracene, and phenol derivatives. The range of toxicity depends on the exposure concentration, amount, and duration. Effects may include irritation, burns, and several forms of cancer.
Medical Conditions Aggravated by Long-Term Exposure: Chronic respiratory or skin diseases.
Target Organs: Eyes, skin, bladder, kidneys, and respiratory system.
Primary Entry Routes: Inhalation, ingestion, and skin contact.
Acute Effects: Skin contact may cause irritation, burning, itching, redness, pigment changes, dermatitis (a rash of redness and small bumps), or burns. Photosensitization (worsening of rash with exposure to sunlight) may occur. Inhalation may be irritating to the respiratory tract. Eye contact may cause conjunctivitis (inflammation of the eye's lining), keratitis (corneal inflammation), or corneal burns with scarring. Ingestion may result in nausea, vomiting, abdominal pain, rapid pulse, respiratory distress, and shock. Systemic absorption by any route (including skin absorption) may cause trouble breathing, thready (continuous or drawn out) pulse, dizziness, headache, nausea, vomiting, salivation, and convulsions. Exposure to large doses (particularly by ingestion) may be fatal.
Chronic Effects: Dermatitis, skin cancer, and lung cancer.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* let victim rub eyes or keep them tightly closed. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Wash affected area with soap and flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of milk or water. *Do not induce vomiting!*
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Cresol may be detected in urine.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate hazard area, deny entry, and stay upwind of spills. Shut off all ignition sources--no flares, smoking, or flames in hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If possible with no risk, stop leak. Water spray may be used to reduce vapor but it may not prevent ignition in closed spaces. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Degradation: Coal tar creosote is fouling to shoreline. Ecotoxicity values are: TL_m, goldfish (*Carassius auratus*), 3.51 ppm/24 hr (60:40) mixture of creosote and coal tar; LD_{50}, bob white quail (*Colinus virginianus*), 1,260 ppm/8 days (60:40) mixture of creosote and coal tar.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Material No. U051
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed (as coal tar pitch volatiles) as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent all skin contact. Applying a layer of petroleum jelly or lanolin castor oil ointment to the face reduces vapor contact and penetration through skin. Frequent change of protective garments is an additional protective measure.
Ventilation: Provide general and local exhaust ventilation systems equipped with high-efficiency particulate filters to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Take particular care to avoid any contamination of drains or ventilation ducts. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in a cool, dry, well-ventilated area. Store coal tar creosote as close to area of use as possible to minimize transporting distance.
Engineering Controls: Use engineering controls to keep airborne concentrations below the OSHA PEL. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Always perform synthesis and purification procedures under a vertical ventilation hood and make regular operational safety checks. Label doors to rooms where coal tar creosote is produced, used, or stored as containing a carcinogen. Locate emergency equipment at well-marked and clearly identified stations in case emergency escape is necessary.
Other Precautions: Preplacement and periodic medical examinations of exposed workers emphasizing respiratory, skin, liver, and kidney disorders, including comprehensive work and medical history, physical examination, CXR, PFTs, urinalysis, LFT, and sputum cytology as the attending physician considers appropriate. Educate workers about coal tar creosote's carcinogenicity and proper handling procedures to avoid exposure.
Other Comments: Caution is in order when handling or sawing old creosote-treated lumber since it retains a considerable portion of creosote for up to 25 to 30 years.
Transportation Data (49 CFR 172.101)
Shipping Name: Creosote
Hazard Class: Flammable liquid
ID No.: UN1136
DOT Label: Flammable liquid

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 142, 143, 146, 148, 153, 159
Prepared by: M Gannon, BA; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: Mark Upfal, MD, MPH; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 469
Fuel Oil No. 2

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

Fuel Oil No. 2 Description: A mixture of petroleum hydrocarbons; a distillate of low sulfur content. Fuel oil no. 2 resembles kerosine. Used as a general-purpose domestic or commercial fuel in atomizing-type burners; as a fuel for trucks, ships and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.
Other Designations: CAS No. 68476-30-2, diesel oil.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[71] for a suppliers list.

R 1
I -
S 2
K 2

NFPA
2
0 0
-

HMIS
H 0
F 2
R 0
PPG*
* Sec. 8

Cautions: Fuel oil No. 2 is a skin irritant and central nervous system depressant with high mist concentrations. It is an environmental hazard and a dangerous fire hazard when exposed to heat, flame, or oxidizers.

Section 2. Ingredients and Occupational Exposure Limits

Fuel oil No. 2*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data†
None established	None established	None established	Rat, oral, LD_{50}: 9 g/kg; produces gastrointestinal effects (hypermotility, diarrhea)

* A complex mixture (<95%) of paraffinic, olefinic, naphthenic, and aromatic hydrocarbons; sulfur content (<0.5%); and benzene (<100 ppm). {A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)}.
† Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 363 to 634 °F (184 to 334 °C)
Viscosity: 268 centistoke at 100 °F (37.8 °C)
Specific Gravity: 0.8654 at 59 °F (15 °C)
Appearance and Odor: Brown, slightly viscous liquid.
Water Solubility: Insoluble
Pour Point:* <21 °F (-6 °C)

*Pour point is the lowest temperature at which a liquid flows from an inverted test container.

Section 4. Fire and Explosion Data

Flash Point: 100 °F (38 °C) min.	Autoignition Temperature: 494 °F (257 °C)	LEL: 0.6% v/v	UEL: 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, foam, water fog or spray. Do not use a forced water spray directly on burning oil since this scatters the fire. Use a smothering technique to extinguish fire.
Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. This fuel oil's volatility is similar to gasoline's.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to health and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Fuel oil no. 2 is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Incompatible with strong oxidizing agents; heating greatly increases fire hazard.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of fuel oil no. 2 yields various hydrocarbons and hydrocarbon derivatives and partial oxidation products including carbon dioxide, carbon monoxide, and sulfur dioxide.

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Section 6. Health Hazard Data

Carcinogenicity: Although it has not assigned an overall evaluation to fuel oil No. 2, the IARC has evaluated distillate (light) fuel oils as not classifiable as human carcinogen (Group 3; animal evidence limited).
Summary of Risks: Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, stupor, convulsions, or unconsciousness, depending on concentration and time of exposure. Since intestinal absorption of longer chain hydrocarbons is lower than absorption from lighter fuels, a lesser degree of systemic effects and more diarrhea may result. When removed from exposed area, affected persons usually experience complete recovery. Hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result if oil is aspirated into the lungs. These results are more likely when vomiting after ingestion rather than upon ingestion, as is often the case with lower viscosity fuels. A comparative ratio of oral-to-aspirated lethal doses may be 1 pt vs. 5 ml. Prolonged or repeated skin contact may cause irritation of the hair follicles and may block the sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system (CNS), skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal (GI) irritation, vomiting, diarrhea, and, in severe cases, CNS depression, progressing to coma and death. Inhalation of aerosol or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish coloration of the skin and mucous membranes caused by deficient blood oxygenation).
Chronic Effects: Repeated contact with the skin causes dermatitis.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body are exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Fuel oil no. 2 is an environmental hazard. Report large spills.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for an OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in areas of storage or use.
Engineering Controls: Avoid prolonged skin contact and vapor or mist inhalation. Use only in a well-ventilated area with personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.

Transportation Data (49 CFR 172.101)
DOT Shipping Name: Fuel oil
DOT Hazard Class: Combustible liquid
ID No.: NA1993
DOT Label: None
DOT Packaging Exceptions: 173.118a
DOT Packaging Requirements: None

MSDS Collection References: 1, 6, 7, 12, 73, 84, 103, 126, 127, 132, 133, 136, 143
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: W Silverman, MD; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:
Sheet No. 34
Ozone
Issued: 8/78 Revision: C, 9/92

Section 1. Material Identification

Ozone (O_3) Description: Occurs in the atmosphere from UV light action on oxygen at high altitudes where it acts as an atmospheric shield against UV light penetration. Derived by passage of air or oxygen between electrodes across which is maintained an alternating high voltage potential, or by heating silver difluoride in a dilute aqueous acid. It may also be found as a by-product in welding arcs, in corona discharges by ultraviolet radiation and around high voltage equipment. Ozone's largest use is as an oxidizing agent in azelaic acid production. Also used as a disinfectant for air and water; in bleaching textiles, paper pulp, waxes, starch, and sugar; organic synthesis, processing certain perfumes, vanillin, camphor, peroxide production, rapid drying of varnish and printing inks; for mold and bacteria control in cold storage rooms, and refining mineral oils and their derivatives. Considered for deodorizing and disinfecting certain premises and purifying air with a high carbon monoxide concentration such as found in garages. However this use is controversial because of the high levels of ozone needed and the inherent hazards.

Other Designations: CAS No. 10028-15-6, triatomic oxygen

Manufacturer: Contact supplier or distributor. Consult *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: A powerful oxidizing agent, ozone is highly chemically reactive and extremely shock sensitive as a liquid or solid. Inhalation produces various degrees of respiratory effects from irritation to pulmonary edema (fluid in lungs) as well as affecting the eyes, blood, and central nervous system. Liquid ozone on contact with skin or mucous membranes produces severe burns.

Gas

R	1
I	4
S	-
K	0

HMIS
H 3*
F 0
R 1
PPE†
* Chronic effects
† Sec. 8

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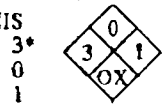

Liquid

R	3
I	4
S	4
K	0

HMIS
H 1*
F 0
R 3
PPE†
* Chronic effects
† Sec. 8

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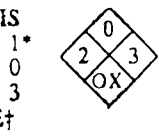

Section 2. Ingredients and Occupational Exposure Limits

Ozone, ca 100%

1991 OSHA PELs
8-hr TWA: 0.1 ppm (0.2 mg/m^3)
15-min STEL: 0.3 ppm (0.6 mg/m^3)

1990 IDLH Level
10 ppm

1990 NIOSH REL
Ceiling: 0.1 ppm (0.2 mg/m^3)

1992-93 ACGIH TLV
Ceiling: 0.1 ppm (0.2 mg/m^3)

1990 DFG (Germany) MAK
TWA: 0.1 ppm (0.2 mg/m^3)
Category 1: local irritant
Peak Exposure Limit: 0.2 ppm, 5 min momentary value, 8 per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 1860 ppb/75 min caused watering eyes, decreased pulse rate with a fall in blood pressure, and cough.
Human, inhalation, TC_{Lo}: 1 ppm caused cough, difficulty breathing, and other changes.
Rat, inhalation, TC_{Lo}: 1500 ppb/24 hr (17 to 20 days of pregnancy) produced behavioral disorders in newborn.
Rat, inhalation, TC_{Lo}: 1040 ppt/24 hr (6 to 9 days of pregnancy) caused developmental abnormalities of the musculoskeletal system.

* See NIOSH, *RTECS* (RS8225000), for additional irritation, mutation, reproductive and toxicity data.

Section 3. Physical Data

Boiling Point: -169 °F (-111 °C)
Melting Point: -315 °F (-193 °C)
Vapor Pressure: > 1 atm
Vapor Density (Air = 1): 1.655
Refraction Index: 1.2226 (liquid)
Odor Threshold: 0.0076 to 0.25 ppm

Molecular Weight: 48
Density: 1.614 g/mL (*liquid*) at -319 °F (-195.4 °C), 2.144 g/L (*gas*) at 32 °F (0 °C)
Water Solubility: Very slightly soluble, 0.49 mL/100 mL at 32 °F (0 °C)
Other Solubilities: Soluble in alkaline solvents.
Ionization Potential: 12.52 eV

Appearance and Odor: Unstable bluish gas [> -169 °F (-112°C)], dark blue liquid [-169 to -315 °F (-112 to 192.5°)], or blue-black crystals [< 315 °F (-192.5°C)], with a pungent odor.

Section 4. Fire and Explosion Data

Flash Point: Nonflammable	Autoignition Temperature: Nonflammable	LEL: None reported	UEL: None reported

Extinguishing Media: Use extinguishing agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: Container may explode in heat of fire. Decomposition of ozone into oxygen can increase strength of fire.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. If possible without risk, remove container from fire area. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Ozone is unstable at normal temperatures and readily decomposes to biatomic oxygen. In its liquid and solid forms, ozone exploded violently when shocked, exposed to heat or flame, or by chemical reaction with reducing agents. Hazardous polymerization cannot occur. Ozones' stability in aqueous solutions decreases as alkalinity increases but this is reversed at high alkaline concentrations. For example, ozones' half-life is 2 min at 1 N sodium hydroxide but 83 hr at 20 N sodium hydroxide.

Chemical Incompatibilities: Ozone accelerates decomposition of rubber and reacts with non-saturated organic compounds to produce ozonides which are unstable and may decompose with explosive violence. It is incompatible with acetylene, alkenes, alkyl metals, benzene, aniline, bromine, charcoal + potassium iodide + friction, isopropylidene compounds, dicyanogen, diethyl ether, *t*-2,3-dichloro-2-butene; 1,1-difluoroethylene; hydrogen bromide; 2-methyl-1,3-butadiene; nitrogen, nitrogen oxide, nitrogen trichloride, fluoroethylene, liquid hydrogen (with solid O_3), ethylene (at -238 °F/- 150 °C), (carbon monoxide, ammonia, or phosphine at 32 or -108 °F/0 or -78 °C), liquid oxygen difluoride + gaseous hydrogen, silica gel, stibine (at -130 °F/-90 °C), tetrafluorohydrazine, and all other reducing materials, organic or inorganic.

Conditions to Avoid: Shock, exposure to heat or flame and contact with incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of ozone can produce oxygen.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list ozone as a carcinogen.

Summary of Risks: Ozones' toxic effects are largely due to its strong oxidative ability. It has a radiomimetic structure (like ionizing radiation) and therefore has no true threshold limit and no exposure (no matter how small) is 'theoretically' without effect. Since it is only slightly water soluble it does not solubilize in the mucous membranes along the respiratory tract but rather passes straight to the smallest.....

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Section 6. Health Hazard Data, *continued*

brochioles and alveoli. Exercise increases inhaled ozones' toxicity. Initial small exposures may reduce cell sensitivity and/or increase mucous thickness producing an adaptation to low levels of ozone. This is shown by the greater reaction of newly exposed individuals as compared with those previously exposed to similar levels. Industrial exposures are most likely due to leakage from ozone-using processes and from exposure to high-voltage electrical equipment and electric-arc welding.

[redacted]ical Conditions Aggravated by Long-Term Exposure: Respiratory disorders.

[redacted]get Organs: Blood, respiratory and central nervous systems.

Primary Entry Routes: Inhalation and skin contact (with liquid ozone).

Acute Effects: Inhalation can cause nose, throat, and respiratory tract irritation, cough, difficulty breathing, visual disturbances, watering eyes, headache, decreased pulse rate with a fall in blood pressure, incoordination, chest pain, substernal soreness, and fatigue. By analogy to animals, severe exposures cause hemorrhage, pulmonary edema (fluid in lungs), and death. Human tissue and animal studies have shown blood changes (disk to spherical RBC shape, thus allowing easier hemolysis), chromosomal changes and reproductive effects. Cell membrane damage has been shown in heavily exposed animals where eventual tissue death can form a characteristic lesion at the junction of the conductive airways and gas exchange lung region, a site expected to be similarly affected in humans. Skin contact with liquid ozone can cause frostbite.

Chronic Effects: Repeated exposure may cause breathing disorders through respiratory tract scarring or premature aging as seen in continued exposure to ionizing radiation.

FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: If frostbite occurs, rapidly rewarm in 107.6 °F (42°C) until completely recovered.

Inhalation: Remove exposed person to fresh air, support breathing, and administer 100% humidified oxygen as needed.

Ingestion: Highly unlikely since ozone is a gas until -169 °F.

Note to Physicians: Detection of lactate dehydrogenase in the blood may indicate increased lung permeability due to ozone damage. Administration of 100% oxygen may be all that is needed to relieve symptoms. Persistent hypoxia may require endotracheal intubation.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. If leak can not be repaired in place, remove cylinder to safe, open area and repair or allow to empty. Cleanup personnel need to protect against gas inhalation or skin contact with the liquid (extremely cold). Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Environmental Data: Ozone contributes to photochemical smog formation. By limiting the emission of air pollutants converted to ozone, such as reactive hydrocarbons and nitrogen oxides, atmospheric ozone concentrations would decrease.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.23): No. D003,
Characteristic of reactivity (*as liquid or solid ozone*)

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 100 lb

SARA Toxic Chemical (40 CFR 372.65): Not listed

[redacted]d "Unlisted Hazardous Waste, Characteristic of reactivity" as a CERCLA [redacted]zardous Substance* (40 CFR 302.4, *as liquid or solid ozone*): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001]

OSHA Designations

Listed as an Air Contaminant
(29 CFR 1910.1000, Table Z-1-A)

Listed as a Process Safety Hazardous Chemical
(29 CFR 1910.119), RQ: 100 lb

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1 ppm, use a supplied-air respirator (SAR) or SCBA. For < 2.5 ppm, use a SAR operated in continuous-flow mode or powered air-purifying respirator with suitable chemical cartridges. For < 5 ppm, use a SAR or SCBA with a full facepiece. For < 10 ppm, use a SAR operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. Seals and tubing used in respirator gear should be oxidation resistant. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. Other: Wear cryogenically (severe cold) protective gloves, boots, aprons, and gauntlets to prevent skin contact. Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. Contaminated Equipment: Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store containers in refrigerated areas away from reducing agents and flammable materials such as iron, copper, or chromium that may catalyze decomposition. Suitably insulate all electrical equipment and electrically ground and bond all equipment used in ozone manufacture, use, storage, transfer, and shipping. Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Enclose or equip with exhaust ventilation, processes employing ozone to capture any escaping gas at the source. Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the respiratory tract. Chest x-rays and pulmonary function tests (FEV& FVC) are advisable. Workers handling liquid O_3 should protect against severe cold (cryogenic materials).

