Operations of a Vapor Extraction/Air Sparging System Naval Weapons Industrial Reserve Plant

Bethpage, NY

Prepared for:

Northern Division
Naval Facilities
Engineering Command
10 Industrial Highway, MS#82
Lester, PA 19113

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Prepared by:

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DRAFT

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OPERATION AND MAINTENANCE MANUAL FOR SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM

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1.0 Introduction

This operations and maintenance manual has been prepared for the Naval Weapons Industrial Reserve Plant (NWIRP, Navy, the site) in Bethpage, New York by Foster Wheeler Environmental Corporation (Foster Wheeler) to assist site personnel in understanding the treatment facilities with respect to the operation and maintenance of the soil vapor extraction and air sparging systems (system). This manual provides the operators the information necessary in understanding of the work required along with basic operational guidance and trouble shooting information. The contents of this manual are not considered final or complete in every aspect of operation and control. Set points, control points, etc. specified herein are based upon assumed field conditions and can only be established through plant experience during the life of the treatment process. The manual is organized in anticipation of varying field conditions and allows the operator to track and control varying set points in order to optimize the treatment process for effectiveness and productiveness.

This manual provides detailed descriptions of all processes, equipment, and control philosophies associated with the treatment system. This manual will also familiarize technical and supervisory personnel with the functional operation and maintenance requirements of the critical unit processes. It is the operators responsibility to recognize that this manual must be kept current. When there are changes in operating conditions or equipment, the manual should be updated to reflect these changes.

The manual is organized to be as operator friendly as possible. Various sections contain quick reference charts, tables, and graphs in order to compile pertinent information in one easily accessible location.

1.1 General Background

This manual provides a general description of the treatment methodology and describes in detail the operating and maintenance procedures necessary for proper functioning of the treatment system. This manual will provide a systematic approach to the remedial effort at the facilities.

1.2 Site History and Description

The site is a 108-acre site located in Long Island in Nassau County, New York, approximately 30 miles east of New York City. The site is bordered on the north, west, and south by the Grumman Aerospace complex and on the east by a residential neighborhood. NWIRP-Bethpage is currently listed by the New York State Department of Environmental Conservation (NYSDEC) as an "inactive hazardous waste site" (#1-30-003B) as is the Northrop Grumman Corporation (#1-30-300A) and the Hooker/Ruco site (#1-30-004). located less than 1/2 mile west of the NWIRP-Bethpage site.

The NWIRP-Bethpage plant was established in 1933 and is no longer an active manufacturing facility. The primary mission for the facility was the research, prototyping, testing, design engineering, fabrication, and primary assembly of military aircraft.

Hazardous waste management practices for the Grumman facilities on Long Island included the marshaling of drummed wastes on the NWIRP-Bethpage property. Such storage first took place on a surface over the cesspool field, east of Plant No. 3. In 1978, the collection and marshaling point was moved a few yards south of the original site, to an area on a concrete pad. In 1982, drummed waste storage was transferred to the present drum marshaling facility located in the Salvage Storage Area.

A remedial investigation was conducted by Haliburton NUS in 1992 and 1993 for the Navy to investigate potential sources of VOC contamination. Based upon this investigation, a source of the groundwater contamination at Site 1 was determined to originate near the near the former drum marshaling pads.

Foster Wheeler designed and constructed a soil vapor extraction/air sparging system to remove VOC contamination in the soil and groundwater. The system extracts soil vapor from several wells and passes the vapor through a moisture separator and vapor phase carbon before discharging to the atmosphere. The system also injects air into the soil below the water table to enhance the effectiveness of the soil vapor extraction.

1.3 Manual Organization

This manual is divided into eleven (11) primary sections.

- Section 1 provides introductory information regarding the purpose and use of this manual.
- Section 2 outlines operation responsibilities.
- Section 3 gives a description of the treatment system.
- Section 4 summarizes start-up procedures.
- Section 5 describes individual system operation.
- Section 6 covers spare parts and maintenance.
- Section 7 outlines records and recordkeeping.
- Section 8 is the Health and Safety Plan (HASP).
- Section 9 describes regulatory compliance.
- Section 10 covers sampling, monitoring, and system effectiveness monitoring.
- Section 11 describes waste disposal requirements.

1.4 Operation and Maintenance Philosophy

The System has been designed to minimize the maintenance and operation requirements. The system is fairly simple and operates continuously 24 hours/day during spring, fall and summer months. The principal means of control operates under manual control with mechanical switches for emergency shutdowns. The equipment and associated systems were designed to minimize maintenance requirements which may include air filter change-outs, carbon replacement, etc. These functions will be described later in detail. However, the maintenance requirements associated with these activities should require bi-weekly or monthly attention as opposed to daily attention. In this manner, the number of hours the operator must be on-site is minimized. Of course, actual field conditions may require modifications to the plan specified herein, and could result in additional operator tasks, however, the primary philosophy remains unchanged which is

to minimize operator activities. As a "fail-safe" measure, the system is equipped with an autodialer system which calls predetermined emergency response numbers if an alarm is detected. Use of this telemetry requires the operator to be on call 24 hours a day in case of an emergency.

The soil vapor extraction/air sparging activities that are considered the most labor intensive are listed below in order of priority. Also listed is a brief overview summary of the operation and maintenance associated with each item.

Health and Safety

First and foremost, the operator should take every precaution necessary to ensure that a safe working environment exists. The operator should recognize that health and safety is the most critical aspect of any task and employing the proper safety devices and procedures is an integral part of this operation and maintenance manual. Common sense is the first step in recognizing health and safety issues. If the operator is not sure about a specific task or procedure - STOP AND ASK - be sure to obtain and comprehend the appropriate instructions before engaging in any activity that is not thoroughly explained or understood. Furthermore, the operator should maintain the Daily Sign-In Log (Exhibit 1). It is important that all site visits are recorded and filed.

Rotating Equipment (pumps, blowers, etc.)

Wear and tear on pumps, blowers, etc. will result in ruptured seals, cracked gaskets, loose flanges, etc. These items are considered standard maintenance issues for this type of equipment and represent a labor intensive activity. It is important that the operator inspect the equipment carefully in accordance with this plan since a mechanical failure may be difficult to predict unless a careful inspection is performed. It is crucial that the air blowers are lubricated and filled with oil regularly.

Report Preparation and Record Keeping (Effectiveness Monitoring, Sampling & Analysis)

The operator is required to perform the tasks associated with the Effectiveness Monitoring Program included in this manual. Once the data is obtained, the operator or the operator's supervising agent is responsible for downloading, compiling, and submitting the appropriate data for review. Once the operator is familiar with the requirements of the Effectiveness Monitoring Program and is associated reports (monthly) this task should become routine since each report is somewhat repetitive of the last with regard to format.

The keeping of adequate records of performance is an integral part of a good treatment plant operation. The operator should take all means necessary to ensure the on-site records are kept in order in a neat, clearly labeled, legible file. The operator is also required to keep a copy of the project file at an off-site location.

Waste Disposal

Occasional hazardous waste disposal may be required. Condensate water that is collected in the system is transferred to a satellite storage area for testing and disposal. Approximately 20-30

gallons per month is conservatively expected to be generated. The operator must remember that, typically, storage can not exceed 90 days.

HVAC Systems Inspections /Balance of Plant

The lighting and HVAC system will require routine inspection/maintenance in accordance with the local requirements and equipment manufacturer's recommendations. The operator should establish a schedule for such events and keep a record of all inspections, etc.

Spare Parts Inventory

The operator should periodically check the spare parts inventory in accordance with the requirements set forth in this manual. Frequently used spare parts should be noted and additional stock should be supplied.

Carbon Regeneration

A qualified person/company/subcontractor will be utilized to handle all aspects of the carbon regeneration which encompasses removal of the DOT approved vessels for off-site regeneration and refilling or vacuum extraction of spent carbon from the vessel into an awaiting truck for disposal, and then reloading the vessel with clean carbon.

Proper waste manifesting and scheduling is required to ensure a smooth and efficient changeout. The schedule below outlines the major operation and maintenance activities for this project.

Task	Equipment Maintenance	System Performance	Waste Disposal	Effectiveness Monitoring
Health & Safety	✓	✓	✓	✓
Waste Manifesting			✓	
Waste Disposal			✓	
Equipment Lubrication	✓			
Sampling		✓		✓
Reporting	✓	✓	✓	✓
Recordkeeping	✓	✓	✓	✓
Equipment Checkouts	✓			
Water Level Measurements		✓		✓

2.0 Operation and Management Responsibility

In order to effectively operate a treatment plant, team work on all levels of management is required. This section outlines the responsibilities of all the team members which include the operator/manager and the owner. The Owner of the site is the United States Navy.

2.1 Operator/Manager Responsibility

The operator/manager of the treatment system is ultimately responsible for maintaining, supervising, and operating all plant activities and processes. The Operator/Manager for the site is Foster Wheeler.

2.1.1 Operator Responsibility

The general responsibilities of the operator include the following:

1. Maintaining the system in operating condition that meets system requirements and be thoroughly familiar with the treatment facilities. This includes knowing the function of each process in the plant, how each process accomplishes its function, how to collect data for the evaluation of each process and where to forward such information for the appropriate review.
2. Being familiar with characteristics of the soil vapor to be treated and knowing those characteristics which are critical to plant operations.
3. Being familiar with discharge limitations.
4. Interpreting operating records in order to adjust the processes to obtain the best possible results for the least cost and to conform to the waste discharge requirements.
5. Knowing and implementing good maintenance procedures.
6. Keeping complete, neat and accurate records of all phases of plant operation and maintenance.
7. Being aware of safety hazards connected with the treatment and establishing a safety oriented approach to the operation.
8. Preparing reports based on operating and maintenance records for the appropriate supervising personnel.
9. Being aware of emergency procedures and alarms including fire alarms.
10. Maintaining a clean, neat, and orderly building.

The operator must also follow and address all federal, state, and local requirements. System operator information is summarized in Exhibit 2.

2.1.2 Manager Responsibility

The general responsibilities of the manager include the following:

1. Provide good working conditions, safety equipment and proper tools for the operating personnel.

2. See that adequate operational and management records are being kept to meet regulatory requirements.
3. Establish operator training programs when required.
4. Prepare budgets and reports as specified in the Effectiveness Monitoring Program.
5. Maintain contracts/permits for operation and maintenance of the system. These include:
   - Carbon Regeneration
   - Waste Disposal
   - Sampling and Analysis (Laboratory)
   - Mechanical and electrical Union Contracts
   - BOCA/OSHA Inspections
6. Submitting reports to appropriate parties.
7. Ensure proper O&M of the system.
8. Pay the electric bill, phone bill, water bill, and any other utility type monthly bills.
9. Pay for new supplies, tools, etc.

2.2 Owner Responsibility

The responsibility of the owner is to act as a liaison between the State of New York and the operator/management on the reporting of the effectiveness of the system. The Owner is also responsible for ensuring that the proper release of funds is established for the duration of this project.

3.0 Type of Treatment

The remedial action for the site encompasses the installation of soil vapor extraction and air sparging wells.

Soil vapor extraction removes volatile organic compounds (VOCs) from the soils above the water table by inducing air flow through soils impacted with petroleum. SVE is typically performed by applying a vacuum to vapor extraction wells screened through the level of impacted soil using a vacuum blower. The resulting vacuum gradient causes the soil gas to migrate through the soil pores toward the vapor extraction wells. The VOCs are volitalized and transported out of the subsurface by the migrating soil gas. SVE also increases the oxygen flow through the contaminated soil, stimulating natural biodegradation of the aerobically degradable contaminants.

Air sparging involves the injection of air under pressure below the water table. This process introduces air to soil pore space by displacing water in the soil matrix. Air sparging has the dual purpose of physically removing organic compounds through volatilization from subsurface soils and groundwater and contributing to the aerobic biodegradation by providing an oxygen source.

3.1 Overall Process Description

The entire soil vapor extraction/air sparging process is shown on Drawing BTH-03. Soil vapor is extracted from thirteen (13) vertical extraction wells using one rotary lobe blower, B-01. Each extraction well is expected to produce a flow rate of about 25 cfm at a vacuum of 9" water column. The vapors are separated from the entrained groundwater via two (2) moisture separators (M-01/M-02) operating in series upstream of the blower. The vapor exiting the blower is directed to two (2) 2,000 pound vapor phase carbon adsorbers operating in series before being discharged to the atmosphere. The entrained groundwater (condensate) is pumped from the moisture separators into 55 gallon drums for testing and proper disposal.

The air sparging system consists of eleven (11) vertical sparge wells and one rotary lobe blower, B-02. The air sparging wells are expected to have a flow rate of about 10 cfm at a pressure of about 4 psi.

Well construction details are located in Appendix E of this manual.

4.0 Start-Up Procedures

4.1 Overview

This start-up plan provides the basic information necessary to effectively initialize and operate certain components of the NWIRP-Bethpage treatment plant and verify that the treatment facility is dynamically stable and that each of the applied process systems, and supporting balance of plant systems function in concert with each other and meet performance objectives. In order to perform the start-up, process, emergency/safety and balance of plant systems must be substantially complete, construction checked and found acceptable. This plan includes the major prerequisite requirements that necessitate verification prior to start-up.

4.2 Start-Up Organization

The Field Engineer will lead the start-up effort, maintains records and provide a prove out report at the end of start up. He/She is supported by the site superintendent, laborer support and the site geologist.

4.3 Electrical Prerequisites

Testing of electrical equipment will be performed to verify the integrity of signal transmission from the instrumentation and equipment to the control panel. The field team is responsible to have previously installed all power, control, and signal cable. Also, the team shall verify conductor continuity, the absence of shorts, and the separation of hot and ground conductors.

The field team should also verify that all instrumentation and control devices have been calibrated based on the manufacturer's recommendations and are operational for the intended use. Instruction calibration is summarized in the next section.

Prior to commencing any tests, all applicable prerequisites shall be verified and all construction electrical responsibilities have been completed for each system component. Checklists are attached (Exhibit 3) for use by the operator.

Other electrical prerequisites include:

1. Building grounding and equipment grounds have been installed and verified to be complete.

2. All control and power wiring and instrumentation conductors to the equipment being tested are clearly labeled and properly installed.

3. Associated electrical safety devices to the equipment being tested, such as breakers, fuses, disconnect, are tagged and installed as required.

4.4 Instrumentation Prerequisites

Testing of instruments shall be conducted to verify the proper operation of pressure, temperature and level switches. As previously mentioned, construction should verify the proper installation and calibration of all field instruments. All calibration data sheets (Exhibit 4) should be available for review during system start-up and eventual incorporation into the system O&M Manual.

4.5 Mechanical Prerequisites

Testing of mechanical equipment will be performed to verify the proper direction of rotation, operational capacity and speed, correct energization/de-energization of the equipment, the absence of operational vibration, excessive thermal loading, and excessive noise. Testing is applicable to all mechanical equipment including pumps, blowers, roof ventilators, and hand control valves.

Other mechanical prerequisites include:

1. Equipment has been properly installed. Anchor or hold down bolts have been verified as being completely tightened.

2. Hydrotesting has been completed by Construction and no leaks are present. All hydrotesting reports have been signed off and are available for review. Exhibit 5 summarizes hydrostatic test results.

3. Equipment bearings have been properly lubricated as per manufacturer's requirements.

4. Any shipping or locking braces or clamps have been removed.

5. Safety stops and personnel warning labels are installed and visible throughout the plant.

6. All valves have been properly tagged using 1/2" stainless steel bands or other suitable permanent marker, securely fastened to each valve using type 304 stainless steel aircraft wire 24 Ga. The valve tagging shall be in conformance with the P&ID enclosed with this plan and with the Master Valve List.

7. Throughout start-up be sure the system is "balanced" and no entrained air is trapped within the system piping. Proper valve management will be required to avoid this.

8. Be sure to have the appropriate and/or critical spare parts available in accordance with the Spare Parts List.

9. Be sure to have the recommended spare tools on-site during any phase of the start-up.

10. Prior to commencing with start-up, the entire system should be air flushed to be sure that the system is free of debris, scrap metal or wood, dust or other impediments that may be present

as a result of manufacturing or shipping. Monitor and record the results of the system flushing.

4.6 Balance of Plant Systems.

Ensure the HVAC systems and lighting is functioning properly.

4.7 Pre-Start-Up Tests

Electrical, mechanical and instrumentation prerequisite checklist items will be validated on the appropriate forms for each System Check-outs (Exhibit 3). Once this is complete, the start-up phase of the project can proceed. Details are summarized below.

1. The engineer should maintain all checklists and verification forms for all processes related to this start-up plan. This includes all pre-start-up prerequisite requirements outlined in Exhibit 3 as well as the subsequent system start-up requirements. Once all the forms have been developed they should be strictly maintained and a controlled copy should be kept on file with the Project Engineer throughout start-up.

2. A controlled copy of this start-up plan should be maintained by the start-up engineer during execution of this plan.

3. Ensure that power is available to all equipment, instrumentation, lighting, and heating and ventilation systems as required.

4. For all switches, perform a continuity test between both poles of the switch in the actuated and un-actuated positions and monitor at the control panel. Record all results and verify that they are correct.

5. Ensure that the moisture separators are configured properly in accordance with the manufacturer's recommendations and the intended operation. Complete the appropriate checklists.

6. Be sure that the carbon adsorption system is configured properly in accordance with the manufacturer's recommendations and intended operation. Complete the appropriate checklists.

7. Ensure that all equipment and instrumentation is configured as required by the manufacturer. Complete the appropriate checklists.

8. Be sure that all pumps and blowers are configured properly in accordance with manufacturer's recommendations. Complete the appropriate checklists.

9. Perform a bump check for all pumps and blowers to ensure the correct direction of rotation and movement of the equipment.

Once all the systems have been checked and approved, the blower initial start-up is to commence. This is done in the following manner:

1. Check to ensure that nothing is in the air chamber or inlet piping.

2. Recheck the blower leveling, drive alignment, and tightness of all mounting belts.

3. Turn the shaft by hand and check if the impellers rotate without bumping or rubbing at any point.

4. Ensure that the blower is correctly lubricated and that the oil level in the gearbox is correct.

5. Close the soil vapor extraction control valves (BV-01 through BV-13).

6. Open the vapor extraction air bleed valve (BV-14).

7. Open the sample port valve (BV-18) downstream of the vapor extraction blower.

8. Close the butterfly valves (BT-02, BT-03) before the carbon adsorbers.

9. Bump the blower a few revolutions with the driver to check the direction of rotation and that both units coast freely to a stop.

10. Start the blower and let it accelerate to full speed and then immediately shut the blower off. Listen for any knocking sounds with both the power on and as the blower slows down.

11. Start the blower and let it accelerate to full speed and let it run for 2-3 minutes. Check for noises and vibrations of 5 mils or greater.

12. Again operate the blower to full speed for ten (10) minutes. Check the oil levels and feel the cylinder and headplate surfaces for development of spots too hot to touch. Also be aware of any increase in vibration.

13. Run the blower for one full hour at normal conditions. Close the discharge valve to apply working pressure. Read both temperature and pressure of the vapor to ensure the operating conditions of the blower is not exceeded.

4.8 Start-Up Procedures

Once the pre-start-up tests are completed, the extraction wells and air sparging wells can be initialized. Refer to Section 8, Health and Safety, for the required air monitoring programs mandatory during start-up. The following sequence is to be followed before the system can be started.

1. Open the extraction well control valves (BV-01 through BV-13)

2. Close the extraction well sample port valves (BV-34 through BV-46)

3. Open the air sparging blower (B-02) run permissive valve (BV-58)

4. Close the vapor extraction sample port valves (BV-18, BV-19, BV-32, BV-33)

5. Close the vapor extraction drain valve (BV-20)

6. Ensure that the moisture separators (M-01/M-02) are empty. Pump any water that may be collected into 55-gallon drums using the condensate transfer pump (P-01)

7. Close the moisture separator valves (BV-15, BV-17) and the condensate transfer pump valve (BV-16)

8. Close the vapor extraction line air bleed valve (BV-14)

9. Ensure that BT-01 is closed

10. Set the carbon adsorber valves in the correct positions as per Exhibit 6

11. Open the valves in the air sparging injection lines (BV-21 through BV-31)

12. Ensure the air monitoring valves (BV-47 through BV-57) on the air sparging lines are closed

13. Close the air sparging bleed valve (BV-58)

14. Start the soil vapor extraction blower (B-01) in accordance with the requirements herein

15. After a vacuum is established on the soil vapor extraction system piping, the air sparging blower (B-02) can be started.

During initial start-up, a continuous air flow is to be maintained of the vapor phase carbon adsorbers for a period of 24 hours. During this time the gas temperature is to be monitored. If at any point the change in temperature between the entrance and exit of the adsorbers reaches 50°F the system is to be shut down and the carbon unit removed. The cause of the temperature rise is to be determined before the system is restarted.

4.9 Extraction/Air Sparging Sequence

The extraction and air sparging wells may be brought on-line sequentially (i.e. EW-01 to EW-13 and IW-01 to IW-11) unless prerequisite prove out and/or health and safety records indicate otherwise.

4.10 System Acceptance Criteria

The start-up should be deemed operational when all the equipment and instrumentation are operating as required to meet the overall system goals. All system instrumentation should be operating at the set points shown in Exhibit 21. Once the system is operating as required, the system is ready to enter beneficial operation, or time zero. From this point on the system is

considered to be in operation mode and the remedial time frame established for the site (24 months) should start at this point. The operator should now complete Exhibit 8 which summarizes the critical operating parameters of the system.

4.11 Measuring Air Velocity in Extraction/Injection Lines

The air velocity of the extraction/injection lines is to be measured using a handheld thermal anemometer. Each extraction/injection line is fitted with a 1/4" NPT connection. The anemometer is to be inserted in that connection and drawn tight such that the anemometer tip is in the center of the pipeline. Exhibit 7 can be used to convert the feet/minute reading to cfm based on the pipesize. All measurements are to be record on Exhibit 8. Refer to Appendix A for other operating instructions.

4.12 Measuring VOCs in Air Streams

The VOCs are to be measured using a photoionization detector with an 11.7 eV lamp. The VOCs in the air stream are to be monitored at various sample ports as shown on Drawing BTH-03. VOC monitoring location and purpose are summarized as follows:

Location	Purpose
BV-14	Influent VOCs to system
BV-18	Influent VOCs to carbon vessels
BV-32	Middle of carbon vessels (breakthrough monitoring)
BV-33	Middle of carbon vessels (breakthrough monitoring)
BV-19	Effluent VOCs to atmosphere

Each sample port is fitted with the appropriate connection to facilitate an easy hook-up to the VOC analyzer. Since the VOC analyzer is calibrated to a specific gas, the measured values must be corrected to be representative of the constituents present in the waste stream. The conversion factor is approximately 1.5 based on current calibration. the operator should be cognizant of this conversion when recording VOC measurements.

4.13 Replacing Lubricant in Blowers

Lubricant in the blowers should be replaced bi-weekly or every 500 hours of operation and done in accordance with the manufacturer's instructions (Appendix A).

4.14 Replacing Air Filters

The air filters should be inspected every two weeks and replaced as necessary. Replaced air filters should be collected and disposed of properly as non-hazardous waste.

4.15 Transferring Condensate Water

The condensate waste is transferred from the moisture separators to 55-gallon drums via the condensate pump. This should be done whenever the moisture separators are nearing full

capacity or when the high level switch, VE-LS-04, is tripped. A one inch hose with camlock connection is to be attached to the piping and used to fill the 55-gallon drums. Ball valves, BV-16, BV-16, and BV-17, are opened and then the condensate pump is turned on. Care should be taken when transferring the one inch hose from drum to drum.

The drums are to be filled in a bermed or diked area to prevent the discharge of condensate to the ground.

4.16 General Housekeeping

The operator should maintain the treatment area in good condition. Any debris and spills should be cleaned immediately. In addition, the grounds of the treatment system should be well manicured.

4.17 System Inspections

System Inspections should be performed whenever the operator is on site or at least monthly. The operator should inspect the piping and equipment for any leaks in the system. The operator should also perform an inspection on the system whenever an alarm switch is activated. All well inspections should be documented on the Extraction/Sparging Well Maintenance Checklist (Exhibit 16). At the end of every month, all inspections and activities should be summarized on the Monthly Operational Status Checklist (Exhibit 24).

4.18 Preventive Maintenance

Preventive maintenance should be performed periodically on all the equipment and instrumentation in the system. Exhibit 22 shows the periodic maintenance which should be performed in order to keep the system operating efficiently.

4.19 System Shutdown

To shut down the system, start by tripping the air injection blower and then proceed to the vapor extraction blower. Be sure to employ all lock out/tag out procedures. Allow any excess water to drain out of the system by opening the drain valves.

4.20 Alarms and Operator Response

All alarm displays appear on the main control panel as an amber light except the high level shutdown in the moisture separator. All alarms will cause the system to shutdown. The alarm will stay lit until the situation is corrected by the operator. The system alarms are summarized later in this section.

To correct an alarm condition, the operator must reset the control panel by depressing the reset button and re-start the blowers. Upon system startup the operator must then verify each flow rate and operating parameter is correct based on data in Exhibit 7.

Summary of System Alarms

ALARM EVENT	OPERATOR RESPONSE
1. Temperature Switch (TS-03) tripped	Investigate the cause of the shutdown, document it and re-start the system
2. Temperature Switch (TS-08) tripped	Investigate the cause of the shutdown, document it and re-start the system
3. Pressure Switch (PS-05) tripped	Investigate the cause of the shutdown, document it and re-start the system
4. Pressure Switch (PS-06) tripped	Investigate the cause of the shutdown, document it and re-start the system
5. Pressure Switch (PS-09) tripped	Ensure Vapor extraction system running correctly. Restart injection blower.
6. Level Switch (LSH-02) tripped	Drain moisture separators and restart system.

5.0 Individual System Operation

The master lists presenting the equipment, instrumentation, motors, and valves that are present in the treatment system are presented in Exhibits 17, 18, 19, and 20, respectively.

5.1 Common Equipment Operating Problems and Trouble-Shooting

Potential operating problems associated with soil vapor extraction/air sparging systems are most likely due to mechanical malfunction of equipment. Equipment or devices that could fail, include the following:

- Vacuum blower; B-01
- Injection blower; B-02
- Limit switches; VE-PS-09, VE-LS-04, VE-TE-03, VE-PS-05, VE-PS-06
- Condensate pump; P-01

Mechanical components may be repaired or replaced by either site personnel or outside repair services. If a malfunction occurs in equipment components, the system may have to be shutdown. For the system shutdown procedure, refer to Section 4.11.

It is possible that an equipment failure could lead to a release of untreated soil vapor to the environment. Site personnel should use appropriate health and safety procedures in accordance with the activity hazard analysis found in Section 8.0.

Analysis of potential problems associated with operating the major process equipment is presented below.

5.1.1 SVE/AS System

Potential operating problems associated with the SVE/AS system and possible causes and remedies for these problems are listed in Exhibit 9. More details on troubleshooting can be found in the vendor material supplied in Appendix A.

5.1.2 Carbon Adsorption System

Potential problems associated with the carbon adsorption system and possible causes of these problems are listed in Exhibit 10.

Proper monitoring of VOC levels and pressure will indicate required changeout.

5.1.3 Condensate Pump System

Potential problems associated with the condensate pump system and possible causes of these problems are listed in Exhibit 11.

5.1.4 Electrical Supply System

Failure of the electrical equipment and components will most likely require outside repair service. Electrical malfunction can occur occasionally in motors and controllers of the mechanical equipment mentioned above, as well as the following components:

- Motor contactors;
- Motor starters;
- Transformers;
- Fuses.

5.2 Sources of Information Regarding Problems

Manufacturer's instructions and operating manuals are the first source reference for most equipment malfunction. At times, a manufacturer's representative will be needed to repair equipment rather than servicing the equipment with site personnel. Often, electronic and electrical equipment repairs require trained service representatives. Most piping problems can be corrected by local plumbers or pipe suppliers.

7.0 Records and Reporting

7.1 Recordkeeping and Reporting Requirements

Operators will supply the following documents to the Navy to enable the Navy to comply with the records retention and reporting requirements under RCRA:

- Generator signed manifests
- TSDF signed manifests
- Manifest Discrepancy and Exception Reports
- Waste Profile Sheets
- TSDF Certificates of Disposal/Destruction

All test results, waste analyses and waste determinations will be documented. These records will be supplied in the Complete Manifest Package with a duplicate submitted in the Project Close-Out Report. Discrepancy Reports will be prepared for the Navy's signature for any manifest discrepancy related to waste type or volume. These reports will be prepared and submitted within 15 days after waste receipt by the TSDF.

Manifest Exception Reports are required if a generator does not receive a TSDF signed manifest within 45 days of the shipment date. If the operator does not receive a manifest by the 35th day, they will contact the TSDF and verify the shipment status and prepare an Exception Report, which the operator will be submitting to the Navy Representative for signature by the 40th day. The operator will document all calls to locate the shipment and include the documentation in the Exception Report.

7.2 Monthly Report Requirements

Every month a report will be sent to the Navy detailing the general status of the operation of the treatment facility. The report will include, but not limited to, the following information:

- Any alarms and shutdowns that have occurred and the corrective action taken
- Any sampling that occurred and the test results of the sampling
- Maintenance, if any, performed on the system and any spare parts used
- List and quantity, if any, of off-site disposal of hazardous or nonhazardous waste
- Any change outs (i.e. carbon) that occurred

A monthly operations checklist is attached to aid the operator in preparing the monthly status report.

7.3 CERCLA Release Reporting

CERCLA requires the immediate reporting of any release of a "reportable quantity" of a hazardous substance onto land, surface or ground water, air in any 24 hour period. Releases permitted under state or federal permits (i.e. NPDES) are not subject to reporting. The materials regulated are hazardous substances and hazardous wastes listed in 40 CFR 302.4. Immediately

upon recognition that a reportable release has occurred, the person(s) in charge of the facility must notify by phone the National Response Center (NRC), the State Emergency Response Center (SERC) and the Local Emergency Planning Committee (LEPC) established under the Emergency Planning and Community Right-to-Know Act (EPCRA). Ideally, the operator would immediately report all releases to the Navy Representative who would in turn notify the NRC, the SERC, and the LEPC, but in the absence of the Navy Representative, the operator would assume reporting responsibilities. A follow up written report must be submitted to the EPA Region II Office, the SERC, and the LEPC within 30 days of the event.

- National Response Center: 800-424-8802
- State Emergency Response Center: NYS Department of Environmental Conservation 800-457-7362 or 518-457-7362
- Local Emergency Planning Committee: Nassau County 516-573-7527

In addition, CERCLA contains a provision Section 111(g) that requires the facility operator to provide reasonable notice about a release of a hazardous substance to potentially injured parties by publication in local newspapers serving the affected area.

7.4 EPCRA Release Reporting

Any person in charge of a facility must provide immediate notification whenever a "reportable quantity" of an Extremely Hazardous Substance (EHS) migrates off-site, this includes releases to air, water, or land. There is no reporting requirements if the release does not go off-site and only results in exposure to persons within the boundaries of the facility. A list of EHSs is published in 40 CFR 372.65. If a material is listed on both EHS and CERCLA lists then the notification must be made to the NRC, SERC and the LEPC. If the material is listed on the EHS, but not the CERCLA list, then notification must only be made to the LEPC and the SERC. The operator will report all EHS releases to the Navy Representative who will perform the required notification. In the absence of the Navy Representative, the operator will perform the notifications. The telephone numbers are the same as those for CERCLA reporting. Newspaper notification is not required for releases of EHSs.

7.5 Clean Water Reporting

Under the Clean Water Act, the facility operator must provide immediate notice by phone to the National Response Center whenever a reportable quantity of oil or hazardous substance is released into a navigable water, or adjoining shoreline. Federal or state permitted releases (i.e. NPDES) are not subject to reporting. A reportable quantity of oil is one which violates applicable water quality standards or if it causes a discoloration of or film onto the surface of the water. Reportable quantities of CWA regulated hazardous substances are published in 40 CFR 117. Although this facility is not identified with being adjacent to navigable water, a reportable release could occur if oil or hazardous material are released into tributaries, swales, or storm drains which could enter navigable waters. The operator will report all suspect releases to the Navy Representative, in the absence of the Navy Representative The operator will provide immediate notification to the NRC.

7.6 NYS Release Reporting

New York State regulates releases of petroleum and hazardous substances from bulk storage facilities that store greater than 1,100 gallons of any liquid, including petroleum, or greater than 1000 kilograms of any hazardous substances for a period of 90 days or more, in USTs, ASTs or drums, that has the potential to pollute the waters or lands of the state. The list of NYS Hazardous Substances is published in 6 NYCRR 597.

Any discharge of petroleum or hazardous substances must be reported to the NYSDEC, at 800-457-7362 or 518-457-7362, within two (2) hours of the discharge or knowledge of the discharge. Releases that are contained within the secondary containment systems and do not reach the land or water are not required to be reported, if within 24 hours of the release, the release is completely contained and all materials released has been recovered. If the facility operator suspects a probable spill, then notification must be provided within 24 hours of the discovery.

Since greater than 1000 kilograms of New York hazardous substance may be expected to be present on-site, Foster Wheeler has determined that these regulations are applicable to the site and report any releases to the Navy. In the event that the Navy Representative is not available, the operator will report any reportable releases to the NYSDEC.

8.0 Health and Safety Plan (HASP)

The HASP is supplied as a stand-alone document that supplements this document.

9.0 Regulatory Compliance

9.1 Applicable or Relevant and Appropriate Requirements (ARARs)

As a NYSDEC inactive hazardous waste site, actions at the site are conducted consistent with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Remedial actions are required to comply with, and upon completion attain ARARs. A requirement that is relevant and appropriate must be complied with to the same degree as if it were applicable. In addition to ARARs, regulatory agency advisors, criteria, or guidance may be identified as requirements "to be considered" (TBCs).

Remedial actions conducted entirely on site need only comply with the substantive aspects of the ARARs/TBCs and not the administrative aspects such as permitting (specifically exempted under CERCLA Section 121(e)) or administrative reviews. Activities off site must comply with all necessary federal, state, and local laws; regulations; and ordinances (e.g., transportation of remedial action wastes must comply with local, state, and federal transportation standards, both substantive and administrative). A list of project-specific ARARs/TBCs is presented in Exhibit 13.

9.2 Hazardous and Solid Waste Management

Any hazardous wastes generated during the operation and maintenance phase will be managed in accordance with Section 11, Waste Disposal, of this manual.

9.3 Permitting Activities

As this is a remedial action under CERCLA, permits are not required for activities to be conducted on-site. Rather, it is necessary to comply with the substansive requirements of the project ARARs.

9.4 Air Pollution Control

The New York State Department of Environmental Protection (NYSDEC) is authorized by the United States Environmental Protection Agency (USEPA) for the enforcement of the Clean Air Act within New York State. The operation of the SVE system will result in VOC emissions which will require the use of activated carbon to control VOC emissions. An air emissions permit application was prepared and submitted to NYSDEC as a courtesy notification even though it is not required for site activities controlled under CERCLA. The permit is included in Appendix D.

9.5 Spill Prevention

Foster Wheeler will take all the necessary precautions to prevent petroleum, hazardous wastes, and other hazardous substances from entering the ground surface, groundwater, or surface

waters. All petroleum fuel, PCB and hazardous waste containers and tanks will be equipped with secondary containment in accordance with 40 CFR 112, 40 CFR 761.65 and 40 CFR 264.

An Emergency Response Section and Spill Control Plan are both contained in the SHSP. Information contained in these sections details how Foster Wheeler will address spill control, prevention, and emergency response activities on-site.

9.6 Training and Certification Requirements for Project Personnel

As indicated in the SHSP, site personnel performing intrusive activities in any exclusion zones must have 40-hour OSHA Hazardous Waste Worker Training. Site supervisory personnel will also have 24-hour on-the-job supervision, 8-hour refresher, 8-hour supervisor, and First Aid/CPR with bloodborne pathogens training. Subcontractor personnel will be required to have training appropriate for the activities they will be required to perform.

Personnel performing hazardous waste management and/or hazardous material shipping activities will be trained in accordance with RCRA training requirements under 40 CFR 265.16, and DOT Hazardous Material Training under 49 CFR 172 Subpart H.

9.7 Inspections by Regulatory Agencies

Site personnel will contact Northdiv RPM if contacted by a regulatory agency for a site inspection. The operator will contact the Project Manager, who will notify the Northdiv RPM and the Foster Wheeler Director of Regulatory Compliance. Foster Wheeler personnel will follow the Foster Wheeler Procedure EHS1-10: External Inspections, revised March 12,1998. In the event of an unannounced inspection, the Foster Wheeler Director of Regulatory Compliance will be contacted immediately.

Any outside party requesting access to the site will be referred to the Project Superintendent, who will initiate the appropriate notification of the SPEM and the Northdiv RPM. Foster Wheeler personnel will not grant site access or answer questions for unauthorized personnel.

10.0 Sampling and Monitoring/Effectiveness Monitoring Program

A sampling and analysis program (SAP) will be implemented to verify the effectiveness of the remedial activities conducted at the NWIRP site in Bethpage, New York. Exhibits 14 and 15 summarize the waste characterization sampling program and field sampling program, respectively Sampling locations are provided on the Drawing BTH-02 in Attachment B.

The operator will monitor the ambient air quality as part of the health and safety surveillance program during the remedial activities. The following instruments are to be used:

- Photoionization Detector 11.7 (Hnu with 11.7elamp or equivalent)
- Combustible Gas Indicator

During air monitoring, operator will generate data on the presence or absence of VOCs. If "hot spots" are found at the site, the health and safety protection levels/requirements and the technical approach to the affected tasks will be modified and implemented, depending on the action level. Details on health and safety monitoring to be performed for the various field tasks are defined in the SHSP.

10.1 Soil Vapor Monitoring Wells

Volatile organic concentrations in the extracted vapor will be collected to estimate the efficiency of the extraction process. Bi-weekly for the first quarter, and twice a month for the balance of the project, one extracted vapor sample will be collected and submitted for laboratory analysis of VOCs. Vapor samples will employ T01 and T02 sampling and methodology using adsorption tubes and sampling pumps.

Six clusters of soil vapor pressure monitors (SVMP 10-15) were installed on the eastern and western edges of the site. These monitors will be used to confirm that all injected air is being captured by the soil vapor extraction system. Each cluster consists of two wells, one near the water table and one near the middle of the unsaturated zone. Soil vapor pressure readings will be collected periodically to monitor the effectiveness of the remediation system and recorded on Exhibit 8.

10.2 Carbon Adsorber Vapor Monitoring

Volatile organic concentrations will be monitored before, in between, and after the two carbon units. PID readings will be collected from sampling ports. PID readings will be collected weekly for a minimum of one month. Based on operating data and projected carbon changeout requirements, the frequency may be increased to monthly during the project. The results are to be recorded in Exhibit 8.

Prior to off-site disposal, it will be necessary to sample and analyze the spent activated carbon to characterize the carbon. A grab sample will be collected from the carbon vessel and will be analyzed for TCLP VOCs, TCLP semi-volatile organic compounds (SVOCs), TCLP Metals,

PCBs, ignitablity, reactivity, and corrosivity. Only one sample will be required to characterize the carbon and fulfill the carbon regeneration facility's pre-acceptance requirements.

10.3 Groundwater Sampling

Analytical results from the perimeter groundwater and one center-of-site shallow monitoring wells will be used to monitor the effectiveness of the air sparging component of the system. It is anticipated that the groundwater monitoring will be performed monthly for the first six months and quarterly for the balance of the remediation. In addition, one round of groundwater samples will be collected approximately six months after the remediation is complete to document the final groundwater conditions at the site.

Prior to performing the groundwater sampling, an initial headspace and measurement for dissolved oxygen will be collected at each well. Static fluid measurements, and the total depth of each well, will then be obtained using an oil/water interface probe or an electronic water level indicator. The depth to groundwater and the thickness of floating product, if present, will be determined in the well at the time of measurement. The fluid levels will be measured to the nearest 0.01 foot. The water levels and well depth measurements will be used to calculate the volume of water in each well and the minimum volume of water that must be purged prior to sampling. Each water level measurement will be made three to four times, with the inner casing of the well being the reference mark.

Three to five well volumes will be purged from the wells prior to sampling. If the well is pumped or bailed dry, purging will be considered complete and an appropriate note will be recorded in the field logbook. While the well is being purged, field measurements of pH, temperature, and specific conductance will be recorded. If all three parameters stabilize, the volume of water purged will be recorded and purging will be considered complete. If the field parameters do not stabilize, purging will continue until three to five volumes have been purged. Field measurements for each well sampled will be recorded on a Groundwater Sample Log and in the field logbook.

After purging has been completed, groundwater samples will be collected using disposable Teflon bailers. Bailers will be lowered slowly into the wells to assure that dissolved VOCs are not driven off. Samples will be transferred from the bailer to the laboratory cleaned sample containers.

10.4 Condensate Sampling

The condensate generated by the SVE system will be placed in 55-gallon DOT-approved steel drums for on-site storage, Due to the RCRA Hazardous Waste Generator 90 day storage limits, it will be necessary to ship the condensate waste off-site for disposal once every 90 days. Approximately six to seven drums will be generated and disposed off every 90 days. A representative sample must be analyzed in order to classify the waste for disposal. After the treatment system's performance has been stabilized, a composite waste classification sample will be prepared by combining grab samples collected from the drums of condensate waste in storage. Per disposal facility requirements, the water sample will be analyzed for TCLP VOCs, TCLP SVOCs, TCLP metals, total organic halogens (TOX), PCBs, ignitability, corrosivity, and

reactivity. If the analyses determine that the condensate is RCRA hazardous, then it will be necessary to resample the waste and perform a Total Constituent Analysis for the constituents regulated under the RCRA Land Disposal Restrictions for all waste codes which are found to be present in the condensate waste. If the waste generation process does not change substantially, the TSDF facility will only require one characterization analysis for approval to accept this waste stream.

10.5 Decontamination and Well Development Water Sampling

The well development water will be segregated based on the location of the well from which it was derived. The development water will be segregated into potential RCRA-hazardous, potential TSCA-hazardous, and potential non-hazardous. The decontamination water will be segregated with the potential non-hazardous well development water. Both the development and decontamination water will be containerized in 55-gallon drums for on-site storage and disposed of once every 90 days. Three composite samples, one composite sample from the drums in each category, will be prepared and submitted for analysis. Each composite sample will be analyzed for Target Compound List (TCL) VOCs, TCL SVOCs, Target Analyte List (TAL) Metals, TOX, specific gravity, PCBs, ignitability, reactivity, and corrosivity.

10.6 Soil Sampling

Approximately ten subsurface soil sample locations were established before the operation of the vapor extraction system. The baseline results are summarized in Appendix F. Soil samples will be taken in the same immediate vicinity of the locations established earlier. Soil samples will be taken every six months of operation for the duration of the project and be analyzed for TCL VOCs. In addition, soil samples will be collected approximately six months after the remediation is complete to document the final soil conditions at the site.

10.7 Sampling and Analysis Matrix

Analytical testing will be performed by a NYSDEC approved laboratory, following either NYSDEC ASP-CLP and/or SW-846 protocols. All of the soil and groundwater samples will be analyzed for TCL VOCs. Exhibits 14 and 15 summarize the analytical sampling program. Sample collection and analytical protocol information, including sample type, number of samples and duplicates, matrix, sampling device, analytical parameter, sample container requirements, sample preservation, laboratory analysis, method detection limits, and holding times, is presented in Appendix C.

10.8 Effluent Goals

The preliminary remediation goals for the NWIRP-Bethpage are presented in this section.

Chemical Constituent	Preliminary Remediation Goals	
	Soil mg/kg	Groundwater[2] µg/l
TCE	0.010	5
PCE	0.021	5
1,2-DCA	NA[1]	5
1,2-DCE	NA[1]	5
1,1-DCE	NA[1]	5
1,1-TCA	0.010	5

[1] No standard has yet been developed

[2] Groundwater Preliminary Remediation Goals have not been finalized

10.9 Potential Corrective Actions for System Effectiveness

During system start-up and during the course of operation, corrective actions may be necessary to accommodate unforeseen operational conditions. The following section describes some of the potential conditions requiring corrective action and the selected remedies. This summary is not intended to exhaust all options or identify all the issues that potentially may require corrective action.

Potential Corrective Actions	
Conditions	Selected Remedy
Overall soil gas sampling suggests that indicator compound concentrations are not decreasing over time.	Postpone soil sampling until a drop off in concentration is detected.
Overall soil gas sampling suggests that indicator concentration are undetected at the required detection limits after 6 months of treatment and testing for start-up spikes has been completed.	Expedite soil sampling, take first round of soil samples. Discontinue service from wells that have attained cleanup levels.
Overall soil gas sampling is widely variable and no consistent decay trend or pattern can be inferred from the data over the first 12 months of the program.	Maintain the current soil sampling schedule.
First round of soil sampling indicates concentrations have not substantially decreased compared to baseline data.	Postpone second round of soil sampling for 6 months.
Cleanup is not progressing as required in certain (or all) locations, remedial objectives are not being met or expedited cleanup is required.	In order to facilitate remediation, the installation of additional extraction wells can be considered in certain problematic zones on a case by case basis.
Extraction well yields very low concentrations of indicator compounds	Determine radius of influence around well and consider installation of a polyethylene liner at the well to prevent short circuiting of air to facilitate enhanced lateral soil vapor extraction.
Cleanup objectives are not wet after four years of treatment.	Continue semiannual soil sampling program until objectives are met or otherwise directed by EPA.

11.0 Waste Disposal

The objective of this Waste Disposal section is to ensure the safe handling, management, transportation and disposal of all waste streams generated during operation. In addition, each of these activities will be conducted in compliance with project ARARs/TBCs for on-site waste management activities and all federal, New York State, and local requirements for off-site waste transportation and disposal.

11.1 Hazardous Wastes

Pursuant to 40 CFR 262.11 and 6 NYSRR 371, generators are required to classify their wastes prior to disposal. Based on the SOW, listed hazardous wastes are not expected to be present on-site. Foster Wheeler anticipates that any SVE condensate water and activated carbon generated from the remediation of Site 1 would be classified as hazardous waste based on the maximum concentration of VOC contamination in the soil. The well development water generated will be segregated, i.e., RCRA-hazardous, TSCA-hazardous, and non-hazardous, based on the location of the well from which they were derived and then classified for appropriate disposal. Likely classifications would include D019 (carbontetrachloride), D028 (1,2-DCA), D029 (1,2-DCE), and D040 (TCE).

The Project Regulatory Specialist will confirm these waste classification assumptions by reviewing the analytical data developed for each remedial action waste stream prior to off-site transportation and disposal. A waste certification and Waste Profile Sheets will be provided to the Navy for review, approval, and generator signature prior to off-site disposal of each waste stream.

11.2 PCB Wastes

Any decontamination water derived from soils containing PCBs will be disposed as TSCA wastes in accordance with the anti-dilution provisions of TSCA. SVE condensate, well development and purge waste will be disposed of as TSCA wastes only if they are determined to contain greater than or equal to 50 ppm of PCBs in accordance with USEPA Guidance Memorandum "PCB Contamination Superfund Site - Relationship of TSCA Anti-Dilution Provision to Superfund Response Action" dated 7/31/1990. PCB wastes will be managed in accordance with requirements under TSCA 40 CFR 761 and New York State Hazardous Waste Regulations under 6 NYCRR 370-375 because PCBs are regulated as a New York State Hazardous Waste.

11.3 Waste Minimization

Foster Wheeler will utilize best management practices to minimize waste generation. These include, but are not limited to, segregating waste streams, reusing/recycling materials, and decontaminating and reusing equipment.

Wastes will be screened and segregated to minimize the mixing of contaminated and uncontaminated materials. The goal is to separate waste as accurately as possible into categories that will facilitate cost-effective management of wastes.

11.4 Accumulation and Storage

DOT specification 1A1 (closed top) and 1A2 (open top) steel drums will be used for containerizing the non-bulk waste streams generated from operation.

All containers storing hazardous wastes will remain on-site for no more than 90 days from its accumulation start date unless specific approval has been received from NYSDEC. Foster Wheeler will obtain Base specific storage requirements from the ROICC prior to mobilization and will incorporate these requirements into the project plan. All on-site storage will comply with generator requirements listed in 40 CFR 262 and 6 NYSCRR 372. All on-site storage of PCB wastes will be conducted in accordance with PCB container storage requirements under 40 CFR 761.65. All waste container storage areas will be equipped with secondary containment.

Hazardous waste and PCB waste container inspections will be performed and logged weekly to ensure proper labeling and marking, and to monitor the condition of the containers and the condition of the storage area. The weekly inspection reports will be maintained in the project file and copies will be provided to the Navy.

11.5 Container Labeling and Marking

At the time of generation, all waste containers will be marked in indelible ink, paint or grease pencil with the following information:

- Source and location
- Contents of material in the container and expected hazards
- Accumulation start date for hazardous wastes
- Out of Service Date for PCB wastes
- Date container was sampled
- Hazardous Waste label on all known or suspected hazardous wastes
- PCB label on all known or suspected wastes

Upon receipt of sampling analytical results, wastes will be classified as specified in Section 2. Based upon final classification, the Regulatory Specialist will select a proper DOT Shipping name description for any DOT regulated hazardous materials. The Regulatory Specialist will direct the completion of any required DOT markings and labels and will specify the placarding for the transportation vehicle.

11.6 USEPA Hazardous Waste Generator Identification Numbers

The Navy's USEPA Hazardous Waste Generator Identification Numbers will be obtained and used for all off-site hazardous and PCB waste disposal. Transporter and disposal facility identification numbers will also be obtained and verified prior to off-site shipment of site wastes.

11.7 Complete Manifest Packages

Hazardous waste manifests will be used for all off-site hazardous and PCB waste shipments. The state hazardous waste manifest to be used will be specified by the state in which the TSDF is located. If the TSDF state does not require its own manifest, then a NYS Hazardous Waste Manifest will be used. Bills of Lading or non-hazardous waste manifests will be used for shipment of all non-hazardous wastes. A Complete Manifest Package (CMP) will be submitted to the Navy for each waste stream destined for off-site disposal. The principal components of the CMP will consist of:

- Hazardous Waste Manifests or Bills of Lading
- Waste Profile Sheets
- Land Disposal Restriction Waste Notification Forms

Supporting documentation will include MSDSs, waste disposal history, all sampling analytical results, waste certifications performed by Foster Wheeler, information reviewed in identifying the proper USEPA waste codes and DOT proper shipping names, packaging, labeling, and marking requirements.

Foster Wheeler will submit a CMP to the NAVY for each waste stream for review and signature prior to shipment. After the CMP has been approved and signed, two copies of the approved and signed CMP will be prepared. One copy will be placed in the project file and one copy will be returned to the Navy with the transporter signed copies of the manifests and Bills of Lading.

Exhibits

EXHIBIT 1
NWIRP-BETHPAGE, NY

Page _____ of _____

DAILY SIGN-IN LOG

NAME	TIME IN	TIME OUT	COMPANY	ACTIVITY ON SITE

EXHIBIT 2

Soil Vapor Extraction/Air Sparging

System Operator Information

Company Name: _____

Primary Contact Name: _____

Address: _____

_____

_____

Phone Number: _____ (Autodialer)

Secondary Number: _____

Fax Number: _____

Home Number: _____

Emergency Number: _____

Beeper Number: _____ (Autodialer)

Contract Number _____

Comments: _____

_____

_____

Notes: _____

_____

_____

EXHIBIT 3
PREREQUISITE SYSTEM START-UP CHECK LIST

A. Equipment/Instrument Check List

Item	Tag	Description	Check	Comments
1.			☐	
2.			☐	
3.			☐	
4.			☐	
5.			☐	
6.			☐	
7.			☐	
8.			☐	
9.			☐	

The above equipment and instruments have been identified received on-site, installed and have been visually inspected for damage and completeness,

_____ _____
Construction Manager Date

B. Construction Activity Verification (where applicable)

	Check	Comments
Equipment, Piping and Valves in System are installed	☐	
Tanks and vessels are opened, inspected and are clean	☐	
Instruments are installed	☐	
Instruments are calibrated and certificates are complete	☐	
Rotating equipment has been finally aligned and lubricated	☐	
Continuity checks have been performed on all cables from each component	☐	
Meggering of all power/grounding cables is complete	☐	
Equipment, instruments and valves are tagged	☐	
Protective coatings are applied	☐	
System piping and equipment have been pressure tested	☐	
Complete pressure test documents are available	☐	
Final construction punch list has been generated	☐	
Spare parts have been inventoried	☐	

The above stated processes, procedures and documentation have been addressed for completeness and adherence to safety. The _____ is ready for system testing with respect to all construction issues.

_____ _____
Resident Engineer Date

EXHIBIT 4
Instrument Calibration Sheet

Tag No. :	Vendor Tag No.:	System:
Make:	Model: S/N:	
Description:		P.O. Number:
Range:	Set Point: A: B:	Signal:
Electrical Supply:	Air Supply:	Control Action:
Trip Point: A: B:	Reset: A: B:	Comments:

Desired Reading		Actual Readings			
		Increase		Decrease	
Input	Output	Input	Output	Input	Output

Test Equipment:

Remarks:

Calibrated By: _____ Date: _____

Accepted By: _____ Date: _____

EXHIBIT 5

Hydrostatic Test Results

Line Number	Piping Section		Date Tested	Test Pressure	Test Medium	Test Duration
	From	To				

EXHIBIT 6

Vapor Phase Carbon Adsorption System
Operation Matrix
Valve Position

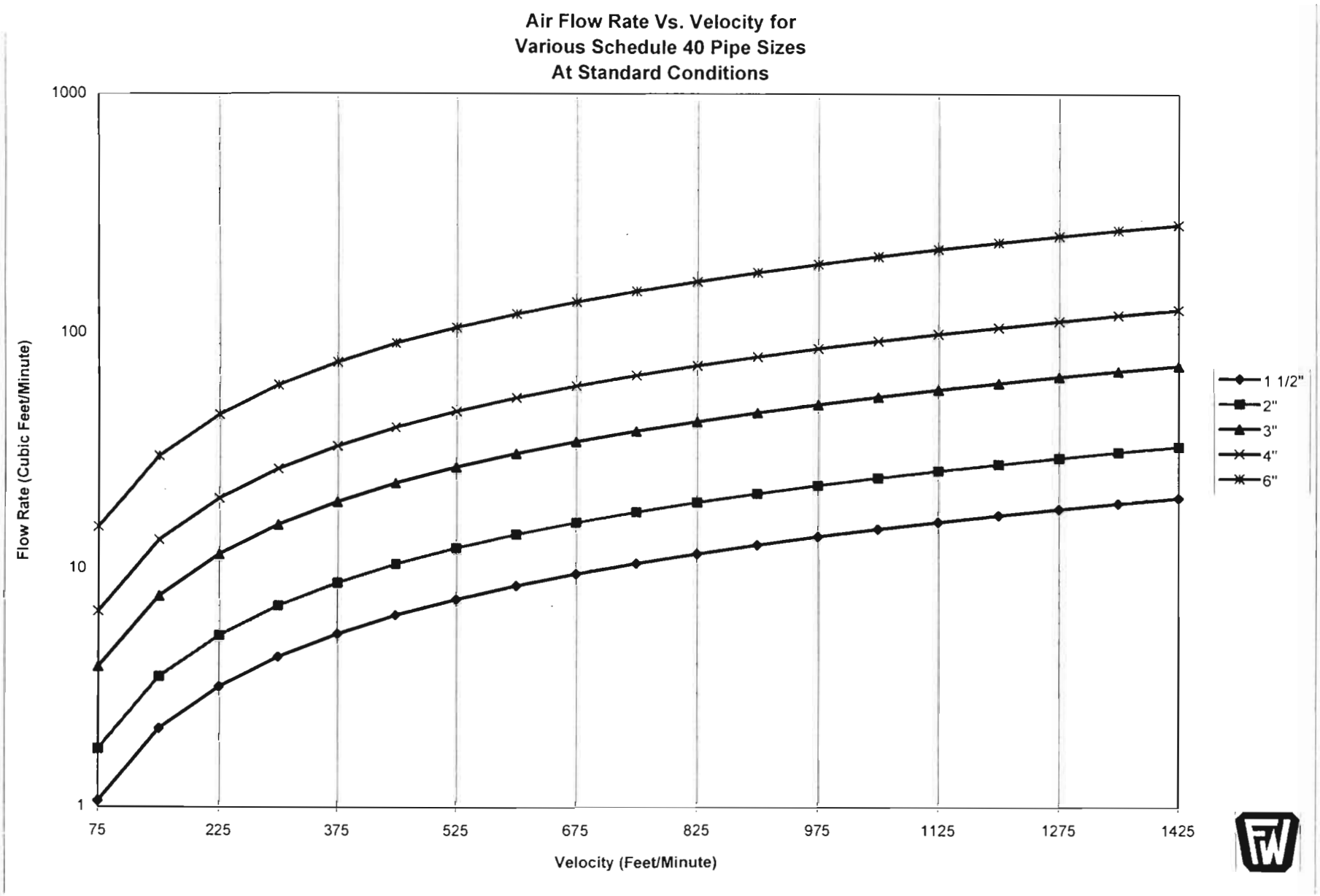
Valve Number	Operating Scenario		
	V-01 Lead/V-02 Lag	**V-02 Lead/V-01 Lag**	**Parallel Operation**
BT-02	NC	NO	NO
BT-03	NO	NC	NO
BT-04	NC	NO	NO
BT-05	NO	NC	NC
BT-06	NC	NO	NC
BT-07	NO	NC	NO

Notes:

1. NO - Normally open
2. NC - Normally closed
3. BT-0X - Butterfly Valve, see drawing BTH-03
4. V-0X - Carbon Adsorption vessel identification

OPERATION OF A SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

EXHIBIT 7



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Operational Data Form Soil Vapor Extraction/Air Sparging System Naval Weapons Industrial Reserve Plant Bethpage, NY Contract No. N62472-94-D-0398 Delivery Order 0004	Date: _____ Day: _____ Time: _____ Technician: _____ Page : 1 of 3 **EXHIBIT 8**

Soil Vapor Extraction System		Air Sparging System	
Soil Vapor Extraction Blower (B-01)		Air Sparging Blower (B-02)	
Vacuum	_____ " H2O	Pressure	_____ psi
Temperature	_____ °F	Temperature	_____ °F
Particulate Filter	_____	Particulate Filter	_____
Bleed Air Valve Setting (BV-14)	_____	Bleed Air Valve Setting (B-__)	_____
Liquid Level	_____		

Vapor Carbon Adsorption System			Vapor Carbon Adsorption System		
Carbon Adsorber V-01			Carbon Adsorber V-02		
Pressure	_____	psi	Pressure	_____	psi
Inf. VOC Level	_____	ppm	Inf. VOC Level	_____	ppm
Eff. VOC Level	_____	ppm	Eff. VOC Level	_____	ppm
Change-Out Date	_____		Change-Out Date	_____	

Comments

Operational Data Form Soil Vapor Extraction/Air Sparging System Naval Weapons Industrial Reserve Plant Bethpage, NY Contract No. N62472-94-D-0398 Delivery Order 0004	Date: _____ Day: _____ Time: _____ Technician: _____ Page : 2 of 3 **EXHIBIT 8**

Soil Vapor Extraction Wells				
Location	Flow (ft/min)	Valve Setting	Vacuum (" H_2O)	Comments
EW-01				
EW-02				
EW-03				
EW-04				
EW-05				
EW-06				
EW-07				
EW-08				
EW-09				
EW-10				
EW-11				
EW-12				
EW-13				

Air Sparging Wells				
Location	Flow (ft/min)	Valve Setting	Pressure (psi)	Comments
IW-01				
IW-02				
IW-03				
IW-04				
IW-05				
IW-06				
IW-07				
IW-08				
IW-09				
IW-10				
IW-11				

Operational Data Form Soil Vapor Extraction/Air Sparging System Naval Weapons Industrial Reserve Plant Bethpage, NY Contract No. N62472-94-D-0398 Delivery Order 0004	Date: _____ Day: _____ Time: _____ Technician: _____ Page : 3 of 3 **EXHIBIT 8**

Soil Vapor Extraction Wells		
Location	Vacuum (" H_2O)	Comments
SVMP-10		
SVMP-10S		
SVMP-11		
SVMP-11S		
SVMP-12		
SVMP-12S		
SVMP-13		
SVMP-13S		
SVMP-14		
SVMP-14S		
SVMP-15		
SVMP-15S		

Notes:

SVMP - Soil Vapor Monitoring Point

EXHIBIT 9
POTENTIAL PROBLEMS, CAUSES, AND REMEDIES FOR SVE/AS SYSTEM

Problem	Possible Cause	Possible Remedy
No Air Flow	Speed too low	Check for slippage and readjust tension.
	Wrong rotation	Change Driver.
	Obstruction in piping	Check piping, screen, valves, silencer, to assure an open flow path.
Low Capacity	Speed too low	Check for slippage and readjust tension. Check inlet vacuum and discharge pressures
	Excessive pressure	Check piping, screen, valves, silencer, to assure an open path.
	Obstruction in piping	Check inside of casing for worn or eroded surfaces causing excessive clearances. Check air filter.
	Excessive slip	Check inside of casing for worn or eroded surfaces causing excessive clearances.
Excessive Power	Speed too high	Check speed and compare with manufacturer's listed speed.
	Pressure too high	Check inlet vacuum and discharge pressure.
	Impellers rubbing	Inspect outside of cylinder and headplates for high temperature areas, then check for impeller contacts at these points. Correct blower mounting, drive alignment.
Overheating of Bearings, or Gears	Inadequate lubrication	Restore correct oil levels in gearbox and lubricate.
	Excessive lubrication	Check gear oil level, if necessary drain and refill with clean oil of recommended grade.
	Excessive pressure rise	Check inlet vacuum and discharge pressure.
	Coupling misalignment	Check and realign if necessary
	Excessive belt tension	Readjust for correct tension.
	Speed too low	Low speeds will overheat the entire blower.
Vibration	Misalignment	Check and realign if necessary
	Impellers rubbing	Inspect outside of cylinder and headplates for high temperature areas, then check for impeller contacts at these points. Correct blower mounting, drive alignment.
	Worn bearings/gears	Check gear backlash and condition of bearings.
	Unbalanced or rubbing impellers	Remove scale or process material buildup on casing and impellers to restore original clearances and impeller balance.
	Driver or blower loose	Tighten mounting bolts securely.
	Piping resonances	Determine whether standing wave pressure pulsations are present in the piping. Contact manufacturer.

EXHIBIT 9
POTENTIAL PROBLEMS, CAUSES, AND REMEDIES FOR SVE/AS SYSTEM

Problem	Possible Cause	Possible Remedy
Vacuum Relief Valve Open	Moisture separator tank full	Turn off blower and drain tank.
	Extraction valves closed	Open extraction valves

EXHIBIT 10
POTENTIAL PROBLEMS, CAUSES AND REMEDIES FOR THE CARBON ADSORPTION SYSTEM

Problem	Possible Cause	Possible Remedy
High Inlet or Differential Pressure	Carbon plugging due to particulate carryover from upstream unit	Add filter between units, switch order of units and/or change out upstream unit.
Premature VOC Breakthrough	Inlet vapor temperature too high	Add temporary chiller.
	Flow channeling due to uneven flow or pressure	Ensure valves are in the proper positions, reverse inlet connections.
	Constituents not amicable to carbon adsorption	Check inlet stream conditions via air sampling.
Water Accumulation or Carryover	Malfunction of level sensor in moisture separator	Check level sensor switch.

EXHIBIT 11
POTENTIAL PROBLEMS, CAUSES, AND REMEDIES FOR THE CONDENSATE PUMP

Problem	Possible Cause	Possible Remedy
Motor not running	Tripped thermal protector	Check wiring and inspect pump assembly. Clean out pump assembly if obstruction.
	Open circuit breaker	Close circuit breaker
	Blown fuse	Check fuse and replace
	Rotating parts binding	Disassemble, inspect and clean pump. Check lubrication.
	Motor wired improperly	Check wiring diagram
	Defective motor	Replace motor
Little or no liquid delivered	Not primed	Prime pump
	Discharge plugged or valve closed	Inspect and clean pump discharge and piping. Open any valves.
	Incorrect rotation	Check power supply leads
	Suction not submerged, inlet screen plugged	Inspect inlet screen and clean out. Check water level in separators
	Low voltage	Check voltage level at starter. Inspect cable for damage
	Phase loss	Check overload relay
	Air or gasses in liquid	Start and stop pump several times
	System head too high	Ensure all valves are fully open, reduce piping length and/or change impeller size
	NPSHA too low	Reduce suction piping length or lower pump
	Impeller worn or plugged	Clean out pump casing or replace impellers
	Check valve installed backwards	Arrow on valve should point in flow direction
	Incorrect impeller diameter	Replace with correct diameter impeller
Excessive noise and vibration	Rotating parts binding	Disassemble, inspect and clean pump. Check lubrication.
	Defective motor	Replace motor
	Incorrect Rotation	Check power supply leads
	Air or gasses in liquid	Start and stop pump several times
	NPSHA too low	Reduce suction piping length or lower pump
	Impeller worn or plugged	Clean out pump casing or replace impellers
	Head too low causing excessive flow rate	Partially close discharge valve or change impeller size
	Worn bearings	Replace bearings
	Pump or piping loose	Tighten pump achnor bolts and check piping connections

EXHIBIT 11
POTENTIAL PROBLEMS, CAUSES, AND REMEDIES FOR THE CONDENSATE PUMP

Problem	Possible Cause	Possible Remedy
Power consumption too high	Rotating parts binding	Disassemble, inspect and clean pump. Check lubrication.
	Incorrect impeller diameter	Replace with correct diameter impeller
	Head too low causing excessive flow rate	Partially close discharge valve or change impeller size
Fuse blows or circuit breaker trips when pump starts	Pump impeller clogged, causing the motor to run slow and overload	Remove pump and clean
	Motor starter defective	Replace motor starter
	Fuse size or circuit breaker too small	Check fuse or circuit breaker size and resize if necessary

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Soil Vapor Extraction/Air Sparging
Naval Weapons Industrial Reserve Plant
Bethpage, NY
EXHIBIT 12
Master Spare Parts List

Assembly	Recommended Spare Part	Quantity	In Stock	Reorder Date	Date Used
1/2" B.V	Seal Repair Kit	2			
1-1/2" B.V.	Seal Repair Kit	2			
2" B. V.	Seal Repair Kit	2			
6" But. Val.	6" Full Face Gaskets (EPDM)	6			
6" But. Val.	Bolt Kit (Flange)	2			
P-01 Pump	Casing O-Ring (513) Guards Buna-N	1			
	Guidevane O-Ring (349) Guards Buna-N	1			
	Mechanical Seal 383-10K10 Ceramic	1			
	O-Ring Drain Vent Plug (412B) Buna-N	1			
B-01; B-02	Shaft Seals (Part No. 27)	4			
	Drive Shaft Seal (Part No. 33)	1			
	Lubrication Oil	1 Qt.			
	Gearbox Gasket (Pant No. 7)	1			
A-01; A-02	Replacement Air Filters	4			

Notes:
B.V - Ball valve
But. Val. - Butterfly Valve

EXHIBIT 13
List of Applicable or Relevant and Appropriate Requirements (ARARs)
and Requirements to be Considered (TBCs)

Requirement	Citation	Description
Federal		
USDOT Hazardous Materials Transportation Regulation	49 CFR 172	Defines DOT Hazard classes, Proper Shipping Names and labeling, marking and shipping paper requirements for transportation of DOT Hazardous Materials.
	49 CFR 172.700-704	Requirements for DOT training for hazardous materials employees.
	49 CFR 173	Packaging requirements for DOT regulated hazardous materials.
Hazardous Waste Classification	40 CFR 261	Requirements for the identification of hazardous waste.
Hazardous Waste Generation	40 CFR 262, 40 CFR 265, Subparts C, D	Requirements for generators of hazardous waste including storage limits, inspections, marking, record keeping and Contingency Plan.
Transportation of Hazardous Waste	40 CFR 263	Requirements applicable to the off-site transportation of hazardous waste.
Storage of Hazardous Waste	40 CFR 265, Subpart I, CC	Requirements for the use and management of containers at generator location.
Employee Training	40 CFR 265.16	Specifies training requirements for all generator employees involved in hazardous waste management activities.
RCRA Land Disposal Restrictions	40 CFR 268.7	Establishes Universal Treatment Standards for RCRA wastes, and Generator notification requirements.
CERCLA Release Reporting	40 CFR 302	Reporting requirements for releases of CERCLA Hazardous Substances
ERCRA Release Reporting	40 CFR 372	Report Requirements for release of Extremely Hazardous Substances
Clean Water Act Release Reporting	40 CFR 110 and 117	Reporting Requirements for releases of petroleum and hazardous substances into surface waters.
New York		
Air Pollution Control Regulations	Air Guide 1 6NYCRR 200-257	Specifies requirements and standards for new source controls for VOCs from point sources.
Hazardous Waste Management	6NYCRR 371; 371 & 373	Specifies standards for identification and classification of hazardous wastes; generator management requirements and requirements for hazardous waste transportation.
Hazardous Materials Transportation	17NYC RR 507	NYS Department of Transportation regulations for transportation of DOT hazardous materials.
NY State Release Reporting	6NYCRR613.8 & 6NYCRR595.2	Specifies NY State Requirements for petroleum and hazardous materials release.

EXHIBIT 14
Summary of Waste Characterization Sampling Program for Operation & Maintenance

MATRIX	SAMPLE LOCATION	LABORATORY ANALYSIS													
		TCL VOCs	TCLP VOCs	TCL SVOCs	TCLP SVOCs	TCLP Pest/Herb	TAL Metals	TCLP Metals	TOX	PCBs	Paint Filter Test	Specific Gravity	Ignitability	Reactivity	Corrosivity
Condensate	55-gallon drums		1		1			1	1	1			1	1	1
Soil	55-gallon drums		3		3	3		3	3	3	3		3	3	3
Spent Activated Carbon	Carbon Vessel		1		1	1		1		1			1	1	1

NOTES:

TCL indicates Target Compound List
TCLP indicates Toxicity Characteristic Leaching Procedure
VOCs indicates Volatile Organic Compounds
SVOCs indicates Semi-Volatile Organic Compounds
Pest/Herb indicates Pesticides/Herbicides
TAL indicats Target Analyte List
PCBs indicates Polychlorinated Biphenyls

EXHIBIT 15
Summary of Field Sampling Program

MATRIX	SAMPLE LOCATION	HEADSPACE ANALYSIS	WATER LEVEL MEASUREMENTS	LABORATORY ANALYSIS				
				NUMBER OF QA/QC SAMPLES				
				VOCs	DUPLICATE SAMPLES	TRIP BLANKS	FIELD BLANKS	MS/MSD
Air/Vapor	Extracted Vapor	N/A	N/A	2 per week for first 3 months, 2 per month thereafter	N/A	N/A	N/A	N/A
	Carbon Units	Weekly for one month, then monthly	N/A	2 per week for first 3 months, 2 per month thereafter	N/A	N/A	N/A	N/A
Groundwater	Monitoring Wells/ Extraction Wells	Each well head screened prior to sampling	Prior to each sampling round	14 - 1st round, 5 - subsequent rounds, 19 - confirmation round	1 per sampling round	3 - 1st round, 2 - subsequent rounds, 5 - confirmation round	1 per sampling round	1 per sampling round

EXHIBIT 16

Extraction/Sparging Well Maintenance Checklist

Prepared by: _____ Date: _____

1. Purpose of inspection _____ routine _____ potential problem. If the purpose of this inspection is due to an alarm or other observance, describe problem:

   _____

   _____

   Is this the first time this problem has occurred? _____

   If no, Describe: _____

   _____

2. Are the instruments in good working condition? _____

   If no, describe: _____

   _____

3. Any noticeable leaks in the piping, valves, flanges? _____

   If yes, describe: _____

   _____

4. Describe any other unusual conditions: _____

   _____

   _____

5. Maintenance actions

   Item: _____

   Describe the action taken: _____

   _____

   _____

   Spare parts used: _____

   _____

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Soil Vapor Extraction/Air Sparging
Naval Weapons Industrial Reserve Plant
Bethpage, NY
EXHIBIT 17

Master Equipment List

Tag Number	Description	Manufacturer	Model Number	Wetted Construction	Rating
M - 01	Moisture Separator	Product Recovery Management	MS-550	lined steel	75" w.c. vaccum
P - 01	Condensate Pump	Goulds	NPE-1 x 1 1/4 x 6	stainless steel	25 gpm @ 75 feet TDH
B - 01	SVE Blower	Roots	47URAI	steel	375 cfm @ 45 " w.c. vacuum
B - 02	Injection Blower	Roots	32URAI	steel	115 cfm @ 6 psi
V - 01	Carbon Unit	Carbtrol	G-5	lined steel	375 scfm @ 2 psig
V - 02	Carbon Unit	Carbtrol	G-5	lined steel	375 scfm @ 2 psig
V - 03	Carbon Unit	Carbtrol	G-5	lined steel	375 scfm @ 2 psig

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Soil Vapor Extraction/Air Sparging
Naval Weapons Industrial Reserve Plant
Bethpage, NY
EXHIBIT 18

Master Instrumentation List

Tag No.	Description	Manufacturer	Model Number	Part Number	Serial Number	Operating Range	Wetted Construction
VE-FI-01	Flow Meter	Erdco	34-1-1-24-F-1	-	-	50 - 500 scfm	Aluminum
VE-TS-08	High Temperature Switch	Allen Bradley	836 A6	-	-	60 - 143 C	Steel
VE-FI-07	Flow Meter	Erdco	34-1-1-16-F-1	-	-	15 - 150 scfm	Aluminum
S-01	Silencer	Stoddard	F65-3	45015	96-1112K	0 - 400 scfm	Steel
A-02	Air Filter	Universal	CCF-2	34-302-AA	B4213-97	0 - 400 scfm	Steel/Felt
A-02	Air Filter elements	Universal	Paper: 81 0471	Felt: 81 1203	Wire Mesh: 81 1036	0 - 400 scfm	Paper/Felt/Wire
VE-PI-09	Vacuum Gauge	Marsh	17135	-	-	0 - 30" Hg	-
VE-PI-10	Pressure Gauge	LHA		-	-		
PRV-01	Pressure Relief Valve	Kunckle		-	-		
M-02	Moisture Separator	Egg Rotron	M5350B	51-50-11	AH90200	350 cfm/20" Hg	Steel
S-02	Receiving Tank	Burgess Manning	DBSA-2Y2-C1095	-	-		Steel
S-03	Receiving Tank						Steel
S-04	Receiving Tank	Burgess Manning	DIS2-C1095	51-90-3	-		Steel
VE-PI-11	Pressure Gauge	Marsh				0 - 30 psi	
VE-PS-09	Pressure Switch	Allen Bradley	837-37	-	-	0 - 75 psi	
VE-LSH-02	Level Switch	Flotect	L-6EPB-B-S-3-A			SPDT Switch	
VE-LS-04	Level Switch	Flotect	L-6EPB-B-S-3-A	-	441G	SPDT Switch	
VE-TE-03	Temperature Switch	Allen Bradley	837-37	-	-	80 - 180 °C	
VE-PS-05	Pressure Switch	Mercoid	AP-153-37	-	-	1 - 30 psig (pressure)	
VE-PS-06	Vacuum Switch	Mercoid	AR-153-53	-	-	2 - 20" wc	
VE-PI-01	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-02	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-03	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-04	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-05	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-06	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-07	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-08	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-09	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-10	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-11	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-12	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-13	Vacuum Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 30" wc (vac)	Bronze/Brass
VE-PI-14	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-15	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-16	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-17	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-18	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-19	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-20	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-21	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-22	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-23	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
VE-PI-24	Pressure Gauge	Ashcroft	25-1491-A-02L	-	-	0 - 10 psi (pressure)	Bronze/Brass
PRV-02	Pressure Relief Valve	Fuji Electric	VV8	-	-	100" wc	PVC

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Soil Vapor Extraction/Air Sparging
Naval Weapons Industrial Reserve Plant
Bethpage, NY
EXHIBIT 19
Master Motor List

Tag Number	Equipment Description	Hp	Voltage	Phase	Hertz	Frame	Type	Enclosure
B-01	SVE Blower B-01	7.5	460	3	60	213T	CT	TE
B-02	AS Blower B-02	7.5	460	3	60	213T	CT	TE
P-01	Condensate Pump P-01	1.5	460	3	60	56J	CT	TEFC

Tag Number	Equipment Description	SF	Amps	RPM	Duty	Code	Max. Amb	Design
B-01	SVE Blower B-01	1.15	10.7	1740	Cont	M	40 °C	B
B-02	AS Blower B-02	1.15	10.7	1740	Cont	M	40 °C	B
P-01	Condensate Pump P-01	1	2.7-2.9	2875	Cont	M	40 °C	B

Tag Number	Equipment Description	Shiftend Bearing	Opp. End Bearing	ID #	NEMA	Nom. Eff.	FLA	
B-01	SVE Blower B-01	6208-2ZJC3	6206-2ZJC3	E401-A02Z345R06#M		86.5	22.5	
B-02	AS Blower B-02	6208-2ZJC3	6206-2ZJC3	E401-A02Z345R06#M		86.5	22.5	
P-01	Condensate Pump P-01	-	-	1312480103			2.4	

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Soil Vapor Extraction/Air Sparging
Naval Weapons Industrial Reserve Plant
Bethpage, NY
EXHIBIT 20
Master Valve List

Valve Tag	No.	Type	Size (inch)	Material	Connections	Seals	Specification	Location
BV-	01	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	02	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	03	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	04	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	05	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	06	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	07	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	08	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	09	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	10	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	11	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	12	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal, Type I Grade A PVC	Soil Vapor Extraction Well
BV-	13	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	14	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Air Bleed
BV-	15	Ball	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Moisture Separator (M-1)
BV-	16	Ball	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Condensate Transfer Pump (P-01)
BV-	17	Ball	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Existing Moisture Separator
BV-	18	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Sample Port
BV-	19	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Effluent Carbon Adsorption Sample Port

Soil Vapor Extraction/Air Sparging
Naval Weapons Industrial Reserve Plant
Bethpage, NY
EXHIBIT 20
Master Valve List

Valve Tag	No.	Type	Size (inch)	Material	Connections	Seals	Specification	Location
BV-	20	Ball	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Effluent Carbon Adsorption Drain Valve
BV-	21	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	22	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	23	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	24	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	25	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	26	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	27	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	28	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	29	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	30	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	31	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption Sample Port
BV-	32	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption Sample Port
BV-	33	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	34	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	35	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	36	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	37	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	38	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port

Soil Vapor Extraction/Air Sparging
Naval Weapons Industrial Reserve Plant
Bethpage, NY
EXHIBIT 20
Master Valve List

Valve Tag	No.	Type	Size (inch)	Material	Connections	Seals	Specification	Location
BV-	39	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	40	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	41	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	42	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	43	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	44	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	45	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	46	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	47	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	48	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	49	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	50	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	51	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	52	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	53	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	54	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	55	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	56	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	57	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port

Soil Vapor Extraction/Air Sparging
Naval Weapons Industrial Reserve Plant
Bethpage, NY
EXHIBIT 20
Master Valve List

Valve Tag	No.	Type	Size (inch)	Material	Connections	Seals	Specification	Location
BV-	58	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	59	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Air Sparging Air Bleed
BT-	01	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	CarbonAdsorption System
BT-	02	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	03	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	04	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	05	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	06	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	07	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
CK-	01	Ball Check	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Condensate Transfer Pump (P-01)

EXHIBIT 21
Start-Up Checklist
Set Points

Item	Tag No.	Fixed Set Point	Adjustable Set Point	Set Point	Unit (see Notes)	Comments
1	PRV-01	x			vac	
2	PRV-02	x			vac	
3	VE-FI-01			325	cfm	
4	VE-FI-07			115	cfm	
5	VE-LS-04	x		-	level	
6	VE-LSH-O2	x		-	level	
7	VE-PI-01	x		9"	vac	
8	VE-PI-02	x		9"	vac	
9	VE-PI-03	x		9"	vac	
10	VE-PI-04	x		9"	vac	
11	VE-PI-05	x		9"	vac	
12	VE-PI-06	x		9"	vac	
13	VE-PI-07	x		9"	vac	
14	VE-PI-08	x		9"	vac	
15	VE-PI-09	x		9"	vac	
16	VE-PI-10	x		9"	vac	
17	VE-PI-11	x		9"	vac	
18	VE-PI-12	x		9"	vac	
19	VE-PI-13	x		9"	vac	
20	VE-PI-14	x		4 psi	pres	
21	VE-PI-15	x		4 psi	pres	
22	VE-PI-16	x		4 psi	pres	
23	VE-PI-17	x		4 psi	pres	
24	VE-PI-18	x		4 psi	pres	
25	VE-PI-19	x		4 psi	pres	
26	VE-PI-20	x		4 psi	pres	
27	VE-PI-21	x		4 psi	pres	
28	VE-PI-22	x		4 psi	pres	
29	VE-PI-23	x		4 psi	pres	
30	VE-PI-24	x		4 psi	pres	
31	**VE-PS-05**		**1" w.c.**		**vac**	
32	**VE-PS-06**		**2 psi**		**pres**	
33	**VE-PS-09**		**5" Hg**		**pres**	
34	**VE-TS-03**		**150°F**		**temp**	
35	**VE-TS-08**		**150°F**		**temp**	

Notes:
vac - vacuum
pres- pressure
level -level, fixed point in vessel
temp -air temperature

EXHIBIT 22
Preventive Maintenance Matrix

Tag #	Equipment	Bi-Weekly (B)	Monthly (M)	Quarterly (Q)	Semi-Annually (S)	Yearly (Y)	Comments
B-01; B-02	Blowers	Change oil in blower (every 500 hours)	Visually inspect oil levels.	N/A	N/A	The unit should be dismantled and all internal parts and passages cleaned and inspected for wear.	
P-01	Condensate Transfer Pump	N/A	Visually inspect unit for leaks.	N/A	N/A	The unit should be dismantled and all internal parts and passages cleaned and inspected for wear.	
A-01; A-02	Air Blower Intake Filters	Remove filter and inspect for dirt, dust and debris. Replace as necessary.	N/A	N/A	N/A	Clean air filter housings.	
C-01; C-02	Vapor Phase Carbon Units	N/A	N/A	N/A	N/A	Inspect internal parts to ensure that the underdrain, vessel lining, and nozzles are in good condition.	
VE-PI (All)	Pressure Gauges	N/A	Inspect for broken glass and ensure that dirt is kept out of the bearings and teeth.	N/A	N/A	Oil gauge movements and linkages with high grade instrument oil.	
PRV-01; PRV-02	Pressure Relief Valves	N/A	N/A	Check to ensure proper valve setting.	N/A	N/A	
VE-LSH-02; VE-LS-04	Level Switches	N/A	N/A	Inspect and clean wetted parts.	N/A	N/A	

EXHIBIT 23
Recommended Operation and Maintenance Accessories

Item No.	Description	Typical Use	Supplier	Comments
1	Hand Held Thermal Anenometer	Air Flow Velocity	Dwyer	Model # 470-1
2				
3				
4				
5				
6				
7				
8				
9				
10				

EXHIBIT 24
Monthly Operational Status Checklist

Prepared by: _____ Date: _____

Questions

1) Have any alarms or shutdowns occurred, and if so, what caused the alarm or shutdown? _____

2) If an alarm or shutdown occurred, what actions were taken to correct the situation? _____

3) Did any sampling occur during the month, and if so what was sampled? _____

4) What maintenance was performed on the system? _____

5) What spare parts were used, if any, and if so should more be ordered? _____

6) Were any hazardous or non-hazardous substances transported and disposed off-site? If so, materials and quantities? _____

7) Were the carbon units changed out? If so, how much carbon was replaced? _____

APPENDIX A

Vendor Operations and Maintenance Manuals

Certificate

This is to certify that this instrument has been calibrated for the fluid conditions specified on the purchase order and embossed on the nameplate. Measuring devices that are traceable to the United States National Institute for Standards and Technology (NIST- formerly National Bureau of Standards) were used for this calibration.

Robert McClellan 4/7/98
Technician Date

981646
Instrument Serial Number

ERDCO Engineering Corporation
721 Custer Av ♦ Post Office Box 6318
Evanston, IL 60204-6318 USA

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ERDCO Engineering Corporation
721 Custer Av ♦ Post Office Box 6318
Evanston, IL 60204-6318 USA

Installation & Operation

ERDCO direct reading flowmeters provide simple and reliable flow rate measurement. These rugged variable area meters work well in a wide variety of applications. Linearity is optimized over 80% of the measuring range.

See-Flo® 3100 & 3200 Series

The indicating pointer is part of the vane and directly visible through the sight window. To read the meter, compare the vane position with the externally mounted scale. The sight window may also be used to observe turbulence, cleanliness and other fluid conditions.

Armor-Flo™ 3400-3700 Series

This product range utilizes the same simple design as the See- Flo with the added benefit of a flow isolated housing. High intensity magnets couple the vane and indicator without any mechanical linkage or dynamic seals. Temporary decoupling of the vane and indicator can occur under erradic flow conditions, but will self correct as the indicator moves through the flow range.

Installation

Your ERDCO flowmeter is complete and ready to use. It has been individually calibrated and tested in accordance with your order. When installing, observe these recommended practices:

1. Install in a full pipe system.
2. Connect observing the "IN" and "OUT" markings on the meter.
3. For best performance, install with ten pipe diameters of straight pipe upstream and five diameters of straight pipe downstream.
4. Locate valves and other turbulence creating devices downstream of the flowmeter where possible.
5. Mount the meter in its intended orientation (ie: in a horizontal or vertical piping section) as designated by the model number.
6. Orient the face of the meter in a vertical plane. It should not point to the sky or the ground.
7. Maintain the fluid conditions on the nameplate. Different conditions can affect accuracy. Do not exceed the maximum ratings of the meter.

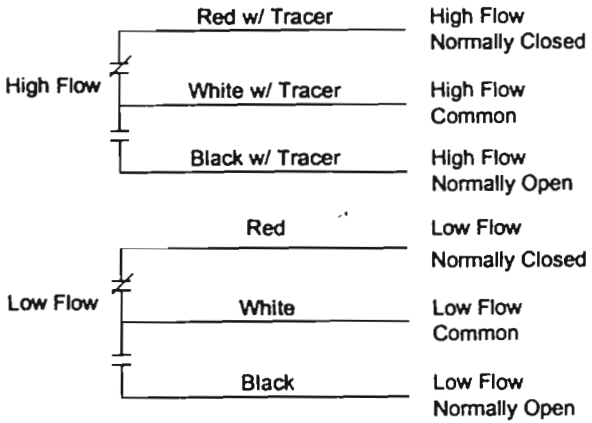
Limit Switch Adjustment

3500 Series and certain 3700 Series flowmeters include single pole double throw switches rated at 0.25 amperes at 120 vac (1.5 amperes at 24 vdc). The switches are configured for low or high flow actuation depending on order specifications.

To adjust the switch actuation point:

1. Remove the window retaining ring and window.
2. Locate the indicator at the desired trip point, and temporarily hold it in place. Do not bend the indicator or use force.
3. Monitor switch continuity (light, horn, multi-meter, etc.) while sliding the switch along the switch guide until the switch contacts open or close.
4. Tighten slotted screw to secure switch in position.
5. Repeat steps 2 through 4 if there is a second switch.
6. Position window on o-ring for a good seal. Reinstall retaining ring.

Wiring Diagram



Notes:
1. Switches shown in normal condition (not actuated).
2. Select low / high switch diagram as applicable.

Transmitters

Refer to the detailed instructions provided separately.

Service

Factory repair and recalibration services are available. For more information call 847-328-0550 or fax 847-328-3535.

ERDCO Engineering Corporation
721 Custer Av ♦ Post Office Box 6318
Evanston, IL 60204-6318 USA

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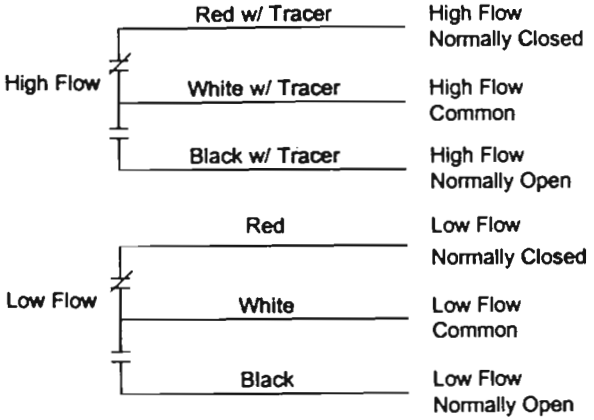
Wiring Diagram



Notes:
1. Switches shown in normal condition (not actuated).
2. Select low / high switch diagram as applicable.

Transmitters

Refer to the detailed instructions provided separately.