Transportation Data (49 CFR 172.101)

DOT Name: Compressed liquefied gas, n.o.s.; zone A
DOT Hazard Class: 2.3
ID No.: UN1955
[redacted] Packaging Group: ---
[redacted] Label: Poison Gas
Special Provisions: (172.102): 1

Packaging Authorizations
a) Exceptions: None
b) Nonbulk Packaging: 173.192
c) Bulk Packaging: 173.245

Quantity Limitations
a) Passenger, Aircraft, or Railcar: Forbidden
b) Cargo Aircraft Only: Forbidden

Vessel Stowage Requirements
Vessel Stowage: D
Other: 40

MSDS Collection References: 26, 73, 89, 100, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 163, 164, 167, 171, 174, 175, 180
Prepared by: M Gannon, BA; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: AC Darlington, MD

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PERFORMANCE ▲ COMMITMENT ▲ INTEGRITY

PCI OZONE & CONTROL SYSTEMS, INC
A Subsidiary of PCI, Inc.

ONE FAIRFIELD CRESCENT
WEST CALDWELL, N.J. 07006 USA
(201) 575-7052
FAX: (201) 576-8941

MATERIAL SAFETY DATA SHEET

OZONE

SECTION I

Manufacturer Name: PCI OZONE & CONTROL SYSTEMS, INC.
Manufacturer of Ozone Generator Systems.
Emergency phone number: 201-575-7052
Address: 1 Fairfield Crescent, West Caldwell, New Jersey 07006

Chemical Family: Gaseous Oxident
Chemical Formula: 03

SECTION II

Hazardous Ingredients:

OZONE - 2% by weight in dry air
3% by weight in oxygen

SECTION III

Physical Data:

Melting Point: Centigrade -251
Boiling Point: Centigrade -111
Water Solubility - 14 mg/l from 2% ozone in air
Appearance and odor at ambient temperature and pressure:
Clear colorless gas with pungent odor.

SECTION IV

Fire and Explosion Hazard Data:

Ozone is most often generated from air at concentrations of 1-10% by weight. At these concentrations ozone is non-explosive. Ozone at these concentrations will support combustion only slightly better than air itself. Firefighting equipment would be any equipment suitable for fighting fires suitable for other hazards.
If high ozone concentrations are present.
Self contained breathing apparatus should be used.

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FAX: (201) 575-8941

Material Safety Data Sheet
Page 2

SECTION V

Health Hazard Data

Threshold limit value: 0.12 mg/l in air for a weighted 8 hour exposure according to O.S.H.A.
Effects of exposure: coughing, headaches, loss of appetite, drowsiness, inflammation of upper respiratory track.
Emergency and first aid procedures:
Remove from air containing ozone: administer oxygen, if necessary.

SECTION VI

Stability: Slowly decomposes to oxygen from which it was made.
Conditions to avoid: Concentrating ozone to high levels (20%) where its reactivity and rate of decomposition accelerates.
Incompatability: Most organic materials are ozone reactive. Reactivity increases with materials which are saturated.

SECTION VII

Leak Procedures:
Procedure in case ozone is released: Leave area and remove ozone by exhausting the atmosphere.

SECTION VIII

SPECIAL PROTECTION INFORMATION

Respiratory protection: Self-contained breathing apparatus approved by U.S.Bureau of Mines is adequate if used for a short period of time.

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(201) 575-7052
FAX: (201) 575-8941

Ventilation: Use in well ventilated areas if leaks are anticipated.
Protective gloves: Plastic rather than rubber.
Other Protective Equipment: Plastic suits.

SECTION IX
Special Precautions:

Precautions to be taken in handling: Do not attempt to produce pure or high concentrations of ozone. If leaks are anticipated use only in well ventilated areas.

SECTION X

Primary route of entry is by the pulmonary system.

OTHER/msds

NO. 409A

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

CRESYLIC ACID

Date December 1979

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: CRESYLIC ACID
OTHER DESIGNATIONS: "Cresol", GE Material D5J3, CAS #001 319 773 (Cresol), CAS #001 300 716 (Xylenol)

DESCRIPTION: Commercial mixtures of phenolic compounds of which at least 50% boils higher than 204 C (arbitrary standard; see Ref. 7) and which vary widely depending on b.p. and source.

MANUFACTURE: Material available from several suppliers, including Koppers Co., Inc., Organic Materials Division.

SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Composition of Cresylic Acid Mixtures:		
Phenol (MSDS #355)	ca 0-8	8-hr TWA 5 ppm (skin)* or 19 mg/m^3
Cresol Isomers (MSDS #409)	<50	8-hr TWA 5 ppm (skin)* or 22 mg/m^3
Xylenol Isomers, Ethyl Phenol Isomers and C_9 Phenolics	>50	No TLV established**

*ACGIH (1979) and OSHA TLV.

**For regulatory purposes NIOSH has proposed that mixtures of xylenols with cresols be considered "cresols"; also NIOSH has proposed a 10-hr TWA of 2.3 ppm or 10 mg/m3 as the airborne exposure limit for both "cresols" and cresylic acids.

SECTION III. PHYSICAL DATA

Boiling range at 1 atm, deg C ---- 195-250* Specific gravity (H_2O=1)---- 1.02-1.04
Vapor pressure at 50 C, mm Hg ---- <1* Melting point, deg C ------- 0 to 50*
Water solubility ---------- Sl. Soluble
Appearance & Odor: Phenolic odor. Varied appearance: Mostly liquids but also slurries or solid depending on composition. Colorless to highly colored, depending on impurity.

*Illustrative property only; actual data depends on the composition of the individual cresylic acid.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Usually >200 F				

Extinguishing Media: Foam, dry chemical, carbon dioxide, and water spray or fog. Cool fire-exposed metal containers with a water spray.

This combustible material can be a moderate fire hazard and a slight explosion hazard when exposed to heat or flame.

Toxic vapors and gases are emitted from this material in a fire situation; firefighters must wear self-contained breathing apparatus and full protective clothing.

SECTION V. REACTIVITY DATA

This material is stable under conditions of normal handling and use. It does not undergo hazardous polymerization. Its properties are analogous to phenol and cresol, but it has a higher molecular weight.

This combustible material is incompatible with strong oxidizing agents; it can react exothermically with strong bases, with oleum, nitric acid, and chlorosulfonic acid.

Thermal-oxidative degradation will produce toxic vapors and gases, including carbon monoxide.

Hot cresylic acid readily attacks copper, aluminum, magnesium, zinc and lead. Ordinary carbon steel resists corrosion satisfactorily, but use stainless steel to retain high purity. It will dissolve or soften many organic polymers.

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GENIUM PUBLISHING CORP.

No. 470

DIESEL FUEL OIL NO. 2-D

Date October 1981

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: DIESEL FUEL OIL NO. 2-D
DESCRIPTION: Mixture of petroleum hydrocarbons; a distillate oil of low sulfur content
OTHER DESIGNATIONS: ASTM D975, CAS # 068 476 346
MANUFACTURER: Available from many suppliers

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Diesel Fuel Oil No. 2-D		
Complex mixture of paraffinic, olefinic, naphthenic and aromatic hydrocarbons**	>95	8-hr TWA 5mg/m^3* (mineral oil mist)
Sulfur content	<0.5	---
Benzene***	<100 ppm	

*Current OSHA standard and ACGIH (1981) TLV
**Diesel fuels tend to be low in aromatics and high in paraffinics. A min. Cetane No. of 40 is required (ASTM D613).
***A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)

SECTION III. PHYSICAL DATA

Boiling point range, deg F, -------	Ca 340-675	Specific gravity (H_2O=1) ----	<0.86
Solubility in water ----------	negligible	Cloud point (wax), deg C ---	Ca 0
Viscosity at 40 C, cSt ----------	1.9-4.1		

Appearance and Odor: Clear, bright liquid with a mild petroleum odor.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air % by volume	LOWER	UPPER
125F min (PM)	>500F		0.6	7.5

Extinguishing Media: Dry chemical, carbon dioxide, foam, water spray. Use a water spray to cool fire exposed containers. Use a smothering technique for extinguishing fire of this combustible liquid. Do not use a forced water stream directly on oil fire as this will only scatter the fire. Material is a OSHA Class II combustible liquid. Firefighters should wear self-contained breathing apparatus and full protective clothing.

SECTION V. REACTIVITY DATA

This is a stable material in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.
Incompatible with strong oxidizing agents; heating greatly increases fire hazard.
Thermal -oxidative degradation may yield various hydrocarbons and hydrocarbon derivatives (partial oxidation products), CO_2 and CO and SO_2.

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SECTION VI. HEALTH HAZARD INFORMATION

TLV 5 mg/m^3 (oil mist) (See Sect II)

Inhalation of excessive concentrations of vapor or mist can be irritating to the respiratory passages and can cause the following symptoms: headache, dizziness, nausea, vomiting, and loss of coordination. Prolonged or repeated skin contact may cause irritation of the hair follicles and block the sebaceous glands. This produces a rash of acne pimples and spots, usually on the arms and legs. (Good personal hygiene will prevent this).

Chemical pneumonitis may result when ingestion occurs and oil is aspirated in the lungs.

FIRST AID:

Eye Contact: Flush thoroughly with running water for 15 min. including under eyelids.

Skin Contact: Remove contaminated clothing. Wipe excess oil off with a dry cloth. Wash affected area well with soap and water.

Inhalation: Remove to fresh air. Restore and/or support breathing as required.

Ingestion: Do not induce vomiting.

Seek medical assistance for further treatment, observation and support.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of leaks or spills. Remove sources of heat or ignition. Provide adequate ventilation. Clean-up personnel to use protection against liquid contact and vapor or mist inhalation. Contain spill by diking. Small spills can be contained by using absorbants, such as rags, straw, polyurethane foam, activated carbon, and sand. Clean up spills promptly to reduce fire or vapor hazards.

DISPOSAL: May be disposed of by a licensed waste disposal company, or by controlled incineration or burial in an approved landfill.

Follow Federal, State and Local regulations. Report large oil spills.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide adequate ventilation where operating conditions (heating or spraying) may create excessive vapors or mists. Use explosion-proof equipment. Provide approved respiratory apparatus for nonroutine or emergency use. Use an approved filter & vapor respirator when vapor/mist concentrations are high. Wear protective rubber gloves and chemical safety glasses where contact with liquid or high mist conc. may occur. Additional suitable protective clothing may be required depending on working conditions. An eye-wash fountain and washing facilities to be readily available near handling and use areas.

Launder soiled or contaminated clothing before reuse (at least weekly laundering of work clothes is recommended).

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated area away from sources of open flame, heat, strong oxidizing agents, and ignition. Protect containers from physical damage. Use non sparking tools and explosion-proof electrical equipment. Prevent static electric sparks.

Avoid prolonged skin contact and breathing of vapors or mists.

No smoking in areas of use. Follow good hygienic practice in the use of this material. Do not wear oil contaminated clothing. Do not put oily rags into pockets. Wash exposed skin areas several times a day with soap and warm water when working with this material.

DOT Classification: COMBUSTIBLE LIQUID

DATA SOURCE(S) CODE: 1,6,7,12

APPROVALS: MIS CRD J. M. Miller

Industrial Hygiene and Safety JW 10-12-81

MEDICAL REVIEW: 21 October 1981

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GENIUM PUBLISHING CORP.

NO. 488

KEROSINE BURNER FUEL

DATE November 1982

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: KEROSINE BURNER FUEL*
DESCRIPTION: Refined petroleum middle distilate consisting of hydrocarbons having ~10-16 carbon atoms for use in burners and wick-fed lamps.
OTHER DESIGNATIONS: Kerosene Burner Fuel, Coal Oil, Range Oil, ASTM D3699, CAS #008 008 20
MANUFACTURER: Available from many suppliers.

*The spelling "kerosine" is preferred by ASTM and ACS. See also Kerosene Solvent, MSDS #387

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Hydrocarbon Mixtures (variable) consisting of paraffins (mainly), naphthenes, olefins & aromatics	>98	No TLV Established*
Total Sulfur Content, max.		
Kerosine No. 1-K Low Sulfur Grade	0.04	
Kerosine No. 2-K Regular Grade	0.30	
(Flue connection required for burners for 2-K use.)		
Mercaptan Sulfur, max.	30 ppm	Rat, Oral LDLo 28 g/kg
*Exposure limits depend on components (variable); get supplier recommendation for product. NIOSH (1977) recommended 10-hr TWA of 100 mg/m^3 or about 14 ppm for kerosene with b.p. 347-617 F.		..

SECTION III. PHYSICAL DATA

Boiling range, deg C at 1 atm ---- 175-300
Vapor pressure at 20 C, mm Hg ---- ca 5
Vapor density (Air=1) ---------- ca 4.5
Solubility in water ------------ insoluble

Specific gravity (H_2O=1) -- ca 0.8
Freezing point, deg C --- below -30
Viscosity at 40 C, cSt ---- 1.0-1.9

Appearance & Odor: Pale yellow or water-white, mobile, oily liquid; mild petroleum odor.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
100F (min) (CC)	>410F	Volume %	ca 0.8	ca 6

Extinguishing Media: Dry chemical, carbon dioxide, foam, water spray or fog. Use a smothering technique for extinguishing fire. A forced stream of water could scatter flames of burning kerosine. Flammable vapors will be emitted from heated liquid.
Use a water spray (Caution!) to cool fire-exposed containers to prevent violent rupture. Water runoff to sewer may carry combustible kerosine and create a fire or explosion hazard.
Firefighters should use self-contained breathing apparatus and protective clothing.

SECTION V. REACTIVITY DATA

This material is stable in closed containers at room temperature under normal storage and handling conditions. It does not polymerize. Heating greatly increases the flammability hazard of this OSHA Class II combustible liquid.
Kerosine is incompatible with strong oxidizing agents.
Thermal-oxidative degradation can yield partial oxidation products, hydrocarbons, carbon monoxide and dioxide, and small amounts of sulfur dioxide (depending on sulfur content).

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AIR PRODUCTS & CHEMICALS -- HELIUM - HELIUM, TECHNICAL, GRADE A
MATERIAL SAFETY DATA SHEET
NSN: 6830006600027
Manufacturer's CAGE: 00742
Part No. Indicator: C
Part Number/Trade Name: HELIUM

General Information

Item Name: HELIUM, TECHNICAL, GRADE A
Company's Name: AIR PRODUCTS AND CHEMICALS INC.
Company's Street: 7201 HAMILTON BLVD
Company's City: ALLENTOWN
Company's State: PA
Company's Country: US
Company's Zip Code: 18195-1501
Company's Emerg Ph #: 800-523-9374
Company's Info Ph #: 215-481-4911
Record No. For Safety Entry: 006
Tot Safety Entries This Stk#: 014
Status: FM
Date MSDS Prepared: 01JUL90
Safety Data Review Date: 09DEC94
Supply Item Manager: GSA
MSDS Serial Number: BJZBR
Specification Number: BB-H-1168
Hazard Characteristic Code: G3
Unit Of Issue: CF
Unit Of Issue Container Qty: 217 CF
Type Of Container: METAL

Ingredients/Identity Information

Proprietary: NO
Ingredient: HELIUM
Ingredient Sequence Number: 01
NIOSH (RTECS) Number: MH6520000
CAS Number: 7440-59-7
OSHA PEL: NOT ESTABLISHED
ACGIH TLV: NOT ESTABLISHED
Other Recommended Limit: NONE SPECIFIED

Physical/Chemical Characteristics

Appearance And Odor: HELIUM IS COLORLESS AND ODORLESS IN BOTH GASEOUS AND LIQUID STATES.
Boiling Point: -452F,-269C
Melting Point: -458F,-272C
Vapor Density (Air=1): 0.01114
Specific Gravity: 0.138 @ 1ATM 0C
Solubility In Water: 0.861% (VOL) @ 68 F

Fire and Explosion Hazard Data

Flash Point: NA
Unusual Fire And Expl Hazrds: CYLINDERS EXPOSED TO INTENSE HEAT OR FIRE MAY VENT RAPIDLY OR EXPLODE.