Service

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ERDCO Engineering Corporation
721 Custer Av ♦ Post Office Box 6318
Evanston, IL 60204-6318 USA

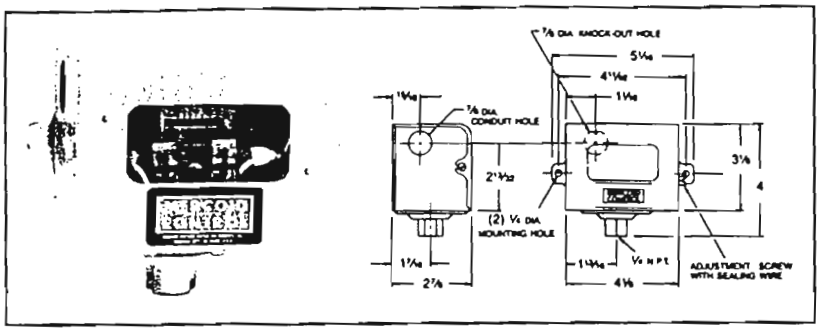
Mercoid®

A Division of
DWYER INSTRUMENTS, INC.

SERIES AP

Diaphragm Operated Pressure Switches

Visible setpoint adjustment compact, low cost



PHYSICAL DATA

Temperature Limits: -30°F to 150°F.
Pressure connection: ¼" NPT female
Electrical Rating:
Mercury: SPDT 4A @ 120V, 2A @ 240V AC/DC
Snap: SPDT 15A @ 120VAC., 8A @ 240VAC.
Conduit Opening: ½" conduit.
Wiring Connections: 3 screw type, common, normally open and normally closed.
Set Point Adjustment: Screw type — adjustable from outside cover
Housing and Cover: Painted steel.
Wetted Parts: Steel, solder, Buna-N/Nylon (316SS, Teflon available)
Weight: 2 lbs. net.
Installation: Mercury switch unit — vertical, snap switch unit — any position.

Reliable and convenient, series AP pressure switch is a compact low cost switch for instrument air or other low pressure applications. Visible set point and external adjustment add convenience. Used on air, noncorrosive gas or liquid service compatible with wetted parts.

Suggested Specification:

Pressure switches shall be Mercoid Series AP-(___) operated by Buna N diaphragm. Setpoint shall be visible, and shall be externally adjustable without shutting down process. Deadband shall be fixed. Switch shall incorporate (hermetically sealed mercury switch) (SPDT snap switch).

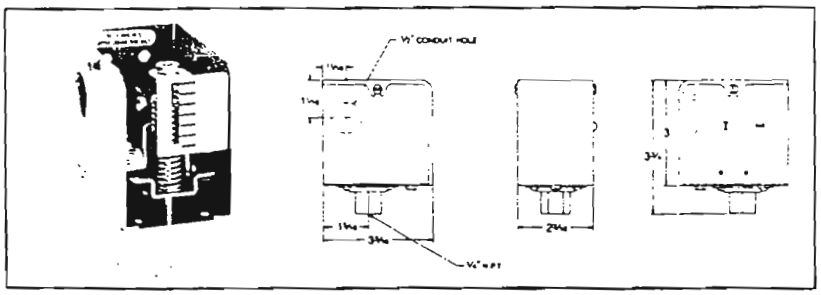
SERIES AP SWITCHES — OPERATING RANGES AND DEAD BANDS

Model Number	Model Number	Switch Type SPDT	Switch DeadBand		Maximum Pressure	Price
			Low	High		
AP-153-33	10" vac-50" wc	Mercury	5" wc	6" wc	15 psig	$89.00
AP-153-37	1-30 psig	Mercury	0.8 psig	1.5 psig	60 psig	84.00
AP-153-39	10-125 psig	Mercury	4 psig	10 psig	160 psig	89.00
AP-7021-153-33	10" vac.-50" wc	Snap	8" wc	10" wc	15 psig	84.00
AP-7021-153-37	1-30 psig	Snap	0.75 psig	1.5 psig	60 psig	84.00
AP-7021-153-39	10-125 psig	Snap	3 psig	7 psig	160 psig	84.00

SERIES CS

Low Cost Diaphragm Operated Pressure Switches

Visible set points, fixed deadband



Model CS-Fixed Deadband

Model No.	Adjustable Operating Range	Fixed Deadband Maximum	Adjustable Deadband	Max. Pressure
CS-1	1-30" Hg. Vac.	1.5" Hg.	No	30 psig
CS-3	1-100" w.c.	7" w.c.	No	30 psig
CS-10	1-10 psig	0.4 psig	No	30 psig
CS-30	1-30 psig	1.0 psig	No	50 psig
CS-150	10-150 psig	5 psig	No	175 psig

Price: All CS models listed above $69.00

PHYSICAL DATA

Temperature Limits: -30°F to 150°F
Pressure Connections: ¼" NPT.
Electrical Rating: SPDT AC 15A @ 120V 8A @ 240V ½ HP @ 120V 1 HP @ 240V
Conduit Opening: ½"
Wiring Connections: 3 screw type, common, normally open and normally closed
Set Point Adjustment: Screw type, inside cover.
Housing: Galvanized steel
Diaphragm: Buna-N/Nylon.
Calibration Spring: Plated steel
Weight: 1 lb
Installation: Any position.

Model CS combines advanced design and precision construction with small size and low price. Unit is ideal for instrument panels, small compressors and general industrial applications. Visible set point and easy to wire SPDT snap switch reduce installation time. Operates in any position and is vibration resistant.

Suggested Specification:

Pressure switches shall be operated with Buna N/Nylon reinforced diaphragm. Units shall have fixed deadband. Set point shall be easily adjustable. Set point shall be visible on calibrated scale. Motion of diaphragm shall be transmitted to the switch button via a direct mechanical linkage. Switches shall be Mercoid Model (CS-___).

Dwyer Instruments, Inc. P.O. Box 373/Michigan City, Indiana 46361/Phone 219-879-8000/Fax 219-872-9057 • U.K. Phone (01494)-461707 • Australia Phone (02) 9756-5355

SERIES AP PRESSURE SWITCHES WITH SNAP ACTION SWITCHES

INSTALLATION AND OPERATING INSTRUCTIONS

TYPES AP, APW, APWT, APH –With Suffix Numbers:
-7021-153 or -8021-153 -7041-153 or -8041-153
-7021-804 or -7041-804

OPERATION

A variation in control pressure causes the diaphragm to actuate the snap-action switch.

APPLICATION

TYPE AP, APH, APW, APWT with suffix numbers 7021-153 or 8021-153 are for use with mediums not injurious to steel, silver solder, Nylon/Buna N diaphragm.

TYPE AP, APH, APW, APWT with suffix numbers 7041-153 or 8041-153 are for use with mediums not injurious to 316 stainless steel and Teflon covered diaphram.

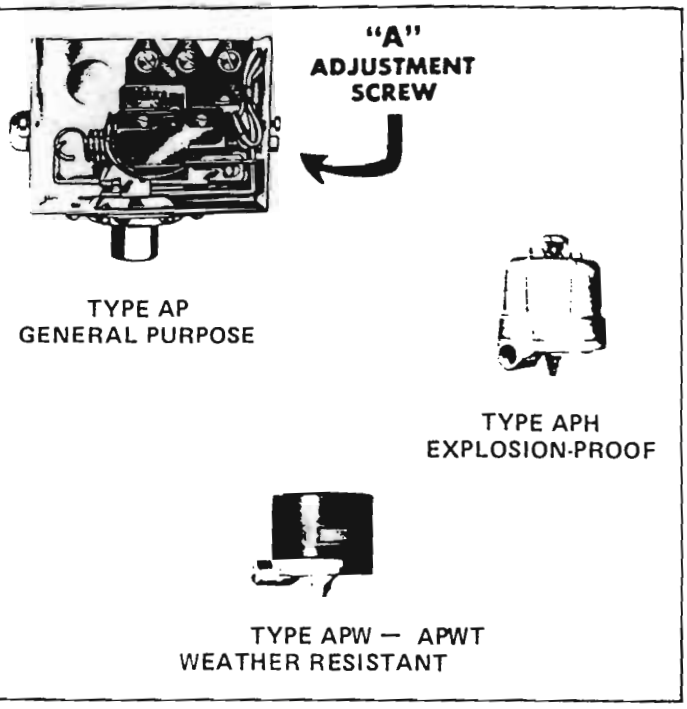
MOUNTING – MOUNT IN ANY POSITION

TYPE AP (General Purpose) can be installed on a panel or smooth surface using the two mounting ears or the 1/4" NPT bottom connection. **Do not mount by twisting the case, use a wrench on the square part of the 1/4" bottom pipe connection.**

TYPE APW–NEMA 3 (Weather-Resistant) 1/4" NPT male bottom connection.

TYPE APWT–NEMA 4 (Water-tight) 1/4" NPT male bottom connection.

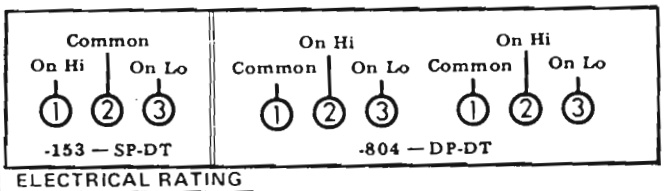
TYPE APH (Explosion-Proof) 1/4" NPT male connection or use mounting bracket No. PP-135-95.



OPERATING RANGES - DIFFERENTIALS

Operating Ranges PSIG. Adjustable	Order By Range Number	MAX. Surge Press. PSIG	Approximate Switch Differential With Pointer Set At			
			-153		-804	
			LOW	HIGH	LOW	HIGH
10" Vac-50" wc	33	15	8"wc	10" wc	4.5" wc	5" wc
1-20 PSIG	36	60	0.5 psig	1.5 psig	.75 psig	1.5 psig
1-30 PSIG	37	60	0.75 psig	1.5 psig	.75 psig	1.5 psig
10-125 PSIG	39	160	3.0 psig	7.0 psig	1.75 psig	4 psig

ALL TYPES
SINGLE-POLE DOUBLE-THROW (-153) OR
DOUBLE-POLE DOUBLE-THROW (-804) OPERATION



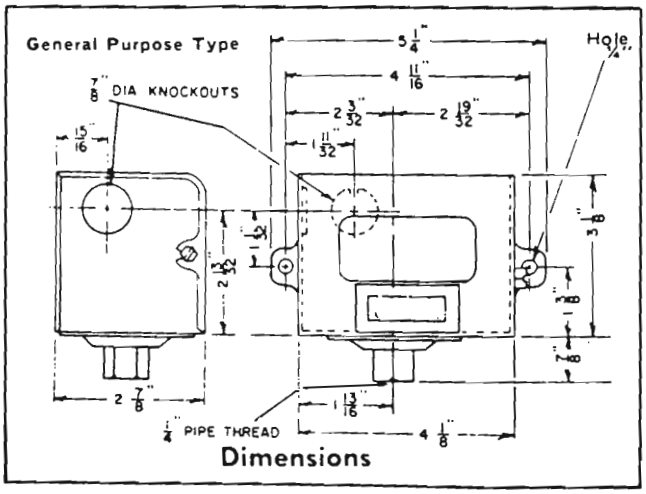
ELECTRICAL RATING

SERIES 7021-153 and 7041-153 – SPDT
15 Amp. max. 120V AC; 8 Amp. max. 240V AC
0.5 Amp. max. 120V DC; 0.25 Amp. 240V DC.
¾ Hp. 120V AC. 1 Hp. 240V AC

SERIES 8021-153 and 8041-153 – SPDT
15 Amp. 120V AC; 8 Amp. 240 V AC; 4 Amp. 480V AC
0.5 Amp. 120V DC; .25 Amp. 240V DC.
¾ Hp. 120V AC; 1½ Hp. 240V AC.
SERIES 7021-804 and 7041-804 (2 SPDT)
5 Amp. 120/240AC – 30V. DC Resistive

ADJUSTMENTS

Turn adjustment screw "A" (see illustration) until pointer on dial indicates desired operating pressure.



WIRING

Wire in accordance with the National Electrical Code and local regulations. Observe wiring diagram inside enclosure and details below for Type No. and electrical rating. Where control is connected directly into the load circuit it must be wired into hot side of line. **Do not overload.**

Do Not Oil Any Parts.

ERCOID DIVISION
WYER INSTRUMENTS, INC.
P. Box 258
higan City, IN 46360 (USA)
PHONE 219-879-8000
FAX 219-872-9057
TELEX 25916

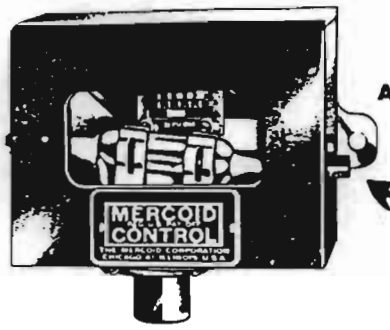
FR 88-442111-00

Mercoid®

SERIES AP PRESSURE SWITCHES WITH MERCURY SWITCHES

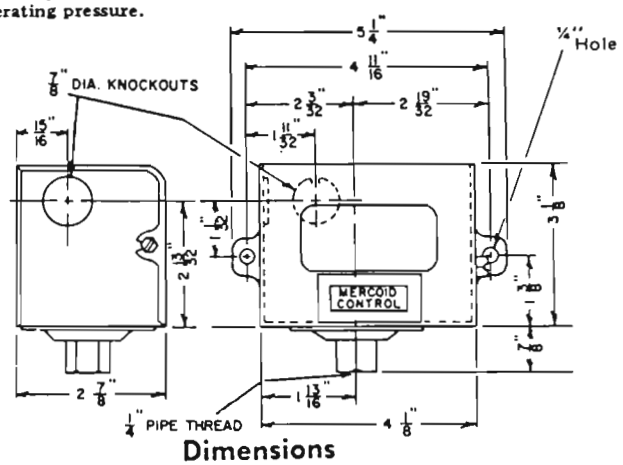
INSTALLATION AND OPERATING INSTRUCTIONS

TYPE AP and AP-41
With Suffix Nos.
-153, -2, -3, -26, -36, -88, -89



HOW TO SET OPERATING POINT

Turn adjustment screw "A" until pointer on dial indicates desired operating pressure.



Dimensions

OPERATION

A variation in control pressure causes the diaphragm to actuate the hermetically sealed mercury switch to open or close the electrical contact.

APPLICATION

TYPE AP with suffix numbers -153, -2, -3, -26, -36, -88, -89 are for use with mediums not injurious to steel, silver solder or Fairprene diaphragm.

TYPE AP-41 with suffix numbers -153, -2, -3, -26, -36, -88, -89 are for use with mediums not injurious to 316 SS and Teflon.

MOUNTING

Install control firmly in a **LEVEL POSITION** on a panel or smooth wall surface by means of the two mounting ears. Where pipe mounting is desired, control may be connected by means of the 1/4" I.P.S. connection. **Do not mount control by twisting the case, use a wrench on the square part of the 1/4" bottom pipe connection.**

To level, sight across the two cover screws or check the lower end of the glass opening in cover to see that instrument is lined up horizontally.

WIRING

Wire in accordance with local electrical codes or equipment manufacturers instructions. See nameplate attached to inside of control case for terminal markings and electrical rating. Do not overload. Do not oil any parts. Do not tamper with switch wires. Position of these wires is essential for proper operation. Tampering with these wires will void warranty.

ELECTRICAL RATING

CODE		CODE	
A–	4A. 120V. 2A. 240V. AC/DC (single phase AC 1/8 h.p.)	B–	10A. 120V. 5A. 240V. AC/DC (single phase AC 3/4 h.p. DC 1/3 h.p.)
C–	Non-Inductive AC heater only: 17A. 120/240/277V. AC Resistive	D–	1/2A. 120V. 1/4A. 240V. AC 1/4A. 120V. 1/8A. 240V. DC

RANGES—DIFFERENTIALS—ELECTRICAL RATINGS Differential Non-Adjustable—(factory set)

ADJUSTABLE OPERATING RANGE PSIG.	SWITCH DIFFERENTIAL WITH POINTER SET AT LOW OR HI END OF SCALE		SWITCH ACTION ON PRESSURE RISE	ELEC. RATING SEE CODE	FOR MEDIA NOT INJURIOUS TO STEEL SILVER SOLDER OR NYLON & BUNA N	FOR MEDIA NOT INJURIOUS TO 316 SS & TEFLON
	LOW	HIGH				
	5" wc	6" wc	SP-DT	A	AP-153	AP-41-153
10" Vac. 50" wc	5" wc	7" wc	SP-ST Opens	B	AP-2	AP-41-2
	5" wc	7" wc	SP-ST Closes	B	AP-3	AP-41-3
RANGE NO. 33	1.5" wc	1.5" wc	SP-ST Closes	D	AP-88	AP-41-88
	2" wc	2" wc.	SP-ST Opens	D	AP-89	AP-41-89
	0.3 psig.	0.5 psig.	SP-DT	A	AP-153	AP-41-153
	0.5 psig.	1.0 psig.	SP-ST Opens	B	AP-2	AP-41-2
1-20 PSIG.	0.5 psig.	1.0 psig.	SP-ST Closes	B	AP-3	AP-41-3
	0.75 psig.	1.25 psig.	SP-ST Opens	B&C	AP-36	AP-41-36
RANGE NO. 36	0.75 psig.	1.25 psig.	SP-ST Closes	B&C	AP-26	AP-41-26
	2" wc	4" wc	SP-ST Closes	D	AP-88	AP-41-88
	3" wc	6" wc	SP-ST Opens	D	AP-89	AP-41-89
	0.4 psig.	0.75 psig.	SP-DT	A	AP-153	AP-41-153
	0.5 psig.	1.5 psig.	SP-ST Opens	B	AP-2	AP-41-2
1-30 PSIG.	1.0 psig.	1.5 psig.	SP-ST Closes	B	AP-3	AP-41-3
	1.25 psig.	1.75 psig.	SP-ST Opens	B&C	AP-36	AP-41-36
RANGE NO. 37	1.25 psig.	1.75 psig.	SP-ST Closes	B&C	AP-26	AP-41-26
	3" wc	6" wc	SP-ST Closes	D	AP-88	AP-41-88
	4" wc	8" wc	SP-ST Opens	D	AP-89	AP-41-89
	2 psig.	6 psig.	SP-DT	A	AP-153	AP-41-153
	3 psig.	8 psig.	SP-ST Opens	B	AP-2	AP-41-2
10-125 PSIG	4 psig.	8.5 psig.	SP-ST Closes	B	AP-3	AP-41-3
	4 psig.	10 psig.	SP-ST Opens	B&C	AP-36	AP-41-36
RANGE NO. 39	4 psig.	10 psig.	SP-ST Closes	B&C	AP-26	AP-41-26
	.75 psig.	1.5 psig.	SP-ST Closes	D	AP-88	AP-41-88
	.75 psig.	1.5 psig.	SP-ST Opens	D	AP-89	AP-41-89

Litho in U.S.A. 6/92

BULLETIN 0-408R
REVISION 6-69.

MERCOID CONTROL

MERCOID SERIES AG, AGR, AK, AKR LOW PRESSURE-VACUUM CONTROLS

Series AG and AGR
Suitable for Air or City Gas

A Nylon fabric diaphragm coated with Buna N actuates the hermetically sealed mercury switch to open or close the electrical circuit. Pressure inlet 1/4" NPT has an orifice which controls the gas flow into the pressure chamber and conforms to Underwriters' requirements. Has outside adjustment for setting operating point over the visible calibrated dial.

TYPE AG-153 — **4 amp. 115 volts, 2 amp. 230 volts**

ADJUSTABLE OPERATING RANGE	SUSTAINED PRESSURE RATING PSIG	MAX. SURGE LIMIT PSIG	MINIMUM DIFFERENTIAL	SWITCH ACTION ON PRESSURE RISE
2-18"wc VAC.	4	6	1"wc	SP-DT
2-20"wc PRESS.	4	6	1"wc	SP-DT

Series AK and AKR
Suitable for Low Pressures and Air Flow Applications

Construction: Nylon fabric diaphragm coated with Buna N. Hermetically sealed mercury contact. 1/4" NPT pressure connection. Outside adjustment with locking device. Cadmium plated steel control case. Glass fronted cover for visual on-off operation.

TYPE AK-153 — **4 amp. 120 volts, 2 amp. 240 volts**

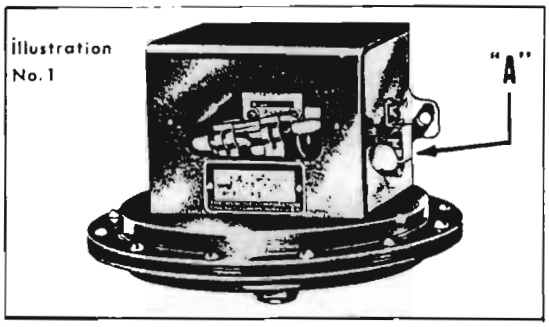
ADJUSTABLE OPERATING RANGE	SUSTAINED PRESSURE RATING PSIG	MAX. SURGE LIMIT PSIG	MINIMUM DIFFERENTIAL	SWITCH ACTION ON PRESSURE RISE
.2-1.5" wc vac.	4	6	0.2	SP-DT
.2-1.5" wc press.	4	6	0.2	SP-DT

FULLY AUTOMATIC TYPES

Controls with prefix AG or AK operate to automatically actuate the mercury switch as the pressure rises to the scale setting and falls below the setting, an amount equal to the operating differential.

SEMI-AUTOMATIC WITH MANUAL RESET

Controls with prefix AGR or AKR function to automatically actuate the switch to one position but require manual reset to return it to the other position. Letters L or U are included in the type number to denote whether manual reset occurs after a pressure rise or fall has automatically tripped the switch. Example: AGR-2L represents a switch which automatically opens on a pressure rise with manual reset after the pressure falls (L). Type AGR-2U represents a switch which automatically closes on a pressure fall with manual reset after a pressure rise (U).



MOUNTING: Install control firmly in a LEVEL POSITION. Do not mount control by twisting the case, use wrench on the square part of the ¼" bottom pipe connection.

To level, sight across the two cover screws or check the lower end of the glass opening in cover to see that instrument is lined up horizontally.

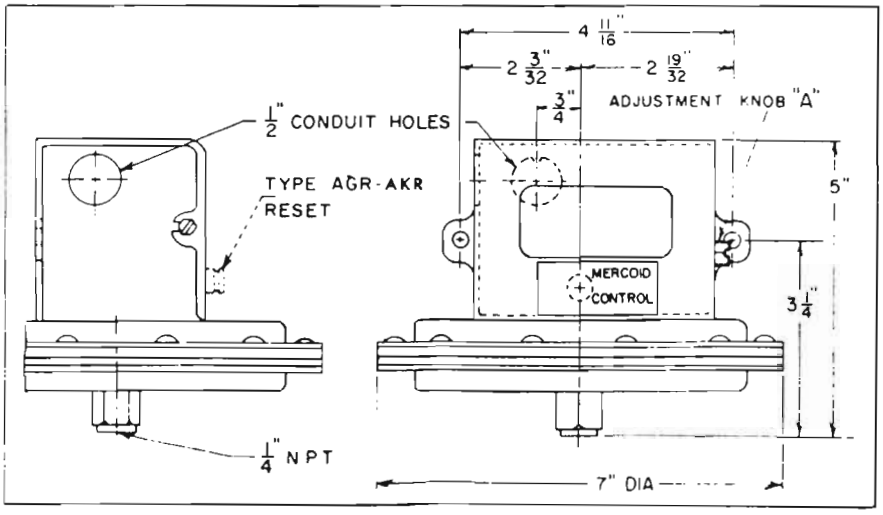
HOW TO SET OPERATING POINT: Turn adjustment screw "A" (illustration No. 1) until pointer on dial indicates desired operating pressure

WIRING: Wire in accordance with local electrical codes or equipment manufacturer's instructions. See nameplate attached to inside of control case for terminal markings and electrical rating.

CAUTIONS: Do not overload—see electrical rating on nameplate located inside of control case. Do not oil any parts.

IDENTIFICATION OF SWITCH BY TYPE SUFFIX

Suffix		Switch and Contact Action
(-2)	9-51 (2 wire)	S.P.S.T. opens contact on pressure rise
(-3)	9-51 (2-wire)	S.P.S.T. closes contact on pressure rise
(-4)	9-A67 (3 wire)	TWO CIRCUIT closes contacts on pressure rise
(-54)	9-A67 (3 wire)	TWO CIRCUIT opens contacts on pressure rise
(-153)	9-A64 (3 wire)	S.P.D.T. one contact opens; other closes on pressure rise or fall.

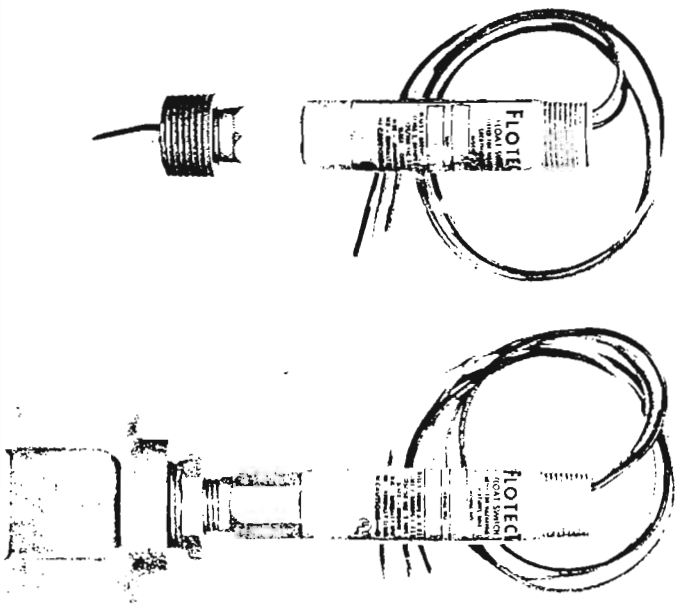


THE MERCOID CORPORATION, CHICAGO, ILLINOIS 60641

1 75 T PRINTED IN U.S.A.

FLOTECT. MODEL L-6 FLOAT SWITCH

Installation and Operating Instructions



Explosion-Proof; U.L. and C.S.A. Listed -
Class I, Groups *A, B, C & D
Class II, Groups E, F & G
CENELEC: EExd IIC T6 (T amb=75°C)
*(Group A, stainless steel body only)

PHYSICAL DATA

Temperature Limit: 220°F (105°C) maximum
Maximum Pressure: See chart below
Switches: One or two SPDT snap switches
Electrical Rating: U.L.: 5A @ 125/250 VAC.
C.S.A. and CENELEC: 5A @ 125/250 VAC, 5A resistive, 3A inductive @ 30 VDC.
Optional ratings: MV option—Gold contacts for dry circuits. Rated 0.1A @ 125 VAC MT option: 400°F (205°C) 5A @ 125/250 VAC (not listed).
Wiring Connections: 3-18" (460mm) wire leads, 18 ga.
CENELEC models only: push-in type terminal blocks
Black = common, blue = N.O., red = N.C.
Minimum Specific Gravity:
Polypropylene float - 0.9
Round SS float - 0.7
Cylindrical SS float - 0.5
Switch Body: Brass 3/4" NPT conduit connection.
For SS switch body, change model no. to L6EPS.
Piping/Mounting Connection: 1" NPT
Installation: Horizontal, index arrow pointing down
Weight: 1 lb. (.5 KG); w/external chamber 1-3/4 lb. (.8 KG)

WETTED MATERIALS CHART

Model	Brass	Bronze	Ceramic	Polypropylene	301SS	303SS	304SS
B-S-3-A	X		X		X		X
B-S-3-B	X	X	X	X	X		
B-S-3-C	X		X		X		X
B-S-3-H	X	X	X		X		X
B-S-3-O	X		X	X	X		
S-S-3-A			X	X	X		X
S-S-3-C			X		X	X	X
S-S-3-L			X		X	X	X
S-S-3-O			X	X	X	X	
S-S-3-S			X	X	X	X	

MAXIMUM PRESSURE CHART

Model Number	Float	Pressure Rating PSIG (KG/CM²)
L6EPB-B-S-3-A	Cylindrical SS	200 (14)
L6EPB-B-S-3-B	Polypropylene	250 (18)
L6EPB-B-S-3-C	Round SS	350 (25)
L6EPB-B-S-3-H	Round SS	250 (18)
L6EPB-B-S-3-O	Polypropylene	1000 (70)
L6EPB-S-S-3-A	Cylindrical SS	200 (14)
L6EPB-S-S-3-C	Round SS	350 (25)
L6EPB-S-S-3-L	Round SS	350 (25)
L6EPB-S-S-3-O	Polypropylene	2000 (140)
L6EPB-S-S-3-S	Polypropylene	2000 (140)

INSTALLATION:

Unpack switch and remove any packing material found inside lower housing or float chamber.

Switch must be installed with body in a horizontal plane and arrow on side pointing down.

If switch has an external float chamber (tee), connect it to vertical sections of 1" NPT pipe installed outside vessel walls at appropriate levels. If unit has no external float chamber, it must be mounted in a 1" NPT half coupling welded to the vessel wall. The coupling must extend through the wall.

Inspect and clean wetted parts at regular intervals.

ELECTRICAL CONNECTIONS:

Connect wire leads in accordance with local electrical codes and switch action required. N.O. contacts will close and N.C. contacts will open when liquid level causes float to rise. They will return to "normal" condition on decreasing liquid level. Black = common. Blue = N.O. and Red = N.C.

For units supplied with both internal and external grounds, the ground screw inside the housing must be used to ground the control. The external ground screw is for supplementary bonding when allowed or required by local code. Some CSA listed models are furnished with a separate green ground wire. Such units must be equipped with a junction box, not supplied but available on special order.

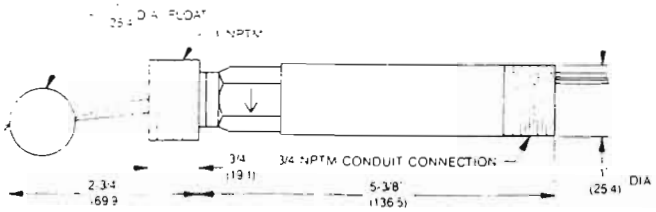
CENELEC certified models include a junction box. Cable should enter enclosure through an approved EX cable gland, not supplied. Push stripped and tinned leads into appropriate openings in terminal block(s). To connect fine stranded leads or to remove any wire, depress spring release with small screwdriver first.

All wiring, conduit and enclosures must meet applicable codes for hazardous areas. Conduits and enclosures must be properly sealed. For outdoor or other locations where temperatures vary widely, precautions should be taken to prevent condensation inside switch or enclosure. Electrical components must be kept dry at all times. **CAUTION:** To prevent ignition of hazardous atmospheres, disconnect the device from the supply circuit before opening. Keep assembly tightly closed when in use.

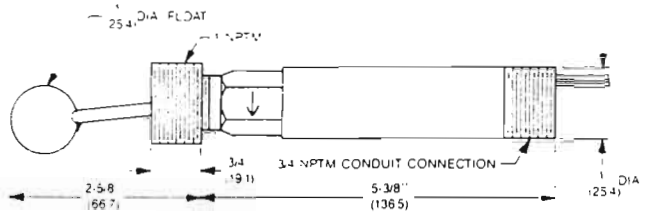
Dimensions on reverse

W.E. ANDERSON DIV., DWYER INSTRUMENTS, INC.
P. O. BOX 358 • MICHIGAN CITY, INDIANA 46360, U.S.A.
Telephone 219/879-8000
Fax 219/872-9057

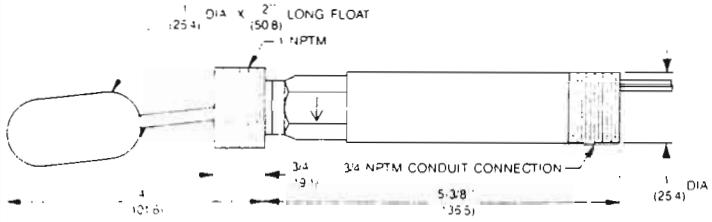
FLOTECT MODEL L-6 FLOAT SWITCH — DIMENSION DRAWINGS



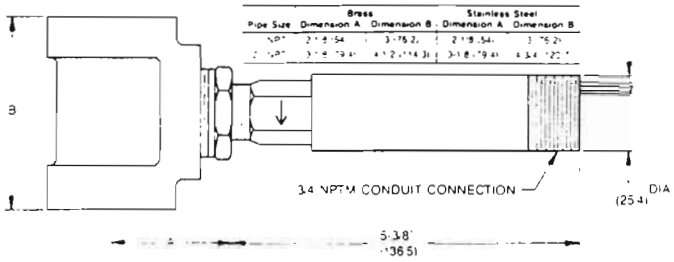
Polypropylene Float



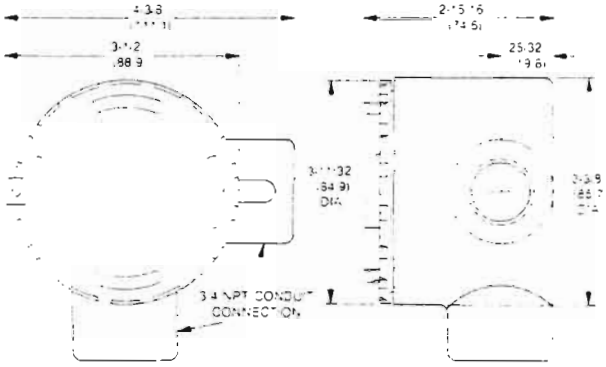
Round Stainless Steel Float



Cylindrical Stainless Steel Float



With External Float Chamber (Tee)



CSA, CENELEC Conduit Enclosure

W.E. ANDERSON DIV., DWYER INSTRUMENTS, INC.
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Michigan City, IN 46360
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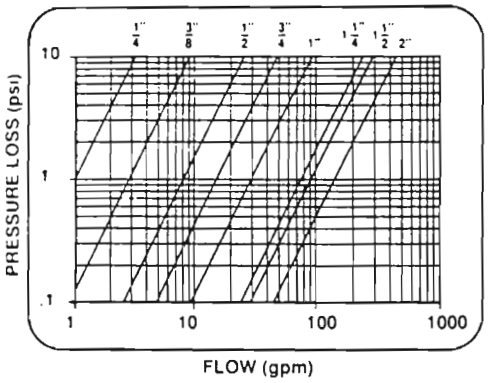
FR 82-440726-00
Printed in U.S.A. 10/93

1/4"-2" Sure Block™ True Union Ball Valves

Hayward Sure Block True Union Ball Valves provide quick quarter turn shut off and eliminate the need for unions. Their design allows for easy valve body removal from a piping system without disturbing pipe connections. Simply, unscrew the two assembly nuts and lift the valve body out of line.

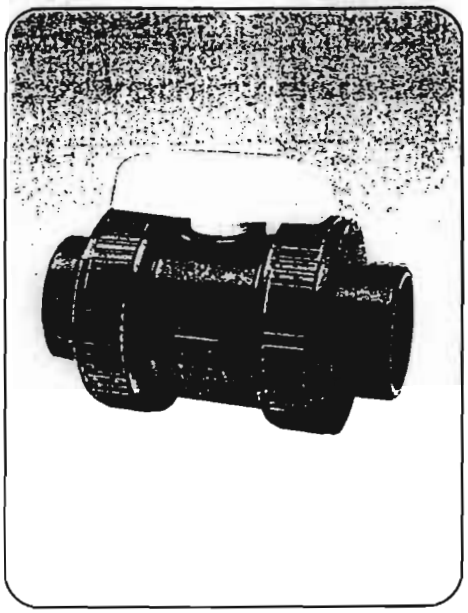
All Hayward True Union Valves are Sure Blocked and rated to 225 psi. The valve's seal retainer incorporates a fine pitch thread for accurate seat adjustment. Sure Bock valves feature reversible Teflon seats. Should they become worn or scored, they simply have to be removed, turned over, and reinstalled to put the valve back in service. Hayward Sure Block Ball Valves, 1/4" through 2", are a Full Port design. The orifice in the ball is equivalent to pipe ID with no flow restrictions.

Hayward Sure Block Valves are made from NSF approved material and are available in PVC, CPVC, PPL, sizes 1/4" - 2". with Viton or EPDM o-rings.



Engineering Specifications

All True Union Ball Valves, 1/4" through 2", to be (PVC, CPVC, or PPL) with (Socket, Threaded, or Flanged) end connections. Seals to be (Viton or EPDM) with Teflon seats. Valves to be Full Port design for low pressure loss and have a fine pitched threaded seal retainer for precise seat adjustments. Valve seats to be reversible and self lubricating for bubble tight seal. All valves to be of Sure Block design and rated to 225 psi. As manufactured by Hayward Industrial Products, Inc.

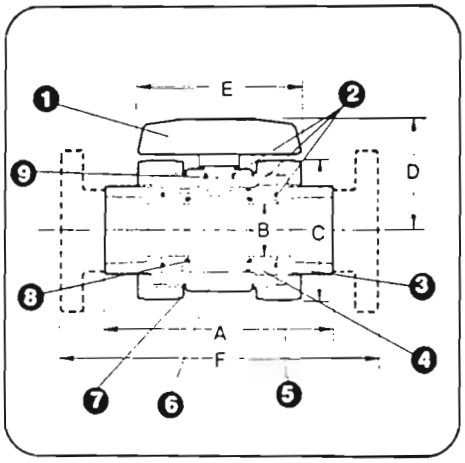


Features

- Sure Block design
- Fully serviceable. Internals can be inspected and serviced
- Fine pitch threaded seal retainer to adjust for seat wear
- Reversible Teflon seats. Doubles the life of the seating material
- Full Port design for greater Cv values

Options

- 2" Square operating nut
- Valve Safe Lockout
- Spring return handle
- Pneumatic & Electric Actuators



1/4" - 2" Sure Block True Union Ball Valve Parts List

1 Handle
2 O-Ring Seals
3 End Connector
4 Seal Retainer
5 Union Nut
6 Ball
7 Body
8 Teflon Seat
9 Stem

Dimensions

Size	A	B	C	D	E	F	Weight in lbs. Soc/Thd	Flanged
1/4"	4.63	.50	2.25	1.88	3.00	–	.75	–
3/8"	4.63	.50	2.25	1.88	3.00	–	.75	–
1/2"	4.63	.50	2.25	1.88	3.00	6.75	.75	1.00
3/4"	4.75	.75	2.63	2.13	3.00	7.13	.75	1.00
1"	5.25	1.00	3.00	2.63	4.00	8.00	1.13	2.13
1-1/4"	6.44	1.25	3.56	2.88	4.00	9.44	1.75	2.75
1-1/2"	6.75	1.50	4.00	3.00	4.00	9.88	2.13	3.63
2"	8.00	2.00	4.75	3.63	5.00	11.38	3.75	6.25

Dimensions are in inches. For reference only.

Selection Chart

Size	Material	End Connection	Seals	Pressure Rating
1/4" - 3/8"	PVC	Socket or Threaded	Viton	225 psi @ 70° F non shock
1/2" - 2"	PVC or CPVC	Socket, Threaded or Flanged	Viton/EPDM	
1/2" - 2"	PPL	Threaded or Flanged	Viton	

HAYWARD 900 Fairmount Avenue, Elizabeth, New Jersey 07207
908/351-5400
Fax: 908/351-7706

HAYWARD INDUSTRIAL PRODUCTS

BUTTERFLY VALVE

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

INSTALLATION

Hayward Butterfly Valves should be installed between two pipe flanges. In dead end service, it is recommended they be installed between one pipe flange and a downstream companion or blind flange. The use of additional gaskets are not necessary and not recommended.

The "LUG" design can be installed on one pipe flange with a maximum upstream pressure of 5.3 Kg/cm^2.. Flow must be in the direction of the arrow on the body.

When installed between two existing flanges, the flanges should be separated to provide clearance on the face to face of the valve. This will prevent the valve sealing surfaces from distortion during installation. Pipe flanges should be clean and, free of debris including old gasket material. A light coating of a lubricant such as "Non-Fluid Oil" HWD#2/TF applied to the flange sealing surface will aid in installation.

Hayward Butterfly Valves are designed for use with all pipe flanges that have bores equal to or larger than listed below. The inside of the pipe flange must be chamfered at a 45 degree angle to a diameter listed if the inside bore is smaller than listed. Sharp edges and burrs must be removed.

Valves can be opened to approximately 15° when installed. Do not open fully during installation to prevent damage to the edge of the disc by the mating flanges.

Install the valves using well lubricated studs or bolts and nuts. For plastic flanges metal washers are recommended between nut/bolt head and pipe flange. With a torque wrench, uniformly tighten nut to approximately 10 foot pounds in an alternating sequence, diametrically opposed to the previously tightened nut. Final tightening should be performed in the same sequence following the recommended torque in the following chart.

For plastic Schedule 80 pipe the maximum allowable displacement is 3 mm off center in any direction. Maximum angular misalignment of 1.5 mm is allowable.

Normal pipe hanger spacing is recommended. *Do not allow valve to support the weight of pipe.* When using pneumatic or electric actuators, additional support directly to the actuator is recommended.

Manual Butterfly Valves are shipped without the lever installed. The lever is installed by aligning the point of the lever with the arrow stamped on the shaft and carefully engaging the mating hexes. Install the flat washer, the lock washer and the 1/4" screw. Push the "H" black cap into the lever.

RECOMMENDED FLANGE BOLT TORQUE FOR BUTTERFLY VALVES

Size Nominal (mm)	Minimum Pipe / Flange Bore (mm)	Stud Dia (mm) x Length (mm)	Bolt Dia (mm) Thread	Flat Face Type Flange Torque N*M	Van-Stone Type Flange Torque N*M
40	36.8	M13 x 115	N/A	15-20	5-15
50	36.8	M16 x 115	M16x2	20-35	15-30
90	72.9	M16 x 140	M16x2	25-35	15-30
110	95.3	M16 x 150	M16x2	25-35	15-30
160	145	M20 x 165	M20x2.5	40-55	25-40
225	192	M20 x 180	M20x2.5	40-55	25-40
250	241	M20 x 240	M20x2.5	70-85	70-80
300	287	M20 x 250	M20x2.5	70-85	70-80

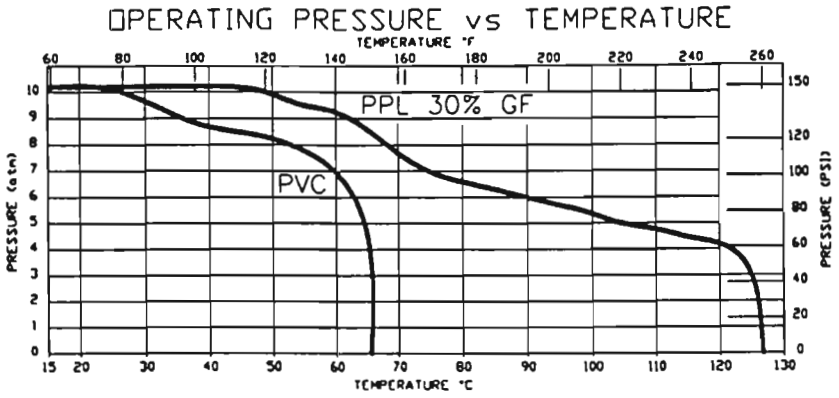
NOTE: On valves of the "LUG" design, bolts are recommended. "LUG" design not available on 40mm.

OPERATION

When installation is complete, check for proper alignment. Fully open and close the valve 3 or 4 times. With a lever installed, fully squeeze the handle and hold in for the full stroke 90° stroke of the lever. For optimum operation the lever handle should be held up until full stroke of valve is reached. The handle should be relaxed only at end of stroke.

Maximum operation pressure at ambient temperature is 10 BAR (10.5 $Kg/cm^{2)}$

See Chart Below for pressure in PSI derating at temperature.



MAINTENANCE & DISASSEMBLY OF VALVE

I. Minimal valve maintenance is required. The valve is field repairable.

II. Actuator Assembly: Actuators can be removed and installed without removing valve from the line. The line should be depressurized before any actuator is removed.
   A. Handle Assembly: remove black logo bezel by lifting with a thin bladed screwdriver of knife. Remove exposed slotted head screw and flat washer. Lift the handle off.
   B. Gear Actuators: remove four (4) hex nuts and the washers that hold the actuator to the body.
   C. Pneumatic / Electric Actuator: removed by unscrewing either four (4) socket head cap screws or hex nuts which hold the actuator to the valve.

III. VALVE DISASSEMBLY

1. Depressurize and drain line.
2. Remove valve from line and wash thoroughly.
3. For 225mm and smaller valves remove cap plug from valve bottom (use a 1/2" drive racket). For 250mm and 300mm valves remove wedge from body utilizing a small punch to drive wedge out of body.
4. Remove shaft by pushing down on shaft from top, out through bottom of valve body. Note placement of O-ring around plug removed.
5. Remove upper elastomeric moisture seal.
6. Remove upper bearing or 3 bearings on 250mm and 300mm valves, (use the shaft to twist out).
7. Remove lower bearing (use the shaft to twist out).
8. To remove seal retainers, place shaft through one seal retainer and approximately 3/4 through the disc. Rotate disc approximately 30°, push shaft through disc against opposite seal retainer. Corner of shaft will push against flats of seal retainer. Remove shaft, and insert from opposite side of disc. Rotate disc approximately 30° and push out remaining seal retainer.
9. Slide disc out of liner.
10. Inspect all parts for wear and replace as required. NOTE: The liner is not a replaceable part of the valve.
11. **To reassemble:** lightly lubricate all moving parts and seals (using a lubricant such as "Non-Fluid Oil" HWD#2/TF) and reverse above procedure.

Manual 1-1/2"-8" Butterfly Valves

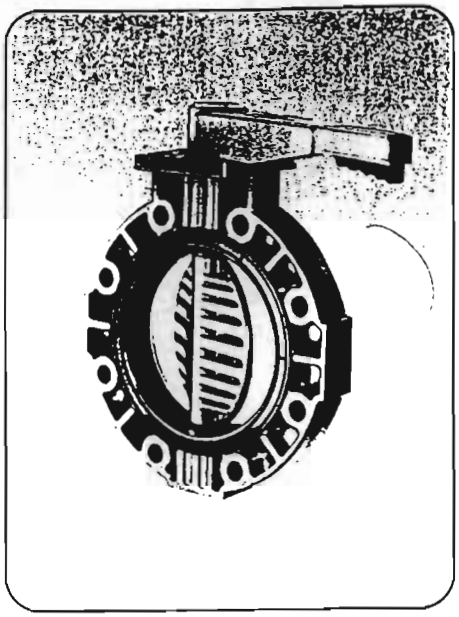
Hayward 1-1/2" through 8" Lever Operated PVC Butterfly Valves are rated at a full 150 psi. They provide quick quarter turn off and are ideal for flow throttling applications. The integrally molded mounting pad has seven stops to position the disc at 0°, 15°, 30°, 45°, 60°, 75°, and 90°. The lever assembly is rugged, lightweight, and constructed from corrosion resistant plastic. For applications requiring a "lock out", the lever can be locked in any of the seven positions by simple installation of a pad lock through the lever hand grip.

Hayward Butterfly Valves feature a blow out proof stainless steel stem and a unique liner that incorporates a "V" notch retension design. This assures positive sealing of the liner to the valve body without the use of adhesives or thermal bonding. An integrally molded face seal provides positive sealing against the mating flange without the need for additional gaskets.

Unlike other plastic butterfly valves, Hayward valves are constructed from a rugged one piece body that incorporates fully supported flanged bolt holes to prevent stressing of the mating pipe flanges. Strong system integrity and a longer service life is ensured. All sizes meet industry face to face standards allowing simple retrofit to replace most metal butterfly valves.

Hayward Butterfly Valves have no metal in contact with the process media; therefore, they cannot corrode nor will they contaminate sensitive fluids flowing through them. Typical applications include ultra pure deionized water, highly corrosive chemical waste, water treatment, chemical processing, methane gas and leachate recovery. Their rugged design make them an excellent choice for demanding abrasive and slurry applications.

Hayward 1-1/2" through 8" PVC Butterfly Valves are available with EPDM, Viton, or Nitrile liner and seals, and either PVC or Polypropylene discs.

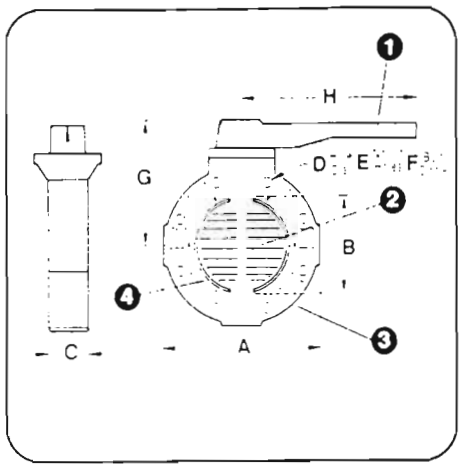


Features

- 150 psi rated valve
- Fully supported flange bolt holes tha prevent stressing of mating pipe flan
- V-Notch retention design liner provic positive sealing of liner to the valve b
- Plastic lever assembly is chemically and corrosion resistant
- Meets face to face industry standarc and will replace most metal valves
- Lock out handle to lock valve in one seven positions

Options

- 316 stainless steel shaft
- Titanium shaft
- Stem extensions
- Lug body design
- 2" square operating nut
- Gear operator, electric actuator and pneumatic actuator



Manual 1-1/2"-8" Butterfly Valve Parts Li

1 Lever
2 PVC/PPL Disc
3 PVC Body
4 EPDM, Nitrile, or Viton Liner

Dimensions

Dimensions are in inches. For reference on

Size	A	B	C	D	E	F	G	H	Weights in lbs
1-1/2"-2"	6.00	2.18	1.50	.63/.75	4	3.88/4.75	6.25	10.50	3.5 lbs.
3"	7.75	3.13	2.00	0.75	4	6.00	6.69	10.50	4.60 lbs.
4"	9.25	3.94	2.19	0.75	8	7.50	7.94	12.00	7.30 lbs.
6"	11.25	5.81	2.31	0.88	8	9.50	9.50	14.00	11.40 lbs.
8"	13.75	7.75	2.50	0.88	8	11.75	10.63	16.00	16.50 lbs.

Selection Chart

Size	Body Material	Disc Material	Liner & Seals	Pressure Rating
1-1/2"-8"	PVC	PVC PPL	EPDM, Nitrile or Viton	150 psi @ 70° F non shock

Engineering Specifications

All Hayward Butterfly Valves 1-1/2" through 8" shall be wafer type single piece body design rated at 150 psi bubble tight shut off. Valve body shall be molded of PVC (Polyvinyl Chloride) with disc molded of Polypropylene alternately, PVC. The shaft shall be 416 stainless steel and blow out proof. Liner and o-ring seals shall be EPDM (alternately, Viton or Nitrile). The liner shall have a V-notch retention design and an integrally molded flange face seal. Valves 1-1/2" through 8" shall have a plastic molded lever assembly. As manufactured by Hayward Industrial Products, Inc.

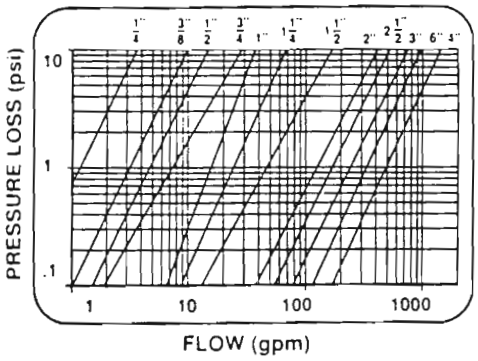
HAYWARD 900 Fairmount Avenue, Elizabeth, New Jersey 0
908/351-5400 Fax: 908/351

Ball Check Valves

Hayward Plastic "True Check" Ball Check Valves prevent reversal of flow in piping systems. They are ideal where backflow could potentially cause damage to pumps, filters, or process equipment. Line pressure unseats the solid plastic ball to open the valve. When inlet flow ceases, the back pressure seats the ball on a special square cut elastomer seat, thus stopping back flow.

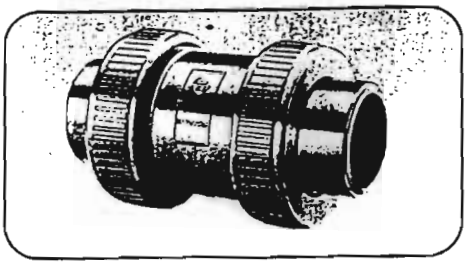
Hayward True Checks up to 4" feature a full port, safe block design, and can be installed either horizontally or vertically. Our unique 1/4" and 3/8" "Trim Checks", because of their compact design, are not True Union. They are, however, fully repairable and retain all of the other features of our True Check Valves. Hayward True Checks are available in PVC, CPVC, PPL, with Viton or EPDM seals in sizes from 1/4" - 6", and are manufactured from NSF approved materials.

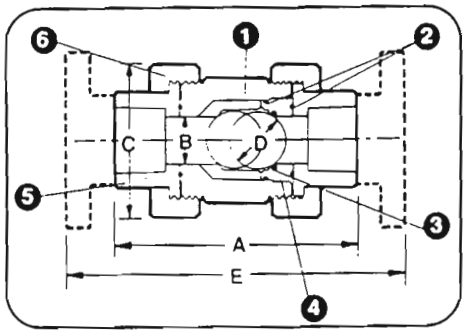
Note: *Check Valves should be installed a minimum of 10 pipe diameters away from the pump.*



Engineering Specifications

All Ball Check Valves to be (PVC, CPVC, or PPL), with (Socket, Threaded, or Flanged) end connections. Seals and seats shall be (Viton or EPDM). Valves 1/2" - 4" shall be of True Union design and be easily retrofittable as Foot Valves if required. Valves 1/4" and 3/8" shall be of Trim check design. Seat O- ring to be square cut for positive sealing with minimal back pressure. 1/2" - 4" valves to be of full port design. As manufactured by Hayward Industrial Products, Inc.





Features

- 1/2" - 6" Safe Block design
- Square cut seating ring
- Ideal for horizontal or vertical installation
- Seats with minimum back pressure
- Free floating ball never seats in same position twice
- Full port 4" Check Valve for greater flow with minimum pressure loss

Ball Check Valves Parts List

1 Body
2 O-Ring Seals
3 Square Cut Seal
4 Seal Retainer
5 End Connector
6 Union Nuts

Dimensions

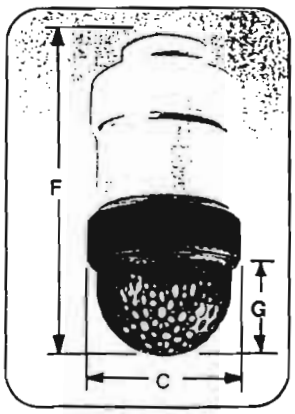
Size	A	B	C	D	E	F	G	Weight in lbs. Soc/Thd	Flanged
1/4"	3.06	0.31	1.38	0.50	N/A	N/A		0.13	N/A
3/8"	3.06	0.31	1.38	0.50	N/A	N/A		0.13	N/A
1/2"	4.63	0.50	2.25	0.75	6.75	4.88	2.32	0.75	1.00
3/4"	4.75	0.75	2.63	1.00	7.13	5.00	2.60	0.75	1.38
1"	5.25	1.00	3.00	1.25	7.75	5.88	2.88	1.25	2.13
1-1/4"	6.44	1.25	3.56	1.50	9.44	6.94	3.25	1.75	2.75
1-1/2"	6.75	1.50	4.00	1.75	9.75	7.06	3.75	2.00	3.75
2"	8.00	1.94	4.75	2.25	11.25	8.56	4.50	3.75	5.75
2-1/2"	10.56	2.88	6.56	3.25	14.38	11.25	2.50	11.00	15.00
3"	10.56	2.88	6.56	3.25	14.44	11.25	2.50	10.00	14.00
4"	12.94	4.00	8.56	4.25	17.00	14.63	4.25	17.00	25.00
6"**	N/A	4.00	8.56	4.25	19.19	N/A		N/A	30.20

3" valve bushed down to 2" Dimensions are in inches. For reference only.

Selection Chart

Trim Check	Material	End Conn.	Seal	Pressure Rating
1/4" - 3/8"*	PVC	Socket, Threaded	Viton	150 psi @ 70° F
1/2" - 4"	PVC	Socket, Threaded	EPDM	non shock
	PVC or CPVC	Socket, Threaded or Flanged	Viton	
1/2"- 2"	PPL	Threaded, Flanged		
6"**	PVC	Flanged		

* Trim Checks ** 4" Valve Venturied to 6"



Foot Valve

Foot Valves are typically installed on the suction side of a pump, submerged in a tank or sump. They prevent solids from entering the pipeline which could prevent the valve from seating or cause damage to th pump or other process equipment. A Hayward True Check Ball Check Valve is easily converted to a foot valve by replacing one end connection with a foot valve screen.

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HAYWARD INDUSTRIAL PRODUCTS
INSTALLATION OPERATION & MAINTENANCE
OF TRUE UNION BALL VALVES

SOCKET CONNECTION:

Socket end connections are manufactured to ASTM D2467-87A. Solvent cementing of socket end connections to pipe should be performed per ASTM specifications D2855-87. Cut pipe square. Chamfer and deburr pipe. Surfaces must be cleaned and free of dirt, moisture, oil and other foreign material. Remove assembly nuts and end connectors from valve body. Slide assembly nuts, with threads facing valve, onto pipe to which the end connector is to be cemented. Apply primer to inside socket surface of end connector. Never allow primer or cement to contact valve ball or end connector o-ring sealing surfaces, as leaking may result. Use a scrubbing motion. Repeat applications may be necessary to soften the surface of the socket. Next, liberally apply primer to the male end of the pipe to the length of the socket depth. Again apply to the socket, without delay apply cement to the pipe while the surface is still wet with primer. Next apply cement lightly, but uniformly to the inside of the socket. Apply a second coat of cement to the pipe, and assemble the end connector to the pipe, rotating the end connector 1/4 turn in one direction as it is slipped to full depth on to the pipe. The end connector should be held in position for approx. 30 seconds to allow the connection to "set". After assembly wipe off excess cement. Full set time is a minimum of 30 minutes at 60 to 100 F. Full cure time should be based on the chart below.

JOINT CURE SCHEDULE:

The cure schedules are suggested as guides. They are based on laboratory test data, and should not be taken to be the recommendations of all cement manufacturers. Individual manufacturer's recommendations for their particular cement should be followed.

Temperature Range During Cure Period(B) °F(°C)	Test Pressures for Pipe Sizes 1/2 to 1-1/4 In. Up to 180 PSI (1240 kPa)	Test Pressures for Pipe Sizes 1/2 to 1-1/4 In. Above 180 to 370 PSI (1240 to 2550 kPa)	Test Pressures for Pipe Sizes 1-1/2 to 3 In. Up to 180 PSI (1240 kPa)	Test Pressures for Pipe Sizes 1-1/2 to 3 In. Above 180 to 315 PSI 1240) to 2170 kPa)	Test Pressures for Pipe Sizes 4 to 5 In. Up to 180 PSI (1240 kPa)	Test Pressures for Pipe Sizes 4 to 5 In. Above 180 to 315 PSI (1240 to 2170 kPa)	Test Pressures for Pipe Sizes 6 to 8 In. Up to 180 PSI (1240 kPa)	Test Pressures for Pipe Sizes 6 to 8 In. Above 180 to 315 PSI (1240 to 2170 kPa)
60 to 100 (15 to 40)	1 h	6 h	2 h	12 h	6 h	18 h	8 h	24 h
40 to 60 (5 to 15)	2 h	12 h	4 h	24 h	12 h	36 h	16 h	48 h
20 to 40 (-7 to 5)	6 h	36 h	12 h	72 h	36 h A	4 days A	3 days A	9 days A
10 to 20) (-15 to 7)	8 h	48 h	16 h	96 h	72 h A	8 days A	4 days A	12 days A
Colder than 10 (-15)	Extreme care should be exercised on all joints made where pipe, fittings or cement is below 10°F.							

A: It is important to note that at temperatures colder than 20°F on sizes that exceed 3 in., test results indicate that many variables exist in the actual cure rate of the joint. The data expressed in these categories represent only estimated averages. In some cases, cure will be achieved in less time, but isolated test results indicate that even longer periods of cure may be required.
B: These cure schedules are based on laboratory test data obtained on Net Fit Joints (NET FIT=in a dry fit the pipe bottoms snugly in the fitting socket without meeting interference).

THREADED CONNECTION:

Threaded end connections are manufactured to ASTM specifications D2464-88. F437-88 and ANSI B2.1. Wrap threads of pipe with Teflon tape of 3 to 3-1/2 mil thickness. The tape should be wrapped in a clockwise direction starting at the first or second full thread. Overlap each wrap by, 1/2 the width of the tape. The wrap should be applied with sufficient tension to allow the threads of a single wrapped area to show through without cutting the tape. The wrap should continue for the full effective length of the thread. Pipe sizes 2" and greater will not benefit with more than a second wrap, due to the greater thread depth. To provide a leak proof joint, the pipe should be threaded into the end connection "hand tight". Using a strap wrench only. (Never use a stillson type wrench) tighten the joint an additional 1/2 to 1-1/2 turns past hand tight. Tightening beyond this point may induce excessive stress that could cause failure.

FLANGED CONNECTION:

Flange bolts should be tight enough to slightly compress the gasket and make a good seal, without distorting or putting excessive stress on the flanges. Suitable washers should be used between the bolt head and flange and the nut and flange. Bolts should be tightened in alternating sequence.

RECOMMENDED FLANGE BOLT TORQUE

FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.	FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.
1/2	1/2	10-15	2	5/8	15-25
3/4	1./2	10-15	2-1/2	5/8	20-25
1	1/2	10-15	3	5/8	20-25
1-1/4	1/2	10-15	4	5/8	20-25
1-1/2	1/2	10-15	6	3/4	30-40

NOTE: USE WELL LUBRICATED METAL BOLTS AND NUTS. USE SOFT RUBBER GASKETS.

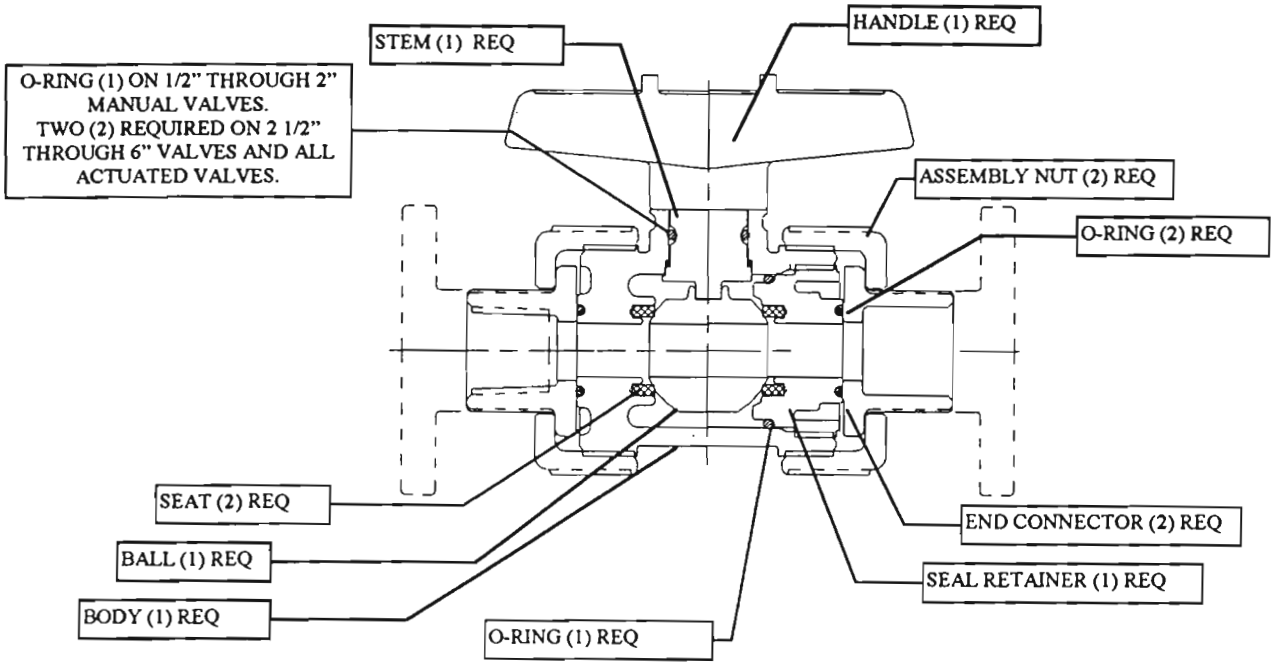
ADJUSTMENT:

EXTREME CAUTION MUST BE TAKEN WHEN WORKING ON THIS VALVE.
THE PIPING SYSTEM MUST BE DEPRESSURIZED AND DRAINED. PROPER CARE MUST BE TAKEN. CONSULT M.S.D.S. (MATERIAL SAFETY DATA SHEETS) INFORMATION REGARDING YOUR SPECIFIC APPLICATION.

Remove the assembly nut and end connector from the "adjust" end of the body, or the complete valve body from the piping system. The front face of the seal retainer indicates which direction of rotation tightens or loosens the seal retainer, with the word "tighten" and a directional arrow, and the word "loosen" and a directional arrow. Direction of rotation may vary depending on date of manufacture. The Assembly nut should be installed on the valve "hand tight". Using a strap wrench only the joint may be tightened 1/2 to 3/4 of a turn past hand tight.

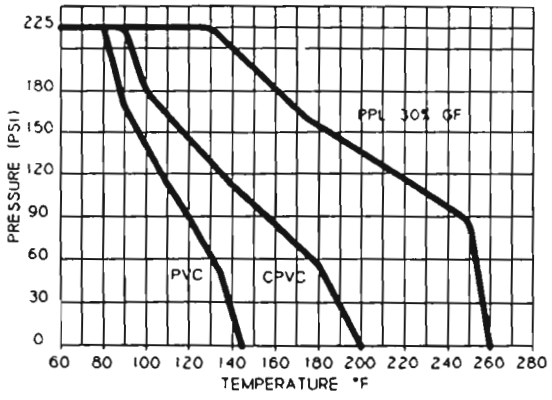
REPAIR:

Follow the adjustment sequence and information above, but rotating the seal retainer completely in the "loosen" direction and remove it from valve body. The o-rings and seals are now accessible for replacement using a "seal" repair kit. Carefully remove the o-rings from their respective locations taking care not to scratch their sealing surfaces. Use a non-petroleum base lubricant to lubricate the o-rings, and re-assemble the valve. See table below.



OPERATING PRESSURE TEMPERATURE

TRUE UNION, TRUE CHECK, & SINGLE ENTRY ONLY



Recommended valve stem torque to rotate the ball 360° when valve is reassembled.

VALVE SIZE	TORQUE IN•LB
1/2"	30
3/4"	40
1"	50
1 1/4"	60
1 1/2"	60
2"	80
3" & 2 1/2"	140
4" & 6"	170

HAYWARD INDUSTRIAL PRODUCTS, INC.

900 FAIRMOUNT AVENUE • P.O. BOX 18 • ELIZABETH, NEW JERSEY 07207 (201) 351-5400
TELEX 139414

BUTTERFLY VALVE

VALVE INSTALLATION AND MAINTENANCE INSTRUCTIONS
SIZES 3", 4", 6" & 8"

INSTALLATION

Hayward Butterfly Valves are installed between two pipe flanges, or in dead end service to one pipe flange. The use of additional gaskets are not necessary. Flange clearance requirements and bolt or stud torques are given in the installation chart below.

Recommended Flange Bolt Torque for Plastic Butterfly Valves

Size (in.)	Bolt Dia. (in.)	Torque ft.-lb.
3	5/8	20-30
4	5/8	20-30
6	3/4	33-50
8	3/4	33-50

A maximum displacement of 1/8" on pipe centers is allowed in any direction. Maximum angular misalignment of 3/32" for 3" and 4" valves, and 1/8" for 6" and 8" valves is allowed.

Normal pipe hanger spacing is recommended for long pipe runs, with hangers equally spaced on either side of valve. Do not allow valve to support the weight of pipe. When using pneumatic or electric actuators additional support directly to valve should be used.

When installing a valve between flanges, open valve to approximately 60° - 75°. Do not open fully during installation to prevent possible damage to edge of disc on mating flanges.

If the spacing between mating flanges is tight, the flange sealing surfaces of the liner should be lightly lubricated to prevent distortion during installation. Use a non-hydrocarbon base material such as silicone on EPDM liners or an oil base material such as glycerine on viton liners.

Install valve in line using well lubricated studs or bolts with metal back-up washers on both sides of flange. With a torque wrench, uniformly tighten nut (approximately 15 foot pounds) in an alternating sequence, diametrically opposed to each other. Final tightening of nuts should be performed in the same sequence following the recommended torques in the above chart.

When the installation is complete, check for proper alignment and ease of operation, by fully opening and closing the valve two or three times.

Hayward Butterfly Valves are designed for use with all pipe up to and including schedule 80. Should the use of pipe greater than schedule 80 (Example: schedule 120) occur, then the inside diameter of the pipe must be chamferred to a diameter equal to or greater than the inside diameter of schedule 80 pipe. Remove sharp edges or burrs.

MAINTENANCE & DISASSEMBLY OF VALVE

1. Handle assembly

   a. Remove logo bezel by lifting with thin screw driver or knife, exposing slotted head screw. Remove screw and flat washer. Lift off handle.

   Gear Operator/Actuator

   b. Remove by unscrewing four (4) hex nuts which hold operator to body.

   c. Pneumatic/Electric actuator bracket is removed by unscrewing four (4) socket head cap screws with hex nuts which hold bracket to body.

2. Remove cap plug from bottom of valve body. (Use a 1/2" drive ratchet.)

3. Remove valve shaft by pushing out through bottom of valve body.

4. Remove upper moisture seal.

5. Remove upper bearing (use shaft to twist out).

6. Remove lower bearing (use shaft to twist out).

7. Remove seal retainer (top and bottom).

8. Slide disc out of liner.

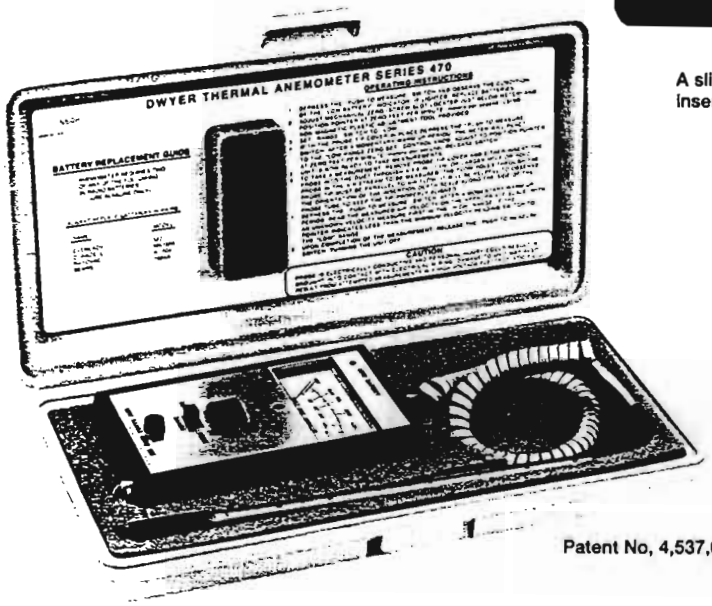
9. Remove liner by peeling interlock section from body and folding liner into a heart shape.

10. Inspect all parts for wear and replace as necessary.

11. To reassemble; reverse above procedure.

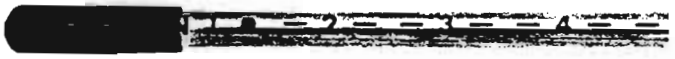
Dwyer Model 470-1 Handheld Thermal Anemometer

Measures air velocity to 6,000 feet per minute. ±5% accuracy, but low cost. Compact, light weight, easy to use.

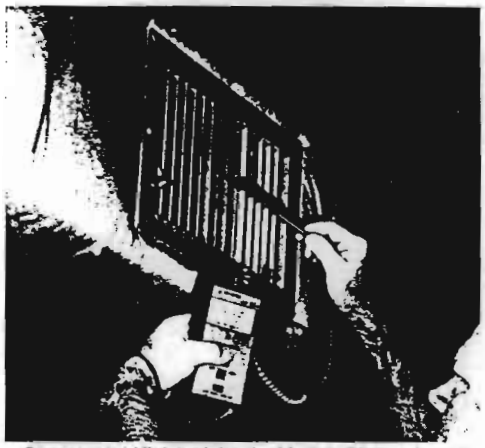


Patent No, 4,537,068

Foam padded polypropylene carrying case, included with the Model 470-1, has complete operating instructions inside the cover.



A slip-on cover protects the probe tip when not in use and a depth insertion scale on the probe body aids in making duct traverses.

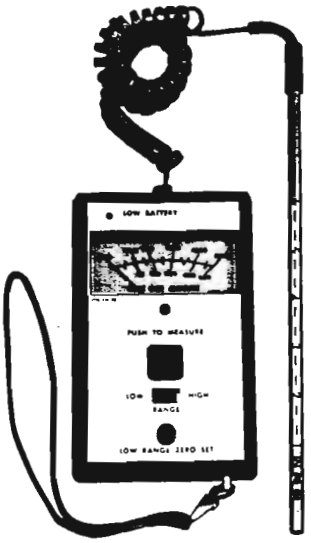


Compact and lightweight, the Model 470-1 makes air velocity measurements in any location.

The versatility of the Dwyer Model 470-1 Handheld Thermal Anemometer makes it ideal for a wide range of air velocity measurements. Easy to carry and use in the field, the 470-1 can be used to balance heating and air conditioning systems, measure velocity in HVAC ducts, read fume and exhaust hood face velocities, as well as make wind speed measurements associated with agricultural, forestry, highway and recreational activities. This low cost battery powered electronic instrument provides two switch selected air velocity ranges of 0-600 FPM and 500-6000 FPM displayed on an easily read analog meter. Two standard 9 volt alkaline batteries provide eight hours of operating time (equivalent to over 5000 readings) and a convenient LED low-battery indicator avoids lost time on the job when battery replacement is required. Sophisticated temperature compensation circuitry maintains ±5% of full range accuracy over an air stream temperature of 30°F to 180°F. Secured by means of a wrist strap and held in either the right or left hand, the indicating unit provides easy one hand access to the range switch, zero adjust, and the push-to-measure switch. The opposite hand is free to insert the stainless steel probe into ducts up to a depth of 8" with probe insertion depth indicated by means of a scale etched on both sides of the probe body. The 1 foot coiled probe cord stretches to 5 feet for both convenient storage and operation. The spring return push-to-measure switch turns the unit off automatically after each reading to prevent unnecessary battery drain. The Model 470-1 Thermal Anemometer comes complete with a durable polypropylene, foam-lined carrying case with full operating instructions provided on the inside of the case lid.

SPECIFICATIONS:

Ranges: 0-600 FPM, 500-6000 FPM (0-3, 2-30 MPS metric).
Accuracy: ±5% of full scale.
Response time: 1 sec. for velocity change; 5 sec. for temperature change (in air moving over 50 FPM).
Temperature ranges:
Air stream: 32°F to 180°F.
Operating: 32°F to 160°F.
Storage: -22°F to 212°F.
Controls: Range switch
Push-to-measure switch
Zero adjust
Probe: #316 stainless steel, 10" long by 3/16" diameter with 8" insertion depth scale and tip shield.
Power: Two 9 volt alkaline transistor batteries.
Battery Life: 8 hours operating time in normal usage.
Weight: 13 oz. (unit only); 1 lb. 9 oz. (in carrying case)
Dimensions: Indicating unit 6"L x 3⅜"W x 1¼"H; Carrying case 12¼"L x 6⅜"W x 1¾"H.



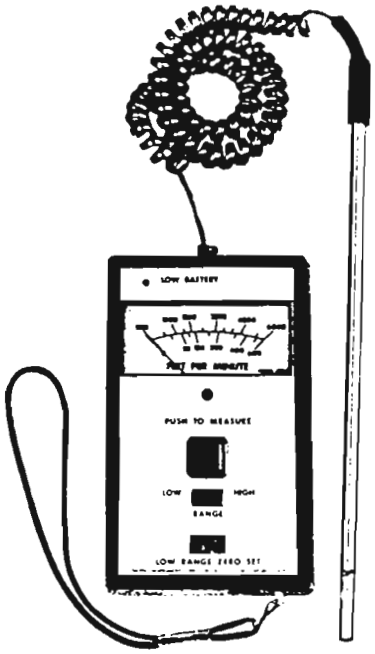
Wrist strap, coil cord, simple controls, and easy-to-read meter add up to real operating convenience.

Prices

470-1, dual range, 0-600 and 500-6000 FPM	**$298.00**
M-470-1, dual range, 0-3 and 2-30 MPS	**298.00**

Model 470-1
Handheld Thermal Anemometer

Operating Instructions



Specifications:

Ranges:	0-600 FPM, 500-6000 FPM (470-1) 0-3 MPS, 2-30 MPS (M470-1)
Accuracy:	± 5% of full scale
Response time:	1 sec. for velocity change; 5 sec. for temperature change (in air moving over 50 FPM)
Temperature ranges:	
Air Stream:	32°F to 180°F. 0°C to 82°C.
Operating:	32°F to 160°F. 0°C to 71°C.
Storage:	−22°F to 212°F. −13°C to 100°C.
Controls:	Range switch Push-to-measure switch. Low range zero set
Probe:	316 stainless steel, 10" long by 5/16" diameter with 8" insertion depth scale and tip shield.
Power:	Two 9 volt alkaline batteries.
Battery Life:	8 hours operating time, average.
Weight:	13 oz. (unit only); 1 lb. 9 oz. (in carrying case).
Dimensions:	
Indicating unit:	6" L x 3⅝" W x 1¼" H.
Carrying case:	12¼" L x 6⅜" W x 1¾" H.

BATTERY INSTALLATION: Unit is shipped with batteries packed separately to prevent damage should leakage occur. To install, remove 4 phillips head screws on back and lift off cover. Attach polarized connectors and place batteries in case. Replace cover.

IMPORTANT: Use extreme caution to avoid damaging the thermistor located in the outermost hole in the probe. It is very fragile. Use only in reasonably clean airstreams. Airborne particles of dust, sand, powder, etc. can cause blockage and/or permanent damage. Keep cover in place when not in use.

OPERATING INSTRUCTIONS

Read all instructions carefully before use.

CAUTION

Probe is electrically conductive and personal injury could result if brought into contact with electrical wiring. Damage to unit may also result from attempted measurements in a high voltage electrostatic field.

1. Depress the "Push To Measure" switch and observe the condition of the "Low Battery" indicator. If lighted, replace batteries.
2. Adjust mechanical zero (screw slot located just below meter) and position pointer at zero feet per minute (meters per second) using non magnetic plastic adjustment tool provided.
3. Set "Range" switch to "Low".
4. With the probe tip cover in place, depress the "Push To Measure" switch. After a momentary warm up period, the meter will react to the "Low Range Zero Set" control knob. Adjust to position pointer at zero feet per minute (meters per second). Release switch.
5. Unit is now ready to take measurements.
6. To take a reading, remove probe tip cover and insert the probe into the duct through a 3/8" (9 mm) hole or hold it in an open airstream. Air flow must be parallel to the flow holes and enter from the side with dot markings next to the 1" and 8" graduations.
7. Depress the "Push To Measure" switch and after the momentary warm up period read the measured air velocity on the appropriate scale. With an unknown velocity measure first in the "High" range and if the pointer indicates less than the minimum velocity reading, switch to the "Low" Range.
8. Upon completion of the measurement, release the "Push To Measure" switch, turning the unit off. Replace tip cover before storage.

TIP CLEANING: The tip containing the thermistor sensor must be kept clean for proper operation. Before returning unit for repair, perform the following cleaning procedure which often will restore "like new" performance.

Remove batteries before cleaning. Provide adequate ventilation and gently bathe the probe tip in a small container of isopropyl alcohol. This should be done briefly without extended soaking. Allow tip to completely air dry before replacing batteries and returning to service. Do not use pressurized cleaners or compressed air which could cause permanent damage.

Litho in U.S.A. 12/93 FR. NO. 02-440446-00

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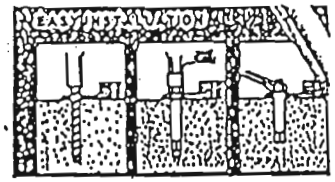
Telephone 219/879-8000
Fax 219/872-9057



Thunder Stud®

Installation Instructions

1. Always wear safety glasses.
2. Follow the drill manufacturer's safety instructions.
3. Use only solid carbide-tipped bits meeting the ANSI B94-12 tip diameter as shown below in Table 1.
4. Drill the hole perpendicular to the work surface. To assure full holding power, do not ream the hole or allow the drill to wobble. (Figure 1)
5. Drill the hole as deep as the full length of the anchor, but not closer than two anchor diameters to the bottom (opposite surface of the concrete).
6. Clean the hole using compressed air and a wire brush. A clean hole is necessary for proper performance. (Figure 2)
7. Assemble the washer and nut on the anchor so the nut is recessed slightly below the head of the anchor.
8. Tap the anchor through the fixture (must be 1/8" larger than diameter of the anchor) and into the hole making sure the nut and washer rests solidly against the fixture or tap the anchor into the hole and then place bracket over the anchor. (Figure 3)
9. Tighten the nut with a torque wrench to the proper torque shown in Table 2. (Figure 4).
10. If spinning occurs, pull up on the anchor using the claw end of a hammer and then torque.

Table 1 Drill Bit Tolerances

Anchor Diameter	Minimum	Maximum
1/4"	.260"	.268"
3/8"	.390"	.398"
1/2"	.520"	.530"
5/8"	.650"	.660"
3/4"	.775"	.787"
7/8"	.905"	.917"
1"	1.030"	1.042"
1 1/4"	1.285"	1.300"

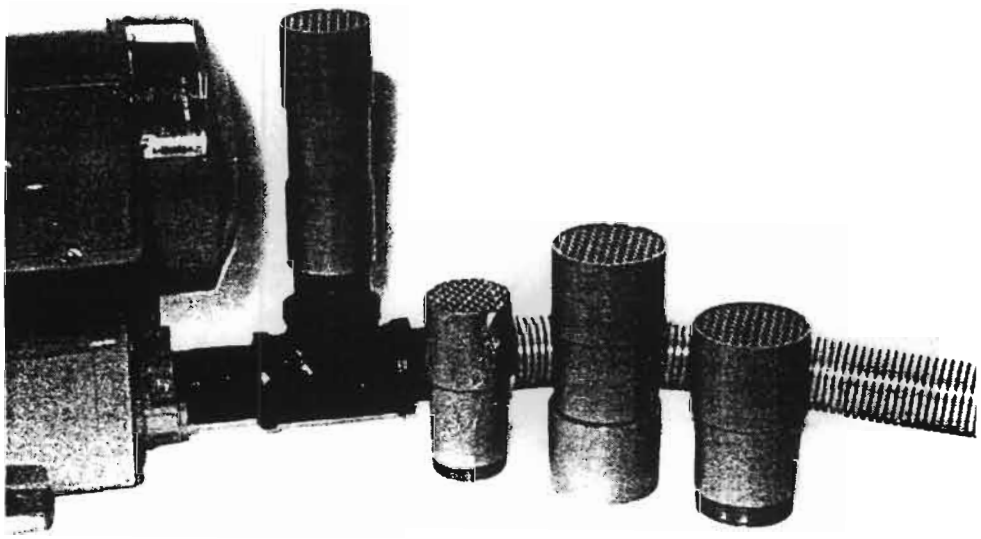
Table 2 Torque Requirements

Anchor Diameter	Torque Range
1/4"	5 - 10 ft.-lbs.
3/8"	25 - 30 ft.-lbs
1/2"	50 - 60 ft.-lbs
5/8"	75 - 90 ft.-lbs
3/4"	150 - 175 ft.-lbs
7/8"	200 - 250 ft.-lbs
1"	250 - 300 ft.-lbs
1 1/4"	400 - 450 ft.-lbs

FUJI ELECTRIC

Park 80 West Plaza II
Saddlebrook, NJ 07663
Phone: (201)712-0555
Fax: (201)368-8258

VACUUM AND PRESSURE RELIEF VALVES



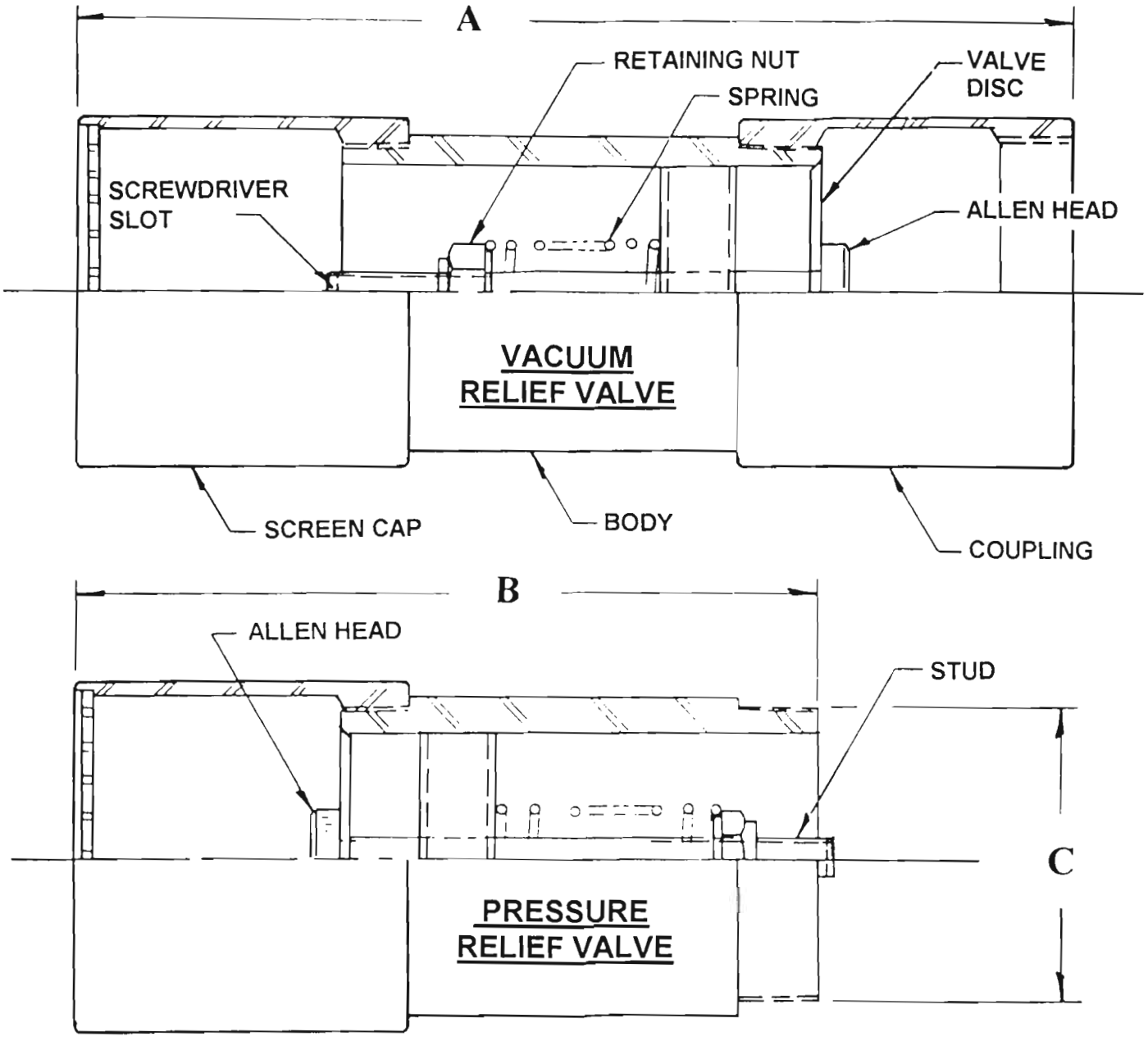
The Fuji Vacuum and Pressure Relief Valves are designed to protect Ring Compressors from overheating either in a vacuum or pressure ("dead-head") condition. Valves are preset to provide protection for each Ring Compressor. Or, Valves are adjustable to provide down to approximately 65% "dead-head" vacuum or pressure. Valves for Fuji Models VFC 309A, VFC409A, VFC504A are 1-1/2" NPT size. Valves for Models VFC604A, VFC704A, and VFC804A are 2" NPT. Model VFC904A Valves are 2-1/2" NPT. Valves should be checked periodically to assure proper setting.