Reactivity Data

Stability: YES
Hazardous Poly Occur: NO

Health Hazard Data

Route Of Entry - Inhalation: YES
Health Haz Acute And Chronic: HELIUM IS ODORLESS AND NONTOXIC, BUT MAY PRODUCT CAUSE SUFFOCATION BY DILUTING THE CONCENTRATION OF OXYGEN IN AIR BELOW LEVELS NECESSARY TO SUPPORT LIFE. IF OXYGEN CONCENTRATION IS BELOW 19.5% USE W/SCBA OR AIRLINE RESPIRATOR. EXPOSURE TO OXYGEN-DEFICIENT ATMOSPHERES MAY PRODUCE *
Signs/Symptoms Of Overexp: *DIZZINESS, NAUSEA, VOMITING, LOSS OF CONSCIOUSNESS, DEATH.DEATH MAY RESULT FROM ERRORS IN JUDGMENT, CONFUSION OR LOSS OF CONSCIOUSNESS WHICH PREVENTS SELF-RESCUE.AT LOW OXYGEN CONCENTRATIONS UNCONSCIOUSNESS & DEATH MAY OCCUR IN SECONDS WITHOUT WARNING. EXTENSIVE TISSUE DAMAGE/BURNS FROM LIQUID/COLD HELIUM VAPOR EXPOS
Emergency/First Aid Proc: REMOVE TO FRESH AIR. SCBA MAY BE REQUIRED TO PREVENT ASPHYXIATION OF RESCUE WORKERS. CPR AND SUPPLEMENTAL OXYGEN SHOULD BE GIVEN IF THE VICTIM IS NOT BREATHING. IF CRYOGENIC LIQUID OR COLD BOIL-OFF GAS CONTACTS A WORKER'S SKIN OR EYES, FROZEN TISSUES SHOULD BE FLOODED OR SOAKED W/TEPID WATER. DO NOT USE HOT WATER. SEE PHYSICIAN FOR CRYOGENIC BURNS WHICH RESULT IN BLISTERING/DEEPER TISSUE FREEZING.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: AVOID CONTACT OF SKIN W/LIQUID HELIUM OR ITS COLD BOIL-OFF GAS. FLUSH LIQUID SPILL W/WATER TO DISPERSE. VENTILATE ENCLOSED AREAS TO PREVENT FORMATION OF OXYGEN-DEFICIENT ATMOSPHERES CAUSED BY EVAPORATION OF LIQUID HELIUM OR RELEASE OF GASEOUS HELIUM.
Waste Disposal Method: LET LIQ HELIUM EVAPORATE IN WELL-VENT LOCATION AWAY FROM WORK AREAS. VENT HELIUM GAS SLOWLY TO WELL-VENT OUTDOOR LOCATION AWAY FROM WORK AREAS. DO NOT DISPOSE IN COMPRESSED GAS CYLINDERS.RETURN CYLINDERS TO AIR PRODUCTS W/VALVE TIGHTLY CLOSED/CAP ON.
Precautions-Handling/Storing: STORE/USE IN WELL-VENT AREA. KEEP FROM HEAT SOURCES. STORE IN AREAS W/O HEAVY TRAFFIC. KEEP VALVE CAPS ON CYLINDERS NOT CONNECTED FOR USE.
Other Precautions: PREVENT SKIN CONTACT/ENTRAPMENT OF LIQUID IN ENCLOSED SYSTEM. HANDLE CYLINDERS W/CARE. USE PRESSURE REDUCING REGULATOR WHEN CONNECTING TO LOWER PRESSURE PIPING SYSTEMS. NEVER USE DIRECT FLAME TO HEAT CYLINDER. SECURE CYLINDER WHEN IN USE.**

Control Measures

Respiratory Protection: USE SELF-CONTAINED BREATHING APPARATUS IN OXYGEN-DEFICIENT ATMOSPHERES. CAUTION! AIR PURIFYING RESPIRATORS WILL NOT FUNCTION. THEIR USE MAY RESULT IN ASPHYXIATION.
Ventilation: NATURAL OR MECHANICAL WHERE GAS IS PRESENT. VENTS SHOULD BE SITUATED TO AVOID HIGHER THAN NORMAL HELIUM CONCENTRATIONS.
Protective Gloves: IMPERMEABLE OR LEATHER GLOVES.
Eye Protection: SAFETY GLASSES, CHEM GOGGLES, FACESHIELD
Suppl. Safety & Health Data: **USE CHECK VALVE TO PREVENT BACK FLOW INTO STORAGE CONTAINER. AVOID DRAGGING, ROLLING OR SLIDING CYLINDERS, EVEN FOR A SHORT DISTANCE. USE SUITABLE HAND TRUCK. SEGREGATE FULL & EMPTY CYLINDERS. STORAGE AREAS SHOULD BE FREE OF COMBUSTIBLE MATERIAL. AVOID EXPOSURE TO AREAS WHERE SALT OR CORROSIVE CHEMICALS ARE PRESENT.

Transportation Data

Trans Data Review Date: 91122

DOT PSN Code: GZR
DOT Proper Shipping Name: HELIUM, COMPRESSED
DOT Class: 2.2
DOT ID Number: UN1046
DOT Label: NONFLAMMABLE GAS
IMO PSN Code: HWT
IMO Proper Shipping Name: HELIUM, COMPRESSED
IMO Regulations Page Number: 2144
IMO UN Number: 1046
IMO UN Class: 2(2.2)
IMO Subsidiary Risk Label: -
IATA PSN Code: NCJ
IATA UN ID Number: 1046
IATA Proper Shipping Name: HELIUM, COMPRESSED
IATA UN Class: 2.2
IATA Label: NON-FLAMMABLE GAS
AFI PSN Code: NCJ
AFI Prop. Shipping Name: HELIUM, COMPRESSED
AFI Class: 2.2
AFI ID Number: UN1046
AFI Basic Pac Ref: 6-6,6-10
MMAC Code: NK

Disposal Data

Label Data

Label Required: YES
Label Status: G
Common Name: HELIUM
Special Hazard Precautions: HELIUM IS ODORLESS AND NONTOXIC, BUT MAY PRODUCT CAUSE SUFFOCATION BY DILUTING THE CONCENTRATION OF OXYGEN IN AIR BELOW LEVELS NECESSARY TO SUPPORT LIFE. IF OXYGEN CONCENTRATION IS BELOW 19.5% USE W/SCBA OR AIRLINE RESPIRATOR. EXPOSURE TO OXYGEN-DEFICIENT ATMOSPHERES MAY PRODUCE * *DIZZINESS, NAUSEA, VOMITING, LOSS OF CONSCIOUSNESS, DEATH.DEATH MAY RESULT FROM ERRORS IN JUDGMENT, CONFUSION OR LOSS OF CONSCIOUSNESS WHICH PREVENTS SELF-RESCUE. AT LOW OXYGEN CONCENTRATIONS UNCONSCIOUSNESS & DEATH MAY OCCUR IN SECONDS WITHOUT WARNING. EXTENSIVE TISSUE DAMAGE/BURNS FROM LIQUID/COLD HELIUM VAPOR EXPOS
Label Name: AIR PRODUCTS & CHEMICALS, INC., INDUSTRIAL GAS DIV
Label City: ALLENTOWN
Label State: PA
Label Zip Code: 18195
Label Country: US
Label Emergency Number: 800-523-9374

EXHIBIT A-E

AIR MONITORING FORM
DAILY INSTRUMENT CALIBRATION CHECK FORM
NOISE MONITORING FORM

AIR MONITORING FORM

Project Name:

Project Number:

Contaminants:

Date	Time	Ionization Detector Reading		Explosimeter Reading		Detector Tube Readings (ppm)	Location	Purpose	Initials
		FID	PID	%LEL	$\%O_2$				

FLUOR DANIEL GTI

AIR MONITORING FORM

Project Name:

Project Number:

Contaminants:

Date	Time	Ionization Detector Reading		Explosimeter Reading		Detector Tube Readings (ppm)	Location	Purpose	Initials
		FID	PID	%LEL	$\%O_2$				

FLUOR DANIEL GTI

DAILY INSTRUMENT CALIBRATION CHECK FORM

Project Name_____ Instrument_____

Job Number_____ ID #_____

DATE	INSTRUMENT	BATTERY CHECK OK?	ZERO ADJUST OK?	CALIBRATION GAS (PPM)	READING (PPM)	CALIBRATED BY:	COMMENTS

DAILY INSTRUMENT CALIBRATION CHECK FORM

Project Name_____ Instrument_____

Job Number_____ **ID #**_____

DATE	INSTRUMENT	BATTERY CHECK OK?	ZERO ADJUST OK?	CALIBRATION GAS (PPM)	READING (PPM)	CALIBRATED BY:	COMMENTS

NOISE MONITORING FORM

Project Name:

Project Number:

Noise: Equipment Used: (Type/Model)*

Date	Task	Location/Employee	Noise Reading dB(A)	Initials

*Pre-calibrate noise monitor prior to conducting noise survey.

NOISE MONITORING FORM

Project Name:

Project Number:

Noise: Equipment Used: (Type/Model)*

Date	Task	Location/Employee	Noise Reading dB(A)	Initials

*Pre-calibrate noise monitor prior to conducting noise survey.

EXHIBIT A-F

EXCAVATION/TRENCHING SAFETY PROCEDURES
TRENCH SAFETY DAILY FIELD REPORT
SOILS CLASSIFICATION CHECKLIST
SOILS ANALYSIS CHECKLIST
EXCAVATION/TRENCHING - UNDERGROUND UTILITIES
UNDERGROUND UTILITY CONTACT PREVENTION AND MANAGEMENT PLAN
EXCAVATION/TRENCHING - USTs
UST REMOVALS

ATTENTION:

THE TRENCH SAFETY DAILY FIELD REPORT FORM
MUST BE COMPLETED AT LEAST DAILY DURING EXCAVATION/TRENCHING OPERATIONS
AND MORE FREQUENTLY IF CONDITIONS CHANGE.

EXCAVATION/TRENCHING SAFETY PROCEDURES

Evaluation: Conducted by Competent Person 29 CFR 1926.

Two soil classifications must be completed to determine sloping/shoring requirements. Conduct daily inspections of all open excavations prior to entry.

Egress: Excavation areas 4 feet (1.22 meters) or more deep

Ladders must be spaced no more than 25 feet (7.62 meters) apart so that a person in the trench is always within 25 feet (7.62 meters) of a ladder for egress.

Shoring: Excavation areas 5 feet (1.52 meters) or more deep

Excavations must be sloped or shored if personnel will be entering the excavation. Soil classification may be done only by a competent person using both a visual and manual test.

WARNING: One soil classification may not be enough. Outside disturbances during excavation may change even the best classification.
Inspect the soil after any condition change.

Storage: All excavations

Spoils and heavy equipment must be stored a minimum of 2 feet (0.61 meters) from the edge of the excavation.
Store spoils on the downhill side.

Maximum Allowable Slopes

Soil or Rock Type	Maximum allowable slopes (H:V)[1] for excavations less than 20 feet (6.10 meters) deep[2]
Stable Rock[3]	Vertical (90°)
Type A - highly cohesive soil	3/4:1 (53°)
Type B - cohesive soil with some sand	1:1 (45°)
Type C - loose, wet, or sandy soil	1½:1 (34°)

Notes:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

2. Sloping or benching for excavations greater than 20 feet (6.10 meters) deep shall be designed by a registered professional engineer.

3. A short-term maximum allowable slope of ½ H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 meters) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 meters) in depth shall be 3/4 H:1V (53°)

TRENCH SAFETY DAILY FIELD REPORT

DATE:_____

Project Name:_____
Project Manager:_____
Weather Conditions:

I hereby attest that the following conditions existed and that the following items were checked or reviewed during this inspection.

INSPECTION ITEM	YES	NO	NA
All open trenches were inspected.			
Were any tension cracks observed along top of any slopes?			
Was any water seepage noted on trench walls or trench bottom?			
Was bracing system installed in accordance with design?			
Type shoring being used_____.			
Is shoring secure?			
Was there evidence of shrinkage cracks in trench walls?			
Was there any evidence of caving since the last field inspection?			
Trench box(s) certified with tabulated data?			
Traffic in area adequately away from trenching operations with barricades			
Surface encumbrances and other hazards in area accounted for?			
Protective measures taken for standing water in trench.			
All site personnel wearing reflective vest.			
Atmospheric testing conducted in trenched < 4 feet deep.			
Vibrations from equipment or traffic too close to trenching operation?			

Observations:_____

Competent Person signature_____

Soils Analysis Checklist

This checklist must be completed when soil analysis is conducted to determine the excavation soil type. A separate analysis must be performed on each layer of soil excavation walls. Additional soil analysis must also be performed for the excavation (trench) when it stretches over a distance where soil type may change.

Name:_____ Date:_____ Time:_____

Competent person:_____

Where was the sample taken from?_____

Excavation: Depth_____ Width_____ Length_____

SOIL CLASSIFICATION - VISUAL TEST				
ITEM	TEST PROTOCOL	YES	NO	COMMENTS/ACTIONS
1	**Soil Particle Type** Fine Grained/Cohesive Course Grained(Sand or Gravel)			
2	**Excavation Water Conditions** Dry Surface Water Present Submerged Water Present			
3	**Soil Condition** Undisturbed Disturbed Layered Soil Dipping Into Excavation Excavation Exposed to Vibrations Cracked/Fissures/Spalling Observed			
4	**Additional Excavation Hazards** Surface Encumbrances(If YES - What Type) Hazardous Atmosphere in Excavation (If YES - List Source and Conditions)			

SOIL ANALYSIS - MANUAL TEST		
RESULTS	THUMB TEST	Check here if conducted
	Type A - Soil identified by thumb with great degree of effort	
	Type B - Soil identified by thumb with some degree of effort	
	Type C - Soil identified by thumb with little degree or no effort	
RESULTS	PENETROMETER OR SHEARVANE - Circle which used	Write in brand/model
	Type A - Soil with unconfined compressive strength of 1.5 tons per square foot (tsf) or greater	
	Type B - Soil with unconfined compressive strength > 0.5 to 1.5 tsf	
	Type C - Soil with unconfined compressive strength < 0.5 tsf or soil that is submerged or exposed to water	

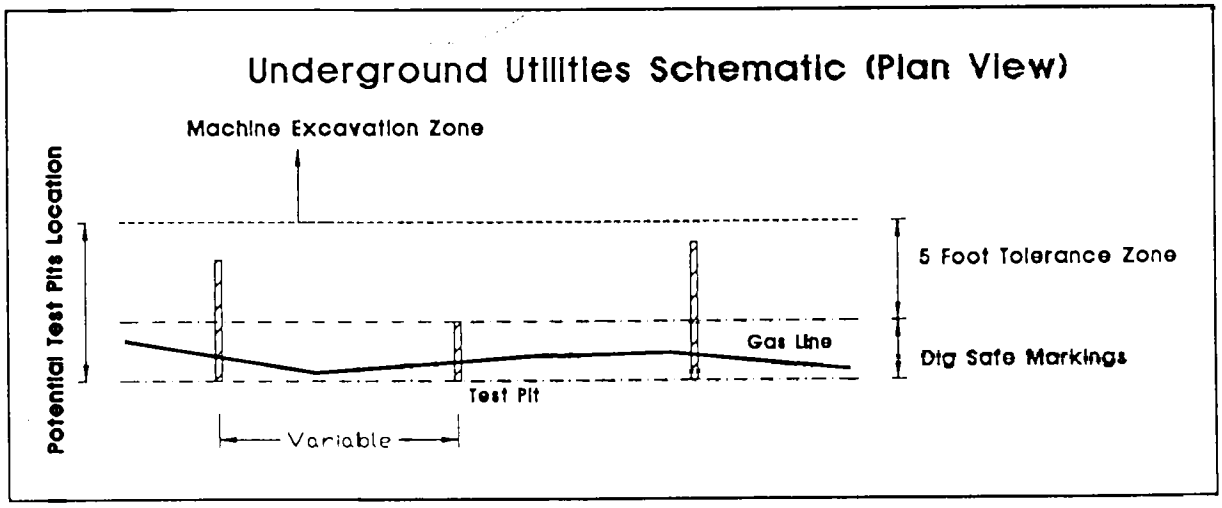
Soil Classification		
Type A	Type B	Type C

Selection of Protective System (Appendix F)	
PROTECTIVE SYSTEM	Sloping Specify angle_____ _____ Timber shoring _____ Aluminum hydraulic shoring _____ Trench Shield Max Depth in this soil_____

Note: Although OSHA will accept the above tests in most cases, some states do not - check your state safety requirements for trenching regulations.

EXCAVATION/TRENCHING - UNDERGROUND UTILITIES

Documentation:
Contact the local utility service (Digsafe, Misutility...), and document permit number A company utility representative in questionable areas, elaborate trenching projects tight/tricky areas or whenever drilling adjacent to a building or structure Contact the property owner and/or town building department for plans
Physical Location:
Use a metal detector to aid in the identification of obstructions Observe utility markers, vent pipes, catch basins, newly paved areas, etc.
Safety Procedures:
Machine excavate five feet from any underground utility, tank, or utility marker Hand dig in utility "five-foot tolerance zone" until the service is exposed Utilize test pits to establish and QC markers for sensitive utility locations
General Notes:
Comply with local and state codes and regulations Utilize experienced and trained equipment operators Use appropriate subcontractors and applicable insurance riders Hand dig per customer mandate



UTILITY MARK-OUT RECORD SHEET

Facility:_____ Location:_____

Fluor Daniel GTI Representative:_____ Date Called:_____

County of Work:_____ Township of Work:_____

Contact Miss Dig to have subgrade utilities marked. The nearest intersecting street for this site is: _____. We need the entire site area marked since we do not know exactly where we will be drilling/excavating. The site needs to be marked by:_____

List which utilities they will have marked. Confirmation Number:_____

List other known utilities in the area that they do not mark:_____

Contact other known utilities not contracted by Miss Dig to have them mark the site.

MAJOR UTILITIES MARKED BY COLOR CODE

ELECTRIC - RED

GAS - YELLOW

COMMUNICATIONS/CABLE - ORANGE

WATER - BLUE

SEWER - GREEN

OTHER CONTACTS:

IMPORTANT NOTE: ALL UNDERGROUND UTILITIES MAY NOT BE LOCATED BY MISS DIG.

UNDERGROUND UTILITY CONTACT PREVENTION AND MANAGEMENT PLAN

Check Off When Completed

STEPS	TASK DESCRIPTION	RESPONSIBLE EMPLOYEE
STEP 1	Obtain site blueprints from client, if available, to show buried utility/conduits.	PM
	If site blueprints are unavailable **other methods should be employed to identify subsurface conduits in the field. Examples include privately contracted utility locators such as SM&P, a hand-held utility location device, field observations (cut pavement, signs and overhead lights, water, electric, and gas meters, etc.), and customer personnel with knowledge of conduit locations. No one tool should be relied upon. Instead, as many tools as practicable should be employed to insure that all known/suspect conduits have been identified.**	PM and/or field personnel
	Mark out any proposed digging locations with white survey paint.	
STEP 2	Contact underground utility locating service (before you dig). Give proposed drilling dates, location, etc. **Documented notification of the proper underground notification service at a minimum of 48 or 72 hours prior to the scheduled site work.* (Check with the state for notification requirements).**	PM Assistant for contacting "miss dig" and/or field personnel
	If possible, arrange site visit with client, facilities maintenance manager, or other site knowledgeable person to verify, utility and drilling/excavation locations.	PM
	Regarding subcontractors: at a minimum, excavation subcontractors will be required to supply sufficient labor to complete all requested installation tasks.	PM
STEP 3	The HASP will be amended to include emergency telephone numbers for all utility companies identified during the notification process.	Office safety coordinator updates HASP with PM approval.

STEPS	TASK DESCRIPTION	RESPONSIBLE EMPLOYEE
STEP 4	On the day that on-site activities are scheduled to begin, at the first tailgate safety meeting, the locations of all known/suspect utilities (subgrade and overhead) will be reviewed with all personnel in the field (Fluor Daniel GTI and subcontractors). Make sure that all underground utility locator markings are visible for each noted utility, etc. Note any discrepancies. Visually inspect for undocumented trenches, laterals, etc. that may be visible as discolored areas, patched pavement, and not marked accordingly.	PM and/or field personnel PM and/or field personnel
STEP 5	Pre-screen each drilling/digging location by hand augering and/or post hole digger to a depth of at least 3 to 5 feet using a 3-inch OD minimum clam-shell style post hole digger and/or hand auger. Inspect excavation periodically with flashlight to check for visual obstructions. Discontinue immediately upon encountering any substantial resistance to hand auger and/or post hole digger.	Subcontractors to conduct hand augering and/or post hole digging under Fluor Daniel GTI oversight.
STEP 6	During excavation/trenching activities, barricades and cones with flags will be used to mark the 10-foot distance from a located conduit. This will serve as a reminder of the conduit's presence and to alert the Fluor Daniel GTI supervisor that it is time to pay close attention to excavation/trenching activities.	Field personnel

UNDERGROUND UTILITY CONTACT PREVENTION AND MANAGEMENT PLAN (continued)

STEPS	TASK DESCRIPTION	RESPONSIBLE EMPLOYEE
STEP 7 ENCOUNTER	In the unlikely event that a subsurface utility/conduit is encountered, immediately halt all drilling/digging operations and secure the area. Try to determine the source (i.e., gas line, water line, etc.) and contact the emergency numbers for that utility. Contact the PM immediately. Take all safety precautions to insure that all flames, etc. are extinguished, and all personnel are kept away from the area. Monitor for LEL, O_2, PID, and any other substances that may be present as appropriate for that utility encounter (i.e., gas line). The PIR is filled out by field personnel and submitted to the PM.	Fluor Daniel GTI field personnel secures area and contacts PM immediately. PM contacts client, etc., to discuss appropriate actions. Fluor Daniel GTI field personnel contacts local emergency officials as necessary (i.e., fire, police, EPA, public works, etc.). PM submits PIR to appropriate Fluor Daniel GTI management and prepares follow-up report.

EXCAVATION/TRENCHING - UST

Documentation:

Refer to existing UST plans for potential location.
Contact property owners for potential location.
Contact local Fire or Building Department for information.

Physical Location Characteristics: Cross-check to existing documentation, if available

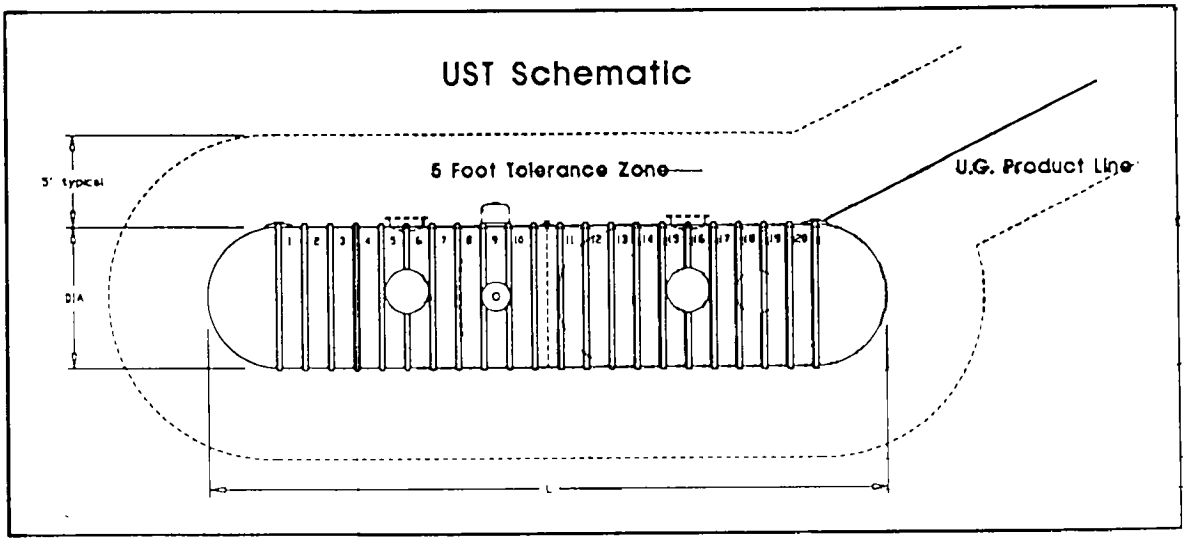
Determine tank capacity (from tank chart, owner, delivery records).
Determine tank opening locations and spacing.
Determine tank diameter (from tank chart, inventory records or gauge stick).
Determine if tank is fiberglass or steel; single walled or double walled
Refer to available UST vendor info charts on standard USTs for dimensions and tank opening locations.

Safety Procedures:

Empty tank of flammable liquids prior to excavation activities. Inert tank of flammable vapors and eliminate ignition sources (if practical).
Drill no closer than five feet from suspected tank location or other nearby underground utilities.

General Notes:

Concrete pad on top of the USTs is sized to overhang the footprint of the tanks by 1 to 2 feet in each direction. Beware of exceptions.
When possible, have the owner/client mark the locations for drilling and accept responsibility for potential mishaps in writing.
Redundant information cross-checking to reduce oversight errors
Visual inspection of augured or excavated materials for pre-gravel, etc., indicative of UST backfill/bedding.



UST REMOVALS*		
Minimum Action	**Site Set-Up**	**Precautions**
1. Ignition sources must be eliminated 2. Designate a no smoking zone or area. 3. Use pneumatic/nonsparking tools when appropriate. 4. Define the work area with barricades and hazard tape. 5. Contact local underground utility locating service: Check location of all utilities including water and sewer. 6. Wear Level D PPE: hard hat, safety glasses, steel-toed and shank boots, and traffic vest. Upgrade to modified Level D when possibility of contact to skin or work uniform can occur. Upgrade to Level C when air monitoring reveals action levels have been exceeded. This applies to all on-site personnel including subcontractors. 7. Perform air monitoring with an oxygen/combustimeter and an organic vapor analyzer at frequent intervals.	1. Ground vacuum truck. 2. Park vacuum truck downwind of excavation. 3. Vent vacuum truck vapors at least 12 feet from the ground surface; refer to the American Petroleum Institute (API) recommendations for greater clearance requirements. 4. Inert the tank with dry ice (1½ lbs. dry ice per 100 gallons tank capacity) or nitrogen. 5. Wear Level B PPE when cleaning tank interiors when indicated by HSR.	1. Verify tank inerting has been accomplished by measuring oxygen to be less than 8%. 2. Monitor LEL and organic vapors frequently in areas around tanks during removal process. **Note: LEL measurements taken in oxygen deficient atmospheres (e.g., in inerted tanks) will not be accurate.** 3. Check local/state requirements for tank removal/disposal regulations. 4. Assist subcontractor in performing tasks according to the HASP. 5. Notify the PM immediately when a sub-contractor will not follow site specific safety protocols. The PM must inform the client.
* Refer to Fluor Daniel GTI's UST Safety Training Manual for detailed information.		

EXHIBIT A-G

CSE HAZARD ANALYSIS FORM
SITE-SPECIFIC CONFINED SPACES
CSE PERMIT
CONFINED SPACE PERSONNEL REQUIREMENTS

Fluor Daniel GTI, Inc.
CSE
Hazard Analysis Form

Site Name:_____

Site Address:_____

_____

CSE Name/Number:_____

CSE Definition: Vault Pit Tank/Vessel Other_____

CSE Dimensions:

Length =_____

Width =_____

Depth =_____

Sketch:

Tasks/Activity/Reasons for Entry:

Well Gauging
Bailing Product
Pump Maintenance
Well Sampling
Product Recovery
_____

Potential hazards within space:

Oxygen Deficiency
Combustible Vapors
Toxic Vapors
Engulfment
No Hazards

Other CSE Hazards:

Greater than 5' deep
Difficult access/egress
Energy/isolation*
Prone to flooding
Slippery surface
Hot surfaces (i.e., pipes)

*Check here if LO/TO must be performed inside confined space.

FOR USE BY AUTHORIZED CSE SUPERVISOR

CSE Classification

Class I_____

Class II_____

Class III_____

Requirements:

Completed by:_____ Date_____

Reviewed by:_____ Date_____

SITE-SPECIFIC CONFINED SPACES

Site work may require personnel to enter confined spaces. No Fluor Daniel GTI employee or subcontractor shall enter an area identified as a confined space without using the CSE procedures described in this appendix and completing the site specific entry procedures presented in the CSE Permit. The purpose of the CSE procedure is to protect employees from potentially hazardous environments and to facilitate immediate rescue in an emergency situation. A CSE Permit must be posted at the entrance to each confined space.

CONFINED SPACES
Definition
A confined space has limited or restricted means of entry or exit, is large enough for an employee to enter and perform assigned work, and is not designed for continuous occupancy by the employee.
Examples
These spaces may include, but are not limited to, underground vaults, tanks, storage bins, pits and diked areas, vessels, and silos.
Characteristics
A permit-required confined space is one that meets the definition of a confined space and has one or more of these characteristics: Contains or has the potential to contain a hazardous atmosphere, Contains a material that has the potential for engulfing an entrant, Has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section, and/or Contains any other recognized serious safety or health hazards.
Protocol for CSE
Personnel trained to conduct CSE procedures. Perform the appropriate air monitoring activity at various depths in the space prior to entry. Monitor for: (1) oxygen level, (2) flammable vapors, and (3) toxic vapors. Ventilate the atmosphere in the space so that entry may be made safe without respiratory protection. If this is not feasible, appropriate respiratory protection must be worn by authorized entrants and attendants. Wear appropriate respiratory protection when ventilation alone can not achieve acceptable atmospheric levels of oxygen or flammable or toxic vapors. Have appropriate retrieval equipment worn by employees in the event of a mishap.

SITE-SPECIFIC CONFINED SPACES			
Location	Permit Required (Y or N)	Buddy Required (Y or N)	Specific Entry Procedures

CSE PERMIT

This permit must be completed prior to entering any confined space and is ONLY VALID FOR THE DATE AND TIME INDICATED ON THIS FORM. All procedural requirements contained in Fluor Daniel GTI Health and Safety Policy and Procedure No. 11 must be followed. In the event a confined space emergency situation develops and rescue is required, notify the following appropriate emergency services:

Ambulance:_____ Fire:_____ Police:_____

Purpose of entry:_____ Location of confined space:_____

Date:_____ Authorized duration:_____ Expires on:_____

Atmospheric Hazards: [ ] Oxygen Deficiency [ ] Flammable [ ] Toxic [ ] Other_____ [ ] Other_____

Physical Hazards: [ ] Mechanical [ ] Electrical [ ] Chemical [ ] Engulfment [ ] Other_____

PRE-ENTRY REQUIREMENTS

Yes N/A

[ ] [ ] Entry area is free of debris and objects
[ ] [ ] Warning barriers and signs are in place
[ ] [ ] Atmospheric monitoring conducted
[ ] [ ] All hazardous lines have been isolated
[ ] [ ] Hot work permit attached
[ ] [ ] All energy sources have been locked out/tagged out
[ ] [ ] The confined space has been drained and flushed
[ ] [ ] Forced air or exhaust ventilation is provided
[ ] [ ] Electrical equipment is properly grounded
[ ] [ ] Ground fault circuit interrupters (GFCI) provided accessible

Yes N/A

[ ] [ ] Non-sparking tools used
[ ] [ ] Low voltage (less than 25v) lighting used
[ ] [ ] Electrical equipment rated for explosive atmospheres
[ ] [ ] No compressed gas cylinders in the confined space
[ ] [ ] Host employer and/or contractors notified
[ ] [ ] Entry and emergency procedures have been reviewed
[ ] [ ] All personnel have been trained (classroom/exercise)
[ ] [ ] All personnel have been informed of potential hazards
[ ] [ ] Attendant stationed at entrance and property inspected
[ ] [ ] Rescue equipment on location and readily

PROTECTIVE EQUIPMENT

Yes	No		Yes	No		Yes	No	
[ ]	[ ]	Hard Hat	[ ]	[ ]	Protective clothing	[ ]	[ ]	Communications Equipment
[ ]	[ ]	Eye/Face Protect.	[ ]	[ ]	Hearing protection	[ ]	[ ]	Ventilation to Provide Fresh Air
[ ]	[ ]	Boots	[ ]	[ ]	Retrieval Device/Tripod	[ ]	[ ]	Respirator (type)_____
[ ]	[ ]	Gloves	[ ]	[ ]	Harness and Lifeline	[ ]	[ ]	Other_____

Atmosphere Test(s) to be taken*	Yes	No	Acceptable Entry Conditions	Time	Time	Time	Time	Time	Time	Time	Time	Time	Time	Time
			Allowable Limits	Enter Air Monitoring Findings Below										
Oxygen			19.5% - 22.0%											
Combustible Gas			Below 10% LEL											
PID/FID														
Carbon Monoxide			0-15 PPM											
Hydrogen Sulfide			0-5 PPM											
Hydrogen Cyanide			0-2 PPM											
Sulfur Dioxide			0-1 PPM											
Ammonia			0-10 PPM											
Benzene			0-0.5 PPM											
Other														

SUPERVISOR APPROVAL: I certify that all necessary precautions have been taken to make this confined space safe for entering and conducting the work during the prescribed time(s) as well as emergency response procedures.