Vacuum and Pressure Relief Valve Settings

	Model	Ring Compressor	Factory Set H_2O	Adjustment Range
VACUUM	VV3	309	39"	39" to 25"
	VV4	409	42"	42" to 27"
	VV5	504	60"	60" to 39"
	VV6	604	86"	86" to 55"
	VV7	704	85"	85" to 56"
	VV8	804	100"	100" to 65"
	VV9	904	97"	97" to 75"
PRESSURE	PV3	309	42"	42" to 27"
	PV4	409	46"	46" to 29"
	PV5	504	68"	68" to 44"
	PV6	604	100"	100" to 65"
	PV7	704	98"	98" to 64"
	PV8	804	127"	127" to 82"
	PV9	904	120"	120" to 82"

Factory Settings within the Adjustment Range may be made if specified on order.

IMPORTANT: For use with blowers other than Fuji models, please consult your manufacturer's operating manual.



To adjust Vacuum or Pressure Relief Valve, remove Screen Cap, hold Retaining Nut or Allen Head with 1/2" Wrench and turn stud with Screwdriver. It is suggested that a Vacuum or Pressure Gauge be used to make accurate adjustments.

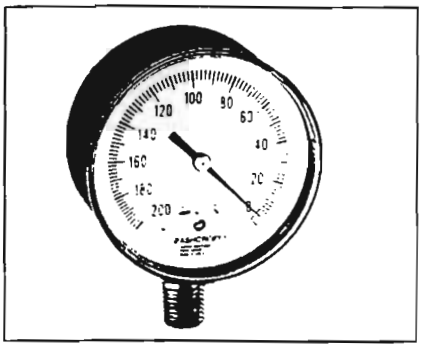
Ring Compressor	A	B	C
309, 409, 504	6-1/4	4-11/16	1-1/2 NPT
604, 704, 804	6-1/4	4-11/16	2 NPT
904	9-3/8	6-3/4	2-1/2 NPT

ASHCROFT

Low Pressure Diaphragm Gauges
Series 1490, Grade A (2-1-2%)

- *2½" dial size*
- *Steel case/black epoxy painted*
- *Bronze diaphragm*
- *Brass socket*
- *Sensitive diaphragm-capsule sensor mechanism*
- *For use with gases that are not corrosive to bronze and brass*

The Ashcroft® Type 1490 series of product measures low pressures from 10" H_2O thru 15 psi as well as vacuum and compound ranges. This gauge uses a diaphragm capsule which is very sensitive for measuring low pressures and vacuum.



SELECTION TABLE

Case Size	Gauge Type	Tube and Socket Material	Connection Size and Location	Variations	Range
Code	Code / Steel-Black Painted case	Code	Code	Code	
25 (2½")	1490 Phosphor bronze element	A Bronze diaphragm	02L (¼ NPT lower) 02B (¼ NPT back)	TU Throttle plug NH Wired stainless steel tag	Per standard range table
	1490 Threaded connection	Brass socket	01L (⅛ NPT lower) 01B (⅛ NPT back)		Consult factory for special range requirements

STANDARD METRIC RANGES

Pressure	Figure Intervals	Minor Graduation
0-60 cm H2O	10	
0-2.5 kPa	0.5	0.05
0-4.0 kPa	0.5	0.05
0-10 kPa	1	0.1
0-16 kPa	1	0.1
0-25 kPa	5	0.5
0-40 kPa	5	0.5
0-100 kPa	10	
Vacuum		
-2.5-0 kPa	0.5	0.05
-4.0-0 kPa	0.5	0.05
-10-0 kPa	1	0.1
-16-0 kPa	1	0.1
-25-0 kPa	5	0.5
-40-0 kPa	5	0.5
-100-0 kPa	10	
Compound		
-10-60 cm H2O	10	
-10-80 cm H2O	10	
-20-40 cm H2O	10	
-10-100 cm H2O	10	
-10-120 cm H2O	10	

STANDARD RANGES

Pressure	Figure Intervals	Minor Graduation
0-10 in H2O	1	0.1
0-15 in H2O	5	0.2
0-30 in H2O	5	0.5
0-60 in H2O	10	1
0-100 in H2O	10	1
0-160 in H2O	20	2
0-200 in H2O	20	2
0-300 in H2O	50	5
0-10 oz/in²	1	0.1
0-15 oz/in²	5	0.2
0-30 oz/in²	1	0.1
0-60 oz/in²	10	1
0-100 oz/in²	10	1
0-160 oz/in²	20	2
0-360 oz/in²	50	5
0-5 psi	0.5	0.05
0-15 psi	1	0.1
0-30 psi	1	0.1
0-15 psi	5	0.2
Vacuum		
-15-0 in H2O	5	0.2
-30-0 in H2O	5	0.5
-60-0 in H2O	10	1
-100-0 in H2O	10	1
-200-0 in H2O	20	2
-15-0 oz/in²	5	0.2
-30-0 oz/in²	1	0.1
-60-0 oz/in²	10	1
-100-0 oz/in²	10	1
Compound		
-30-30 in H2O	10	1
-30-30 oz/in²	10	1
-30-10 in H2O	2	0.2

Dual Scale

Range		Graduations			
		Inner Scale		OuterScale	
Inner Scale	Outer Scale	Figure Intervals	Minor Grad.	Figure Intervals	Minor Grad.
0-15 in H2O	0-15 in H2O	1	0.2	5	1
0-30 oz/in²	0-30 in H2O	5	0.5	5	0.5
0-25 oz/in²	0-60 in H2O	5	0.5	5	0.5
0-60 oz/in²	0-100 in H2O	10	1	10	1

Other ranges available on request. Consult factory.

TO ORDER THESE LOW PRESSURE DIAPHRAGM GAUGES:

Select:	25	1490	A	02L	XXX	10"H2O
1 Dial size-2						
2 Case type						
3 Tube and socket material						
4 Connection size-(02)						
5 Connection location-Lower (L) Back (B)						
6 Options-see page 38						
7 Standard pressure range-10 H2O						

Accessories-see pages 138-144

Reference Bulletin QG-1

INSTRUMENT DIVISION DRESSER

ROOTS DRESSER

$2.00

Universal RAI BLOWER

INSTRUCTIONS

ROTARY LOBE BLOWERS

CONTENTS

NUMBERS IN ( ) ARE METRIC EQUIVALENTS

DO THESE THINGS To Get The Most From Your Roots Blower

1 Check shipment for damage. If found, file claim with carrier and notify Sales Office.

2 Unpack shipment carefully, and check contents against Packing List. Notify Sales Office if a shortage appears.

3 Store in a clean, dry location until ready for installation, if possible. Lift by methods discussed under INSTALLATION to avoid straining or distorting the equipment. Keep covers on all openings. Protect against weather and corrosion if outdoor storage is necessary.

4 Read LIMITATIONS and INSTALLATION sections in this manual and plan the complete installation.

5 Provide for adequate safeguards against accidents to persons working on or near the equipment during both installation and operation. See SAFETY PRECAUTIONS.

6 Install all equipment correctly. Foundation design must be adequate and piping carefully done. Use recommended accessories for operating protection.

7 Make sure both driving and driven equipment is correctly lubricated before start-up. See LUBRICATION.

8 Read starting check points under OPERATION. Run equipment briefly to check for installation errors and make corrections. Follow with a trial run under normal operating conditions.

9 In event of trouble during installation or operation, do not attempt repairs of Roots furnished equipment. Notify Sales Office or factory, giving all nameplate information plus an outline of operating conditions and a description of the trouble.

10 Unauthorized attempts at equipment repair may void Manufacturer's warranty. Units out of warranty may be repaired or adjusted by the owner. It is recommended that such work be limited to the operation described in this manual, using Factory Parts. Good inspection and maintenance practices should reduce the need for repairs. See Distributor List on last page for parts and service after warranty period.

Bulletin IRB-103-994

OPERATING CHARACTERISTICS

Roots UNIVERSAL RAI® blowers, as covered in this manual, are designated as air blowers, and may be used for handling air in either pressure or vacuum service. They are unsuitable for handling gases because shaft seals are not designed to prevent leakage to atmosphere.

The Roots rotary lobe blower is a positive displacement type unit, whose pumping capacity is determined by size, operating speed and pressure conditions. It employes two double-lobe impellers mounted on parallel shafts and rotating in opposite directions within a cylinder closed at the ends by headplates. As the impellers rotate, air is drawn into one side of the cylinder and forced out the opposite side against the existing pressures. The differential pressure developed, therefore, depends on the resistance of the connected systems.

Effective sealing of the blower inlet area from the discharge area is accomplished by use of very small operating clearances. Resulting absence of moving contacts eliminates the need for any internal lubrication. Clearances between the impellers during rotation are maintained by a pair of accurately machined timing gears, mounted on the two shafts extending outside the air chamber.

Operation of the familiar basic rotary lobe blower is illustrated in FIGURE 1, where air flow is right to left from inlet to discharge with the bottom impeller rotating clockwise. In Position 1 it is delivering a known volume (A) to the discharge, while space (B) between the upper impeller and cylinder wall is being filled. Counterclockwise rotation of this impeller then traps equal volume (B) in Position 2, and further rotation delivers it to the discharge in Position 3. At the same time, another similar volume is forming under the lower impeller, and will be discharged when rotation reaches Position 1 again.

One complete revolution of the driving shaft alternately traps four equal and known volumes of air (two by each impeller) and pushes them through to the discharge. The pumping capacity of a lobe blower operating at a constant speed therefore remains relatively independent of reasonable inlet or discharge pressure variations. To change capacity, it is necessary either to change speed of rotation or vent some of the air.

No attempt should ever be made to control capacity by means of a throttle valve in the intake or discharge piping. This increases the power load on the driver, and may seriously damage the blower. Likewise, if a possibility exists that flow to the blower inlet may be cut off during normal operation of a process, then an adequate vacuum relief valve must be installed near the blower. A pressure type relief valve in the discharge line near the blower is also strongly recommended for protection against cut-off or blocking in this line.

When a belt drive is employed, blower speed can usually be adjusted to obtain desired capacity by changing the diameter of one or both sheaves. See pages 18 and 20 for minimum sheave diameter. In a direct coupled arrangement, a variable speed motor or transmission is required, or air may be vented through a manually controlled unloading valve and silencer. If discharge air is returned to the blower inlet, it must be cooled to 100° F (38° C) through a cooling by-pass arrangement.

Before making any change in blower capacity or operating conditions, contact the nearest Distributor for specific information applying to your particular blower. In all cases, operating conditions must be maintained within the approved range of pressures, temperatures and speeds as stated under LIMITATIONS. Also, the blower must not be used to handle air containing liquids or solids, or serious damage to the rotating parts will result.

OPERATING LIMITATIONS

To permit continued satisfactory performance, a Roots UNIVERSAL RAI® blower must be operated within certain approved limiting conditions. The Manufacturer's warranty is, of course, also contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in Table 1 for various sizes of UNIVERSAL RAI® blowers. These limits apply to all blowers of normal construction, having operating clearances as listed in Table 5 when operated under standard atmospheric conditions. **Do not exceed any of these limits.**

Example: The listed maximum allowable temperature rise (increase in air temperature between inlet and discharge) for any particular blower may occur well before its maximum pressure or vacuum rating is reached. This can easily occur at high altitude or at very low speed.

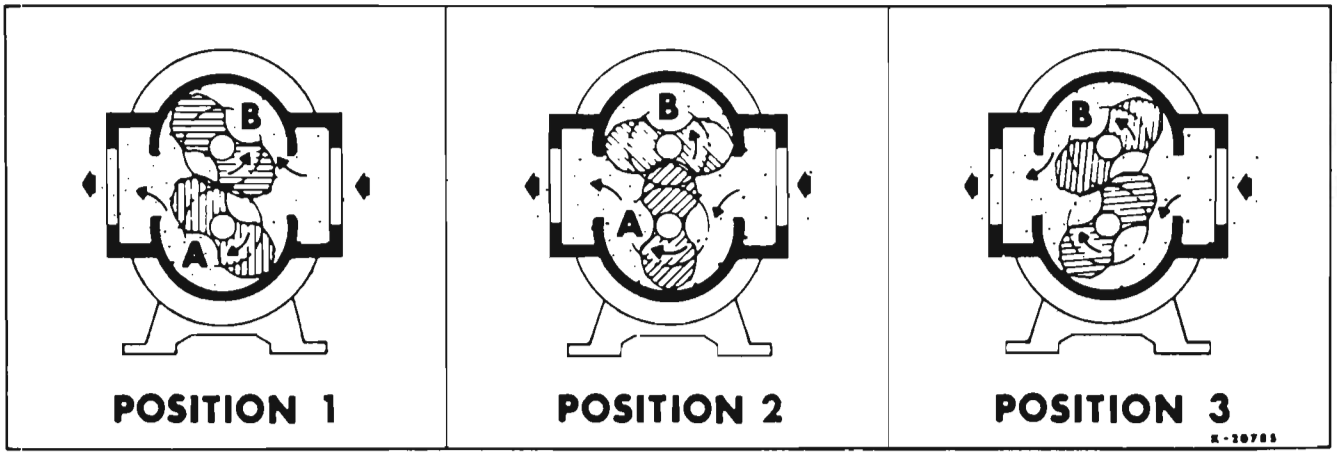


Figure 1 — Flow Through a Basic Type RAI Blower

Temperature rise then is the limiting condition. In other words, the operating limit is always determined by the maximum rating reached first. It can be any one of the three: pressure, temperature or speed.

Be sure to arrange connections or taps for thermometers and mercury type pressure or vacuum gauges at or near the inlet and discharge connections of the blowers. These, along with a good tachometer, will enable periodic checks of operating conditions to be made easily.

PRESSURE — On pressure service, the pressure rise in pounds per square inch (kPa) (between blower inlet and discharge) must not exceed the figure listed for the specific blower frame size concerned. Also, in any system where the blower inlet is at a positive pressure above atmosphere, the discharge pressure must never exceed 25 PSI (172 kPa) gauge regardless of blower size.

On vacuum service, with the discharge going to atmospheric pressure, the inlet suction or vacuum in inches of mercury (Hg.) (kPa) must not be greater than the values listed for the specific frame size.

TEMPERATURE — Various blower frame sizes are approved only for installations where the following temperature limitations can be maintained in service.

A. Measured temperature rise in Fahrenheit degrees (C°) must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the blower. This is not outdoor temperature unless the blower is installed outdoors.
B. If inlet temperature is higher than ambient, the listed allowable temperature rise values must be reduced by ⅔ of the difference between the actual measured inlet temperature and the ambient temperature.
C. Average of inlet plus discharge temperature must not exceed 250°F (139°C).

SPEED RANGE — UNIVERSAL RAI® blowers may be operated at speeds up to the maximums listed for various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be the limiting factor as noted in the preceding example.

Table 1 — Maximum Allowable Operating Conditions

Frame Size	Speed RPM	Inlet Vac. Inches Hg. (kPa)	Temp. Rise Fahr. Deg. (C°)	Press. Rise PSI (kPa)
22	5275	15 (50)	225 (125)	12 (82)
24	5275	15 (50)	210 (117)	7 (47)
32	3600	15 (50)	225 (125)	15 (101)
33	3600	15 (50)	225 (125)	12 (82)
36	3600	15 (50)	225 (125)	7 (47)
42	3600	15 (50)	240 (133)	15 (101)
45	3600	15 (50)	225 (125)	10 (68)
47	3600	15 (50)	225 (125)	7 (47)
53	2850	15 (50)	225 (125)	15 (101)
56	2850	15 (50)	225 (125)	10 (68)
59	2850	15 (50)	225 (125)	7 (47)
65	2350	16 (53)	250 (139)	15 (101)
68	2350	16 (53)	240 (133)	12 (82)
615	2350	12 (40)	130 (72)	6 (40)
76	2050	16 (53)	250 (139)	15 (101)
711	2050	16 (53)	210 (117)	10 (68)
718	2050	12 (40)	130 (72)	6 (40)

BLOWER ORIENTATION

The unique removable feet feature of Roots UNIVERSAL RAI® blowers permit field modification of blower mounting by repositioning blower feet and gear box breather as shown in Fig. 3.

Four blower mounting positions are possible:

1. Horizontal mounting, vertical air flow, drive shaft on left.
2. Same as (1) except drive shaft on right.
3. Vertical mounting, horizontal air flow, drive shaft on bottom.
4. Same as (3) except drive shaft on top.

To change blower mounting:

1. Place blower on its feet.
2. Loosen feet capscrews (32).
3. Place blower on a solid base resting on the gear box end with drive shaft on top.
4. Remove feet. (Note - Feet capscrews (32) are longer than cylinder capscrews (26), only capscrews (32) are to be used for feet.)
5. Remove cylinder capscrews (32) where feet are to be re-installed. Install capscrews (26) in the location previously occupied by feet capscrews (32).
6. Install feet using capscrews (32).
7. Place blower on its feet on flat surface.
8. Loosen feet capscrews (32) and square up blower and re-tighten capscrews (32).
9. Gear box has four threaded holes, one with breather and three with pipe plugs. Remove pipe plug (21) from the top most hole. Remove breather (25) and install it in the top most hole. Install pipe plug that was removed from the top hole into the hole previously occupied by the breather. The breather and the pipe plug should be sealed with a thread sealer.

For convenience, the position of the grease fitting (37) and the relief fitting (38) could be interchanged, however each bearing must have one grease fitting (37) and one relief fitting (38).

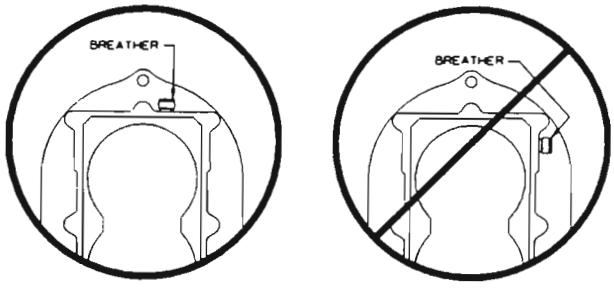


Figure 2 — Breather Installation

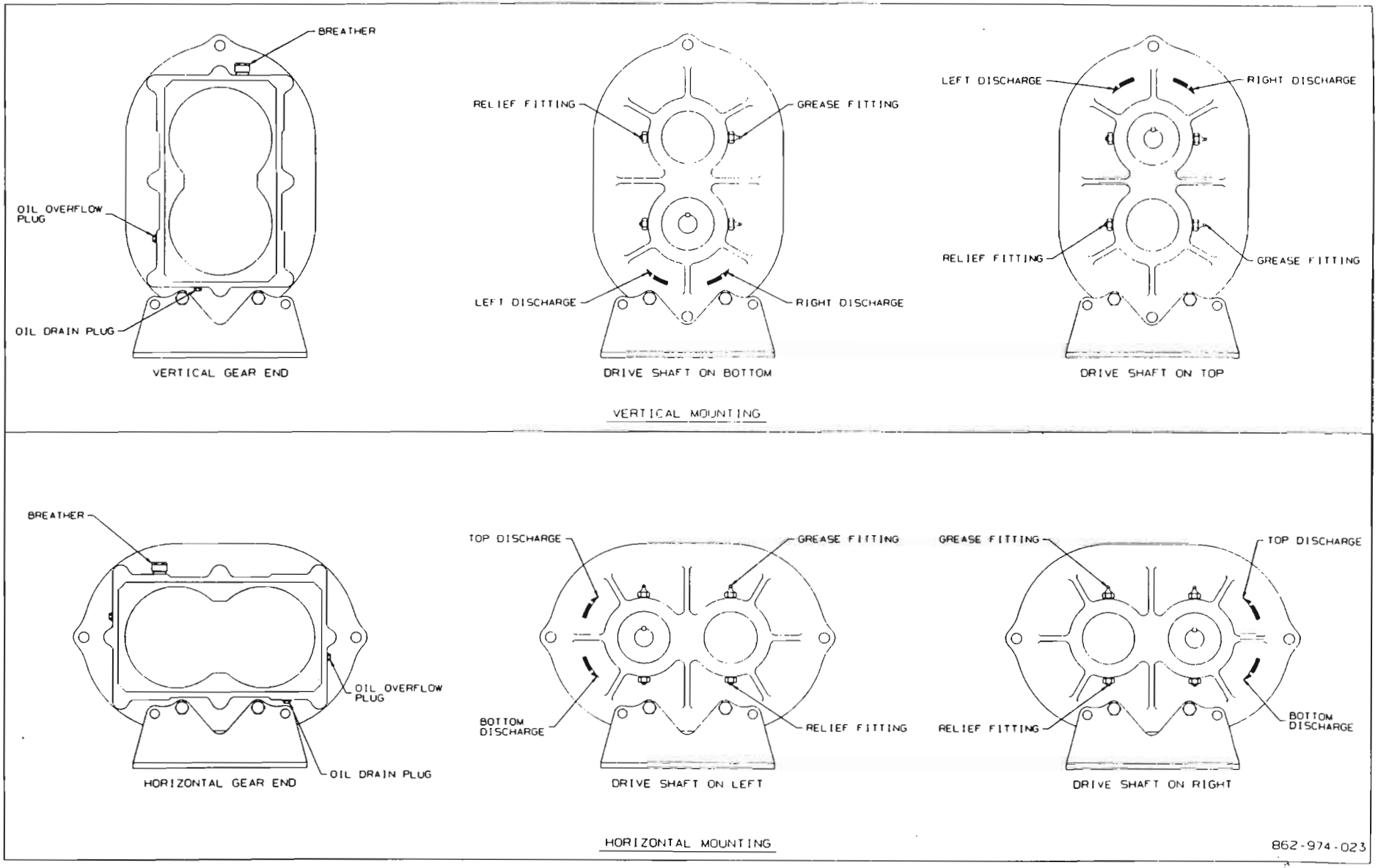


Figure 3 — Blower Orientation and Lubrication Points

INSTALLATION

Roots UNIVERSAL RAI® blowers are internally and externally treated after factory assembly to protect against normal atmospheric corrosion before installation. Maximum period of internal protection is considered to be one year under average conditions, if closing plugs or seals are not removed. **Protection against chemical or salt water atmosphere is not provided.** Avoid opening the blower until ready to start installation, as protection will be lost quickly by evaporation.

NOTE — If there is to be an extended period between delivery (and/or installation) and startup, the following steps should be taken to insure corrosion protection:

1. Coat internals of cylinder and gearbox with Nox-Rust No. VCI10 or equivalent. Repeat once a year or as conditions may require. Motorstor is oil soluble and does not have to be removed before lubricating. If desired, No. VCI10 may be removed from within the cylinder shortly before startup by spraying a fine mist of petroleum solvent through the blower while it is running at a slow speed with open inlet and discharge, or it can remain in the blower if it is not harmful to the operation of the connected system.
2. Fill drive end bearing cavities with grease as specified in Lubrication section.
3. Paint shaft extension, inlet and discharge flanges, and all other exposed surfaces with Nox-Rust X-110 or equivalent.
4. Seal inlet, discharge, and all vent openings with tape. It is not recommended that the unit be set in place, piped to the system, and allowed to remain idle for extended periods. If any part is left open to the atmosphere, the Motorstor vapor will escape and lose its effectiveness.
5. Units are not to be subjected to excessive vibration during storage. If stored outdoors, provide coverage such as a tarpaulin or lean-to.
6. Rotate drive shaft three or four revolutions every two weeks.
7. Prior to startup, remove flange covers on both inlet and discharge and inspect internals to insure absence of rust. Check all internal clearances. Also, at this time, remove gearbox and inspect gear teeth for rust.

Because of the completely enclosed blower design, location of the installation is generally not a critical matter. A clean, dry and protected indoor location is to be preferred. However, an outdoor or wet location will normally give satisfactory service. Important requirements are that the correct grade of lubricating oil be provided for expected temperatures, and that the blower be located so that routine checking and servicing can be handled conveniently after installation. Effect of the location on driver and accessory equipment must also be considered.

Supervision of the installation by a Factory Service Engineer is not usually required for these blowers. Workmen with experience in installing light-medium weight machinery should be able to produce satisfactory results. Handling of the equipment needs to be accomplished with care, and in compliance with safe practices. Blower mounting must be solid, without strain or twist, and air piping must be clean, accurately aligned and properly connected.

A bare blower without base should be lifted by a rope sling, with one loop passing under the gearhouse and the other loop under the cylinder.

When a blower is furnished mounted on a baseplate, with or without a driver, use of lifting slings passing under the base flanges is required. Arrange these slings so that no strains are placed on the blower casing or mounting feet, or on any mounted accessory equipment.

Before starting the installation, remove plugs, covers or seals from blower inlet and discharge connections and inspect the interior completely for dirt or foreign material. If cleaning is required, finish by washing the cylinder, headplates and impeller thoroughly with a petroleum solvent such as DuPont Triclene D. After this, turn the drive shaft by hand to make sure that the impellers turn freely at all points. Anti-rust compound on the drive shaft extension may also be removed at this time with the same solvent. Then plug the inlet and discharge connections to keep out dirt until ready to connect the air piping. Washing out is not required if the interior is found to be clean. The corrosion inhibitor used will vaporize and disappear during operation.

Care, plus consideration of all possible problems, will pay dividends when arranging the blower mounting. This is especially true when the blower is a "bare" unit furnished without a baseplate. The convenient procedure may be to mount such a unit directly on a floor or small concrete pad, but this generally produces least satisfactory results. It definitely causes the most problems in leveling and alignment.

Direct use of structural framing members is also not a recommended mounting. If unavoidable, the members must be rigidly reinforced when part of a building, and spring type mountings should not be used. Noise transmission can usually be reduced by use of a cork insulating pad 1 to 2 inches (25 to 50 mm) thickness. The pad should be supported by a full steel plate attached to the structure, with a rigid concrete slab laid on top of the cork to carry the blower and driver.

For a blower without base, it is recommended that a well anchored and carefully leveled steel or cast iron mounting plate be provided at the installation point. The plate should be ¾ to 1¼ inches (19 to 32 mm) thick, with its top surface machined flat, and needs to be large enough to provide leveling areas at one side and one end after the blower is mounted: It should have properly sized studs or tapped holes located to match the blower foot drilling. As an alternative, smaller plates at each end of the blower may be used. This is more complicated, usually makes leveling more difficult, and can produce twist or strains in the blower. Use of a high quality machinist's level is important. With the mounting plate in place and leveled, set the blower on it without bolting and check for rocking. If it is not solid, determine the total thickness of shims required under one foot to stop the rocking. Place half of this under each of the two short feet, and tighten the mounting studs or screws. Rotate the drive shaft to make sure the impellers still turn freely. If the blower is to

be direct coupled to a driving motor, consider the height of the motor shaft and the necessity for it to be aligned very accurately with the blower shaft. Best arrangement is for the blower to be bolted directly to the mounting plate while the driver is on shims of at least ⅛ inch (3 mm) thickness. This allows adjustment of motor position in final shaft alignment by varying the shim thickness.

Satisfactory installation can be obtained by setting the baseplate on a concrete slab that is rigid and free of vibration, and leveling the top of the base carefully in two directions so that it is free of twist. The slab must be provided with suitable anchor bolts. The use of grouting under and inside the base, after it has been carefully leveled by shimming, is recommended.

When blower and driver have been factory mounted on a common baseplate, the assembly will have been properly aligned and is to be treated as a unit for leveling purposes. It is possible for a base mounted assembly to become twisted during shipment thus disturbing the original alignment. For this reason, make the following checks after the base has been leveled and bolted down. Disconnect the drive and rotate the blower shaft by hand. It should turn freely at all points. Loosen the blower foot hold-down screws and determine whether all feet are evenly in contact with the base. If not, insert shims as required and again check for free impeller rotation. Finally, if blower is direct coupled to the driver, check shaft and coupling alignment carefully and make any necessary corrections prior to grouting.

In planning the installation, and before setting the blower, consider how piping arrangements are dictated by the blower design and assembly.

When a blower is DIRECT COUPLED to its driver, the driver RPM must be selected or governed so as not to exceed the maximum speed rating of the blower. Refer to LIMITATIONS for allowable speeds for various blower sizes. A flexible type coupling should always be used to connect the driver and blower shafts.

For engine drives, couplings with proper stiffness must be selected to avoid resonant torisonal vibrations. Also, safe operating speed must be limited to avoid critical speeds.

Coupling halves must be accurately aligned, and a sufficient gap between shaft ends provided, so that side strains and end thrust on either shaft are avoided or minimized. This will require considerable care in the mounting of the driver. The two shafts must be in as near perfect alignment in all directions as possible, and the gap must be established with the motor armature on its electrical center if end play exists. Coupling halves must be fitted to the two shafts such that they can be worked into place by hand. Maximum deviation in offset alignment of the shafts should not exceed .005" (.13 mm) total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" (.03 mm) when checked at six points around the coupling.

CAUTION

Couplings as well as sheave bushings must have a slight slide fit with the blower shaft such that they can be installed in place by hand. Any force used to install them will change blower end clearances resulting in blower damage. If an interference fit is desired for the coupling, the coupling hub should be heated and shrunk on the shaft. For engine drives, use "Locktite" between the coupling hubs and the blower/engine shafts and on the threads of the coupling set screws.

When a blower is BELT DRIVEN, a proper selection of sheave diameters can usually be made to adapt any standard driver speed to the required blower speed. This flexibility can sometimes lead to operating temperature problems caused by blower speed being too low. Make sure the drive speed selected is within the allowable range for the specific blower size, as specified under LIMITATIONS.

Belted drive arrangements usually employ two or more V-belts running in grooved sheaves, and a variety of positions are available for the driver. Installation of the driver is less critical than for direct coupling, but its shaft must be level and parallel with the blower shaft. The driver must also be mounted on an adjustable base to permit installing, adjusting and removing the V-belts. To position the driver correctly, both sheaves need to be mounted on their shafts and the nominal shaft center distance known for the belt lengths to be used.

Install the blower sheave (usually the larger one) so that its inner hub face is not more than ¼ inch (7 mm) from the bearing end cover. The shaft fit should be such that the sheave can be worked into place by hand. A tight or driving fit can damage a bearing, and may cause internal blower damage by forcing the impeller out of its normal operating position. A loose fit or wobbly sheave will cause vibration, and may result in shaft breakage.

The driver sheave should also be mounted as close to its bearing as possible, and again should fit the shaft correctly. Position the driver on its adjustable base so that ⅔ of the total movement is available in the direction away from the blower, and mount the assembly so that the face of the sheave is accurately in line with the blower sheave. This position minimizes belt wear, and allows sufficient adjustment for both installing and tightening the belts. After belts are installed, adjust their tension in accordance with the manufacturer's instructions. However, only enough tension should be applied to prevent slippage when the blower is operating under load. *Excessive tightening* can lead to early bearing failures.

Failure to properly align the blower and drive sheaves will result in the impeller being forced against one of the headplates during operation causing serious damage to the blower.

In the absence of belt manufacturer's instructions for tensioning, the following procedures may be used.

1. With the belts loose, pull the slack on all of them to the bottom side of the drive.
2. Adjust motor position to tighten belt until they appear to be seating in the sheave grooves.
3. Thump the belts with your fist. If they feel dead, tighten them more until they vibrate and feel springy when struck.
4. Run-in the drive for a short period, after preparing the blower as instructed in a following paragraph. While running, adjust until only a very slight bow appears in the slack side of the belts.
5. Stop the motor and compare the tensions of the individual belts by pressing down firmly with one hand on the top surface. It should be possible to deflect each

belt only to the point where its top surface is even with the bottoms of the other undeflected belts.

6. A new set of belts should be first tensioned about ⅓ greater than normal to allow for stretch and wear-in. Before putting the drive into normal operation, increase the tension as obtained above by a small amount. Recheck after each 8 hour operating period during the first 50 hours, and adjust as necessary.

Before operating the drive under power to check initial belt tension, first remove covers from the blower connections. Make sure the interior is still clean, then rotate the shaft by hand. Place a screen over the inlet connection to prevent anything being sucked into the blower while it is operating, and avoid standing in line with the discharge opening. Put oil in the gearhouse per instructions under LUBRICATION.

Before connecting piping, remove any remaining antirust compound from blower connections. Piping must be clean and should be sized so that the air velocity will not exceed 75 feet per second (23 m per second). Pipe used should be no smaller than blower connections. In addition, make sure it is free of dirt, scale, cuttings, weld beads, or foreign materials of any kind.

To further guard against damage to the blower, especially when an inlet filter is not used, install a substantial screen of 16 mesh backed with hardware cloth at or near the inlet connections. Make provisions to clean this screen of collected debris after a few hours operation. It should be removed when its usefulness has ended, as the wire will eventually deteriorate and small pieces going into the blower may cause serious damage.

Pipe threads or flanges must meet the blower connections accurately and squarely. Do not attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the blower casing and cause impeller rubbing. In severe cases it can prevent operation or result in a broken drive shaft. For similar reasons, piping should be supported near the blower to eliminate dead weight strains. Also, installation of flexible connectors or expansion joints is recommended.

Figure 4 represents in diagram form a blower installation with all accessory items that might be required under various operating conditions. Inlet piping should be completely free of valves or restrictions. When a shut-off valve (not shown) cannot be avoided, make sure a full size vacuum relief is installed near the blower inlet. This will protect against blower overload caused by accidental closing.

Need for an inlet silencer will depend on blower speed and pressure, as well as sound-level requirements in the general surroundings. An inlet filter is normally recommended, especially in dusty or sandy locations, for blower protection. A discharge silencer is also normally suggested. Specific recommendations on silencing can be obtained from the nearest Distributor. Silencers should be mounted as close to blower as possible.

Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the blower under no-load conditions. Reliable pressure/vacuum gauges and good thermometers at both inlet and discharge are recommended to allow making the important checks on blower operating conditions. If the demand is constant, but somewhat lower than the blower output, excess may be blown off through the manual unloading valve.

In multiple blower installations when two or more units discharge into a common header, use of check valves is recommended. These should be of a direct acting or free swinging type, with one valve located in each blower

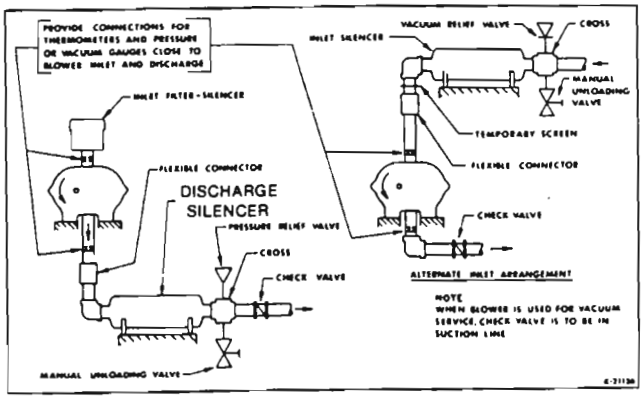


Figure 4 — Installation with Accessories

discharge line. Properly installed, they will protect against damage from reverse rotation caused by air backflow through an idle blower.

After piping is completed, and before applying power, rotate the drive shaft by hand again. If it does not move with uniform freedom, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment. Do not operate the blower more than briefly at this time because of possible inadequate oil supply in the gearhouse. Read LUBRICATION section.

LUBRICATION

A simple but very effective lubrication system is employed on UNIVERSAL RAI® blowers. At the drive shaft end the bearings are grease lubricated using hydraulic pressure relief fittings. These relief fittings vent any excess grease, preventing pressure build-up on the seals. A restriction plug and metering orifice prevent loss of lubricant from initial surges in lubricant pressure but permit venting excess lubricant under steadily rising pressures.

The blind end bearings and timing gears are enclosed by a gearhouse located opposite the drive end of the blower. In a side outlet blower, the lower timing gear functions as an oil slinger, carrying lubricant to the upper timing gear and providing splash lubrication for the bearings. Pressure within the gearbox is vented through the breather vent plug (25).

The above description also applies in general to the top or bottom outlet style blower, the principal difference being that both gears dip into the oil sump.

Before starting blower, be sure oil has been put in gearhouse, as **ALL OIL WAS DRAINED FOLLOWING SHOP TESTS.** For recommended lubricating oil see Table 2. Use a good grade industrial type rust, oxidation, and foam inhibited, non-detergent oil such as Mobil DTE BB, Texaco R&O 220, Amoco 220 or equal.

Table 2 — Recommended Oil Grades

Ambient Temperature ° F.	Viscosity Range SSU at 100° F.	ISO No.
(°C)	(38°C)	
Above 90° (32°)	1000 - 1200	320
32° to 90° (0° to 32°)	700 - 1000	220
0° to 32° (– 18° to 0°)	500 - 700	150
Below 0° (– 18°)	300 - 500	100

To fill the gearbox, remove the breather plug and the oil overflow plug (Fig. 3). Fill the reservoir up to the overflow hole. Place the breather and the overflow plug back into their respective holes.

Table 3 — Oil Sump Capacities

Frame Size	Capacity, Fl. Oz. (Liters) Vertical	Horizontal
22	3.4 (.1)	6.1 (.18)
24	3.4 (.1)	6.1 (.18)
32	8.5 (.25)	16.0 (.47)
33	8.5 (.25)	16.0 (.47)
36	8.5 (.25)	16.0 (.47)
42	12.7 (.37)	22.8 (.67)
45	12.7 (.37)	22.8 (.67)
47	12.7 (.37)	22.8 (.67)
53	16.0 (.47)	27.6 (.82)
56	16.0 (.47)	27.6 (.82)
59	16.0 (.47)	27.6 (.82)
65	28.3 (.84)	52.1 (1.54)
68	28.3 (.84)	52.1 (1.54)
615	28.3 (.84)	52.1 (1.54)
76	32.3 (.96)	59.5 (1.76)
711	32.3 (.96)	59.5 (1.76)
718	32.3 (.96)	59.5 (1.76)

Proper lubrication is usually the most important single consideration in obtaining maximum service life and the most satisfactory operation from the unit. Unless operating conditions are quite severe, a weekly check of gearhouse oil level and necessary addition of lubricant should be sufficient. However, oil should be changed after initial 100 hours of operation. Thereafter, a complete oil change normally is made after 1000 operating hours, or less, depending on the type of oil and oil operating temperature.

Shaft bearings at the drive end of the blower are grease lubricated and each bearing housing is equipped with pressure type grease fittings and pressure type relief fittings. When servicing drive end bearings, use a NLGI #2 premium grade, petroleum base grease with high temperature (300° service temperature) and moisture resistance and good mechanical stability. Using a pressure gun, force new lubricant into each drive end bearing housing until traces of clean grease comes out of the relief fitting.

After a long shutdown, it is recommended that the grease relief fittings be removed, the old grease flushed out with kerosene or #10 lubricating oil, drained thoroughly, and bearings refilled with new grease. Be sure grease relief fittings are reinstalled. Grease should be added using hand operated grease gun to the drive end bearings at varying time intervals depending on duty cycle and RPM. Table 4 has been prepared as a general greasing schedule guide based on average operating conditions. More frequent intervals may be necessary depending on the grease operating temperature and under unusual circumstances.

Table 4 — Suggested Bearing Lubrication Intervals

Speed in RPM	Operating Hours Per Day		
	8	16	24
	Greasing Intervals in Weeks		
750 - 1000	7	4	2
1000 - 1500	5	2	1
1500 - 2000	4	2	1
2000 - 2500	3	1	1
2500 - 3000	2	1	1
3000 and up	1	1	1

OPERATION

Before operating a blower under power for the first time, check the unit and the installation thoroughly to reduce the likelihood of avoidable troubles. Use the following procedure list as a guide, but consider any other special conditions in the installation.

1. **Be certain** that no bolts, tools, rags or dirt have been left in the blower air chamber.
2. **Be certain** that inlet piping is free of debris. If an outdoor intake without filter is used, be sure the opening is located so it cannot pick up dirt and is protected by a strong screen or grille. Use of the temporary protective screen at the blower as described under **INSTALLATION** is strongly recommended.
3. **Recheck** blower leveling, drive alignment and tightness of all mounting bolts if installation is not recent. If belt drive is used, adjust belt tension correctly.
4. Turn drive shaft by hand to make sure impellers still rotate without bumping or rubbing at any point.
5. **Make sure** oil level in blower gearbox is correct.
6. Check lubrication of driver. If it is an electric motor, be sure that power is available and that electrical overload devices are installed and workable.
7. Open the manual unloading valve in the discharge air line. If a valve is in the inlet piping, be sure it is open.
8. Bump blower a few revolutions with driver to check that direction of rotation is correct, and that both units coast freely to a stop.

After the preceding points are cleared, blower is ready for trial operation under "no-load" conditions as set up under Item 7. The following procedure is suggested to cover this initial operating test period.

a. Start blower, let it accelerate to full speed, then shut off. Listen for knocking sounds, both with power on and as speed slows down.
b. Repeat above, but let blower run 2 or 3 minutes. Check for noises, and vibrations of 5 mils or greater.
c. Operate blower for about 10 minutes unloaded. Check oil levels. Feel cylinder and headplate surfaces for development of spots too hot to touch, indicating impeller rubs. Be aware of any noticeable increase in vibration.

Assuming that all trials have been satisfactory, or that necessary corrections have been made, the blower should now have a final check run of at least one hour under normal operating conditions. After blower is re-

started, gradually close the discharge unloading valve to apply working pressure. At this point it is recommended that a good pressure gauge or manometer be connected into the discharge line if not already provided, and that thermometers be in both inlet and discharge lines. Readings from these instruments will show whether pressure or temperature ratings of the blower are being exceeded.

During the final run, check operating conditions frequently and observe the oil levels at reasonable intervals. If excessive noise or local heating develops, shut down immediately and determine the cause. If either pressure rise or temperature rise across the blower exceeds the limit specified in this manual shut down and investigate conditions in the piping system or in the process to which air is being supplied. Refer to the **TROUBLE SHOOTING CHECKLIST** for suggestions on various problems that may appear.

The blower should now be ready for continuous duty operation at full speed. During the first few days make periodic checks to determine whether all conditions remain steady, or at least acceptable. This may be particularly important if the blower is supplying air to a process system where conditions can vary. At the first opportunity, stop the blower and clean the temporary inlet protective screen. If no appreciable amount of debris has collected, the screen may be removed. See comments under **INSTALLATION.** At this same time, verify leveling, coupling alignment or belt tension, and mounting bolt tightness.

Should operating experience prove that blower capacity is a little too high for the actual air requirements, a small excess may be blown off continuously through the manual unloading vent valve. **Never rely on the pressure relief valve as an automatic vent.** Such use may cause the discharge pressure to become excessive and can also

TROUBLE SHOOTING CHECKLIST

TROUBLE	ITEM	POSSIBLE CAUSE	REMEDY
No Air Flow	1	Speed too low	Check by tachometer and compare with speed shown on Roots Order Acknowledgement.
	2	Wrong rotation	Compare actual rotation with Figure 2. Change driver if wrong.
	3	Obstruction in piping	Check piping, screen, valves, silencer, to assure an open flow path.
Low capacity	4	Speed too low	See item 1. If belt drive, check for slippage and readjust tension.
	5	Excessive pressure	Check inlet vacuum and discharge pressure, and compare these figures with specified operating conditions on Order.
	6	Obstruction in piping	See item 3.
	7	Excessive slip	Check inside of casing for worn or eroded surfaces causing excessive clearances.
Excessive Power	8	Speed too high	Check speed and compare with Roots Order Acknowledgement.
	9	Pressure too high	See item 5.
	10	Impellers rubbing	Inspect outside of cylinder and headplates for high temperatures areas, then check for impeller contacts at these points. Correct blower mounting, drive alignment.
Overheating of Bearings, or Gears	11	Inadequate lubrication	Restore correct oil levels in gearbox and lubricate.
	12	Excessive lubrication	Check gear oil level. If incorrect, drain and refill with clean oil of recommended grade.
	13	Excessive pressure rise	See item 5.
	14	Coupling misalignment	Check carefully. Realign if questionable.
	15	Excessive belt tension	Readjust for correct tension.
	16	Speed too low	Speeds lower than the minimum recommended will overheat the entire blower.
Vibration	17	Misalignment	See item 14.
	18	Impellers rubbing	See item 10.
	19	Worn bearings/gears	Check gear backlash and condition of bearings.
	20	Unbalanced or rubbing impellers	Scale or process material may build up on casing and impellers, or inside impellers. Remove build-up to retore original clearances and impeller balance.
	21	Driver or blower loose	Tighten mounting bolts securely.
	22	Piping resonances	Determine whether standing wave pressure pulsations are present in the piping. Refer to Distributors.

result in failure of the valve itself. If blower capacity appears to be too low, refer to the **TROUBLE SHOOTING CHECKLIST** first. If no help is found there it may be possible to increase the blower speed. Before attempting this change, contact the nearest Distributor for recommendations. Be prepared to furnish data on actual air requirements and operating pressure/temperature conditions.