Print Name_____ Sign Name _____ Date_____

Entry Supervisor_____ Permit Prepared by_____

Atmosphere Tester_____ Attendant_____

ENTRANT ACKNOWLEDGMENT: I HAVE BEEN PROPERLY INSTRUCTED FOR SAFE ENTRY INTO THIS CONFINED SPACE AND UNDERSTAND MY DUTIES AND EMERGENCY PROCEDURES

Print Entrant Name	Sign Entrant Name	Employee or S.S. No	Date	Time

*An evaluation should be performed to consider all potential air contaminants which could be present and represent a hazard.

ENTRANT INSTRUCTIONS

All personnel who enter confined spaces must be thoroughly familiar with the following duties for entrants as listed below. Your primary responsibilities include:

Understand the hazards of the confined space to be entered and the physical effects of those hazards.
Continuously monitor the atmosphere inside of the confined space with a calibrated, direct reading, air monitoring instrument.
Evacuate the confined space:

- If atmospheric hazards exceed the action level,
- If a hazardous condition is identified inside of the confined space, and
- Whenever attendant signals entrants to evacuate.

Read and understand the rescue procedures.
If PPE is required, the entrant must be properly trained on the use of the equipment prior to entry. PPE must be in good working condition.

ATTENDANT INSTRUCTIONS

You should be thoroughly familiar with the following duties when you assume the responsibility of attendant for a person or persons inside a confined space. Your primary responsibilities are the following:

Focus on the safety of the personnel inside.
Understand the hazards of the confined space to be entered and the physical effects of those hazards.
Maintain the conditions and requirements listed on entry permit.
Evacuate the space if you observe any condition which you consider hazardous.
Read and understand the rescue procedures. Get help if an emergency situation develops. never enter the confined space in an emergency unless you are trained and equipped with the proper equipment for confined space rescue operations (i.e., self contained breathing apparatus, safety harness, life line) and are relieved by another attendant.
Keep an accurate count of all personnel inside of the confined space at all times.
Do not leave the entrance to the confined space while any personnel are still inside unless you are properly relieved. These instructions must be passes onto your relief.
If you have any questions regarding the job, check with your supervisor or a health and safety professional.

ENTRY SUPERVISOR'S INSTRUCTIONS

You should be thoroughly familiar with the following details to quality as the Entry Supervisor for a permit-required CSE procedure.

Requirements for confined space entrant and attendant instructions.
Knowledge of the hazards that may be faced during entry, including information in the mode, signs and symptoms and consequences of exposure.
Ability to verify that the appropriate entries have been made on the permit, and that all tests specified by the permit have been conducted and that all procedures and equipment specified by the permit are in place before endorsing the permit and allowing entry to begin.
Procedures to terminate the entry permit when the CSE operations have been complete or when a condition exists that is not allowed under entry permit requirements.
Ability to verify that rescue services are available and that the means of summoning them are operable.
Procedures to remove unauthorized individuals who enter or who attempt to enter the permit space during entry operations.
Ability to take responsibility for the confined space when entry is transferred to other personnel.
Ability to determine that entry operations are still consistent with the terms of the CSE permit and that the prescribed intervals regardless of changes in entry personnel.

EXHIBIT A-H

HOT WORK PERMIT
HOT WORK JSA

HOT WORK PERMIT

Project Name_____ Job #_____

Hot Work Task Description:_____

Workers/Welders Conducting Hot Work_____

(PERMIT MUST BE COMPLETED IN ITS ENTIRETY AND POSTED BEFORE HOT WORK BEGINS)

Action Item	Yes	No	NA
Has client representative been notified of intended hot work?			
Hazardous materials involved? Name:_____			
Will hot work impact the general public, customers or operations employees?			
Will the intended hot work need to be coordinated with other contractors who may be working on the site to make them aware of any hazards and the scope of work to be performed?			
Have hazardous energy sources been identified, isolated, and locked out - tagged out before the start of the project?			
Will hot work be conducted within a confined space?			
All testing equipment (i.e., CGI, oxygen meter, etc.) and fire fighting equipment (i.e., extinguisher, etc.) have been checked to ensure proper operation and calibration before the start of this project?			
Does task require a designated fire watch (30 minutes after work)?			
Flammable and combustible materials within 35 feet have been cleared or shielded.			
All fuel sources have been identified and protected (USTs, ASTs, sewers, piping).			
The area has been restricted with proper barriers and signs.			
The area has been tested to be certain that atmosphere is 0% LEL before starting hot work.			
Flame sensitive areas and equipment (including cylinders and gas delivery lines) exposed to slag, heat, and sparks are protected by flame a resistant blanket, shield, or removed from the area?			
Escape routes have been identified before starting work?			
Is ventilation equipment needed? Type needed:_____			

THE FOLLOWING PROTECTIVE EQUIPMENT WILL BE REQUIRED (PLEASE CHECK):

	Yes	No		Yes	No
Welding Goggles/Shield___ Tint			Hearing Protection		
Safety Boots			Head Protection		
Leather Gloves			Safety Harness		
Supplied Air Respirator			Welding Leathers - Top		
APR ___ Cartridge			Welding Leathers - Bottom		
Cold Cut Only Method Required:_____			Hot Cut Method Allowed:_____		

APPROVALS:

_____ _____

Fluor Daniel GTI Site Manager or Site Safety Officer Date

Name of Employee Performing Hot Work_____ Fire Watch Representative_____

Hot Work/JSA Welding/Torch Cutting	
Job Hazards	**Safeguards/Precautions**
1. Unsafe act Untrained worker	a. Require qualified operators only. b. Provide training per 29 CFR 1910.1200. c. Provide proper PPE. d. Inspect area prior to welding/cutting. e. Use permit system. f. Use fire watch for 30 minutes following termination of work.
2. Welder's flash to eye	a. Use filter lens based on actual hazard or welding technique in accordance with the American Welding Society Laws shade selector chart. b. Provide warning signals, barricades or similar means to protect other workers, general public. c. Provide screens or barriers to protect other workers, general public.
3. Radiation burns, skin burns, heat burns	a. Helmet with proper filter lens. b. Gauntlet gloves, leather apron. c. Cotton shirt, long sleeves, buttoned at sleeves and collar. d. Cotton cuffless pants. e. Steel toe boots, 6-inch minimum height. f. Hearing/ear cover protection as appropriate. g. Work zone definition - see 2(a) and (b) above.
4. Faulty equipment	a. Use equipment that is in good working condition. b. Inspect valves, regulators, and hoses prior to use. c. Preventive maintenance performed per manufacturer specifications.
5. Toxic fumes and gases	a. Provide source ventilation. b. Provide respiratory protection, selected based on hazard. c. Rope off area, define work area with cones, caution tape or similar (see 2(a) and (b) above).
6. Adjacent flammable/ combustible materials	a. Move combustibles at least 50 feet from work area. b. If they cannot be moved consider protection by metal guards or flame proof curtain. c. Openings in walls, floors or ducts should be covered if within 35 feet of work area. d. Assure facility sprinklers are in working condition and will not be taken out of service. e. Suitable fire extinguishing equipment shall be readily available at the work area. f. Designate a reliable means of contacting the Fire Department in the event of an emergency.

Hot Work/JSA Welding/Torch Cutting	
Job Hazards	**Safeguards/Precautions**
7. Flammable/combustible vapors	a. If in an environment classified as a hazardous location then define specific tasks using JSA technique. b. Provide equipment per classification (i.e., explosion proof, etc.) c. Post sign: DANGER - NO SMOKING, MATCHES OR OPEN LIGHTS. d. Ensure person is assigned as fire watch and fully charged extinguisher is present.
8. CSE	a. Follow CSE procedures. b. Use CSE permit. c. Define specific JSA techniques for that work. d. Exercise caution when using inertion to address O_2 deficiency. e. Exercise caution when using O_2/acetylene fuel mix, address O_2 enrichment from cylinder leak.
9. Unsecured compressed gas cylinders, cylinder handling	a. Store cylinders upright. b. Secure against stationary object. c. Cylinders in excess of 40 pounds in weight must be moved using wheeled cart or motorized truck. d. Lifting cylinders > 40 pounds in weight is prohibited. e. Compatible storage practices = separate O_2 cylinders from flammable combustible gases. f. Use tags on cylinders to mark full, in use or empty. g. Remove protective cap using hand method or use cylinder "cap wrench". Do not jam screwdriver or wrench in cap slots to loosen.
10. Unsafe practice during inactivity	a. Provide protective cap when cylinders are not in use. b. Valves or gas cylinders shall be closed and line pressure relieved. c. Power source of electric welding equipment shall be disconnected.
11. Improper flow of gases, gas mixing, pressure in gas lines	a. Label cylinders per 29 CFR 1910.1200. b. Color code hoses (green = O_2; red = fuel gases; black = inert gas or air hoses). c. Install "flash back" arresters for fuel mixing welding. d. Use acetylene at 15 pounds per square inch (psi) or less.
12. Improper ignition of oxygen/fuel torch	a. Use "spark lighter" to ignite. b. Don't use cigarette, match or lighter for ignition.
13. Static electricity	a. Provide and use grounding clamp for electric area welding equipment.

EXHIBIT A-I

HEAT/COLD STRESS PROCEDURES

1.0 HEAT STRESS

Heat stress is a significant potential hazard associated with the work task performed and the type and degree of protective equipment used in hot weather environments. Local weather conditions may produce conditions which will require restricted work schedules in order to protect employees. Monitoring for heat stress will follow one of two protocols depending on whether impermeable clothing (tyvek, saranex, rain gear, etc.) or permeable clothing (cotton coveralls) is worn. This section will apply to both hazardous and non-hazardous waste workers at the site. The SHSO with direction from HSR will determine the environmental wet bulb globe temperature (WBGT) and physiological (heart rate [HR] and oral temperature {OR}) monitoring to be conducted for both types of workers.

1.1 Workers Wearing Permeable Clothing

The ACGIH have set TLVs for worker exposure to heat stress in which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. The TLVs assume that workers are acclimatized, fully clothed in permeable clothing with adequate water and salt intake, and capable of functioning effectively under the given working conditions without exceeding a deep body temperature (BT) of 100.4Fahrenheit (F). Measurement of the WBGT has been found to be the most adequately measurable environmental factor in which to correlate with the deep BT and other physiological responses to heat. The following table reviews the work/rest regimen to be followed by all permeably clothed workers based upon routinely measured WBGT.

Permissible Heat Exposure TLVs Applicable to Workers Wearing Permeable Clothing

Work/Rest Regimen	Workload		
	Light	Moderate	Heavy
Continuous work	86 (76)	80 (70)	77 (67)
75% work - 25% rest, each hour	87 (77)	82 (72)	78 (68)
50% work - 50% rest, each hour	89 (79)	85 (75)	82 (72)
25% work - 75% rest, each hour	90 (80)	88 (78)	86 (76)

Values are given in F WBGT.

Rest means minimal physical activity. Rest should be accomplished in the shade. Any activity requiring only minimal activity can be performed during rest period.

() Parentheses indicate the 10 degree adjustment for working in impermeable protective clothing.

1.2 Workers Wearing Impermeable Clothing

Workers who must wear impermeable clothing are held at a higher risk of suffering heat stress. Impermeable clothing impedes sweat evaporation, one of the body's major cooling mechanisms. It is the duty of each employer to alert or notify the SHSO if symptoms of heat stress occur to their respective site personnel. Physiological and environmental monitoring of personnel wearing an impermeable protective equipment ensemble will commence when the ambient temperature rises above 70F. Environmental monitoring will be conducted continuously for as long as the ambient temperature stays above 70F and physiological monitoring will be conducted immediately before and after each work period. Frequency of physiological monitoring will increase as the ambient temperature increases or if slow recovery rates are indicated. The break time must be sufficient to allow workers to recover from the effects of heat stress. This will be accomplished by measuring the recovery HR and OT. The break time duration will be determined using the following methodology and criteria:

Seat person being monitored,
Take OT, and
Measure pulse in the following sequence:

- Pulse #1: 30 seconds to 1 minute after sitting
- Pulse #2: 2½ to 3 minutes after sitting

An excessive heat stress condition exists when any of the following conditions exist:

1. Oral or ear temperature exceeds 99.5F
2. If pulse #2 is greater than 90 beats/minute
3. Pulse #1 is greater than 100 beats/minute

Worker cannot return to work until:

Oral or ear temperature is below 99.5F
Pulse rate is below 90 beats/minute
Recovery HR for workers with HRs over 90 beats per minute is less than 10 beats per minute less than the original HR

Adhering to the guidelines for heat stress prevention and monitoring will greatly minimize the possibility of the occurrence of heat stress. Site personnel must also be aware of the symptoms of heat-related disorders and be prepared to administer the appropriate treatments.

1.2.1 Prevention

A. Provide plenty of fluids. A 50 percent solution of fruit juice or similar solution in water, or plain water will be available. For workers performing work inside an EZ, fluid intake may occur in the CRZ. Workers must first perform a partial decontamination process which will include removal of gloves and washing of hands and face prior to consumption of fluids. The SHSO will monitor the partial decontamination and fluid consumption process to ensure that ingestion of site contaminants does not occur.
B. Work in pairs whenever conducting Level B activity or permit required CSE activity.

C. Provide cooling devices. Ice vests or on-site showers can be provided to reduce BT and/or cool protective clothing.

The amount and type of undergarments worn will be left to the preference of each individual unless prone to heat stress, especially heat rash. In this case, the worker can wear "long john" cotton type underwear to keep skin off chemical resistant clothing.

D. Adjustment of the work schedule. When practicable, the most labor-intensive tasks should be carried out during the coolest part of the day.

E. Shaded or cooled rest areas. Shaded or cooled rest areas will be provided when site environmental and/or workers physiological responses warrant.

1.1.3 Heat Stress Monitoring

Physiological monitoring of personnel wearing an impermeable protective ensemble will be conducted at regular intervals at the beginning and conclusion of the work period. HR must be periodically measured for all site personnel when heat stress conditions (climate or wearing impermeable clothing). Additional physiological monitoring such as BT and body water temperature (BWT) monitoring can be measured for extreme temperatures and when impermeable clothing is worn.

A. HR must be measured by the radial pulse for 30 seconds as early as possible in the resting period and repeated approximately 3 minutes into rest period.

The HR at the beginning of the rest period should not exceed 110 beats per minute. The HR also should not exceed 90 beats per minute after approximately 3 minutes of rest. If the HR does exceed the criteria, the next work period will be shortened by 33 percent, while the length of the rest period will remain the same. If the HR still exceeds the criteria at the beginning of the next rest period, the following work period will be shortened by 33 percent.

B. BT can be measured orally with a clinical or disposable thermometer, in accordance with manufacturer's instructions, as early as possible in the rest period (before drinking liquid). Oral or ear temperature at the beginning of the rest period should not exceed 99.5F. If it does, the next work period will be shortened by 33 percent while the length of the rest period will remain the same. However, if the OT exceeds 99.5F at the beginning of the next rest period, the following work period will be shortened by another 33 percent. A worker will not be permitted to wear a semi-permeable or impermeable protective ensemble when his/her BT exceed 99.5F.

C. Body water loss (BWL) due to perspiration can be measured by having the worker weigh him/her self at the beginning and end of each work day. Similar clothing should be worn at both weighing. BWL should not exceed 1.5 percent total body weight in a work day.

Suggested Frequency of Physiological Monitoring for Fit and Acclimated Workers[1]

Adjusted Temperature[2]	Normal Work Ensemble[3]	Impermeable Ensemble[4]
90F (32.2C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5-90F (30.8-32.2C)	After each 60 minutes of work	After each 30 minutes of work
82.5-87.5F (28.1-30.8C)	After each 90 minutes of work	After each 60 minutes of work
77.5-82.5F (25.3-28.1C)	After each 120 minutes of work	After each 90 minutes of work
72.5-77.5F (22.5-25.3C)	After each 150 minutes of work	After each 120 minutes of work

1 For work levels of 250 kilocalories per hour.
2 Calculate the adjusted air temperature (T_{adj}) using the following equation:
T_{adj} (F) = T_{adj} (F) + (13 x percent sunshine)
Measure the air temperature (T_{adj}) using a standard mercury-in-glass thermometer with the bulb shielded from radiant heat.
3 A normal work ensemble consists of cotton overalls with long sleeves and pants.
4 An impermeable work ensemble consists of impermeable coveralls with long sleeves and pants.

1.1.4 Recognition and Treatment

Any personnel who observes any of the following forms of heat stress either in themselves or in another worker, will report this information to his or her immediate supervisor or the SSHO.

A. Heat Rash (or prickly heat)

Cause: Continuous exposure to hot and humid air, aggravated by chafing clothing.

Symptoms: Eruption of red pimples around sweat ducts accompanied by intense itching and tingling.

Treatment: Remove sources of irritation and cool the skin with water or wet cloths.

B. Heat Cramps or Heat Prostration

Cause: Profuse perspiration accompanied by inadequate replenishment of body water and electrolytes.

Symptoms: Sudden development of pain and/or muscle spasms in the abdominal region.

Treatment: Remove the worker to the CRZ. Remove protective clothing. Decrease BT and allow a period of rest in a cool location.

C. Heat Exhaustion - SERIOUS

Cause: Overexertion in a hot environment and profuse perspiration accompanied by inadequate replenishment of body water and electrolytes.

Symptoms: Muscular weakness, staggering gait, nausea, dizziness, shallow breathing.

Treatment: Perform the following while simultaneously making arrangements for transport to a medical facility.

Remove the worker to the CRZ. Remove protective clothing. Lie the worker down on his or her back in a cool place, and raise the feet 6 to 12 inches. Keep warm, but loosen all clothing. If conscious, provide sips of a salt water solution consistency of one teaspoon salt in 12 ounces water. Transport the worker to a medical facility.

D. Heat Stroke - **EXTREMELY SERIOUS**

Cause: Same as heat exhaustion.

Symptoms: No perspiration, dry mouth, pain in the head, dizziness, nausea.

Treatment: Perform the following while making arrangements for transport to a medical facility.

Remove the worker to the CRZ. Remove protective clothing. Lie the worker down in a cool place and raise the head and shoulder slightly. **Cool without chilling.** Apply ice bags or cold wet cloth to the head. Sponge bare skin with cool water or rubbing alcohol. If possible, place the worker in a tub of cool water. Do not give stimulants. Transport to a medical facility.

HEAT STRESS MONITORING FORM

Project Name:_____

Project Number:_____

SHSO:_____

Date	Title	Ambient Temp	WBGT	Work/ Rest Regimen	Employee/ Location	Pulse Rate	Body Temp	Body Water Loss	Comments

2.0 COLD STRESS

If work on this project begins in the winter months, thermal injury due to cold exposure can become a problem for field personnel. Systemic cold exposure is referred to as hypothermia. Localized cold exposure is generally labeled frostbite.

A. Hypothermia: hypothermia is defined as a decrease in the patient core temperature below 96F. The BT is normally maintained by a combination of central (brain and spinal cord) and peripheral (skin and muscle) activity. Interferences with any of these mechanisms can result in hypothermia, even in the absence of what normally is considered a "cold" ambient temperature. Symptoms of hypothermia include: shivering, apathy, listlessness, sleepiness, and unconsciousness.

B. Frostbite: frostbite is both a general and medical term given to areas of local cold injury. Unlike systemic hypothermia, frostbite rarely occurs unless the ambient temperatures are less than freezing and usually less than 2F. Symptoms of frostbite are: a sudden blanching or whitening of the skin; the skin has a waxy or white appearance and is firm to the touch; tissues are cold, pale, and solid.

Prevention of cold related illness can be aided by educating workers on recognizing the symptoms of frostbite and hypothermia and by identifying and limiting known risk factors. The workers should be provided with enclosed, heated environments on or adjacent to the site, dry changes of clothing, and warm drinks.

To monitor the worker for cold related illnesses, start (oral) temperature recording at the job site:

At the field team leader's discretion when suspicion is based on changes in a worker's performance or mental status.
At a worker's request.
As screening measure, two times per shift, under unusually hazardous conditions (e.g., wind-chill less than 20F, or wind-chill less than 30F with precipitation).
As a screening measure whenever any one worker on the site develops hypothermia.

Workers developing moderate hypothermia (a core temperature of 92F) should not return to work for at least 48 hours.

Table 3. Progressive Clinical Symptoms of Hypothermia

Core Temperature (F)	Symptoms
99.6	Normal core body temperature
96.8	Metabolic rate increases
95.0	Maximum shivering
93.2	Victim conscious and responsive
91.4	Severe hypothermia
89.6 - 87.8	Consciousness clouded, blood pressure difficult to obtain, pupils dilated but react to light, shivering ceases
86.0 - 84.2	Progressive loss of consciousness, muscular rigidity increases, pulse and blood pressure difficult to get, respiratory rate decreases
78.8	Victim seldom conscious
64.4	Lowest accidental hypothermia victim to recover

In order to minimize the risk of the hazards of working in cold environments, workers will be trained and periodically reinforced in the recognition of the physiologic responses of the body to cold stress. In addition, the use of insulated work clothing, warm shelters and work/warming regimens may be used to minimize the potential hazards of cold stress. Also, special attention will be paid to equipment warm-up time and freeze protection for vessels, piping, equipment, tools, and walking/working surfaces. The current ACGIH TLVs for cold stress found in this appendix will be used as a guideline.

EXHIBIT A-J

JSA

JOB SAFETY ANALYSIS

BACKFILL COMPACT EXCAVATION

JOB STEPS	JOB HAZARDS	SAFEGUARDS & PRECAUTIONS
Backfill/Compact Excavation	1. Heavy Equipment	1. a. Only trained personnel will operate equipment b. Same as heavy equipment operations
	2. Physical Hazards: a. Crushing b. Hit in head c. Dust d. Foot injury	2. a. Hard Hat required b. Safety glasses required c. Steel toe boots d. Gloves leather
	3. Open Excavation	3. a. Restricted construction zone b. Barricaded, coned, fenced c. Same safeguards & precautions as excavation & trenching

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JOB SAFETY ANALYSIS

BAIL FREE PRODUCT

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
Bail Free Product Liquid Phase Hydrocarbons (LPH)	1. toxic vapors 2. explosive vapors 3. static electricity	1. use PID/stay upwind 2. use LEL/ventilate 3. a. store bailed product in 5 gallon metal pail (DOT approved container) b. ground 5 gal. pail using bonding cable and grounding clip c. pour off into larger vessel (ie., 55 gallon drum) using bonding/grounding technique d. use dual action drum vent on 55 gallon drum when storing LPH for pressure relief valve purposes e. mark all container with pertinent warning signs and labels

JOB SAFETY ANALYSIS

BUILDING CONSTRUCTION

JOB STEPS	JOB HAZARDS	SAFEGUARD AND PRECAUTIONS
Building Construction	1. Physical hazard involving: a. heavy lifting/injury; b. sharp objects/hand laceration; c. flying objects/eye injury; d. drop equipment/foot injury; e. hit in head/head injury. f. falls while roofing/framing.	1. Training: a. mechanical device 70 lb. rule; b. leather gloves; c. safety glasses; d. steel toe boots; e. hard hat; f. fall protection
	2. Build up of explosive vapors, poor ventilation.	2. Install double doors, O_2/LEL upon entry.
	3. Electrical explosion.	3. a. Wiring done by licensed electrician by CODE. b. Explosion proof lighting.
	4. Swinging loads from cranes. Employee hit by moving equipment.	4. a. Back up signals on equipment. b. Traffic vest for all personnel. c. Foot traffic restricted in area. d. Establish hand signals for laborers assisting in equipment operations.
	5. Crane hazards during frame construction.	5. Follow safe work rules as defined in 29 CFR 1926.550
	6. Overhead utilities.	6. Minimum 20' distance, 10' distance if insulated.
	7. Electrical shock from live equipment.	7. a. De-energize equipment. b. Lockout/tagout
	8. Noise levels exceeding OSHA PEL.	8. Earmuffs and/or ear plugs.

FLUOR DANIEL GTI

JOB SAFETY ANALYSIS WORKSHEET

Operation: Mobile Cranes
Person Doing JSA: James R. Smith

Date: December 10, 1997

Job Steps	Job Hazards	Safeguards and Precautions
1. Inspect crane and rigging	1. Mechanical failures such as brakes and back up alarms, hydraulic levels, and rigging failure causing personal injury.	1a. Complete Safety Inspection Checklist for Construction Equipment (Form S70-2-9) prior to crane operations. Refer to Fluor Daniel's Accident Prevention Standards, APS 7-3, Attachment G.
		1b. Ensure shackles, chockers, and other rigging does not exceed the safety factor of 5:1.
2. Determine whether the load exceeds the cranes capacity	1. Crane tip over or rigging fails, damaging equipment and injure personnel.	1a. Complete Crane lift permit even if the load is not likely to exceed 75 percent of its rated capacity. Ensure the rigging has a safety factor of 5:1. Refer to Fluor Daniel's Accident Prevention Standards, Section APS 7-12, Attachment A.
3. Level the crane	1. Crane tips over	1a. Extend all outriggers and use trench plates on non-solid ground.
4. Crane Operation	1. Confusion of lowering and rasing equipment	1a. Use standard hand signals for cranes in accordance with ANSI standards and post on site.
	2. Swinging of the counterweight could strike or crush personnel	2a. Barricade the swing radius of the counter weight.
	3. Equipment malfunction	3a. A copy of the manufacture's operating manual will be inside the crane's cab.

JOB SAFETY ANALYSIS

ABANDON MONITORING WELL

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
Abandon Monitoring Well Remove or Cut off Well Casing	1. traffic hazards	1. a. proper work zone definition b. Level D PPE (traffic vest, etc.)
	2. a. cut steel well casing b. hand dig below surface c. use powered sawsall or d. use oxy-acetylene cutting torch	2. a. steel well casing b. leather work gloves for hand protection and safety glasses when digging c. goggles and faceshield; use cold cut technique (pneumatic reciprocating sawsall) for wells displaying explosive vapors; place dry ice in well to reduce oxygen levels to <10% d. place dry ice in well to reduce oxygen levels to >10%; leather chaps and leather gauntlet gloves; wear level C PPE - full face respirator (APR) fitted with a welding shield adaptor with a shade 5 or 6 lens; flash back arrestor for oxy-acetylene torch set up; fire watch with ABC multi-purpose fire extinguisher; complete hot work permit prior to any torch work.
	3. a. cut PVC well casing b. hand dig below surface c. use hacksaw or d. use powered sawsall	3. a. PVC well casing b. leatherwork gloves and safety glasses c. proper body positioning avoid over exertion d. safety goggles and faceshield
Backfill Well with Bentonite/Grout	1. heavy lifting-grout pellets	1. maintain 70# lifting rule
	2. obtain water supply from remote distance	2. safe transport to/from water supply
	3. flying objects - eye injury	3. safety goggles

JOB SAFETY ANALYSIS

AIR SPARGE INSTALLATION & PILOT TEST

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
1. Piping Construction/Design	A. improper PVC pipe pressure rating	A. specify proper schedule pipe/fittings
	B. improper PVC gluing type/technique	B. use rollers, drying time needs, etc.
	C. oversight of safety controls	C. install appropriate gauges, high pressure shutoffs and pressure relief valves.
2. Installation/Construction type of air compressor used	A. oversize/undersize specifications	A. identify compressor specifications - in design
	B. overheat due to undersize	B. monitor heat and stress to compressor(s)
	C. fuel refilling - hot surface hazard	C. shut off when refueling; no smoking
	D. noise/sound hazard	D. monitor sound w/SLM for personal and community noise exposure; wear PPE
3. Implementation of Air Sparge Pilot test	A. burst of pipes upon start up	A. shield accordingly; provide distance
	B. leak of pipes	B. wear goggles; faceshield as necessary
	C. noise	C. wear PPE; insulate and provide distance

Job Steps	Job Hazards	Safeguards and Precautions
4. Crane Operation (continued)	4. Load is swinging and bumps an object, injures personnel, or adds stress to the rigging.	4a. Use tag lines and maintain distances from beneath the load.
	5. Boom exceeds its critical angle of 80 percent from the horizontal	5a. Use boom stops to dis-engage the master clutch or kill the engine before it reaches Its critical angle.
	6. Person riding on the crane can be struck by the counter weight or other objects.	6a. Personnel are not to ride on the crane.
	7. Lift exceeds loads rated capacity	7a. A durable load chart and with clearly legible letters shall be posted where it is visible to the crane operator.
	8. Load becomes free of the rigging	8a. Hooks should be inspected periodically, chain slings are inspected every 3 months for wear and defective welds-stretch shall not exceed 5 percent, use manila rope, wire rope, and rope slings with a safety factor of 5:1. Where U-bolt wire rope is used to form eyes, the U section should be in contact with the dead end.
	9. Load falls on personnel.	9a. Loads (tools, equipment, and other materials) shall not be swung or suspended over employees.
	10. Crane traveling with the load causes the crane to tip.	10a. Use a flatbed truck, fork lift, or other means of transportation to move the load to another location.

JOB SAFETY ANALYSIS

EXCAVATE/TRENCHING

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
Excavate/Trenching	1. Collapse of pit; failure of slope	1. a. assign "competent person" as a supervisor per OSHA; b. excavation activities to be performed per OSHA 29 CFR 1926. 650(scope); 1926.651 (general); 1926.652 (protective system); Appendix A (soil classification); Appendix B (sloping/benching); or Appendix C (timber).
	2. Employee buried upon slope failure	2. a. see above; b. allow proper egress from excavations >4' deep using ladder every 25' distance.
	3. Damage to adjacent structures	3. Implement shoring/bracing to preserve integrity of adjacent structures.

JOB SAFETY ANAYLSIS
WORK FROM ELEVATED PLATFORMS

Job Steps	Job Hazards	Safeguards and Precautions
Access tanks and stripper from an arial lift.	Fall from elevated platform	1. Operator must have an effective procedure for leaving the platform when elevated. 2. The anchor point should be at the same height as the operator's harness D-ring. The lanyard should be no more than 4 feet. 3. Anchor points should be capable of withstanding twice the maximum arrest force of the fall arrest device to avoid the possibility of tip-over. 4. Never use the midrail as a step.
	Accessing elevated platform from a ladder.	1. Ladder must be set at a 4' to 1' angle to the tank. 2. Ladder must be tied off. 3. Always face the ladder when climbing or descending. Stay off the top two rungs. Never carry anything that will prevent holding on with both hands. 4. Inspect ladder before use for damage. 5. Metal ladders must not be used near any electrical lines or service. 6. When not in use, the ladder should be returned to storage. 7. The top of the ladder must extend at least three feet above top of tank or stripper. 8. For extenion ladders, check to see that safety dogs or latches are engaged.
	Work on elevated surfaces greater than six feet above the lower work surface.	1. A full body harness with lanyard must be secured to an adequate anchor point.

JOB SAFETY ANALYSIS

Precautions **must** be taken to prevent injuries and exposures to general potential hazards.

Potential Hazard	Control
Exposure to vapors and dusts	1. Stand up-wind of petroleum products whenever possible. 2. Minimize contact and contact time with petroleum products. 3. Avoid walking through discolored areas, puddles, leaning on drums, or contacting anything that is likely to be contaminated. 4. Do not eat, drink, smoke and/or apply cosmetics in the hot or warm zones. 5. Wear gloves when in contact with contaminated surfaces. 6. Safety glasses must be worn at a minimum. 7. Splash goggles must be worn when working with liquids. 8. >75 ppm organic vapors in breathing zone requires upgrade to Level C. 9. >750 ppm organic vapors in breathing zone requires upgrade from Level C to Level B.
Vehicular Traffic	1. Wear traffic safety vest when vehicle hazard exists. 2. Use cones, flags, barricades, and caution tape to define work area. 3. Use vehicle to block work area. 4. Engage police detail for high-traffic situations.
Vault Entry	1. Follow confined space entry procedures. 2. Obtain confined space entry permit. Post sign. 3. Remove vault cover using proper lifting techniques. 4. Promote natural ventilation by opening the space to fresh air. 5. Conduct remote air monitoring prior to entry. 6. Use trained "competent person" (entrant and attendant). 7. Enter if safe; conduct continuous air monitoring.
Inclement Weather	1. Stop outdoor work during extreme weather conditions such as electrical storms, high winds, driving rain, extreme heat or cold temperatures. 2. Take cover indoors or in vehicle. 3. Listen to local forecasts for warnings about specific weather hazards such as tornados, hurricanes and flash floods.
Noise	1. Wear hearing protection when equipment such as a drill rig, jackhammer, cut saw, air compressor, blower or other heavy equipment is operating on the site. 2. Wear hearing protection whenever you need to raise your voice above normal conversational speech due to a loud noise source; this much noise indicates the need for protection.
Electric Shock	1. Maintain appropriate distance from overhead utilities; 20-foot minimum clearance from power lines required; 10-foot minimum clearance from shielded power lines. 2. Use ground-fault circuit interrupters as required. 3. Perform lockout/tagout procedures. 4. Use three-pronged plugs and extension cords. 5. Contact your local underground utility-locating service. 6. Follow code requirements for electrical installations in hazardous locations.