SAFETY PRECAUTIONS

For equipment covered specifically or indirectly in this instruction book, it is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations, the following should particularly be noted:

- **Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.**
- **Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Cover external moving parts with adequate guards.**
- **Disconnect power before doing any work and avoid bypassing or rendering inoperative any safety or protective devices.**
- **If blower is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the discharge air stream.**
- **Stay clear of open inlet piping (suction area) of pressure blowers, and the open discharge blast from vacuum blowers.**
- **Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.**
- **Avoid extended exposure in close proximity to machinery which exceeds safe noise levels.**
- **Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.**
- **Casing pressure must not exceed 25 PSI (172 kPa) gauge. Do not pressurize vented cavities from an external source, nor restrict the vents.**
- **Do not use air blowers on explosive or hazardous gases.**
- **Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be warned by signs and trained to exercise adequate general safety precautions.**

MAINTENANCE & REPLACEMENTS

A good program of inspection and maintenance servicing, followed consistently, is the most reliable method of minimizing repairs to a blower. A simple record of services and dates will help keep this work on a regular schedule. Basic service needs are lubrication, checking for hot spots or increase in vibration and noise and the recording of operating pressures and temperatures. Above all, **a blower must be operated within its specified rating limits,** to obtain satisfactory service life.

A newly installed blower should be checked frequently during the first month of full-time operation. Attention thereafter may be less frequent, depending on what the early checks have shown. Lubrication is normally the most important consideration. Unless operating conditions are unusually severe, a weekly check of oil levels in the gearbox, with addition of oil as required, should be sufficient. Complete oil changes should be made at intervals of 1000 operating hours, or more frequently if oil condition becomes poor.

Driver lubrication practices should be in accordance with the manufacturer's instructions. If direct connected to the blower through a lubricated type coupling, the coupling should be checked and greased each time blower oil is changed. This will help reduce wear and prevent it from causing vibration. In a belted drive system, check belt tension periodically and inspect for frayed or cracked belts. Refer to tensioning instructions under **INSTALLATION.**

In a new and properly installed blower there are no moving contacts between the two impellers, or between the impeller and cylinder or headplates. Wear is then confined to the bearing which support and locate the shafts, the shaft seals, and the timing gears. All are lubricated, and wear should be nominal if clean oil of the correct grade is always supplied. Seals are subject to deterioration as well as wear, and may require replacement at varying periods.

Shaft bearings have been selected to have optimum life under average conditions with proper lubrication. They are critical in the service life of the blower. Gradual bearing wear may allow a shaft position to change slightly, until rubbing develops between impeller and cylinder headplate. This will cause spot heating, which can be detected by feeling these surfaces. Sudden bearing failure is usually more serious. Since the shaft and impeller are no longer supported and properly located, extensive general damage to the blower casing and gears is likely to occur.

Shaft seals should be considered expendible items, to be replaced whenever drainage from the headplate vent cavity becomes excessive or when the blower is disassembled for any reason. Sealing effectiveness can vary considerably from seal to seal and is also affected by shaft smoothness under the seal lip. Because of these normal variables, minor seal leakage should not be considered an indicator for seal replacement.

Timing gear wear, when correct lubrication is maintained should be negligible over a period of years. Gear teeth are cut to provide the correct amount of backlash, and gears correctly mounted on the shafts will accom-

modate a normal amount of tooth wear without permitting contact between lobes of the two impellers.

However, a high oil level will cause churning and excessive heating, indicated by an unusually high temperature at the bottom of the gear housing. Consequent heating of the gears will result in loss of tooth-clearance or backlash, and rapid wear of the gear teeth usually will develop. Continuation of this tooth wear will eventually produce impeller contacts (knocking), and from this point serious damage will be unavoidable if blower operation is continued. A similar situation can be produced suddenly by gear tooth fracture, which is usually brought on by sustained overloading or momentary shock loads.

Operating problems may also develop from causes other than internal parts failure. Operating clearances within a blower are only a few thousandths of an inch (hundredths of a mm). This makes it possible for impeller interferences or casing rubs to result from shifts in the blower mounting or from changes in piping support. Foreign materials sucked into the blower will also cause trouble, which can only be cured by disconnecting the piping and thoroughly cleaning the blower interior.

If this type of trouble is experienced, and the blower is found to be clean, try removing mounting strains. Loosen blower mounting bolts and reset the leveling and drive alignment. Then tighten mounting again, and make sure that all piping meets blower connections accurately and squarely before reconnecting it.

A wide range of causes for operating troubles are covered in the TROUBLE SHOOTING CHECKLIST. The remedies suggested there in some cases need to be performed by qualified mechanics with a good background of general experience, using procedures detailed in this manual. Major repairs generally are to be considered beyond the scope of maintenance, and should be referred to the nearest Distributor listed on the last page.

Warranty failures should not be repaired at all, unless specific approval has been obtained through a Distributor or a factory before starting work. Unauthorized disassembly within the warranty period may void the warranty.

When a blower is taken out of service it may require internal protection against rusting or corrosion. The need for such protection must be a matter of judgment based on existing conditions as well as length of downtime. Under favorable conditions, protection will probably not be needed if shut-down is not longer than a month. Under atmospheric conditions producing rapid corrosion, the blower should be protected immediately. If blower is to be shut down for an extended period of time, see suggestions for corrosion protection under installation.

It is recommended that major repairs, if needed, be performed at a Dresser authorized service facility. However, it is recognized that this may not always be practical, especially when a spare blower is not available. If a blower is out of the warranty period, mechanical adjustments and parts replacement may be undertaken locally at the owner's option and risk. It is recommended that Factory Parts be used to insure fit and suitability. The maintenance of a small stock of on-hand spare parts can eliminate possible delays. When ordering parts give Item Numbers and their word descriptions from Figures 5 & 6. Also specify quantities wanted and the blower size and serial number from the nameplate.

Repairs or adjustments are best performed by personnel with good mechanical experience and the ability to follow the instructions in this manual. Some operations involve extra care and patience, and a degree of precision work. This is especially true in timing impellers and in handling bearings. Experience indicates that a high percentage of bearing failure is caused by dirt contamination before or during assembly. Therefore, the work area should be cleaned before starting disassembly, and new or re-usable parts protected during progress of the work.

In the following outlines of repair procedures, numbers shown in brackets ( ) correspond to the Item Numbers used in assembly drawing, Figures 11 & 13. It is recommended that the procedure be studied carefully and completely, with frequent reference to the drawings, before starting work. This will produce better efficiency through an understanding of what work is to be done, and the order of doing it. Before disassembly, mark all parts so that they may be returned to original locations or relative positions.

A — Replacing Timing Gears

1. Drain all oil from the gearhouse by removing drain plug (21) in the bottom. Remove gearhouse by taking out all cap screws (23) in its flange. It may be necessary to bump the sides with a wood block or mallet to break the flange joint.
2. Reach through one of the blower pipe connections and place a chalk mark on the strip of one impeller and the mating waist of the other, so that they may easily be returned to their original relative positions.

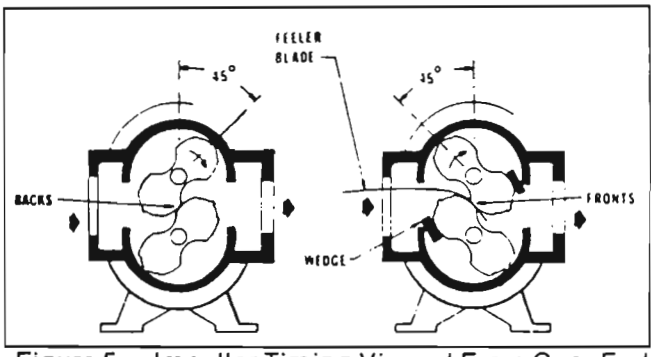


Figure 5 — Impeller Timing Viewed From Gear End

3. GEAR REMOVAL: For this operation, the impellers should be wedged as shown in Figure 5. Back off gear clamping nuts (17) about ¼". Use a puller of the type shown in Figure 10. Position it around the gear per Figure 9. As the puller set screw is torqued, the puller will have a tendency to turn and contact teeth of the other gear. To prevent this contact, hold the puller corner nut with a wrench while torquing the set screw. Once the gear is unseated, remove the puller. Remove gear nuts (17) and the gear. Repeat same procedure for the other gear. NOTE: Do not remove gear nuts (17) completely before the gears are unseated from the taper fits or damage/injury may result.

4. GEAR INSTALLATION: Place impellers in correct position as previously marked. Be sure shafts and gear bores are clean and free of scratches. Clean the shaft tapered fits. Place hardwood wedges as shown in Figure 5. Install drive gear (4) and gear nut (17) so match mark at tooth is at the line of engagement. Tighten the drive gear nut to the torque given in Table 5. Blower assembly must be fastened down for torquing operation.

TABLE 5 — GEAR NUT TORQUE

Gear Size (in.)	Torque	
	lb.-ft.	(kg-m)
2.5	60	(8.3)
3.5	110	(15.2)
4.0	190	(26.3)
5.0	250	(34.6)
6.0	400	(55.3)
7.0	550	(76.1)

5. Installing driven gear (4) - Insert a long, metal feeler gauge between the impellers' lobes at the fronts or backs as shown in Figure 5. Feeler gauge thickness to be a middle value from Table 6 for fronts and backs. Align the gear so the tooth match marks agree with the drive gear, then install nut (17). Tighten lightly with a small wrench, then check front and back clearances against Table 6 for each 45° position. Both fronts and backs should be about the same and within the specified range in Table 6. Adjust gear position, if necessary, then insert the corrected feeler gauge and wedges and use a torque wrench to tighten the gear nut to the torque specified in Table 5. Remove wedges and rotate the drive shaft by hand to make sure there are no gear tight spots or impeller contacts.

   Caution! Keep fingers away from impellers and gears.

6. Check the end clearances between impellers and headplates. Adjust clearances per B-15 below.

7. When clearances are correct, clean and re-install the gearhouse. Check condition of flange gasket (7) and replace if questionable. Fill gearhouse to correct level with proper grade of oil.

B — Replacing Shaft Bearings, and Impellers

Remove coupling or sheave from the drive shaft. Drain and remove gearhouse, and pull the timing gears. If gears are to be re-used, mark them so they may be returned to the same shafts.

1. Break corners and deburr the keyway. Remove bearing end cover at the drive end. Remove bearing clamp plates (34).

2. Make single and double identifying punch marks on the mating edges of headplate and cylinder flanges at the two ends of the blower.

3. At the drive end, drive out the two dowel pins and remove all capscrews holding headplate to cylinder. By inserting jacking screws into the two threaded flange holes, and turning them in evenly, the headplate will be separated from the cylinder. As the headplate comes off the shafts it will bring bearings with it. 2½" and 3½" gear diameter units do not have tapped holes for jack screws in the drive end headplates. Remove dowel pins and all capscrews holding headplate to cylinder and foot on the drive end. Support unit under gear end cylinder flange with the shafts vertical. Using soft metal block against gear end shafts, push them out of gear end headplate.

4. For 2½" and 3½" gear diameter units, support the drive end headplate on the underside, and using soft metal block against drive end, shafts, push them out of drive end headplate.

   For 4", 6" & 7" gear diameter units, from the gear end , using a wood or soft metal block against the ends of the shafts, drive them out of the headplate. If they are to be reused, protect them from damage in this operation.

5. If blower interior surfaces need cleaning, it may be advisable to separate the gear end headplate from the cylinder. Use the same general procedure as employed at the drive end.

6. Working from the back (flat) face of each headplate, push or tap out the bearings and seals. Use a round bar or tube that will pass through the shaft clearance holes in the headplates. All lip seals will be damaged during removal and must be replaced.

7. Clean bearing and seal pockets in headplates and remove burrs or rough edges. (Apply a thin coating of sealant on seal O.D.) Press new seals (27) into gear end headplate using a round tube or bar with recessed end that will bear on the outer metal edge of seal enclosure. Seal lip should point toward the driving tool. Seals to be flush with outboard bore face. Apply a light coat of oil or grease to the seal lips. In a similar fashion, install lip seals into the drive end headplate.

8. Place cylinder on a flat surface. Assemble gear end headplate to cylinder after checking flange punch marks. Drive in the two locating dowel pins before tightening flange screws. Also install gear end foot using the same longer cap screws (32) and washers (41). (on 6" & 7" UNIVERSAL RAI® install both gear and feet.)
9. Place the assembly horizontally on steel blocks with gear end headplate on bottom. The height of the blocks should be sufficient to clear gear end shaft extensions. Assemble impellers into the cylinder with the drive shaft (longer shaft) in same

location as in original assembly. Before starting the shafts through the headplate holes, make sure shaft ends have no sharp or rough edges to damage seal lips. Position impellers at 90° to each other in the cylinder, using lobe-and-waist match marks if original impellers are being re-installed. Install drive end headplate and feet in same manner as gear end.

10. It is recommended that new bearings be used for rebuild. Apply thin film of machine oil on the shaft bearing fit, bearing I.D., and headplate bearing bore. Install drive end bearings into headplate. Use a tube with flanged end that will contact both bearing faces simultaneously. Refer to Fig. 11 for proper bearing depths.

    NOTE: Cylindrical drive bearing should be installed with inner race large shoulder facing outboard.

11. Place blower on its feet on a flat surface. Loosen feet capscrews (32) and square up unit. Re-tighten capscrews (32). Clamp unit down to a solid base for further assembly.

12. Oil the gear end bearing fits as described previously. Install 2½-5" UNIVERSAL RAI® gear end bearings flush with the headplate bearing shoulders using proper drivers. On 6" & 7" UNIVERSAL RAI®, install thrust washer (29) in bearing bores then install gear end bearings so that they protrude 1/16" (1.6mm) above headplate surface.

13. Install bearing clamp plates (34). On 6" & 7" UNIVERSAL RAI®, impeller end clearances are also to be set during this step. Install clamp plates (34) with capscrews (31) making sure that the gap between the clamp plates and the headplate is even all around, at the same time, set end clearances per Table 5.

14. Install gears and time impellers as in (A).

15. For setting end clearances on 2½-5" gear diameter units, special tools, thrust adjuster fork Fig. 7 and thrust adjuster saddle Figure 8 are required. Refer to Fig. 6 for installation of tools. The flat side of the saddle rests against the bearing inner race and the flat side of the fork rests against the back side of the gear. Install a shim, with thickness equal to gear end clearance (Table 6), between the impeller and the gear end headplates. Tap on top of the fork until the shim becomes snug. Remove the shim and check end clearances. To increase gear end clearance, tap on the end of the gear end shaft with a soft metal mallet. On units, UNIVERSAL RAI®, set end clearances for 6" & 7" by turning capscrews (31) evenly in or out.

16. Install drive end cover (5) after packing bearing cavities with suitable grease. Replace drive shaft seal. Lip must point toward (33) the bearing. Exercise care not to damage the lip as it passes over shaft keyway.

17. Install gasket item (7). Install the gear house after cleaning out the inside. Tighten gear box cap screws (23) evenly. Fill with correct grade of oil until oil flows out through oil level hole. Grease drive and bearings. (See Lubrication.)

18. Reinstall coupling or belt sheave making sure that they have a slight slide fit with the shaft and could be installed by hand.

Where repairs involve parts replacement, it is recommended that Factory Parts be used to insure fit and suitability. Delay in making such repairs can be reduced by having spare parts on hand.

When ordering parts, please furnish all information from the blower nameplate.

Repairs or adjustments to blowers should be performed by personnel with a good back ground of general mechanical experience and the ability to follow the detailed instructions in this manual. No special tools are required. Some operations involve extra care and a degree of precision work. This is especially true in timing impellers, and in handling bearings. Experience indicates that a high percentage of bearing failures is caused by dirt contamination before or during assembly. Therefore, clean the work area before starting disassembly, and protect new or reuseable parts during progress of the work. (See page 23 for Repair Kit Information.)

INTERNAL CLEARANCES

References to operating clearances in this manual include only one mention of the specific amount of clearance to be used or expected. For units in good condition this information is not essential in field service work. Situations may arise, however, when it is desirable to compare existing clearances with the correct Engineering values or to re-establish clearances.

Listed in Table 6 are the ranges of impeller clearances used in factory assembly of normal UNIVERSAL RAI® blowers. It should be kept in mind that clearances may change slightly in service, but should never be less than the minimum values listed. Only well qualified personnel should attempt to measure clearances for direct comparison with this data.

Table 6 — Normal Clearances for UNIVERSAL RAI® Blowers — Inches (MM)

SIZE	IMPELLER ENDS			CYLINDER		IMPELLER
	TOTAL	DRIVE END MINIMUM	GEAR END MINIMUM	INLET & DISCHARGE	CENTER	FRONTS BACKS
22	.006/.010 (.15-.25)	.003 (.08)	.003 (.08)	.004/.005 (.10-.13)	.002/.003 (.05-.08)	.007/.01 (.18-.25)
24	.006/.010 (.15-.25)	.003 (.08)	.003 (.08)	.004/.005 (.10-.13)	.002/.003 (.05-.08)	.007/.01 (.18-.25)
32	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.004/.006 (.10-.15)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
33	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.004/.006 (.10-.15)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
36	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.004/.006 (.10-.15)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
42	.008/.011 (.20-.28)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.009/.012 (.23-.30)
45	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.012/.015 (.30-.38)
47	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.012/.015 (.30-.38)
53	.008/.011 (.20-.28)	.004 (.10)	.004 (.10)	.005/.008 (.13-.20)	.003/.004 (.08-.10)	.011/.013 (.28-.33)
56	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.008 (.13-.20)	.003/.004 (.08-.10)	.015/.017 (.38-.43)
59	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.008 (.13-.20)	.003/.004 (.08-.10)	.015/.017 (.38-.43)
65	.012/.016 (.30-.40)	.008 (.20)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
68	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
615	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
76	.012/.016 (.30-.40)	.008 (.13)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.013/.015 (.33-.38)
-711	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.013/.015 (.33-.38)
718	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.013/.015 (.33-.38)

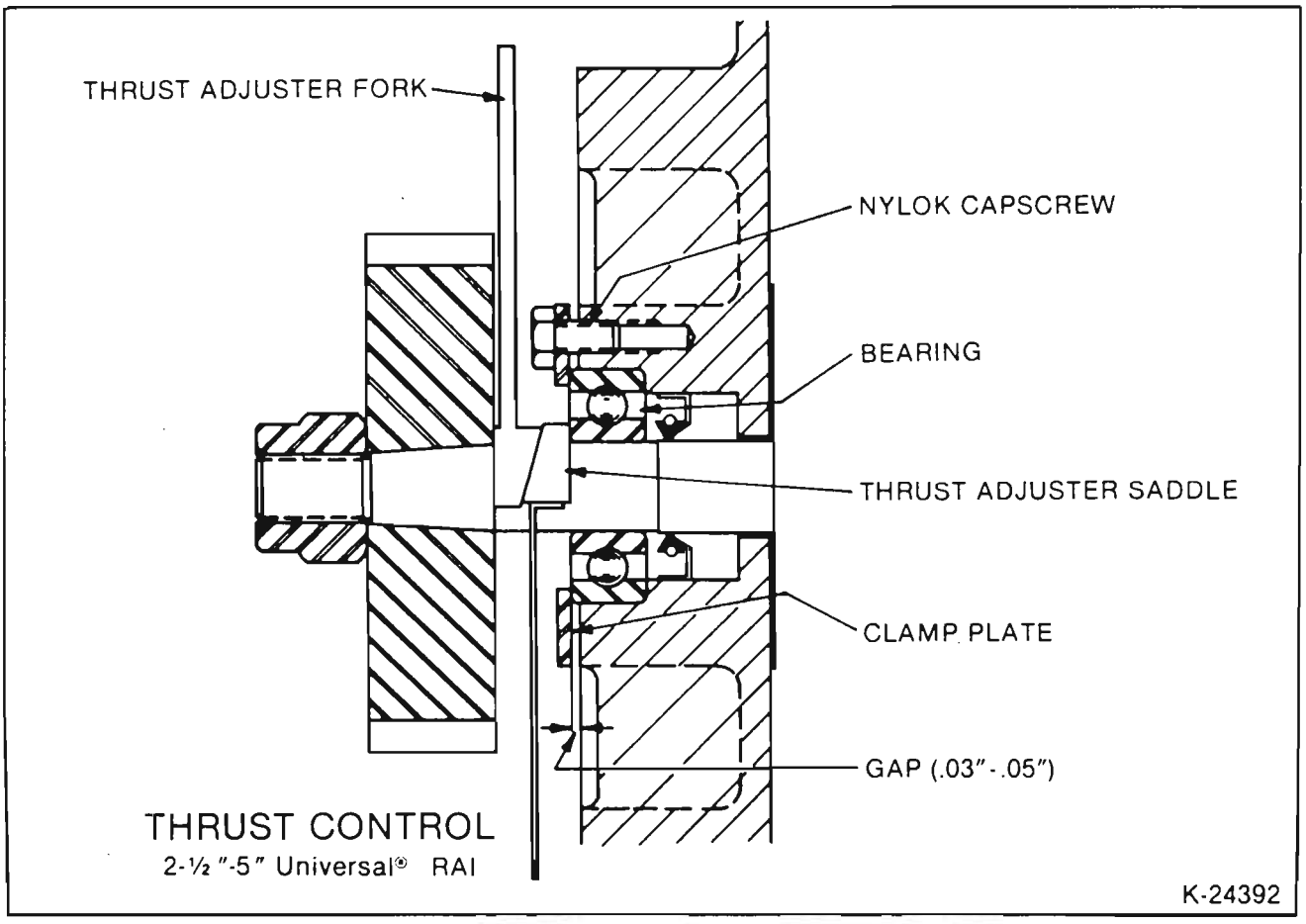
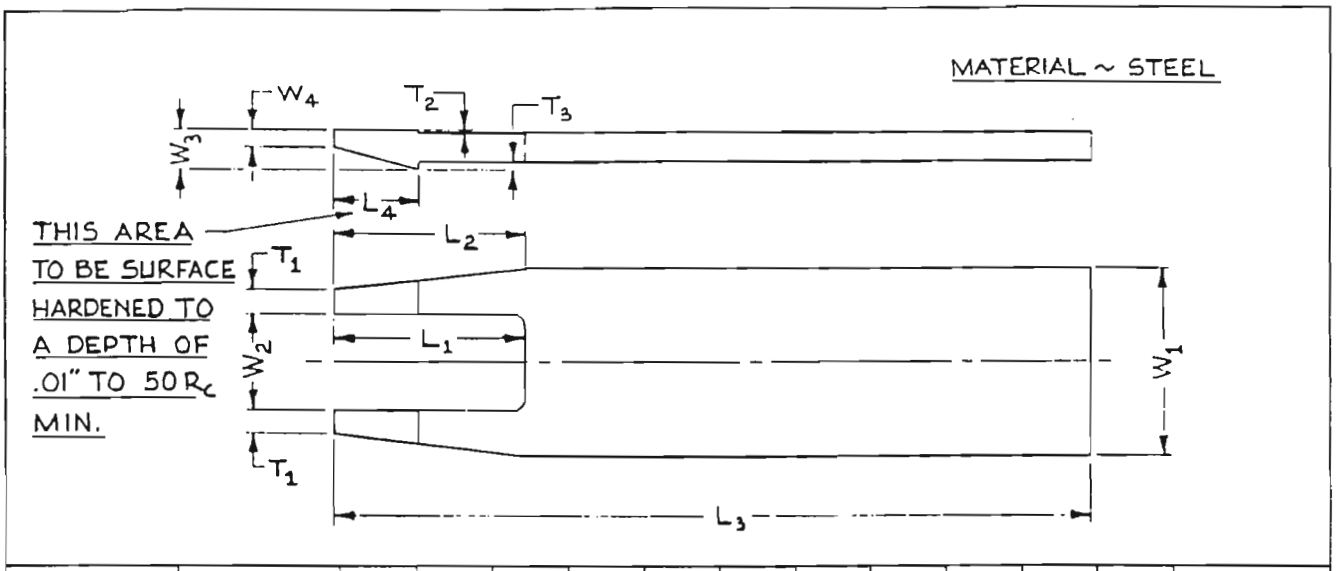
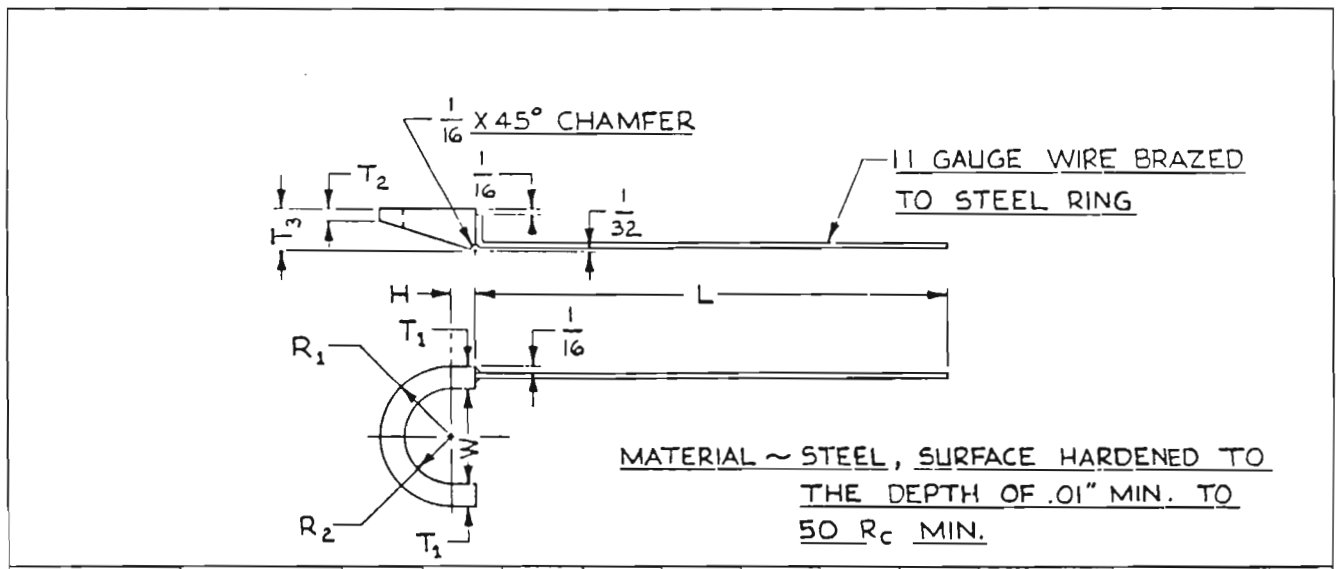


Figure 6 — Thrust Setting, 2½"-5" UNIVERSAL RAI®



PART Nº	BLW. SIZE	L_1	L_2	L_3	L_4	W_1	W_2	W_3	W_4	T_1	T_2	T_3	NOTES
812-973-001	2 1/2"	1 3/4	1 3/4	6 1/2	9/16	1 3/8	11/16	1/4	1/8	7/32	1/32	1/32	
812-973-002	3 1/2"	2	2	7	7/8	1 1/2	13/16	5/16	1/16	7/32	1/32	1/16	
812-973-003	4"	2	2	7 1/2	1	1 3/4	1 1/32	3/8	1/16	1/4	1/32	1/32	
812-973-004	5"	2 1/4	2 1/4	8	7/8	2	1 1/4	13/32	3/16	1/4	1/32	1/16	

Figure 7 — Thrust Adjuster Fork 812-973



PART Nº	BLW. SIZE	R_1	R_2	W	T_1	T_2	T_3	H	L	NOTES
812-974-001	2 1/2"	15/32	11/32	11/16	1/8	1/16	1/4	3/16	3	
812-974-002	3 1/2"	5/8	13/32	13/16	7/32	1/16	5/16	3/16	3 1/2	
812-974-003	4"	49/64	33/64	1 1/32	1/4	1/8	7/16	1/4	4	
812-974-004	5"	7/8	5/8	1 1/4	1/4	1/8	7/16	1/4	5	

Figure 8 — Thrust Adjuster Saddle 812-974

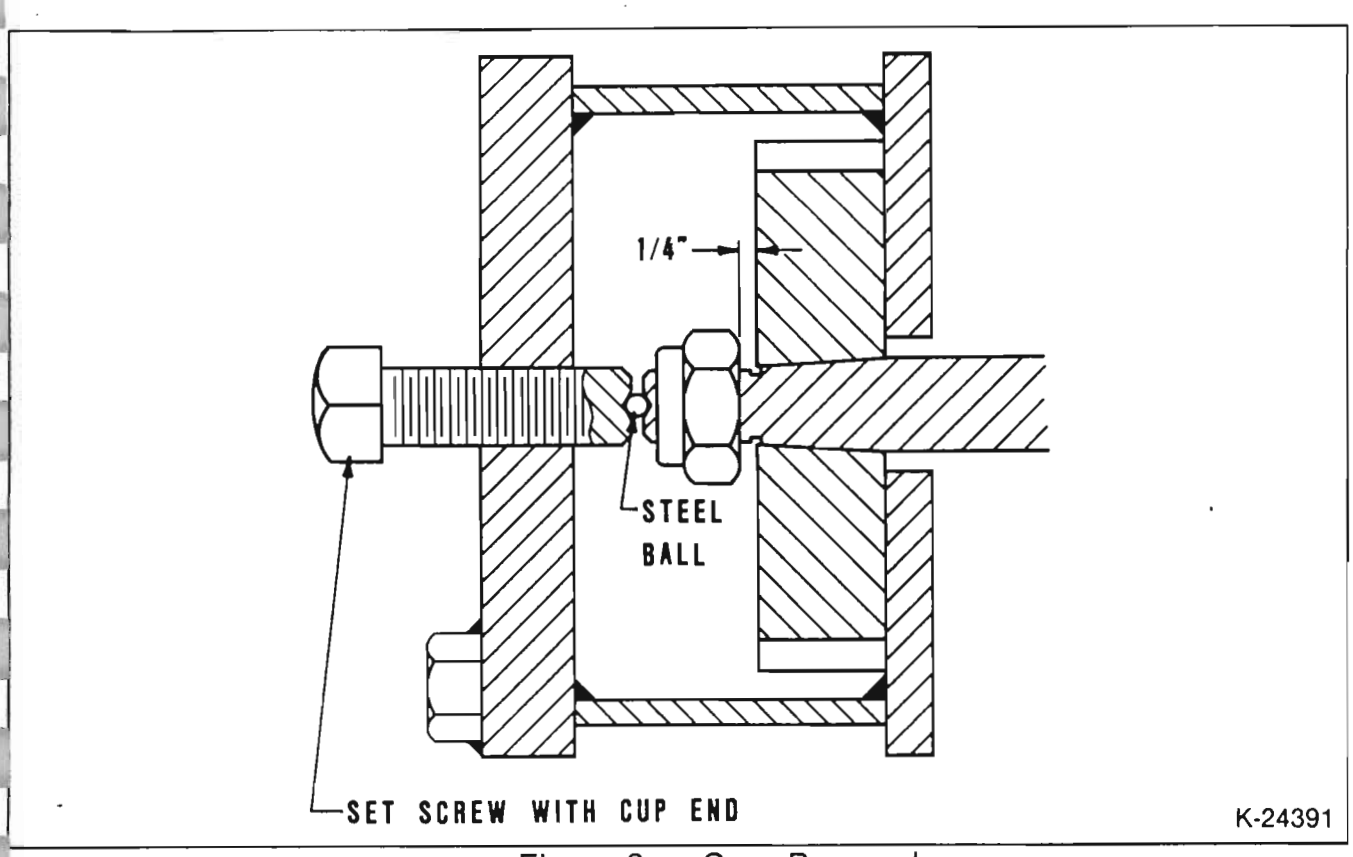
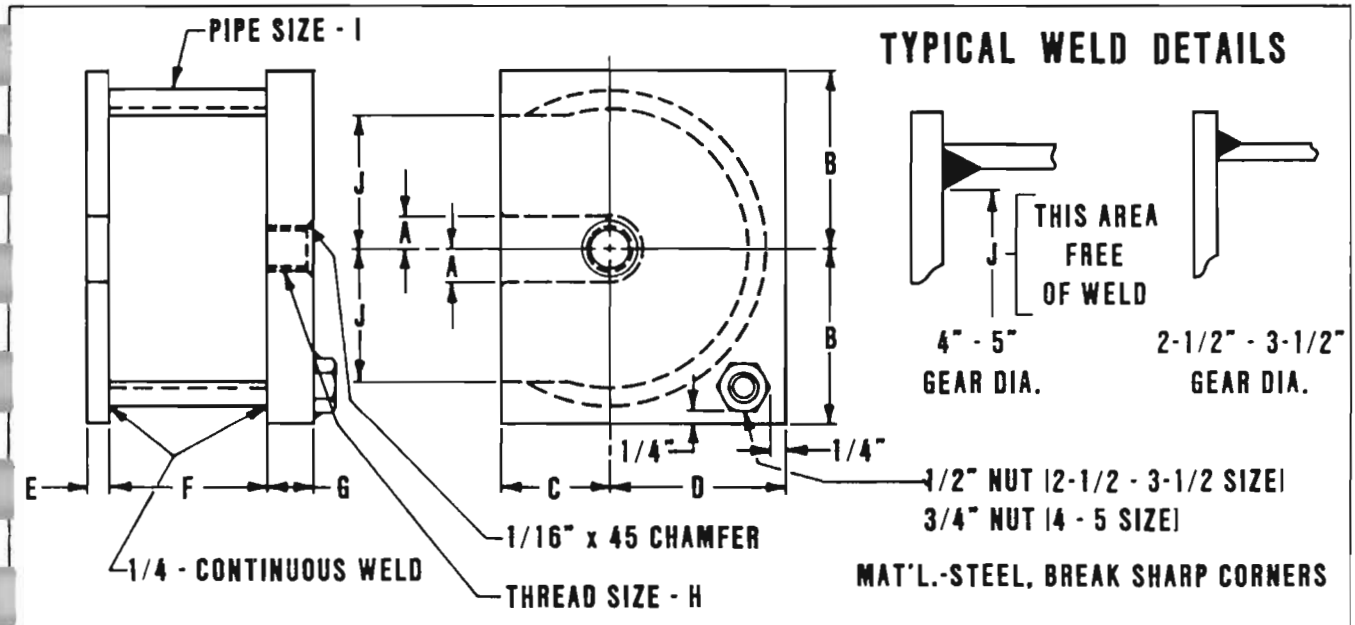
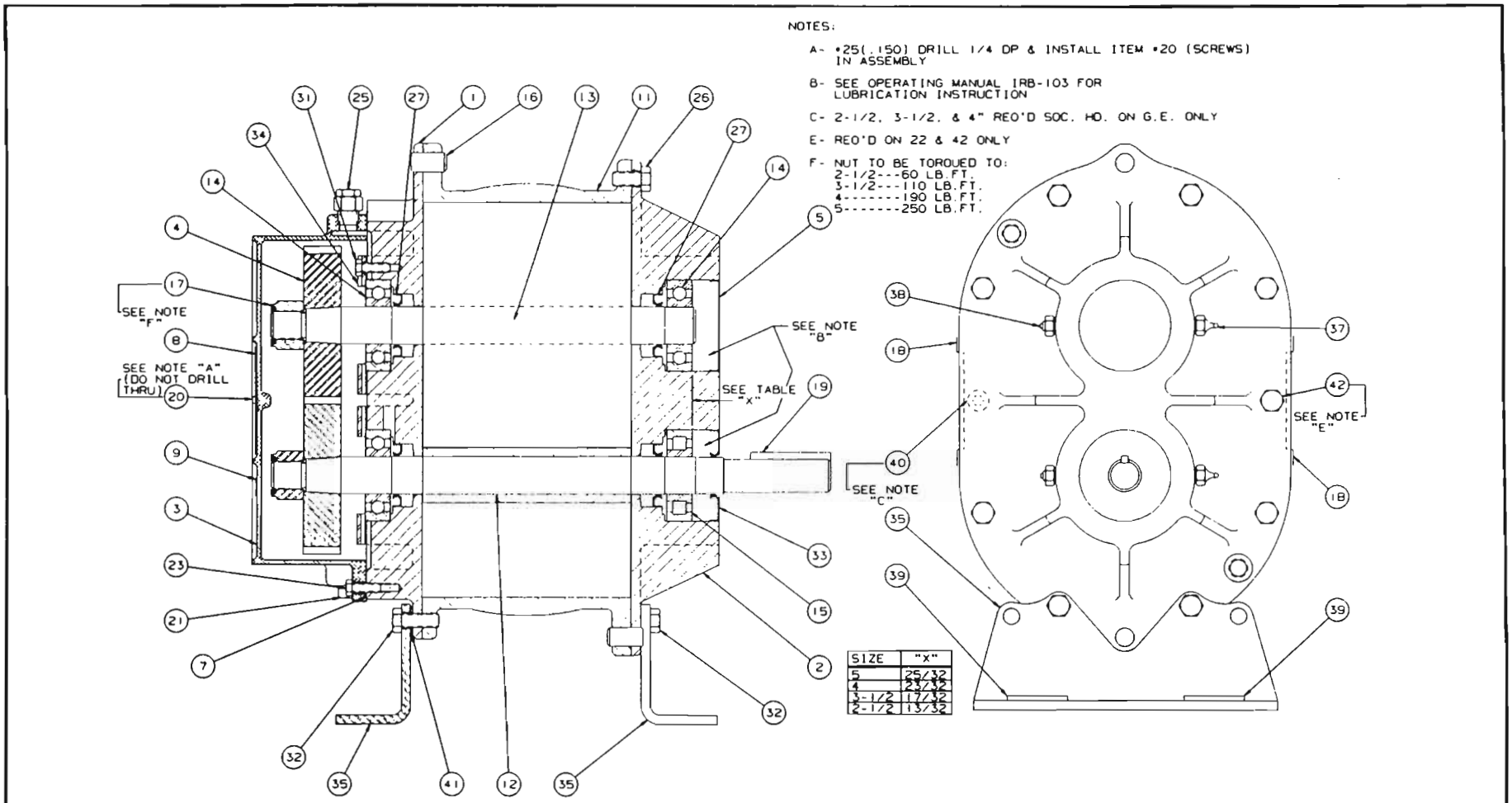


Figure 9 — Gear Removal



BLOWER SIZE	PART NO.	A	B	C	D	E	F	G	H	I	J
2-1/2	812-977-001	3/8	2	1-1/16	2	1/4	2	5/8	7/16-14	3" SCH. - 40	1-3/8
3-1/2	812-977-002	7/16	2-1/2	1-1/4	2-1/2	5/16	2-3/8	3/4	1/2-13	4" SCH. - 40	1-7/8
4	812-977-003	17/32	2-13/16	1-3/4	2-13/16	3/8	2-1/2	3/4	5/8-11	5" SCH. - 40	2-1/8
5	812-977-004	5/8	3-3/8	2	3-3/8	7/16	3	1	3/4-10	6" SCH. - 40	2-11/16

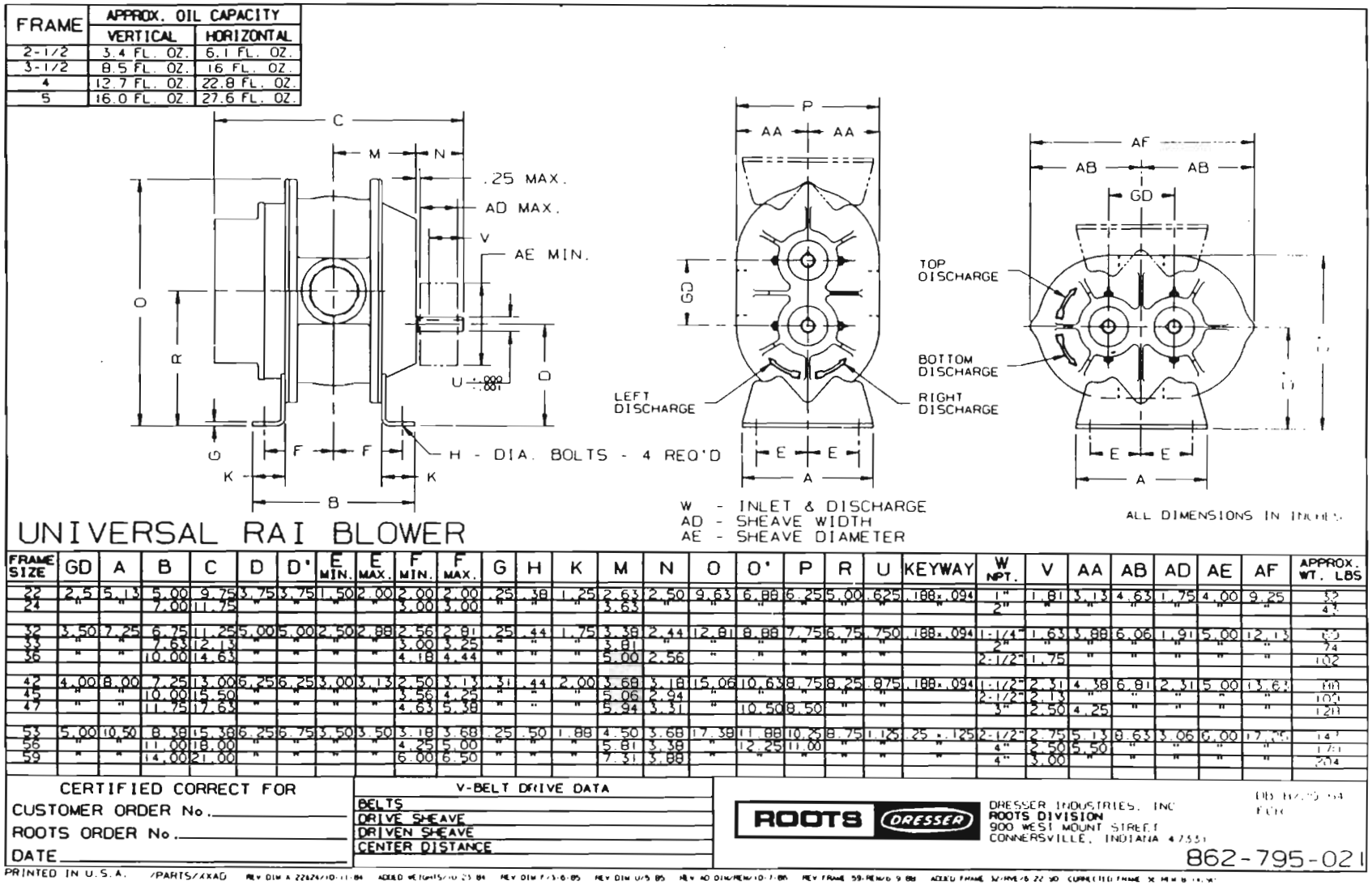
Figure 10 — Gear Pullers for UNIVERSAL RAI® with Tapered Gear Bores 812-977-



ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME
1	Headplate Gear End	12	Impeller & Shaft-Drive	21	Plug, Pipe	35	Foot
2	Headplate Drive End	13	Impeller & Shaft-Driven	23	Screw, Hex	37	Fitting, Grease
3	Gearbox	14	Bearing G.E.,-Driven	25	Breather	38	Fitting, Relief
4	Gears	15	Bearing D.E.-Drive	26	Screw, Hex	7	Gasket
5	Cover-Blind	16	Pin, Dowel	27	Seal, Lip	39	Washer Flat
8	Nameplate-Serial Number	17	Gear Nut	31	Screw, Hex	40	Screw Socket
9	Nameplate-Lub	18	Plug Tin	32	Screw, Hex	41	Washer
		19	Key	33	Seal Lip-Drive	42	Screw Hex
11	Cylinder	20	Screw, Self Tap	34	Clamp Plate		

864-720-023

Figure 11 — Assembly of UNIVERSAL RAI® Blowers, 2½"-5" Gear Diameter



FRAME	APPROX. OIL CAPACITY	
	VERTICAL	HORIZONTAL
2-1/2	3.4 FL. OZ.	6.1 FL. OZ.
3-1/2	8.5 FL. OZ.	16 FL. OZ.
4	12.7 FL. OZ.	22.8 FL. OZ.
5	16.0 FL. OZ.	27.6 FL. OZ.