Potential Hazard	Control
Physical Injury	1. Wear hard hats and safety glasses when on site. 2. Maintain visual contact with the equipment operator and wear orange safety vest when heavy equipment is used on site. 3. Avoid loose-fitting clothing (driller and driller's helper). 4. Prevent slips, trips and falls; keep work area uncluttered. 5. Keep your hands away from moving parts (i.e. augers). 6. Test the emergency shutoff switch on the drill rig daily.
Back Injury	1. Use a mechanical lifting device or a lifting aid where appropriate. 2. If you must lift, plan the lift before doing it. 3. Check your route for clearance. 4. Bend at the knees and use leg muscles when lifting. 5. Use the buddy system when lifting heavy or awkward objects. 6. Do not twist your body while lifting.
Heat Stress	1. Increase water intake while working. 2. Increase number of rest breaks and/or rotate workers in shorter work shifts. 3. Watch for signs and symptoms of heat exhaustion and fatigue. 4. Plan work for early morning or evening during hot months. 5. Use ice vests when necessary. 6. Rest in cool, dry areas. 7. In the event of heat stroke, bring the victim to a cool environment and initiate first aid procedures.
Cold Stress	1. Take breaks in heated shelters when working in extremely cold temperatures . 2. Remove the outer layer of clothing and loosen other layers to promote evaporation of perspiration, upon entering the shelter. 3. Drink warm liquids to reduce the susceptibility to cold stress.
High Crime Areas	1. Be aware of surroundings. 2. Use the buddy system. 3. Request police detail when appropriate.
Insects	1. Tuck pants into socks. 2. Wear long sleeves. 3. Use insect repellent.
Poisonous Plants (such as poison ivy, oak or sumac)	1. Don't enter areas infested with poisonous plants. 2. Immediately wash any areas that come into contact with poisonous plants.
Ladders	1. Make sure ladder rungs are sturdy and free of cracks. 2. Use ladders with secure safety feet. 3. Pitch ladders at a 4:1 ratio. 4. Secure ladders at the top when possible. 5. Do not use ladders for access to air stripper towers. 6. Use non-conductive ladders near electrical wires.

Potential Hazard	Control
Fire Control	1. Smoke only in designated areas. 2. Keep flammable liquids in closed containers. 3. Keep site clean; avoid accumulating combustible debris such as paper. 4. Follow Hot Work Safety Procedures when welding or performing other activities requiring an open flame. 5. Isolate flammable and combustible materials from ignition sources. 6. Ensure fire safety integrity of equipment installations to Hazard Classification.

JOB SAFETY ANALYSIS

GAUGE & BAIL WELLS
(Operations & Maintenance)

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
Gauge & bail water from monitoring wells	1. metal burr on well cap	1. wear NBR gloves
	2. toxic vapors	2. use PID/stay upwind
	3. explosive vapors	3. use LEL/ventilate
	4. static electricity	4. use grounding clip on IP
	5. muscle strain-back	5. proper posture crouch or squat, don't bend exercise and stretch use lumber support belt
	6. muscle strain-shoulder	6. use pump for large volume wells exercise and stretch, avoid over exertion, take breaks
	7. splashing liquid-eyes	7. wear PPE-splash goggles
	8. splashing liquid-skin	8. wear PPE-NBR gauntlet gloves
	9. contamination	9. proper zone set up, zone definition, etc.

JOB SAFETY ANALYSIS WORKSHEET

Operation/Location: Westinghouse/Union City - Hi Vac Pilot Test/Construction of System

Person Doing JSA: Jack Geissert/Tom Tourish Date: 12/14/93

JOB STEPS	JOB HAZARDS	SAFEGUARDS/PRECAUTIONS
Construction of system: -Skid delivery of equipment -Shed construction -Install Pipe and Equipment Start-up	1. Back injury	1. Use combination of techniques to lift safe
	2. Electric shock	2a. Lockout/Tagout power 2b. GFCI for portable tools
	3. Xylene vapors at start-up	3. FID/PID action level of 50 ppm for upgrade to Level C
	4. Explosive Vapors	4. Use LEL meter
	5. Noise from blower	5. Hearing protection
	6. Possible welding	6. Permit for any cutting or welding
	7. Overhead crane hazard	7. Control access to site and don't lift load directly over personnel. Hard hats required.

JOB SAFETY ANALYSIS WORKSHEET

Operation/Location: Westinghouse/Union City - Hi Vac Pilot Test - Operation of System

Person Doing JSA: Jack Geissert/Tom Tourish Date: 12/14/93

JOB STEPS	JOB HAZARDS	SAFEGUARDS/PRECAUTIONS
Operation and Maintenance of System	1. Noise	1. Hearing Protectors
	2. Organic vapors in shed	2. FID/PID @ 50 ppm action level
	3. Explosive atmosphere	3. LEL test <10%
	4. Electric shock	4. Specify O&M tasks and spec where lockout/tagout needs to be done -specify on Appendix C-1
	5. Moving GAC units	5. Use proper lift equipment to move

JOB SAFETY ANALYSIS

HEAVY EQUIPMENT OPERATIONS

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
Heavy Equipment Operations (Backhoes, Drill Rigs, Dump Trucks)	1. Employee run over or hit by moving equipment	1. a. back up signals on equipment; b. traffic safety vest for all field personnel; c. foot traffic restricted in areas of operation; d. establish standard hand signals for laborers assisting in equipment operations.
	2. Physical hazards; a. hit in head b. foreign body in eye c. foot injury	2. a. hard hat; b. safety glasses c. steel toe boots
	3. overhead utilities/overhead obstacles	3. Minimum 20' distance, 10' distance if insulated

JOB SAFETY ANALYSIS

INSTALL EQUIPMENT

JOB STEPS	JOB HAZARDS	SAFEGUARD & PRECAUTIONS
Install Equipment	1. Physical Hazards a. Lifting b. Sharp objects c. Drop equipment d. Loose coils of rope/wires e. Slips, trips & falls 2. Electrical Shock	1. Trained Personnel Install Equipment a. 70# lifting rule b. Use mechanical lifting devices c. Gloves, hard hat, steel toes, safety glasses d. Proper footing/general awareness e. Practice good housekeeping 2. Make Sure De-Energized a. Use Lockout/Tagout procedures b. Use proper grounding & bonding techniques c. Trained personnel (electrician) perform wiring

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FLUOR DANIEL GTI

JOB SAFETY ANALYSIS WORKSHEET

Operation/Location: _____

Person Doing JSA: _____ Date_____

Job Steps	Job Hazards	Safeguards and Precautions

JOB SAFETY ANALYSIS

MOBILIZE PERSONNEL & EQUIPMENT

JOB STEPS	JOB HAZARDS	SAFEGUARD & PRECAUTIONS
Mobilize Personnel & Equipment to Site	1. Vehicles - Traffic In & Out of site	1. a. Provide traffic cones b. Barricade of construction zones c. Provide construction equipment
	2. Heavy Equipment/Construction Supplies	2. a. Provide lay down zone: hardhats, safety glasses, steel toe boots, traffic vests b. Provide mechanical lifting equipment - remember 70# lifting rule

©SM&S:MOBPERS_JSA

JOB SAFETY ANALYSIS

OPERATIONS & MAINTENANCE
(Pneumatic System)

JOB STEPS	JOB HAZARDS	SAFEGUARD & PRECAUTIONS
Air Compressor for Pneumatic Maintenance (Filter Change) (Oil Check) Condensate/Knock-outs Drain	1. a. Air Under Pressure b. Direct Skin Injection c. Dust d. Electricity	1. a. Safety Goggles b. Gloves/Dermal Protection c. Bleed Off Excess Air d. De-energize System e. De-Energize Lockout/Tagout

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JOB SAFETY ANALYSIS

INSTALL RECOVERY TRENCH

JOB STEPS	JOB HAZARDS	SAFEGUARDS & PRECAUTIONS
Install Recovery Trench	Heavy Equipment Operating Noises Physical	1. Establish Heavy Equipment Work Area a. Backup signals on equipment b. Traffic vests for field personnel c. Foot traffic restricted zones d. Establish hand signals for laborers e. Ear plugs/muffs f. Hard hat, steel toe/shank boots, safety glasses, gloves
	Structural Clearances - Utilities Buildings etc.	2. Clearances a. Minimum 20 feet; Distance from overhead
	Trench - Excavation Pit/Trench Collapse/Slope Failure	3. Establish Construction Equipment Work Zone a. Barriers - Construction Fence b. Trench Box/Side Sloping c. Competent trained supervisor per OSHA 29 CFR 1926.650 (slope) 1926.651 (grounded) 1926.652 (protective system) d. Allow proper egress from excavations with >4' deep using ladders every 25' e. Implement shoring/bracing to preserve integrity of trench walls especially in areas of adjacent structures.

JOB SAFETY ANALYSIS

SOIL EXCAVATION

JOB STEPS	JOB HAZARDS	SAFEGUARDS & PRECAUTIONS
Soil Excavation	1. Exposure to airborne contaminants released during intrusive activities. Flammable atmospheres encountered in excavation.	1. Monitor for airborne contaminants. Allow test pits to purge and/or use personal protective equipment.
	2. Sides of excavation can cave in. Possible burying or crushing of workers due to: (1) absence of shoring, (2) misjudgment of stability, (3) defective shoring, and/or (4) undercut sides.	2. a. Provide adequate shoring or sloping of sides of the excavation. Regularly inspect trenches for changing conditions. b. Solid rock, cemented sand or gravel = 90 degrees. c. Compact angular gravel = 63 degrees 26 ft. deep. d. Compacted sharp sand = 33 degrees 41 ft. deep. e. Rounded loose sand = 26 degrees 34 ft. deep.
	3. Falling during access/egress or while monitoring or dismounting equipment, or stumbling into the excavation.	3. Provide ramps or ladders to trenches to allow safe access and egress.
	4. An overhead hazard can result from material, tools, rock and/or soil falling into the excavation.	4. Provide an adequate barrier around open pits. Material from pit must be placed away from edge to prevent cave ins and instability of pit.
	5. Congested work area due to too many workers in a small area.	5. Maintain ample work room between workers.

FLUOR DANIEL GTI

JOB SAFETY ANALYSIS WORKSHEET

Operation/Location: LaGuardia Airport

Person Doing JSA: John Reinemann, CIH Date 8/18/98

Job Steps	Job Hazards	Safeguards and Precautions
Steam cleaning equipment associated with tank removal and cleaning activities	Burns Chemical contact via direct contact and splashing	Cleaning to be conducted through a hole cut in the tank. No tank entry required. Personnel will wear appropriate PPE according to the HASP. Should confined space entry be required, FDGTI confined space entry program, or contractors' program, if equal to FDGTI, will be followed. Personnel will be trained on chemical hazards of the tank contents prior to the cleaning process.

JOB SAFETY ANALYSIS

UTILITY HOOK UP

JOB STEPS	JOB HAZARDS	SAFEGUARD & PRECAUTIONS
Utility Hook-Up	1. Back strain from clearing vegetation for road construction with a scythe or other cutting tool.	1. Back strain can be prevented by frequent breaks in routine. Use slow, even movements and proper lifting techniques (i.e. with the legs). Work gloves will reduce the incidence of hand injury and blisters associated with hand tools.
	2. Irritation from dust generated from road construction.	2. Dust suppression techniques, i.e., wetting the soil with water, will reduce dust exposure.
	3. Driving vehicles, placing trailers, and collecting rubbish, on uneven surfaces creates a possibility of the vehicle rolling, getting stuck in mud or ditches, or of an accident due to flat tires or striking obstacles, and the vehicles.	3. Proper vehicles maintenance will prevent avoidable vehicle breakdown in the field. In order to minimalize accidents from uneven terrain, a site surveillance should be performed on foot to choose a clear driving path. Seatbelts should be worn at all times.
	4. Several types of hazards can be associated with utility hook-up depending on the particular work activity.	4. Hazards associated with the particular utility would be anticipated and proper measures should be undertaken by the subcontractor employer. General provisions of 29 CFR 1910/1926 Subpart K, should be implemented in order to prevent electrical hazards.
	5. Electrical Shock	5. Ensure that all lines, junction boxes, and control panels are properly labeled.

Job Safety Analysis
Welding/Torch Cutting

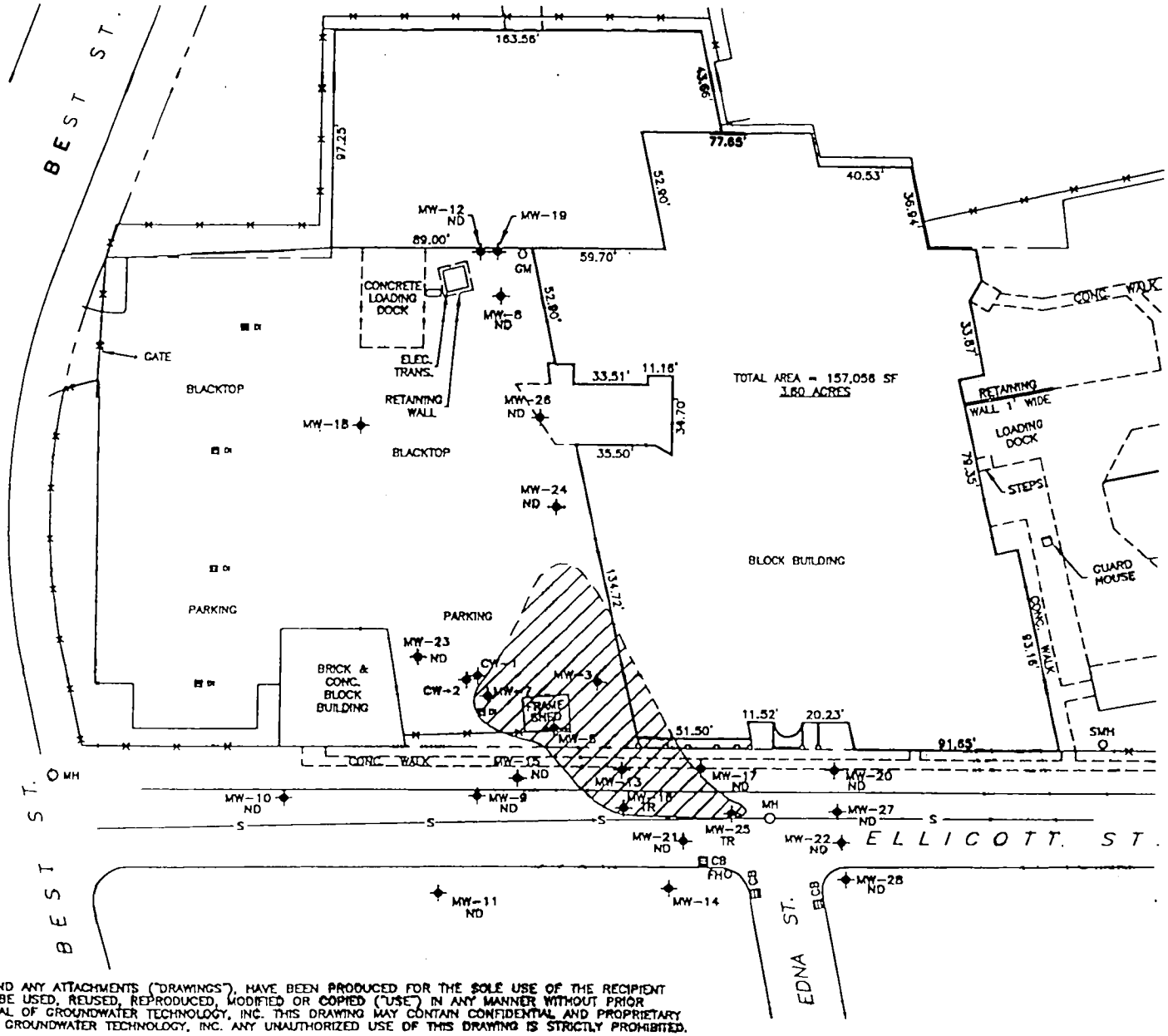
Job Hazards	Safeguards/Precautions
1. Unsafe act Untrained worker	1. a. Require qualified operators only. b. Provide training per 29 CFR 1910.1200. c. Provide proper PPE. d. Inspect area prior to welding/cutting. e. Use permit system. f. Use fire watch.
2. Welder's flash to eye	2. a. Use filter lense based on actual hazard or welding technique in accordance with the American Welding Society Laws shade selector chart. b. Provide warning signals, barricades or similar means to protect other workers, general public. c. Provide screens or barriers to protect other workers, general public.
3. Radiation burns, skin burns, heat burns	3. a. Helmet with proper filter lense. b. Gaunglet gloves, leather apron. c. Cotton shirt, long sleeves, buttoned at sleeves and collar. d. Cotton cuffless pants. e. Steel toe boots, 6" minimum height. f. Hearing/ear cover protection as appropriate. f. Work zone definition - see 2(a) and (b) above.
4. Faulty equipment	4. a. Use equipment that is in good working condition. b. Inspect valves, regulators and hoses prior to use. c. Preventive maintenance performed per manufacturer specifications.
5. Toxic fumes and gases	5. a. Provide source ventilation. b. Provide respiratory protection, selected based on hazard. c. Rope off area, define work area with cones, caution tape or similar (see 2(a) and (b) above).
6. Adjacent flammable/combustible materials	6. a. Move combustibles at least 50' from work area. b. If they cannot be moved consider protection by metal guards or flame proof curtain. c. Openings in walls, floors or ducts should be covered if within 35' of work area. d. Assure facility sprinklers are in working condition and will not be taken out of service. e. Suitable fire extinguishing equipment shall be readily available at the work area. f. Designate a reliable means of contacting the Fire Department in the event of an emergency.

(continued)

Job Safety Analysis Welding/Torch Cutting	
Job Hazards	**Safeguards/Precautions**
7. Flammable/combustible vapors	7. a. If in an environment classified as a hazardous location then define specific tasks using JSA technique. b. Provide equipment per classification (i.e., explosion proof, etc.) c. Post sign: DANGER - NO SMOKING, MATCHES OR OPEN LIGHTS.
8. Confined space entry	8. a. Follow CSE procedures. b. Use CSE permit. c. Define specific JSA techniques for that work. d. Exercise caution when using inertion to address O_2 deficiency. e. Exercise caution when using O_2/acetylene fuel mix, address O_2 enrichment from cylinder leak.
9. Unsecured compressed gas cylinders	9. a. Store cylinders upright. b. Secure against stationary object. c. Cylinders in excess of 40 pounds in weight must be moved using wheeled cart or motorized truck. d. Lifting cylinders > 40 pounds in weight is prohibited. e. Compatible storage practices = separate O_2 cylinders from flammable combustible gases. f. Use tags on cylinders to mark full, in use or empty.
10. Unsafe practice during inactivity	10. a. Provide protective cap when cylinders are not in use. b. Valves or gas cylinders shall be closed and line pressure relieved. c. Power source of electric welding equipment shall be disconnected.
11. Improper flow of gases, gas mixing, pressure in gas lines	11. a. Label cylinders per 29 CFR 1910.1200. b. Color code hoses (green = O_2; red = fuel gases; black = inert gas or air hoses). c. Install "flash back" arrestors for fuel mixing welding. d. Use acetylene at 15 psi or less.
12. Improper ignition of oxygen/fuel torch	12. a. Use "spark lighter" to ignite. b. Don't use cigarette, match or lighter for ignition.
13. Static electricity	13. a. Provide and use grounding clamp for electric area welding equipment.

EXHIBIT A-K

SITE MAPS



LEGEND

- MONITORING WELL
- MONITORING POINT
- SOIL BORING
- MH MANHOLE
- FH FIRE HYDRANT
- FENCE
- —S— SEWER LINE
- APPROXIMATE EXTENT OF LNAPL
- ND NONE DETECTED

0 50 100
SCALE FEET

THIS DRAWING AND ANY ATTACHMENTS ("DRAWINGS"), HAVE BEEN PRODUCED FOR THE SOLE USE OF THE RECIPIENT AND MUST NOT BE USED, REUSED, REPRODUCED, MODIFIED OR COPIED ("USE") IN ANY MANNER WITHOUT PRIOR WRITTEN APPROVAL OF GROUNDWATER TECHNOLOGY, INC. THIS DRAWING MAY CONTAIN CONFIDENTIAL AND PROPRIETARY INFORMATION OF GROUNDWATER TECHNOLOGY, INC. ANY UNAUTHORIZED USE OF THIS DRAWING IS STRICTLY PROHIBITED.

GT ENGINEERING
1245 KINGS ROAD
SCHENECTADY, NY 12303
(518) 370-5831

REV. NO.:	DRAWING DATE: 8/3/98	ACAD FILE: LNAPL

AREAL EXTENT OF LNAPL

CLIENT:	PM:
OSMOSE WOOD PRESERVING COMPANY	BWA
LOCATION: ELLICOTT STREET BUFFALO, NEW YORK	GED: JOG

DESIGNED:	DETAILED:	PROJECT NO.:	FIGURE:
JOG	MET/DEO/SSH	01110-5307	2-1

EXHIBIT A-L

FLUOR DANIEL GTI FIELD INSPECTION FORM

Personal Protective Equipment

ITEM	YES	NO	N/A	YES	NO	N/A	YES	NO	N/A
Name									
Hard Hat									
Safety Glasses									
Safety Boots									
Traffic Vest									
Uniform or Coveralls									
Hearing Protection									

Site Safety Plan

		Yes	No	N/A
1.	Site Specific SSP on site and available.	____	____	____
2.	All personnel on site have signed and acknowledged SSP.	____	____	____
3.	Site map is attached to SSP with hospital location indicated.	____	____	____

Vehicle Inspection

1.	Windshields free of "vision-impaired" cracks.	____	____	____
2.	Mirrors are in good working order.	____	____	____
3.	First Aid Kit is complete and available.	____	____	____
4.	Fire extinguisher is mounted in vehicle, ABC type 10 pound at a minimum.	____	____	____
5.	Vehicle MSDS Package in vehicle.	____	____	____
7.	Seat belt warning sign in vehicle.	____	____	____
8.	Eyewash available.	____	____	____

Respiratory Protective Equipment	Yes	No	N/A
1. Only GTI approved air purifying respirators are used.	____	____	____
2. Respirators are stored in a company provided safety equipment bag.	____	____	____
3. Supplies to clean respirators are available.	____	____	____
4. Respirators appear in good working condition.	____	____	____
5. GTI Facial Hair Policy is in force.	____	____	____
6. Personnel with corrective lenses have obtained a respirator spectacle kit.	____	____	____

Contamination Control			
1. Access to exclusion (hot) zone is restricted and clearly defined through the use of cone(s), caution tape or another similar barricade.	____	____	____
2. Good housekeeping enforced.	____	____	____

Toxic Vapor Monitoring			
1. Air monitoring for organic vapor concentrations has been conducted to assess worker protection and it is documented.	____	____	____
2. Instrumented calibration and maintenance is performed as recommended by the manufacturer and it is documented.	____	____	____
3. Organic vapor air monitoring instrument operating manual is readily available.	____	____	____
4. Confined space entry (CSE) permit is utilized as required.	____	____	____
5. Full body harness retrieval system (tripod) is utilized, for CSE work if appropriate.	____	____	____
6. The buddy system is in effect for CSE as required.			
7. Continuous air monitoring is performed for CSE.	____	____	____

Fire Prevention and Protection	Yes	No	N/A
1. Air monitoring for flammable concentrations has been conducted to assess worker protection and it is documented.	____	____	____
2. Instrument calibration and maintenance is performed as recommended by the manufacturer and it is documented.	____	____	____
3. Oxygen/combustible vapor air monitoring instrument operating manual is readily available.	____	____	____
4. Portable fire extinguishers are appropriate for the job, charged, deemed operable and have current annual inspection tag by a qualified licensed vendor.	____	____	____

Electrical Safety			
1. Electrical equipment is properly rated if used in hazardous areas.	____	____	____
2. Systems are properly grounded/bonded.	____	____	____
3. Extension cords have a 3 prong plug for grounding.	____	____	____
4. Extension cords and electrical cords are in good working condition.	____	____	____
5. A ground fault circuit interrupter (GFCI) is being used as required.	____	____	____
6. Lockout/Tagout is performed as required.	____	____	____

Comments/Notes:_____

_____

_____

_____

_____

_____

Construction Safety	Yes	No	N/A
1. Excavation area has been sloped or shored at depths beyond 5 feet for personnel entry.	____	____	____
2. Excavation areas 4 feet or greater in depth have ladders spaced so there is no greater than 25 foot travel distance for egress.	____	____	____
3. Soils have been stored back greater than 2 feet from top of slope.	____	____	____
4. Forks or buckets are in the down position when equipment is not in use.	____	____	____
5. Construction vehicles and equipment display back alarms as required.	____	____	____
Ladder Safety			
1. Ladder rungs are sturdy and free of cracks or breaks.	____	____	____
2. Ladders have secure safety feet.	____	____	____
3. Ladders are pitched at a 4:1 ratio.	____	____	____
4. Ladders are secured at the top.	____	____	____
5. Ladders are not used for access to air stripper towers.	____	____	____
Chemical Safety			
1. All recovery vessels stored on a GTI site shall be marked with appropriate hazard warning label.	____	____	____
2. All sheds and/or temporary storage structures shall be marked with a 10 inch diamond placard indicating any hazardous contents contained within that structure.	____	____	____
3. Compressed gas cylinders are properly stored.	____	____	____
4. Incompatible chemicals are segregated.	____	____	____
5. MSDS' are available for all chemicals on site.	____	____	____
6. Manufacturers chemical containers and transfer containers are properly labeled.	____	____	____

FIELD AUDIT REPORT

Performed By_____

Audit Date_____ Project Manager_____

Project Name_____ Project Number_____

Name	Site Activity

CC:

DC4:FIELDAUD.N91

HEALTH AND SAFETY SELF-AUDIT CHECKLIST

Name:_____ Date:_____ Site Location_____
Personnel on site:_____

PLEASE INDICATE AS ACCEPTABLE (A), UNACCEPTABLE (U), OR NOT APPLICABLE (NA)

A. PROTECTIVE EQUIPMENT

1. Hard hat ____
2. Safety glasses ____
3. Safety boots ____
4. Traffic vest ____
5. Respirator ____
6. Ear plugs/muffs ____

B. SITE SAFETY

1. SSP on site & available ____
2. SSP has map to hospital ____
3. Nearest phone identified ____
4. Tailgate meeting conducted ____
5. GFCI's used appropriately ____
6. Lockout/Tagout for elec. work ____

C. SITE CONTROL

1. Access to exclusion (hot) zone restricted & properly defined ____
2. Additional precautions taken in high traffic areas ____

D. VEHICLE INSPECTION

1. First aid kit ____
2. Fire extinguisher ____
3. MSDS package ____
4. Mirrors ____
5. Headlights/brakelights/signals ____
6. Housekeeping ____

E. AIR MONITORING

1. Vapor monitoring has been conducted per the SSP ____
2. Calibration and maintenance has been performed per mfg. ____
3. Confined space entry permit has been utilized as required ____

F. CONSTRUCTION SAFETY

1. Excavations >4' have ladders spaces every 25' ____
2. Excavations > 5' have been sloped or shored for entry ____
3. Soils have been stored back > 2' from the pit ____

COMMENTS/CORRECTIONS NEEDED:_____

_____

_____

_____ cc: District Manager, Completed by:_____

_____
Project Manager

DTC5:CHECKLST.AUD

EXHIBIT A-M

DAILY TAILGATE SAFETY MEETING FORM

FLUOR DANIEL GTI
DAILY TAILGATE SAFETY MEETING

Project/Site:_____

Date:_____

Presented by:_____ Title:_____

Topic(s)/Information Reviewed:_____

_____

_____

_____

_____

Comments/Follow-up Actions:

_____

_____

_____

_____

Sign in:

NAME SIGNATURE COMPANY

_____

_____

_____

_____

_____

_____

Instructions:

Conduct a Daily Tailgate Safety Meeting prior to beginning each day's site activities.
Complete form and file with Site HASP.
Follow-up on any noted items and document resolution of any action items.

EXHIBIT A-N

AIR MONITORING AND VAPOR RESPONSE

COMMUNITY AIR MONITORING PLAN
VAPOR EMISSION RESPONSE PLAN
MAJOR EMISSION RESPONSE PLAN

APPENDIX A – N
AIR MONITORING AND VAPOR RESPONSE PLAN

Community Air Monitoring Plan

Real-time air monitoring, for volatile organic compounds (VOCs), ozone, and particulate levels will be performed. This plan will include the following:

- VOCs will be monitored downwind of the work zone daily at 15 minute intervals during disturbance activities (i.e., excavation and/or drilling). If total organic vapor levels exceeds 5 parts per million (ppm) above background, activity will be halted and monitoring continued under provisions of the Vapor Emission Response Plan.

- Particulates will be continuously monitored downwind of the work zone during disturbance activities with a portable particulate monitor. The monitor will have an alarm set at 150 ug/m3 above background. In the event downwind particulate levels exceed 150 ug/m3 above background particulate levels upwind of the work site will be measured. If downwind particulate levels exceed 2 ½ times the upwind level, the disturbances activity will be stopped and a corrective action plan implemented. All readings will be recorded and will be available for NYSDEC and DOH review.

- Ambient ozone will be monitored bi-weekly during the operation and maintenance of the treatment system during any period which ozone is being injected into the ground. Two offsite downwind locations (locations AA-5 and AA-6; O&M Manual; Figure 5-1) will be monitored using Drager-type tubes. If ozone levels exceed 0.07 ppm above background, ozone injection will be halted and monitoring continued under the provisions of the Vapor Emission Response Plan.

Vapor Emission Response Plan

If the ambient air concentration of VOCs exceeds 5 ppm above background, or ozone exceeds 0.07 ppm above background downwind of the work zone, activities will be halted while monitoring is continued. If VOC levels decrease below 5 ppm above background, the disturbance activity will resume with a more frequent monitoring interval. If VOC levels are greater than 5 ppm over background, but less than 25 ppm over background at the perimeter of the work zone, disturbance activity will resume provided:

- The VOC level 200 feet downwind of the work zone or half the distance to the nearest residential or commercial structure, whichever is less, is below 5 ppm over background, and

- More frequent intervals of monitoring, as directed by the Safety Officer, are conducted.

If VOC level is above 25 ppm at the perimeter of the work zone, work activities will be shut down. When work shutdown occurs, downwind air monitoring as directed by the Safety Officer will be implemented to ensure that vapor emission does not impact the nearest residential or commercial structure at levels exceeding those specified in the Major Vapor Emission Section.

If ozone exceeds 0.07 ppm above background, the source of the ozone will be identified prior to re-starting the ozone injection. This may include re-confirming the SVE system area of influence under operational conditions.

Major Vapor Emission Plan

If any organic levels greater than 5 ppm over background are identified 200 feet downwind from the work zone, or half the distance to the nearest residential or commercial property, whichever is less, all work activities will be halted.

If, following the cessation of the work activities, organic levels persist above 5 ppm above background 200 feet downwind or half the distance to the nearest residential or commercial property from the work zone, then the air quality must be monitored within 20 feet from the perimeter of the nearest residential or commercial structure (20 foot zone).

If ozone levels greater than 0.07 ppm over background are identified 200 feet downwind from the injection (work) zone, or half the distance to the nearest residential or commercial property, whichever is less, injection of ozone will be halted. If, following cessation of the ozone injection, ambient ozone persist above 0.07 ppm above background 200 feet downwind or half the distance to the nearest residential or commercial property from the work zone, then air quality must be monitored within 20 feet from the perimeter of the nearest residential or commercial structure (20 foot zone).

If efforts to abate the emission source are unsuccessful and if any of the following levels persist for more than 30 minutes in the 20 foot zone, then the Major Vapor Emission Response Plan shall automatically be placed into effect:

- Organic vapor levels greater than 5 ppm above background
- Ozone levels greater than 0.07 ppm above background

Major Vapor Emission Response Plan

Upon activation, the following activities will be undertaken:

1. The local police authorities will immediately be contact by the Safety Officer and advised of the situation.

2. Frequent air monitoring will be conducted for 10 minute intervals within the 20 foot zone. If four successive readings below action levels are measured, air monitoring may be halted or modified by the Safety Officer.

APPENDIX
G

APPENDIX G

SAMPLING AND ANALYSIS PLAN

This appendix intentionally left blank.

The existing NYSDEC approved QAPP for the Osmose site will be used during operation and maintenance activities. Task specific amendments to the QAPP include:

Section 3.2; Site Description: The description will be changed to include references to the RD/RA Order on Consent and associated tasks.

Section 3.3; Summary of the Problem: The reference to the specific work plan will be changed to reference the general nature and extent of impacts at the Osmose site.

Section 3.4; Project Objectives: References to the current media that will be sampled will be made.

Section 3.5; Investigation Synopsis: The section will be revised to include the current media that will be sampled during O&M activities.

Section 3.6; Data Quality Objectives: The section will be revised to include the current media that will be sampled during O&M activities.

Section 3.7; Project Schedule: This section will be deleted.

Section 4.0; Project Organization: The project organization will be revised to include the following personnel:

- Project Manager: Bruce W. Ahrens, CHMM
- Quality Assurance Officer: Richard A. Hixon, CPG
- Data Validation Chemist: Data Validation Services; Judy Harry
- Project Engineer/Field Operations Manager: Gina O. Senia

Section 6.0; Sampling Procedures: References to "soil gas survey" will be removed and replaced with "sewer sediment sampling".

Section 9.0; Analytical Procedures: Change reference to Analytical Services Protocol (ASP) dated October 1995.

Section 10.0; Data Reduction and Reporting: Only a cursory review of data qualifications will be conducted by the consultant's Project Manager; full validation will not be conducted on data collected for operation and maintenance purposes.

Additionally, Table 3-1, Project Compound List, will be added to the QA/QC Plan

A revised Quality Assurance Project Plan (QAPP) will be submitted under separate cover.