UNIVERSAL RAI BLOWER

FRAME SIZE	GD	A	B	C	D	D'	E MIN.	E MAX.	F MIN.	F MAX.	G	H	K	M	N	O	O'	P	R	U	KEYWAY	W NPT.	V	AA	AB	AD	AE	AF	APPROX. WT. LBS
22	2.5	5.13	5.00	9.75	3.75	3.75	1.50	2.00	2.00	2.00	.25	.38	1.25	2.63	2.50	9.63	6.88	6.25	5.00	.625	.188 x .094	1"	1.81	3.13	4.63	1.75	4.00	9.25	52
24			7.00	11.75					3.00	3.00				3.63								2"							44
32	3.50	7.25	6.75	11.25	5.00	5.00	2.50	2.88	2.56	2.81	.25	.44	1.75	3.38	2.44	12.81	8.88	7.75	6.75	.750	.188 x .094	1-1/4"	1.63	3.88	6.06	1.91	5.00	12.13	65
33			7.63	12.13					3.00	3.25				3.81								2"							74
36			10.00	14.63					4.18	4.44				5.00	2.56							2-1/2"	1.75						102
42	4.00	8.00	7.25	13.00	6.25	6.25	3.00	3.13	2.50	3.13	.31	.44	2.00	3.68	3.18	15.06	10.63	8.75	8.25	.875	.188 x .094	1-1/2"	2.31	4.38	6.81	2.31	5.00	13.63	100
45			10.00	15.50					3.56	4.25				5.06	2.94							2-1/2"	2.13						103
47			11.75	17.63					4.63	5.38				5.94	3.31		10.50	8.50				3"	2.50	4.25					121
53	5.00	10.50	8.38	15.38	6.25	6.75	3.50	3.50	3.18	3.68	.25	.50	1.88	4.50	3.68	17.38	11.88	10.25	8.75	1.125	.25 x .125	2-1/2"	2.75	5.13	8.63	3.06	6.00	17.75	147
56			11.00	18.00					4.25	5.00				5.81	3.38		12.25	11.00				4"	2.50	5.50					171
59			14.00	21.00					6.00	6.50				7.31	3.88							4"	3.00						204

CERTIFIED CORRECT FOR
CUSTOMER ORDER No. _____
ROOTS ORDER No. _____
DATE _____

V-BELT DRIVE DATA
BELTS
DRIVE SHEAVE
DRIVEN SHEAVE
CENTER DISTANCE

ROOTS DRESSER
DRESSER INDUSTRIES, INC
ROOTS DIVISION
900 WEST MOUNT STREET
CONNERSVILLE, INDIANA 47331

862-795-021

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Figure 12 — Dimensional Assembly of UNIVERSAL RAI® Blower (2½"-5")

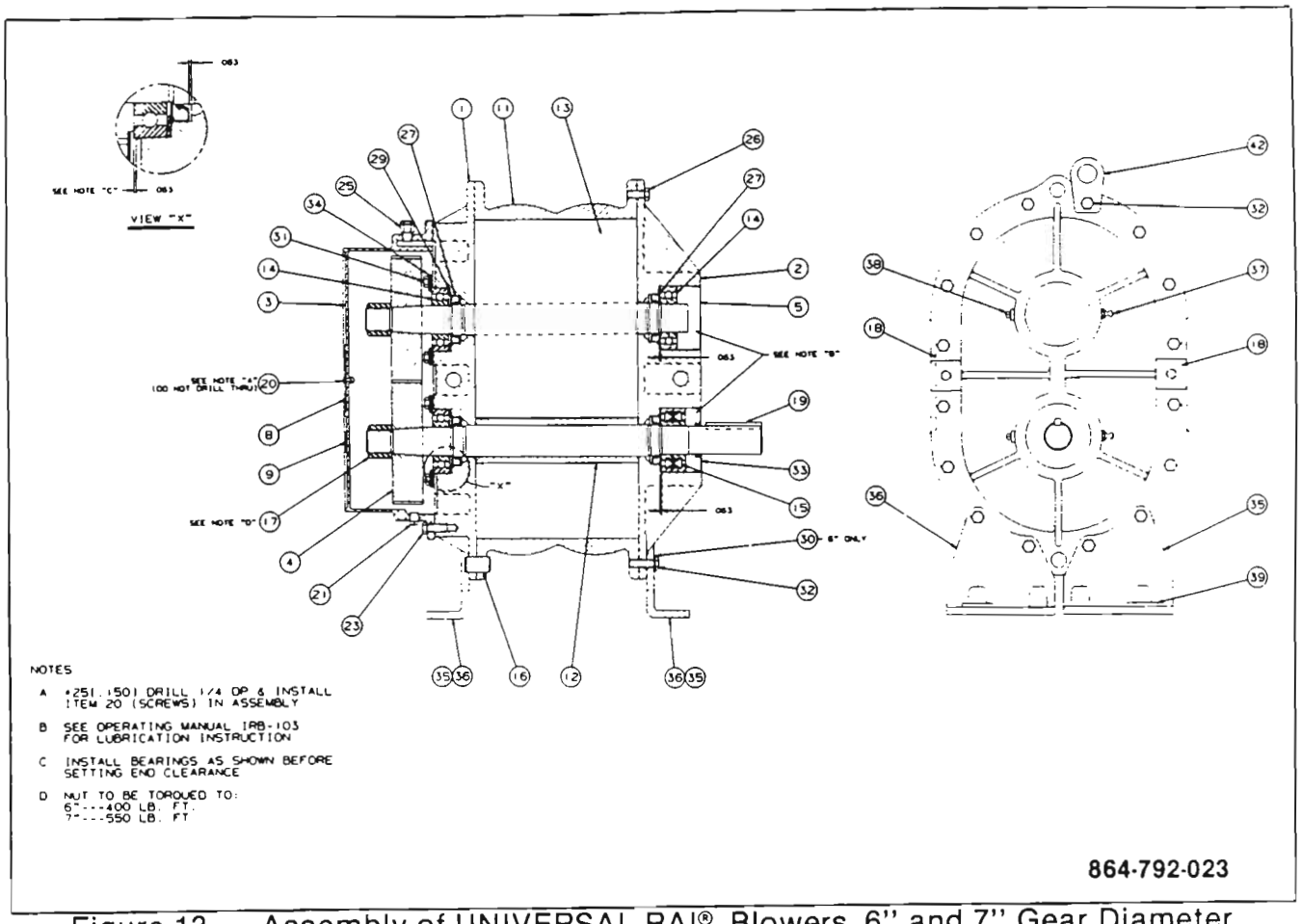
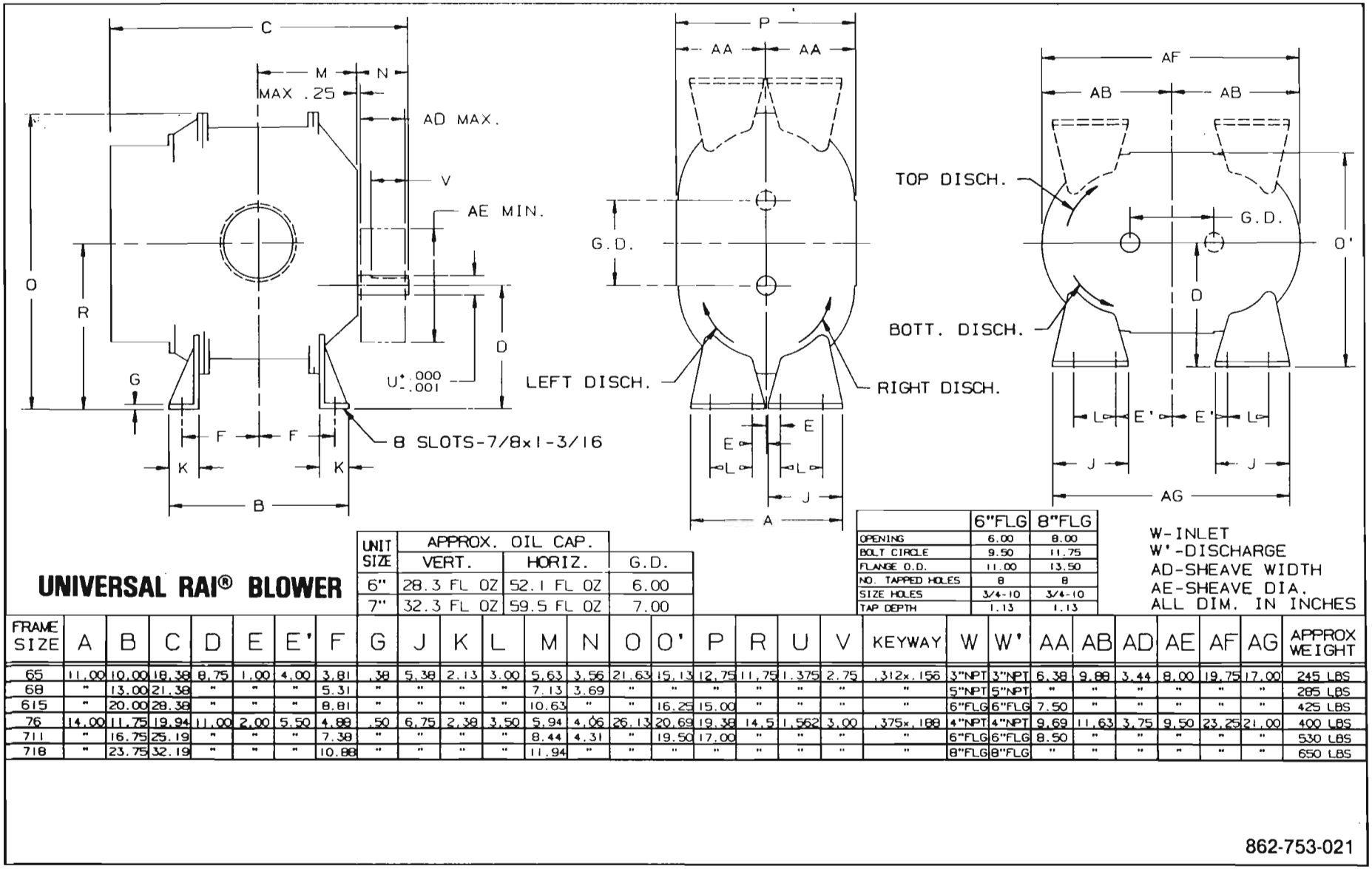


Figure 13 — Assembly of UNIVERSAL RAI® Blowers, 6" and 7" Gear Diameter

PARTS LIST FOR 6"-7" UNIVERSAL RAI®

ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME
1	Headplate - G.E.	13	Imp & Shaft - Drvn	25	Plug - Vent	36	Foot - Lt. Hand
2	Headplate - D.E.	14	Bearing, Ball	26	Screw, Cap - Hex	37	Fitting, Grease
3	Gearbox	15	Bearing, Roller	27	Seal, Lip	38	Plug - Vent
4	Gear Assembly	16	Pin, Dowel	29	Washer - Wavy Spr.	39	Washer - Oblong
5	Plug - Opening	17	Nut, Stop - Hex	30	Washer	40	Pipe - Tbe. (Close)
7	Gasket, Gearbox	18	Plug - Opening	31	Screw, Cap Hex	41	Coupling - Pipe
8	Nameplate - S/N	19	Key, Square	32	Screw, Cap Hex	42	Lifting Lug
9	Nameplate - Lube	20	Screw, Rd. Hd.	33	Seal, Lip		
11	Cylinder	21	Plug, Pipe - Sq. Hd.	34	Brg. Clamp Plate		
12	Imp & Shaft — Drive	23	Screw, Cap - Hex	35	Foot - Rt. Hand		



UNIVERSAL RAI® BLOWER

UNIT SIZE	APPROX. OIL CAP. VERT.	APPROX. OIL CAP. HORIZ.	G.D.
6"	28.3 FL OZ	52.1 FL OZ	6.00
7"	32.3 FL OZ	59.5 FL OZ	7.00

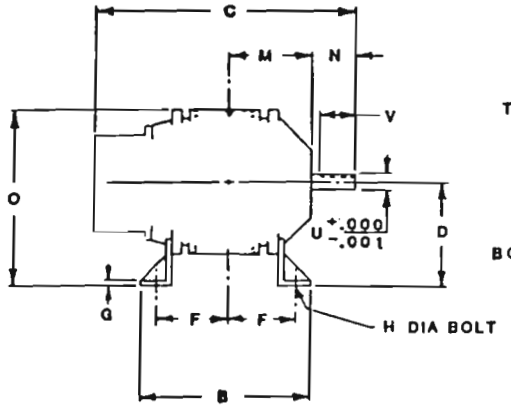
	6"FLG	8"FLG
OPENING	6.00	8.00
BOLT CIRCLE	9.50	11.75
FLANGE O.D.	11.00	13.50
NO. TAPPED HOLES	8	8
SIZE HOLES	3/4-10	3/4-10
TAP DEPTH	1.13	1.13

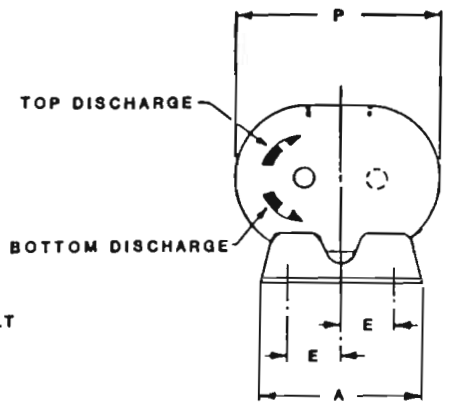
W-INLET
W'-DISCHARGE
AD-SHEAVE WIDTH
AE-SHEAVE DIA.
ALL DIM. IN INCHES

FRAME SIZE	A	B	C	D	E	E'	F	G	J	K	L	M	N	O	O'	P	R	U	V	KEYWAY	W	W'	AA	AB	AD	AE	AF	AG	APPROX WEIGHT
65	11.00	10.00	18.38	8.75	1.00	4.00	3.81	.38	5.38	2.13	3.00	5.63	3.56	21.63	15.13	12.75	11.75	1.375	2.75	.312x.156	3"NPT	3"NPT	6.38	9.88	3.44	8.00	19.75	17.00	245 LBS
68	"	13.00	21.38	"	"	"	5.31	"	"	"	"	7.13	3.69	"	"	"	"	"	"	"	5"NPT	5"NPT	"	"	"	"	"	"	285 LBS
615	"	20.00	28.38	"	"	"	8.81	"	"	"	"	10.63	"	"	16.25	15.00	"	"	"	"	6"FLG	6"FLG	7.50	"	"	"	"	"	425 LBS
76	14.00	11.75	19.94	11.00	2.00	5.50	4.88	.50	6.75	2.38	3.50	5.94	4.06	26.13	20.69	19.38	14.5	1.562	3.00	.375x.188	4"NPT	4"NPT	9.69	11.63	3.75	9.50	23.25	21.00	400 LBS
711	"	16.75	25.19	"	"	"	7.38	"	"	"	"	8.44	4.31	"	19.50	17.00	"	"	"	"	6"FLG	6"FLG	8.50	"	"	"	"	"	530 LBS
718	"	23.75	32.19	"	"	"	10.88	"	"	"	"	11.94	"	"	"	"	"	"	"	"	8"FLG	8"FLG	"	"	"	"	"	"	650 LBS

862-753-021

Figure 14 — Dimensional Assembly of UNIVERSAL RAI® Blower (6" & 7")





W-INLET & DISCHARGE

ALL DIMENSIONS IN INCHES

DIMENSIONS NOT CERTIFIED FOR CONSTRUCTION

NOTE:
UNIVERSAL RAI

1. 45 & 56 U-RAI WILL HAVE TO RUN AT REDUCED SPEED TO DUPLICATE AF PERFORMANCE.
2. LARGER STANDARD SHAFT THAN AF. SEE DIMENSION "U".
3. U-RAI INLET & OUTLET CONNECTIONS ARE LARGER THAN AF ON THE FOLLOWING SIZES: 24, 45, 47, 56 & 59. SEE DIMENSION "W".
4. 45 U-RAI REPLACES 44 AF. 56 U-RAI REPLACES 55 AF.
5. FOR ADDITIONAL INFORMATION CONTACT YOUR SALES REPRESENTATIVE OR THE FACTORY.

FRAME SIZE	A	B	C	D	E	F	H	M	N	O	P	U	V	KEYWAY	W
22 U-RAI	5.13	5.00	9.75	3.75	2.00	2.00	3/8	2.63	2.50	6.88	9.25	.625	1.81	3/16 x 3/32	1" NPT
22 AF	5.50	5.06	9.13	3.75	2.00	2.00	3/8	2.63	1.94	6.86	9.25	.5875	1.31	3/16 x 3/32	1" NPT
24 U-RAI	5.13	7.00	11.75	3.75	2.00	3.00	3/8	3.63	2.50	6.88	9.25	.625	1.81	3/16 x 3/32	2" NPT
24 AF	5.50	7.06	11.13	3.75	2.00	3.00	3/8	3.63	1.94	6.88	9.25	.5875	1.31	3/16 x 3/32	1-1/2" NPT
33 U-RAI	7.25	7.63	12.13	5.00	2.88	3.00	3/8	3.81	2.44	8.88	12.13	.750	1.63	3/16 x 3/32	2" NPT
33 AF	7.25	7.44	12.56	5.00	2.88	3.00	3/8	3.81	2.63	8.88	12.13	.6562	1.66	3/16 x 3/32	2" NPT
36 U-RAI	7.25	10.00	14.63	5.00	2.88	4.18	3/8	5.00	2.56	8.88	12.13	.750	1.75	3/16 x 3/32	2-1/2" NPT
36 AF	7.25	9.81	14.94	5.00	2.88	4.18	3/8	5.00	2.63	8.88	12.13	.6562	1.88	3/16 x 3/32	2-1/2" NPT
42 U-RAI	8.00	7.25	13.00	6.25	3.13	2.94	3/8	3.68	3.18	10.63	13.63	.875	2.31	3/16 x 3/32	1-1/2" NPT
42 AF	8.25	7.13	12.88	6.25	3.13	2.94	3/8	3.68	3.00	10.63	13.63	.7812	2.38	3/16 x 3/32	1-1/2" NPT
45 U-RAI	8.00	10.00	15.50	6.25	3.13	3.56	3/8	5.06	2.94	10.63	13.63	.875	2.13	3/16 x 3/32	2-1/2" NPT
44 AF	8.25	8.83	14.13	6.25	3.13	3.56	3/8	4.31	3.00	10.63	13.63	.7812	2.38	3/16 x 3/32	2" NPT
47 U-RAI	8.00	11.75	17.63	6.25	3.13	5.18	3/8	5.94	3.31	10.50	13.63	.875	2.50	3/16 x 3/32	3" NPT
47 AF	8.25	11.63	17.38	6.25	3.13	5.18	3/8	5.94	3.00	10.63	13.63	.7812	2.30	3/16 x 3/32	2-1/2" NPT
53 U-RAI	10.50	8.38	15.38	6.75	4.25	3.69	3/8	4.50	3.66	11.88	17.25	1.125	2.75	1/4 x 1/8	2-1/2" NPT
53 AF	10.75	8.81	15.44	6.75	4.25	3.69	3/8	4.50	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	2-1/2" NPT
56 U-RAI	10.50	11.00	18.00	6.75	4.25	4.25	3/8	5.81	3.38	12.25	17.25	1.125	2.50	1/4 x 1/8	4" NPT
55 AF	10.75	9.81	16.56	6.75	4.25	4.25	3/8	5.06	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	2-1/2" NPT
59 U-RAI	10.50	14.00	21.18	6.75	4.25	6.50	3/8	7.31	3.38	12.25	17.25	1.125	3.00	1/4 x 1/8	4" NPT
59 AF	10.75	14.31	21.06	6.75	4.25	6.50	3/8	7.31	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	3" NPT

ROOTS DRESSER

DRESSER INDUSTRIES, INC
ROOTS OPERATIONS
900 WEST MOUNT STREET,
CONNERSVILLE, INDIANA 47331

PRINTED IN U.S.A.

COMPARING ROOTS UNIVERSAL RAI® TO ROOTS AF

DB 1-7-85
for
863-813-021

Figure 15

Major Changes when Replacing AF with UNIVERSAL RAI® Blower

Size & Type	Sheave Bushing Dia.	Inlet Size	Disch. Size	Mounting Feet
22 UNIVERSAL RAI®	.625"	1"	1"	Interchangeable
22 AF	.5875"	1"	1"	
24 UNIVERSAL RAI®	.625"	2"	2"	Interchangeable
24 AF	.5875"	1½"	1½"	
32 UNIVERSAL RAI®	.750"	1¼"	1¼"	Special Feet
315 AF	.6562"	¾"	¾"	
33 UNIVERSAL RAI®	.750"	2"	2"	Interchangeable
33 AF	.6562"	2"	2"	
36 UNIVERSAL RAI®	.750"	2½"	2½"	Interchangeable
36 AF	.6562"	2½"	2½"	
42 UNIVERSAL RAI®	.875"	1½"	1½"	Interchangeable
42 AF	.7812"	1½"	1½"	
45 UNIVERSAL RAI®	.875"	2½"	2½"	Reverse Feet
44 AF	.7812"	2"	2"	
47 UNIVERSAL RAI®	.875"	3"	3"	Interchangeable
47 AF	.7812"	2½"	2½"	
53 UNIVERSAL RAI®	1.250"	2½"	2½"	Special Feet
53 AF	.9687"	2½"	2½"	
56 UNIVERSAL RAI®	1.250"	4"	4"	Special Feet
55 AF	.9687"	2½"	2½"	
59 UNIVERSAL RAI®	1.250"	4"	4"	Special Feet
59 AF	.9687"	3"	3"	

*To maintain AF performance with UNIVERSAL RAI®, the blower speed will have to be reduced by sheave change. See Fig. 15 drawing for your specific blower size.

CAUTION CAUTION CAUTION

MAKE CERTAIN THAT THE BREATHER IS LOCATED ON TOP AND THE DRAIN PLUG IN THE BOTTOM OF THE GEAR BOX.

GENERAL TERMS

CONTRACT PERFORMANCE, INSPECTION AND ACCEPTANCE

A. Unless Seller specifically assumes installation, construction or start-up responsibility, all products shall be finally inspected and accepted within thirty (30) days after receipt at point of delivery. Products not covered by the foregoing and all work shall be finally inspected and accepted within thirty (30) days after completion of the applicable work by Seller. All claims whatsoever by Buyer (including claims for shortages) excepting only those provided for under the WARRANTY AND LIMITATION OF LIABILITY and PATENTS Clause hereof must be asserted in writing by Buyer within said thirty (30) day period or they are waived. If this contract involves partial performance, all such claims must be asserted within said thirty (30) day period for each partial performance. There shall be no revocation of acceptance.

Rejection may be only for defects substantially impairing the value of products or work and Buyer's remedy for lesser defects shall be those provided for under the WARRANTY AND LIMITATION OF LIABILITY Clause.

B. Seller shall not be responsible for nonperformance or delays in performance occasioned by any causes beyond Seller's reasonable control, including, but not limited to, labor difficulties, delays of vendors or carriers, fires, governmental actions and material shortages. Any so occasioned shall effect a corresponding extension of Seller's performance dates which are, in any event, understood to be approximate. In no event shall Buyer be entitled to incidental or consequential damages for late performance or a failure to perform.

TITLE AND RISK OF LOSS

Full risk of loss (including transportation delays and losses) shall pass to the Buyer upon delivery of products to the f.o.b. point or if Seller consents to a delay in shipment beyond the contract date at the request of the Buyer, upon notification by the Seller that the products are manufactured.

WARRANTY AND LIMITATION OF LIABILITY

A. Seller warrants that its products and parts, when shipped, and its work (including installation, construction and start-up), when performed will meet all applicable specifications and other specific product and work requirements (including those of performance), if any, of this agreement, will be of good quality and will be free from defects in material and workmanship. All claims for defective products or parts under this warranty must be made in writing immediately upon discovery and, in any event, within eighteen (18) months after installation (not to exceed twenty-four [24] months after shipment) of the applicable item and all claims for defective work must be made in writing immediately upon discovery and in any event within eighteen (18) months after installation (not to exceed twenty-four [24] months after shipment) of completion thereof by Seller. Defective items must be held for Seller's inspection and returned to the original f.o.b. point upon request. THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESS, IMPLIED AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

B. Upon Buyer's submission of a claim as provided above and its substantiation, Seller shall at its option either (i) repair or replace the unit claimed defective within the warranty period defined above, regardless of cause of failure EXCEPT shipping damage, vandalism or mishandling, i.e. dropping or other external impact damage, at the original f.o.b. point of delivery, or (ii) refund an equitable portion of the purchase price.

Seller reserves the right to withdraw the Uncontested Warranty where evidence indicates repeated failures are due to misapplication, abuse, or operation not in accordance with Roots operating instruction bulletin.

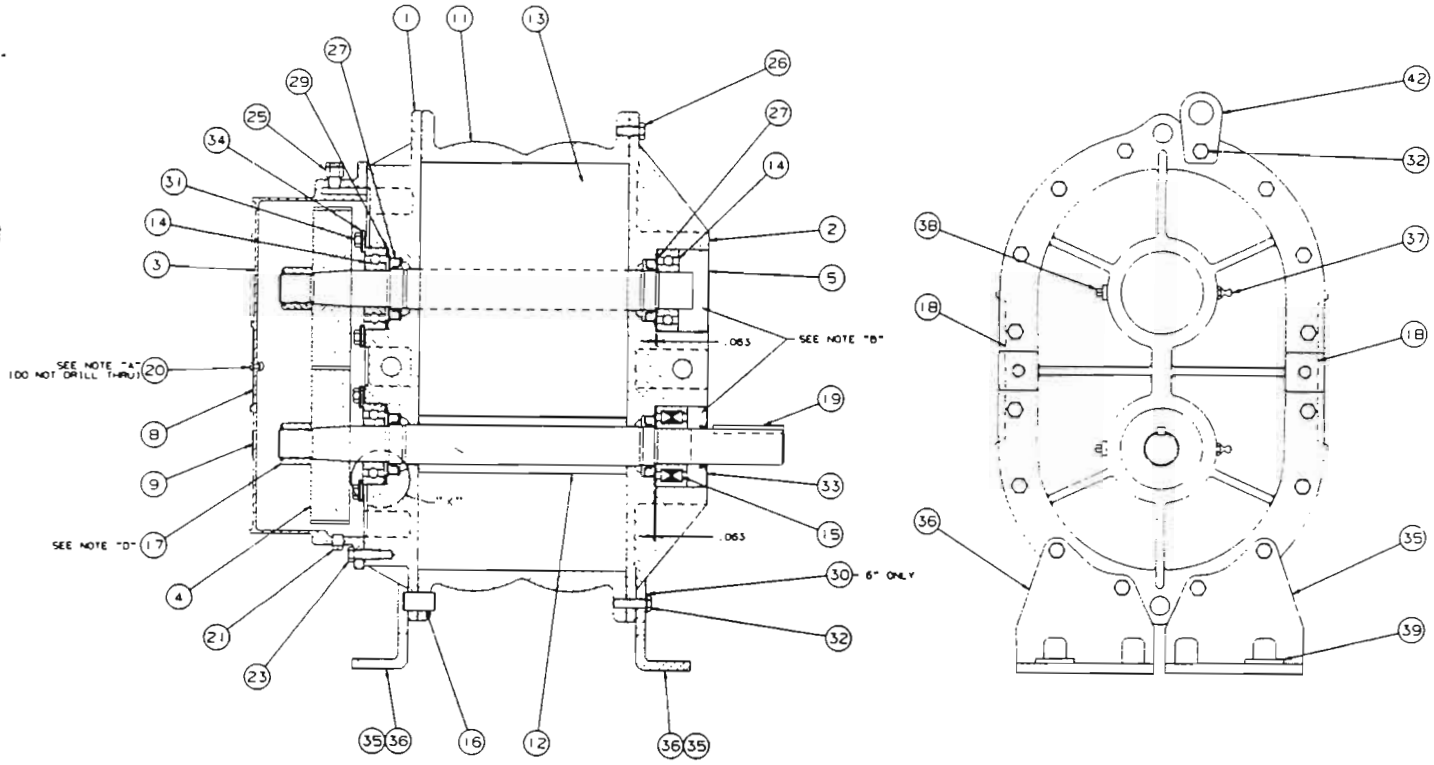
C. The warranty specified herein shall apply to this contract, but it is specifically understood that products sold hereunder are not warranted for operation with erosive or corrosive fluids or those which may tend to build-up within the product quoted. No product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action of any fluid and Buyer shall have no claim whatsoever against Seller therefore, nor for problems resulting from build-up of material within the unit.

D. The foregoing is Seller's only obligation and Buyer's only remedy for breach of warranty, and except for gross negligence, willful misconduct and remedies permitted under the CONTRACT PERFORMANCE, INSPECTION AND ACCEPTANCE and the PATENTS Clause hereof, the foregoing is Buyer's only remedy hereunder by way of breach of contract, tort or otherwise. In no event shall Buyer be entitled to incidental or consequential damages. Any action for breach of this agreement must commence within two (2) years after the cause of action has accrued.

REPAIR KIT INFORMATION

UNIVERSAL RAI®				
REF. NO.	QTY.	PART DESCRIPTION	REPAIR KIT PART NOS.	
4	1 Pr.	Timing Gear	FRAME SIZE	REPAIR KIT NO.
5	1	Plug — Opening	2"	65-101-ORK
7	1	Gasket	3"	65-104-ORK
14	1	Bearing, D.E. — DRVN	4"	65-107-ORK
14	2	Bearing, G.E.	5"	65-111-ORK
15	1	Bearing, Dr. Shaft	*6"	65-115-ORK
17	1	Gear Nut	*7"	65-119-ORK
27	2	Seals, D.E.		
27	2	Seals, G.E.		
31	4	Capscrew — Selflock		
33	1	Seal — Dr. Shaft		

*Repair kits for the 6" and 7" UNIVERSAL RAI® do not contain gears.



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Irving, TX 75015-3287
Ph: 214-986-9300
Fax: 214-986-1589
James Keller, Owner
Craig Lyon, Svc. Manager
Bob Hazzard (151)

Allen-Stuart Equipment Co.** (S13)
12101FM 529
Houston, TX 77041
Ph: 713-896-6510
Fax: 713-896-1693
Steve Allen, President (x118)
Stu Szycher, V.P./Sls. Mgr (x106)
Phil Gordon, Inside Sales (x122)
Bob Hazzard (043)

Duncan Equipment Co. (S07)
3511 No. Central Freeway
Wichita Falls, TX 76306
Ph: 817-855-6110
Fax: 817-855-0849
Choice Thomas, Sls
Dean Faukner, Sls
Bob Hazzard (151)

Mesa Equipment Inc. (S14)
1342 Loma Land Drive
El Paso, TX 79935
Ph: 915-594-1414
Fax: 915-594-9911
Carlos Martinez
RO-CAAM (610)

UTAH
Compressor Pump & Service, Inc.
(W05)
3333 West 2400 South
Salt Lake City, UT 84119
Ph: 801-973-0154
Fax: 801-973-9546
Eric Nelson, Pres.
Rex Feller, V.P
Rudy Doormann (057)

VIRGINIA
Engineered Systems & Products, Inc.
(E09)
P.O. Box 547
East Patricia Ann Lane
Appomattox, VA 24522
Ph: 804-352-5086
Fax: 804-352-7966
George M. Evans, Branch Mgr.
Greg M. Evans, Service Mgr.
Dale Temple (163)

Engineered Systems & Products, Inc.
(E09)
8121 Virginia Pine Court
Richmond, VA 23237
Ph: 804-271-7200
Fax: 804-271-8317
John L. Grant, Pres.
Christopher H. Isenberg, V.P.
M. Meade Gregory, Sls. Engr., P.E.
Dale Temple (163)

WASHINGTON
Rogers Machinery Co., Inc (W09)
P.O. Box 548
3409 Galvin Road
Centralia, WA 98531
Ph: 360-736-9356
Fax: 360-736-8630
Mike Cramer
APSCO (625)

Rogers Machinery Co., Inc. (W09)
7800 Fifth Avenue South
Seattle, WA 98108
Ph: 206-763-2530
Fax: 206-763-1187
Jim Kirkmire, Pres.
Mike Curatty, Branch Mgr.
Mike Schmeltzer, Sales Mgr.
APSCO (625)

Rogers Machinery Co., Inc. (W09)
Spokane Industrial Park
East 15615 Euclid Avenue
Spokane, WA 99216
Ph: 509-922-0556
Fax: 509-922-0910
Dave Syrotchen
APSCO (625)

Northwest Blowers & Equip. (W07)
2879 152ND Avenue, NE
Redmond, WA 98052
Ph: 206-867-5870
Fax: 206-867-5872
Ben Gorman
Rudy Doormann (057)

WEST VIRGINIA
West Virginia Pump (E16)
20 East 24th Street
Huntington, WV 25721
Ph: 304-529-4161
Fax: 304-522-9361
Randy Doss, Sig. Engr.
Terry Warden, Ap. Engr.
Al Bader, Facility Mgr.
Dave Roessler (141)

WISCONSIN
Fuery Filter & Pump, Inc. (M03)
12300 W Carmen Avenue
Milwaukee, WI 53225
Ph: 414-358-5555
Fax: 414-358-5544
George B. Furey, President
Jack Furey, Sales
Douglas Furey, Sales
Jeff Schmidt, Engr.
Jeff Aversa (056)

CANADA
Peacock/Dunbar (C01)
10 Morris Drive, Unit 9
Burnside Industrial Park
Dartmouth, Nova Scotia B3B 1K8
Canada
Ph: 902-468-5599
Fax: 902-468-1061
Paul W. Balcom, Owner
Blake J. Carter, Sales
Dennis Hayes (204)

Beckland Equipment Ltd. (W03)
3250 Beta Avenue
Burnaby, B.C. V5G 4K4
Canada
Ph: 604-299-8808
Fax: 604-299-6162
Fraser Bringeland, Sls. Mgr
Harold Bringland
Rudy Doormann (057)

Canadian Air Compressor Ltd. (C02)
1409 Rue Bergar
Laval, Quebec H7L 4Z7
Canada
Ph: 514-669-9117
Fax: 514-334-3138
Richard F. Pearce, Pres.
Adam E. Pearce, V.P.
Prolew-Scott, Ltd. (615)

Canadian Air Compressor Ltd. (C02)
57 Atomic Avenue
Toronto, Ontario M8Z 5K8
Canada
Ph: 416-252-9505
800-387-7270
Fax: 416-252-9228
Jay Pearce, V.P
Joel Pearce
Dennis Hayes (204)

Prolew-Scott Limited* (C03)
1515 Matheson Boulevard
Unit C-1
Mississauga, Ontario L4W 2P5
Canada
Ph: 905-624-6330
Fax: 905-624-7590
Kent Lowndes, Mgr.
Dennis Hayes (204)

Prolew-Scott Limited* (C03)
5859 CH St-Francois
Montreal, Quebec H4S 1B6
Canada
Ph: 514-336-5661
Fax: 514-336-1158
Gordon Yapp, Pres.
Ray Richer, Sr. Sales
Dennis Hayes (204)

Installation, Operation and Maintenance Instructions

Model NPE/ NPE-F

DESCRIPTION & SPECIFICATIONS:

The Models NPE (close-coupled) and NPE-F (frame-mounted) are end suction, single stage centrifugal pumps for general liquid transfer service, booster applications, etc. Liquid-end construction is all AISI Type 304 stainless steel, stamped and welded. Impellers are fully enclosed, non-trimable to inter-mediate diameters. Casings are fitted with a diffuser for efficiency and for negligible radial shaft loading.

Close-coupled units have NEMA 48J or 56J motors with C-face mounting and threaded shaft extension. Frame-mounted units can be coupled to motors through a spacer coupling, or belt driven.

1. Important:

1.1. Inspect unit for damage. Report any damage to carrier/dealer immediately.

1.2. Electrical supply must be a separate branch circuit with fuses or circuit breakers, wire sizes, etc., per National and Local electrical codes. Install an all-leg disconnect switch near pump.

CAUTION

Always disconnect electrical power when handling pump or controls.

1.3. Motors must be wired for proper voltage. Motor wiring diagram is on motor nameplate. Wire size must limit maximum voltage drop to 10% of nameplate voltage at motor terminals, or motor life and pump performance will be lowered.

1.4. Always use horsepower-rated switches, contactors and starters.

1.5. Motor Protection

1.5.1. Single-phase: Thermal protection for single-phase units is sometimes built in (check nameplate). If no built-in protection is provided, use a contactor with a proper overload. Fusing is permissible.

1.5.2. Three-phase: Provide three-leg protection with properly sized magnetic starter and thermal overloads.

1.6. Maximum Operating Limits:

Liquid Temperature:	212F (100C) with standard seal.
	250F (120C) with optional high temp seal.
Pressure:	75 PSI.
Starts Per Hour:	20, evenly distributed.

1.7. Regular inspection and maintenance will increase service life. Base schedule on operating time. Refer to Section 8.

2. Installation:

2.1. General

2.1.1. Locate pump as near liquid source as possible (below level of liquid for automatic operation).

2.1.2. Protect from freezing or flooding.

2.1.3. Allow adequate space for servicing and ventilation.

2.1.4. All piping must be supported independently of the pump, and must "line-up" naturally.

CAUTION

Never draw piping into place by forcing the pump suction and discharge connections.

2.1.5. Avoid unnecessary fittings. Select sizes to keep friction losses to a minimum.

2.2. Close-Coupled Units:

2.2.1. Units may be installed horizontally, inclined or vertically.

CAUTION

Do not install with motor below pump. Any leakage or condensation will affect the motor.

2.2.2. Foundation must be flat and substantial to eliminate strain when tightening bolts. Use rubber mounts to minimize noise and vibration.

2.2.3. Tighten motor hold-down bolts before connecting piping to pump.

2.3. Frame-Mounted Units:

2.3.1. Bedplate must be grouted to a foundation with solid footing. Refer to Fig.1.

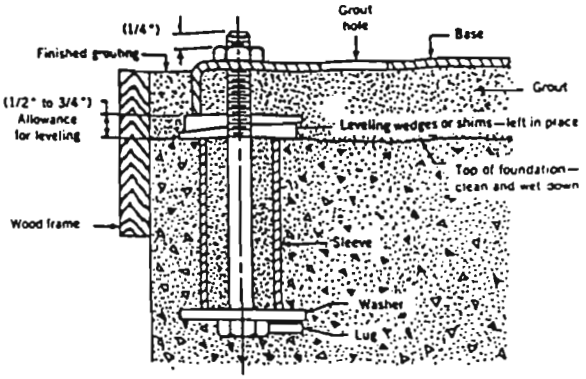


Figure 1

7.2. Make complete check after unit is run under operating conditions and temperature has stabilized. Check for expansion of piping. On frame-mounted units coupling alignment may have changed due to the temperature differential between pump and motor. Recheck alignment.

8. Maintenance:

8.1. Close-Coupled Unit. Ball bearings are located in and are part of the motor. They are permanently lubricated. No greasing required.

8.2. Frame-Mounted Units:

8.2.1. Bearing frame should be regreased every 2,000 hours or 3 month interval, whichever occurs first. Use a #2 sodium or lithium based grease. Fill until grease comes out of relief fittings, or lip seals, then wipe off excess.

8.2.2. Follow motor and coupling manufacturers' lubrication instructions.

8.2.3. Alignment must be rechecked after any maintenance work involving any disturbance of the unit.

9. Disassembly:

Complete disassembly of the unit will be described. Proceed only as far as required to perform the maintenance work needed.

9.1. Turn off power.

9.2. Drain system. Flush if necessary.

9.3. Close-Coupled Units: Remove motor hold-down bolts.

Frame-Mounted Units: Remove coupling, spacer, coupling guard and frame hold-down bolts.

9.4. Disassembly of Liquid End:

9.4.1. Remove casing bolts (370).

9.4.2. Remove back pull-out assembly from casing (100).

9.4.3. Remove impeller locknut (304).

CAUTION

Do not insert screwdriver between impeller vanes to prevent rotation of close-coupled units. Remove cap at opposite end of motor. A screwdriver slot or a pair of flats will be exposed. Using them will prevent impeller damage.

9.4.4. Remove impeller (101) by turning clockwise. Protect hand with rag or glove.

9.4.5. With two pry bars 180 degrees apart and inserted between the seal housing (184) and the motor adapter (108), carefully separate the two parts. The mechanical seal rotary unit (383) should come off the shaft with the seal housing.

9.4.6. Push out the mechanical seal stationary seat from the motor side of the seal housing.

9.5. Disassembly of Bearing Frame:

9.5.1. Remove bearing cover (109).

9.5.2. Remove shaft assembly from frame (228).

9.5.3. Remove lip seals (138 & 139) from bearing frame and bearing cover if worn and are being replaced.

9.5.5. Use bearing puller or arbor press to remove ball bearings (112 & 168).

10. Reassembly:

10.1. All parts should be cleaned before assembly.

10.2. Refer to parts list to identify required replacement items. Specify pump index or catalog number when ordering parts.

10.3. Reassembly is the reverse of disassembly.

10.4. Observe the following when reassembling the bearing frame:

10.4.1. Replace lip seals if worn or damaged.

10.4.2. Replace ball bearings if loose, rough or noisy when rotated.

10.4.3. Check shaft for runout. Maximum permissible is .002" T.I.R.

10.5. Observe the following when reassembling the liquid-end:

10.5.1. All mechanical seal components must be in good condition or leakage may result. Replacement of complete seal assembly, whenever seal has been removed, is good standard practice.

It is permissible to use a light lubricant, such as glycerin, to facilitate assembly. Do not contaminate the mechanical seal faces with lubricant.

10.5.2. Inspect casing O-ring (513) and replace if damaged. This O-ring may be lubricated with petroleum jelly to ease assembly.

10.5.3. Inspect guidevane O-ring (349) and replace if worn.

CAUTION

Do not lubricate guidevane O-ring (349). Insure it is not pinched by the impeller on reassembly.

10.6. Check reassembled unit for binding. Correct as required.

11. Trouble Shooting Chart:

MOTOR NOT RUNNING
(See causes 1 thru 6)

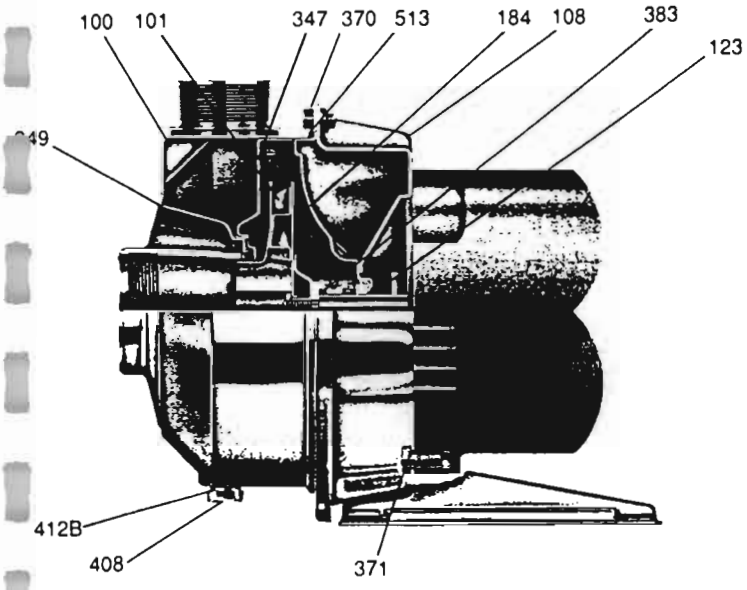
LITTLE OR NO LIQUID DELIVERED:
(See causes 7 thru 17)

POWER CONSUMPTION TOO HIGH:
(See causes 4, 17, 18, 19, 22)

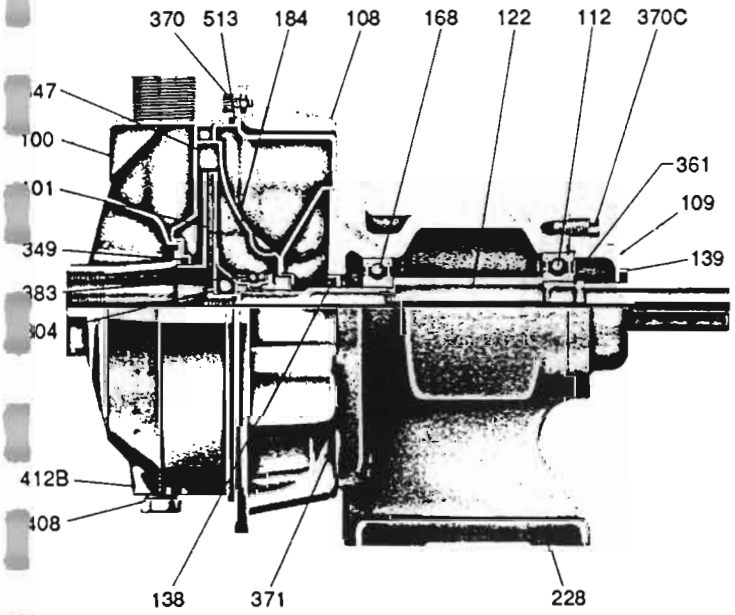
EXCESSIVE NOISE AND VIBRATION:
(See causes 4, 6, 9, 13, 15, 16, 18, 20, 21, 22)

PROBABLE CAUSE:

1. Tripped thermal protector
2. Open circuit breaker
3. Blown fuse
4. Rotating parts binding
5. Motor wired improperly
6. Defective motor
7. Not primed
8. Discharge plugged or valve closed
9. Incorrect rotation
10. Foot valve too small, suction not submerged, inlet screen plugged.
11. Low voltage
12. Phase loss (3-phase only)
13. Air or gasses in liquid
14. System head too high
15. NPSHA too low:
    Suction lift too high or suction losses excessive. Check with vacuum gauge.
16. Impeller worn or plugged
17. Incorrect impeller diameter
18. Head too low causing excessive flow rate
19. Viscosity or specific gravity too high
20. Worn bearings
21. Pump or piping loose
22. Pump and motor misaligned



NPE



NPE-F

Liquid End Components		
Item No.	Description	Materials
100	Casing	AISI 304 Stainless Steel
101	Impeller	
184	Seal Housing	
304	Impeller Locknut	
347	Guidevane	
349	O-Ring, Guidevane	Buna-N
370	Socket Hd. Screws, Casing	AISI 304 S.S.
383	Mechanical Seal	** see chart
408	Drain & Vent Plug, Casing	AISI 304 S.S.
412B	O-Ring, Drain & Vent Plug	Buna-N
513	O-Ring, Casing	Buna-N
	Power End Components	
108	Adapter	AISI 304 S.S.
109	Bearing Cover	Cast Iron
112	Ball Bearing (Outboard)	Steel
122	Shaft	AISI 303 S.S.
138	Lip Seal (Inboard)	Buna/Steel
139	Lip Seal (Outboard)	Buna/Steel
168	Ball Bearing (Inboard)	Steel
228	Bearing Frame	Cast Iron
361	Snap Ring	Steel
370C	Hex. Hd. Cap Screw, Brg. Cvr.	Plated Steel
371	Hex. Hd. Cap Screw, Adapter	Plated Steel

**Mechanical Seals–Item 383						
Part No.	Service	Rotary	Stationary	Elastomer	Metal Parts	Crane Type
10K10	Standard	Carbon	Ceramic	Buna	18-8 S.S.	6
10K6	Option-Severe Duty		Ni-Resist			
10K18	Option-High Temp.			EPR		21
10K24	Option-Chemeical Duty		Ceramic	Viton		

LIMITED WARRANTY

This warranty applies to all pumps and related accessories manufactured and/or supplied by Goulds Pumps, Inc. - Water Systems Division.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the buyer or any subsequent owner during the warranty period. The warranty period shall exist for twelve (12) months from date of installation, or eighteen (18) months from date of manufacture, whichever expires first.

A consumer who believes that a warranty claim exists must contact the authorized dealer from whom the equipment was originally purchased and furnish complete details regarding the claim. The dealer is authorized to adjust any warranty claim utilizing Goulds Customer Relations Department and its distributor organization.

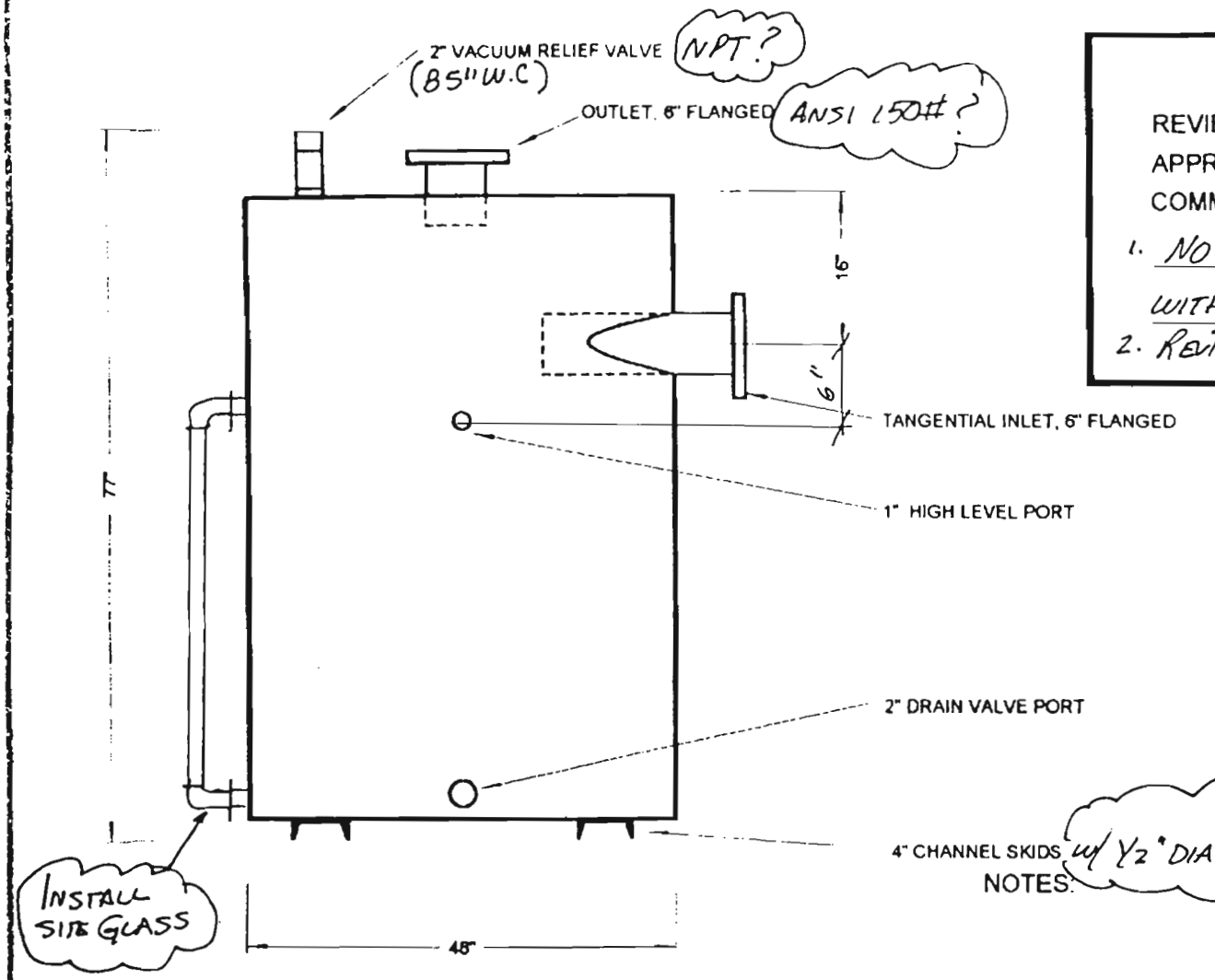
This warranty excludes: (a) Labor, transportation and related costs incurred by the consumer to make the allegedly defective equipment available to the dealer for inspection. (b) Re-installation costs of repaired equipment. (c) Re-installation costs of replacement equipment. (d) Consequential damages of any kind. (e) Reimbursement for loss caused by interruption of service.

Soil Vapor Extraction/Air Sparging
Naval Weapons Industrial Reserve Plant
Bethpage, NY
EXHIBIT 8
Master Motor List

Tag Number	Equipment Description	Hp	Voltage	Phase	Hertz	Frame	Type
B-01	SVE Blower B-01	7.5	460	3	60	213T	CT
B-02	AS Blower B-02	7.5	460	3	60	213T	CT
P-01	Condensate Pump P-01	1.5	460	3	60	56J	CT

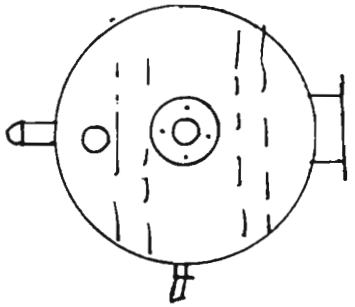
Tag Number	Equipment Description	SF	Amps	RPM	Duty	Code	Max. Amb
B-01	SVE Blower B-01	1.15	10.7	1740	Cont	M	40 °C
B-02	AS Blower B-02	1.15	10.7	1740	Cont	M	40 °C
P-01	Condensate Pump P-01	1	2.7-2.9	2875	Cont	M	40 °C

Tag Number	Equipment Description	Shiftend Bearing	Opp. End Bearing	ID #	NEMA	Nom. Eff.	FLA
B-01	SVE Blower B-01	6208-2ZJC3	6206-2ZJC3	E401-A02Z345R06#M		86.5	22.5
B-02	AS Blower B-02	6208-2ZJC3	6206-2ZJC3	E401-A02Z345R06#M		86.5	22.5
P-01	Condensate Pump P-01	-	-	1312480103			2.4



REVIEW DATE: 3/2/98
APPROVED BY: [signature] AS NOTED
COMMENTS:
1. NO COST IMPACTS ASSOCIATED WITH THESE COMMENTS
2. REVISE AND SUBMIT FINAL DRAWING

SHOW PLAN VIEW:



NOTES: w/ ½" DIA ANCHOR BOLT HOLES

1. DRAIN VALVE, 2" BRASS BALL VALVE, PLUGGED NPT
2. H/L/ SWITCH, DWYER MODEL L6EPB-B-S-3-A (SPST)
3. PRIME TANK, FINISH ENAMEL SAFETY BLUE
4. LABEL TANK "MOISTURE SEPARATOR TANK M-01"
5. VACUUM RELIEF VALVE, FUJI MODEL VV6
6. NO INTERNAL LINING/EPOXY

ADD TO NOTES

TANK BODY 7 GAUGE CARBON STEEL

Foster Wheeler Moisture Separator

APPROVAL DRAWING

FIGURE 1

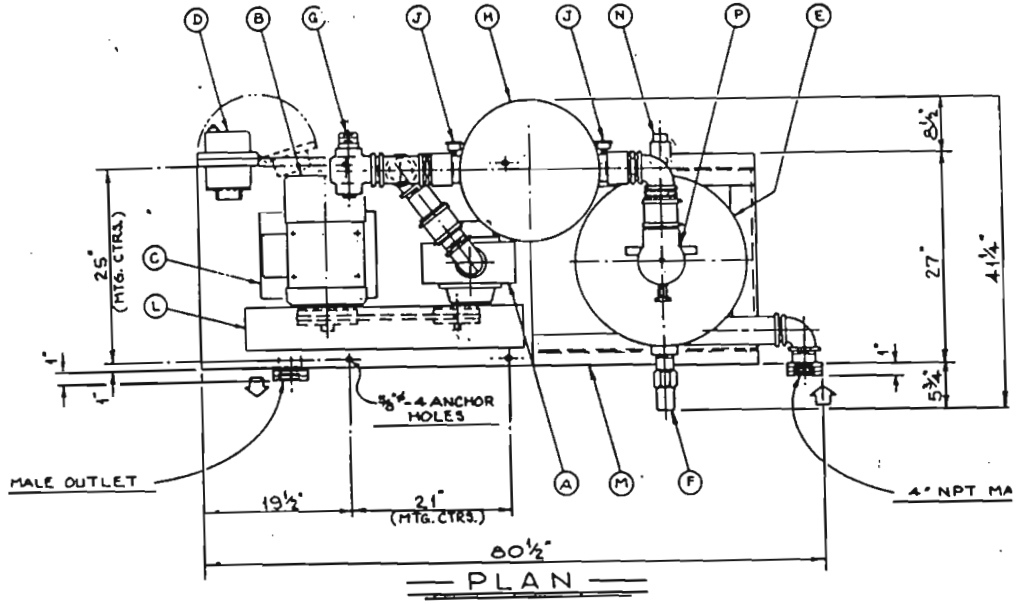
DRAWN BY:	RJP
DATE:	2/27/98
CHECKED BY:	RJP
SCALE:	NSA
DRAWING NO:	

REVISIONS	
NO.	DATE

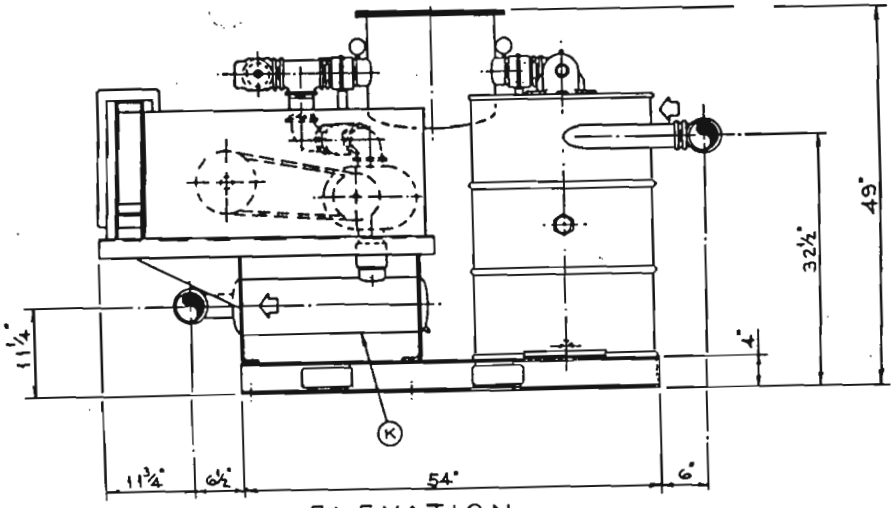
205 BROADWAY STREET
DURHAM, NC 27701
(919) 682-2054
ENVIRONMENTAL SERVICES

B-01 BLOWER

BILL OF MATERIAL		
IT.	QTY.	DESCRIPTION 47
A	1	BLOWER PACKAGE - ROOTS 36URAI
B	1	UNITED ELECTRIC MOTOR 6056, 7½ H.P., 3
		60HZ., 480V., 1760 R.P.M., CLASS 1, GROUP I
		DIV. 2, 213T FRAME
C	1	MOTOR SLIDE BASE - OVERLY HAUTZ 213A?
D	1	BOLTED ENCLOSURE MOTOR STARTER - A-B
		509BEB1, CLASS 1, GROUP D, DIV. 2
E	1	MOISTURE SEPARATOR - EG&G ROTON
		MS350BS
F	1	LEVEL FLOAT SWITCH
G	1	VACUUM RELIEF VALVE - KUNKLE 215-H01-QE
		(SET @ 8" HG) 2" NPT MALE DISCHARGE
H	1	VACUUM INLINE FILTER - STODDARD F65V-3
J	2	VACUUM GAGE - MARSH J7605P
K	1	DISCHARGE SILENCER
L	1	FABRICATED STEEL BELT GUARD
M	1	STRUCTURAL STEEL BASE 76620-BPD-1
N	1	1" DRAIN VALVE
P	1	VACUUM LIMIT RELIEF VALVE



PLAN



ELEVATION

DAN MAKRUCKI SALES ELL

AIRTEK, Inc.
P. O. BOX 466
IRWIN, PA. 15642
(412) 863-1200 · 251-3037
FAX 412-864-7553

airtek inc.

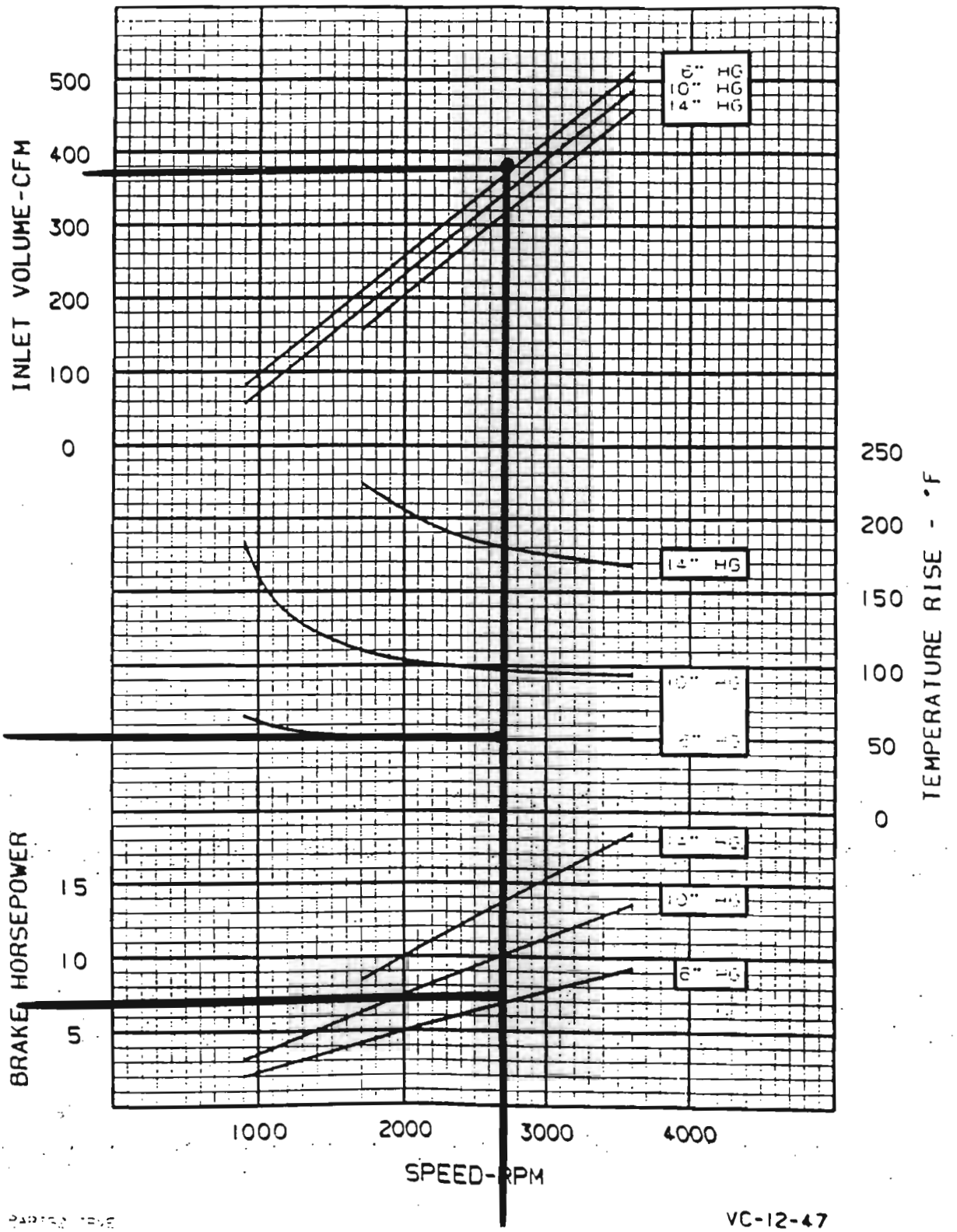
ROOTS 36URAI COMPLETE BLOW
PACKAGE WITH MOISTURE SEPARA

DRAWN BY DTB
DATE 01-21-97
CHKD. BY
DATE

DRAWING NO
76620-APG-1

ROOTS DIVISION

VACUUM PERFORMANCE
FRAME 47 UNIVERSAL RAI BLOWER
MAXIMUM VACUUM=15 IN. HG
MAXIMUM SPEED=3600 RPM



VC-12-47

ROOTS DRESSER
900 WEST MOUNT STREET
CONNERSVILLE, INDIANA 47331

COMPANY : _____ PHN. : _____

ATTN. : _____ FAX : _____

REFERENCE : _____

PERFORMANCE

BAROMETER (PSIA) _____ DISCHARGE PRESSURE (PSIA) _____

INLET PRESSURE (PSIA) _____ DISCHARGE TEMP. (°F) _____

INLET TEMPERATURE (°F) _____ BLOWER SPEED (RPM) _____

INLET FLOW (ACFM) _____ BLOWER BRAKE HP _____

BILL OF MATERIALS – 2F PACKAGE

■ ITEMS SUPPLIED IN PACKAGE

■ BLOWER _____

☐ MOTOR: FRAME _____ HP _____ RPM _____

MFG. _____ VOLT _____

☐ INLET FILTER _____ ■ INLET FILTER/SILENCER _____

☐ INLET SILENCER _____ ■ DISCHARGE SILENCER 2"

☐ CHECK VALVE: Techno-Check 5002 class A

☐ BUTTERFLY VALVE: PDC

☐ TEMP. GAUGE: Ashcroft ; 50-550° RANGE

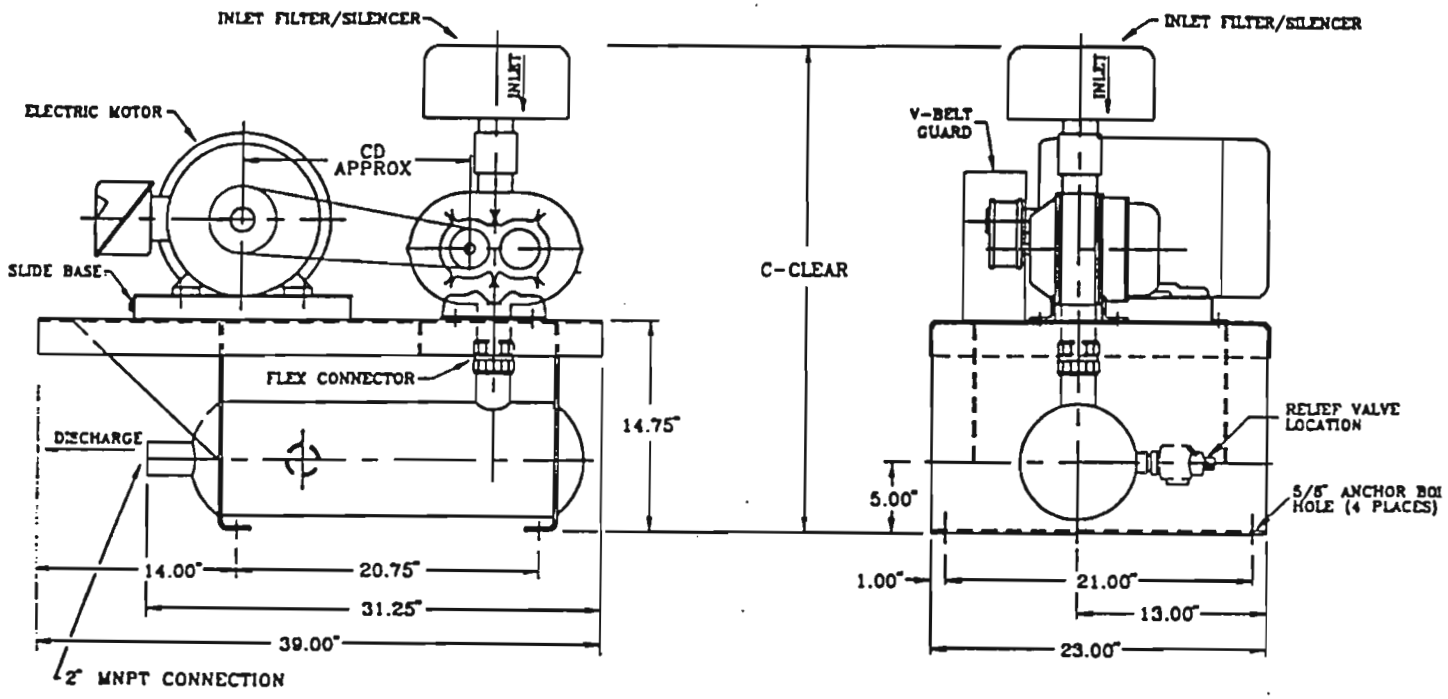
☐ TEMP. SWITCH: 0-425°F RANGE NEMA 4 ( ) NEMA 7 ( )

☐ PRESS. GAUGE: WIKA ; 0-15 PSI RANGE

☐ PRES. SWITCH: 3-20 PSI RANGE NEMA 4 ( ) NEMA 7 ( )

■ RELIEF VALVE: 2"-337

ROOTSPAK STANDARD ARRANGEMENT



MODEL	BLOWER	C	CD	APPROX NET WT. (LBS.)
22-1.5-2	22 URAI	34.38	15.50	240
24-2-2	24 URAI	32.38	15.50	250
32-1.5-2	32 URAI	35.38	15.50	270
32-2-2	32 URAI	36.38	15.50	275
33-2-2	33 URAI	35.88	15.50	280
42-2-2	42 URAI	32.63	15.50	295

NOTES:
1. ALL DIMENSIONS ARE IN INCHES
2. PACKAGES MAY NOT BE EXACTLY AS SHOWN.
3. APPROX. WEIGHTS DO NOT INCLUDE MOTOR.
4. ALL INSTRUMENTS MOUNTED IN DISCH. SILENCER.

FPAK-2

PROPOSAL

PACKAGE PRICE AS SHOWN: _____ EA. QTY: _____

F.O.B. _____ FREIGHT COLLECT

DELIVERY: _____ WEEKS A R O

TERMS OF PAYMENT : NET 30 DAYS

OPTIONAL PRICING : _____

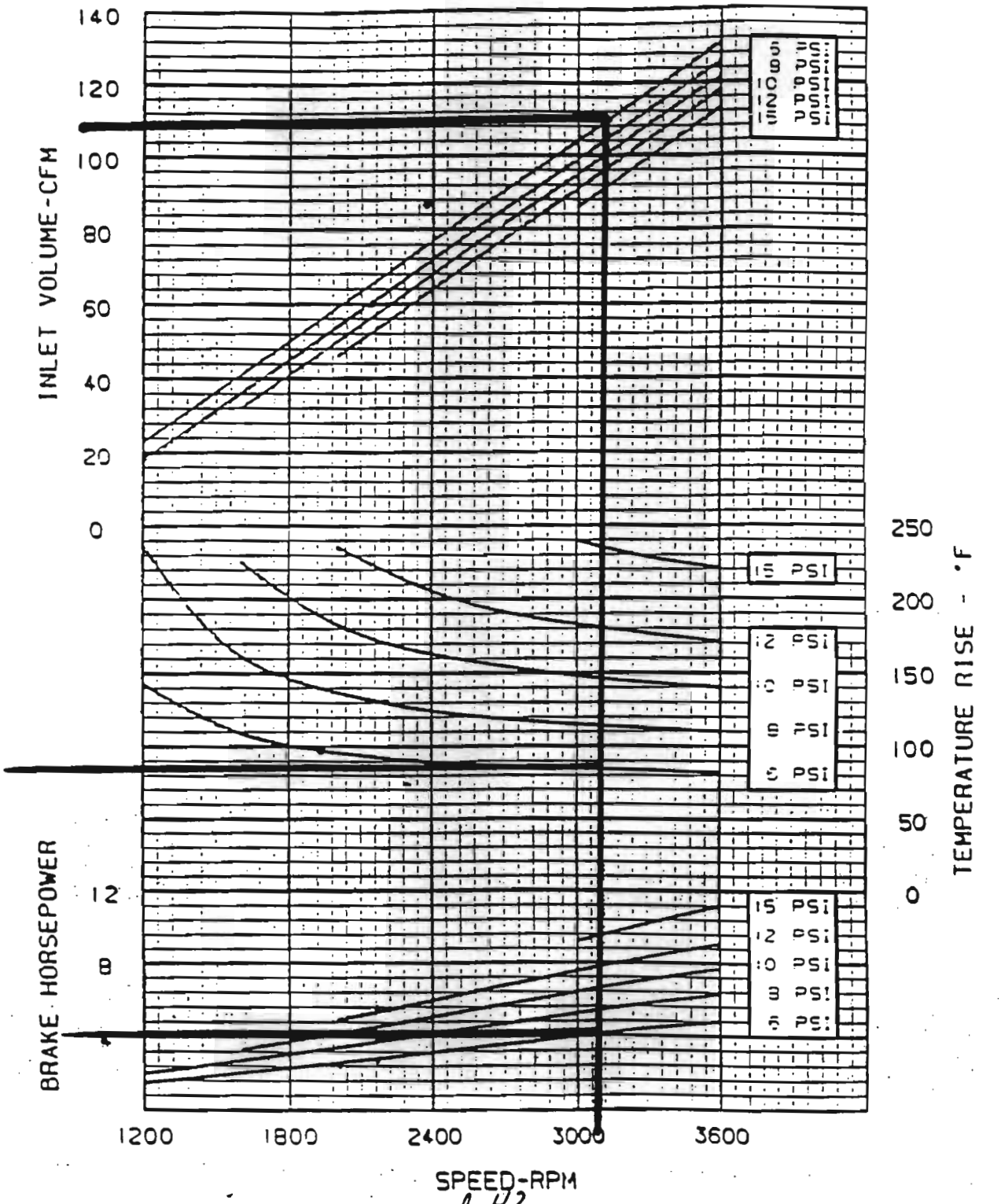
PRICES ARE FIRM THRU DELIVERY & ARE SUBJECT TO ROOTS STANDARD TERMS AND CONDITIONS

POOTS DIVISION
[illegible] WEST MOUNT STREET
[illegible]
PRINTED IN U.S.A.

PERFORMANCE BASED ON
INLET AIR AT 14.7 PSIA & 68°F
[illegible]

B-02

PRESSURE PERFORMANCE
FRAME 32 UNIVERSAL RAI BLOWER
MAXIMUM PRESSURE RISE=15 PSI
MAXIMUM SPEED=3600 RPM



A-43

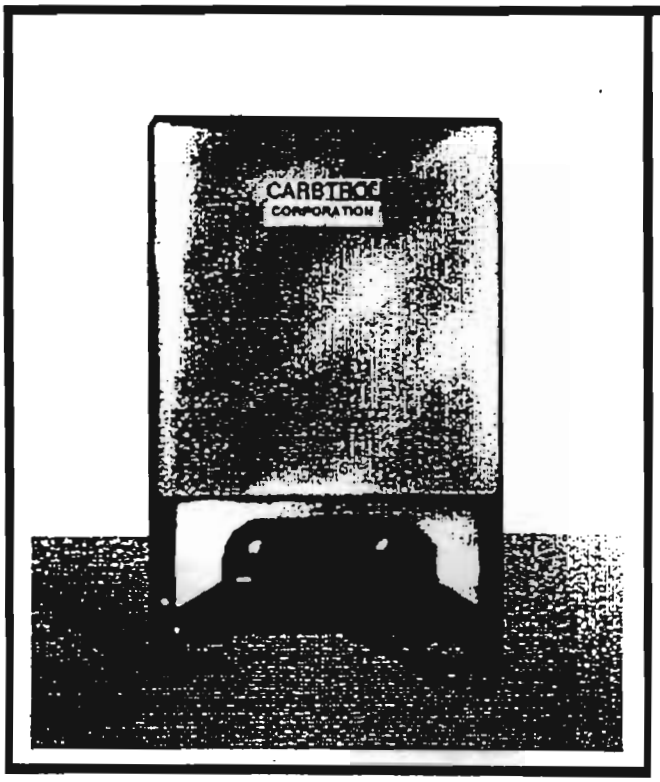
[illegible]

PC-12-32

CARBTROL®

AIR PURIFICATION ADSORBER 2,000 LB. ACTIVATED CARBON

G-5

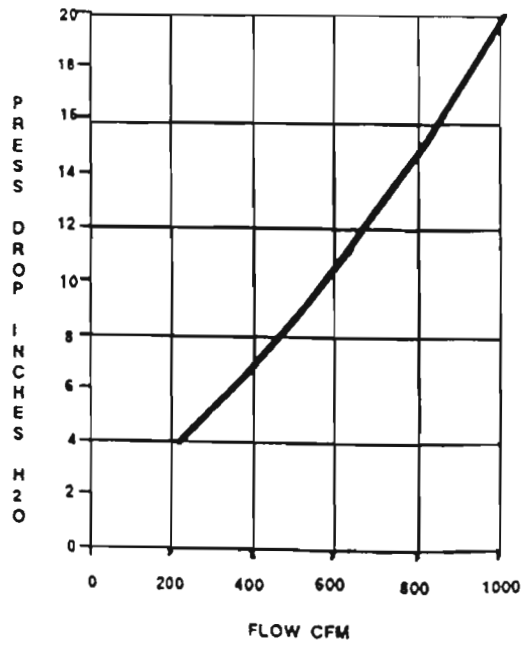


FEATURES

- High activity carbon.
- 600 CFM at only 11" w.c. pressure drop.
- Dump gate for easy carbon removal.
- Fork lift fittings for easy handling.
- Dual 4"Ø perforated inlet distributors.
- Acceptable for transport of hazardous spent carbon.

SPECIFICATIONS

CARBON:	2,000 lbs.
VESSEL:	44" x 52" x 75" height, Mild steel, epoxy internal coating, PVC internal piping.
SHIPPING WT:	2,650 lbs.



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CARBTROL®

TYPE CSV
AIR PURIFICATION CARBON

DESCRIPTION

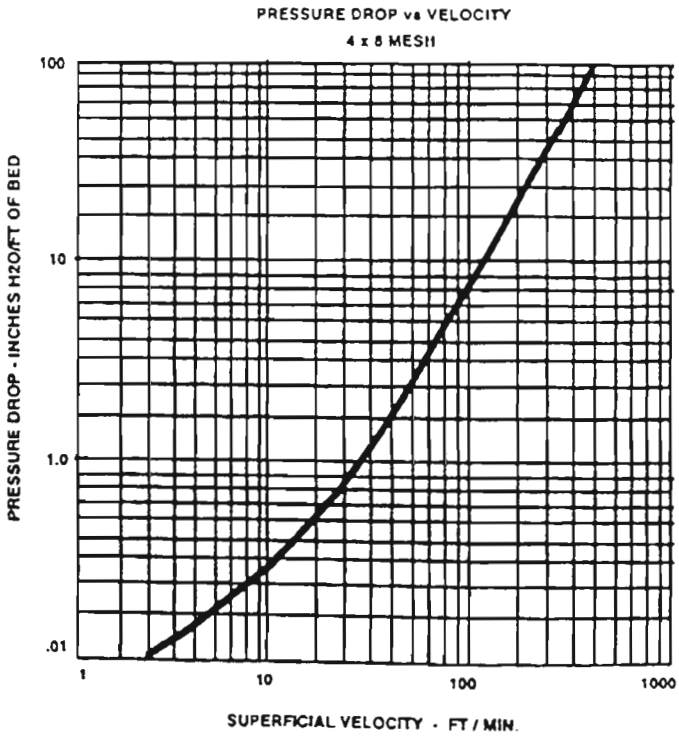
CARBTROL CSV Air Purification Carbon is designed for use in a wide variety of vapor phase treatment applications. It combines high surface area and fine pore structure in a product of exceptional hardness. CSV provides superior performance to most standard grade activated carbons. It is particularly effective for the removal of VOC compounds from air discharges.

SPECIFICATIONS

SIZE (US Sieve):	4 x 8
IODINE (No.): (Minimum)	1200
CCL_4 (No.): (Minimum)	70
APPARENT DENSITY (g/cc):	.45 to .50
MOISTURE (percent):	2
HARDNESS (No.):	90

APPLICATIONS

- VOC adsorption
- Soil vapor extraction
- Evaporative emissions
- Air stripper exhausts
- HVAC adsorption filters
- Tank vents
- Clean room air purification



SAFETY

Certain chemical compounds in the presence of activated carbon may oxidize, decompose or polymerize. This could result in temperature increases sufficient to cause ignition of the activated carbon or adsorbed material. If a compounds reaction with activated carbon is unknown, appropriate tests should be considered.

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 AT-9511/#1

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SPECIFICATION

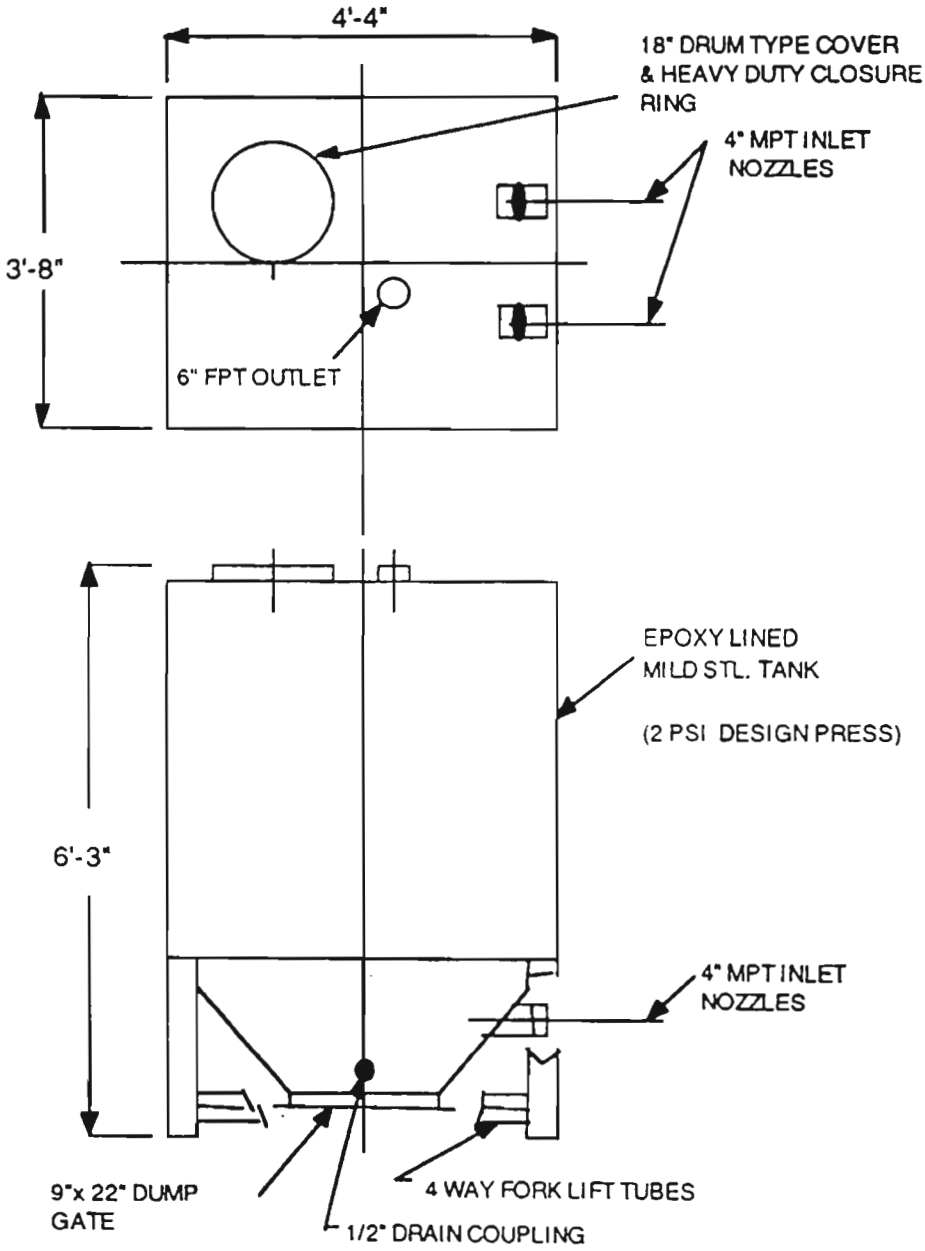
ACTIVATED CARBON ADSORBER
VAPOR PHASE

Model:	G-5
Design Flow (CFM):	1000
Design Features:	
Pressure Drop at Design Flow (in. w.c.):	20
Carbon:	Vapor phase, coconut base, activated carbon, 4 X 8 mesh, min. CCl_4 No. : 70.
Carbon Weight (lbs.):	2000
Adsorber:	Mild steel shell with epoxy internal coating, PVC internal piping, forklift base. Acceptable for transport of hazardous spent carbon.
Max. Recommended Operating Pressure (psi):	2 psi
Dimensions:	
Cross Section:	44" X 52"
Overall Height:	75"
Connections:	
Inlet:	Two (2) 4" MPT side
Outlet:	6" FPT top
Drain:	1/2" FPT side
Carbon Dump Gate:	9" X 22"
Shipping Weight (lbs.):	2650
Availability:	From stock
Drawing Number:	S-1235

11/22/96
*SP-409

AIR PURIFICATION ADSORBER 2,000 LB. ACTIVATED CARBON

G-5



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READ THESE INSTRUCTIONS THOROUGHLY BEFORE STARTUP. IMPROPER STARTUP COULD RESULT IN AN UNSAFE CONDITION.

INSTALLATION AND OPERATING INSTRUCTIONS G-5 VAPOR PHASE CARBTROL® ADSORBERS

ADSORBER PREPARATION

When vapors contact activated carbon, the bed temperature may increase due to water vapor and contaminant heat of adsorption.

Where organic contaminant concentrations above 500 ppm_V are expected, contact Carbtrol Corp. for evaluation of the potential for heat buildup.

When the Carbtrol adsorber is initially installed, maintain a continuous air flow through the adsorber for the first 24 hours of operation, and monitor the effluent gas temperature. A rise in the gas temperature of greater than 50°F is an indication of excessive heat generation. Under these conditions, the unit should be removed from service and the cause of the excessive heat generation should be determined.

Where the reaction of the contaminated gas stream with activated carbon is unknown, Carbtrol recommends thoroughly wetting the carbon with water prior to startup. The following procedure is recommended for wetting the carbon bed:

> Remove the plastic shipping plug from the outlet port. Insert a hose into the outlet port and fill the adsorber with water. The filled adsorber must be allowed to stand for at least one hour.
>
> Remove the water before the adsorber is put into service using the 1/2" bottom drain coupling. Replace the 1/2" drain plug before putting the adsorber into operation.

INSTALLATION

To put the Carbtrol G-5 Adsorber into service, place the adsorber on a well drained, level grade or concrete pad in an accessible area, preferably close to the exhaust vent to be treated. Connect an inlet flow splitter to the two inlet ports, and connect a full size pipe or hose from the process exhaust to the inlet flow splitter pipe. Where required, a full sized vent line can be connected to the adsorber outlet port to direct treated gases from the immediate area.

Before operating the G-5 Adsorber, a minimum size 8 AWG copper grounding cable should be connected between thte cable clamp provided on the adsorber support steel, and the building electrical grounding system. If a grounding system is not available, this grounding cable should be connected to a suitably driven ground rod. (See N.E.C. Section 250.83).

Carbtrol adsorbers are not to be used for explosive gas applications. Where upset conditions may cause exceedence of the LEL (lower explosive limit), flame arresters and/or nitrogen blanketing of the process should be considered.

OPERATION

As the contaminated process exhaust gas passes through the adsorber, the granular activated carbon adsorbs the impurities while the purilfied process gas is discharged from the adsorber. After continued use, the carbon will become saturated with impurities and will require replacement.

Gas discharging from the G-5 Adsorber should be tested regularly to determine when the carbon bed is nearing saturation. Properly scheduled testing of the discharge gas will indicate when breakthrough has occurred and the adsorber should be changed.

The capacity of the activated carbon varies with the type and concentration of impurities in the gases handled. Therefore, the determination of effective adsorber life for a specific use will come with the practical experience of using it under a specific set of operating conditions.

It is recommended that an additional G-5 Adsorber be kept on site, so that when breakthrough of the on-line adsorber occurs, a replacement unit is readily available.

If it is required that the spare G-5 Adsorber should be arranged as a fully piped and ready stand-by unit to allow immediate use, a pipe and valve assembly can be provided to accomplish this switchover and adsorber changeout. Contact the factory for details.

Operating pressure for Carbtrol G-5 Adsorbers should not exceed 2 psig.

Install appropriate shipping plugs and follow all State and Federal EPA regulations when re-shipping spent carbon adsorbers.

WARNING:

A. Activated carbon can react adversely with some contaminants, which can cause excessive heat buildup. If the effect of the contaminant you wish to treat on activated carbon is unknown, then it must first be tested.

B. The initial heat of adsorption that occurs when vapors first contact activated carbon causes a rise of temperature in the carbon bed. As recommended above, maintained air flow or wetting of the carbon bed will minimize the initial heat buildup.

C. Carbtrol adsorbers should not be used with flammable vapors or flammable gas mixtures.

D. Activated carbon depletes oxygen in enclosed spaces. Follow NIOSH guidelines for safety in enclosed spaces.

WARRANTY

This product is designed to remove toxic pollutants from air. However, there is no assurance of its capacity. SELLER WARRANTS THAT THE GOODS ARE AS DESCRIBED. BUT NO OTHER WARRANTY IS GIVEN, WHETHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Seller will not be liable for loss or damage to property or any incidental or consequential loss or expense from property damage due directly or indirectly from the use of the product.

APPENDIX B

Material Safety Data Sheets

Information to be included in final report

APPENDIX C

Foster Wheeler Field Sampling Procedures

Information to be included in final report

APPENDIX D

Substantive Air Discharge Permit

Information to be included in final report

APPENDIX E

Well Boring Logs and Geology Profiles

Information to be included in final report

APPENDIX F

Baseline Sampling Results

Information to be included in final report