DESIGN REPORT
for
SOIL GAS VENTING SYSTEM
at the
CANTOR BROTHERS SITE
FARMINGDALE, NEW YORK
NYSDEC SITE NO. 152021

0311998

Prepared for:

CANTOR BROTHERS
and
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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March 1998

Project: 97810

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1. INTRODUCTION

Handix, as part of their Interim Remedial Investigation (January 1997), conducted a soil boring below the concrete floor at the south end of the manufacturing building (TW-16). Another soil boring (TD-1) was conducted adjacent to the east end of the manufacturing building in the area that formerly contained the trash dumpster. Both soil borings contained Xylene and semi-volatile compounds. Table 1, below, presents the levels of Xylene found in the two soil borings.

Table 1

	Boring Location - Sample Depth		
	TW-16 (20 to 20 feet)	TD-1 (10 to 12 feet)	TD-1 (40 to 42 feet)
Xylene (ppb)	11,000	2,100	14

In order to design the system, it has been assumed that the contaminant to be removed is Xylene, and the levels of contamination present are 22,000 ppb, two times the levels determined by Handex.

The two parameters that determine the feasibility and success of soil vapor extraction are the air permeability (the ability of the contaminated vapors to flow through the soils) and the vapor pressure (a measure of the contaminant's ability to evaporate). Thus, a high vapor pressure reflects an increased tendency to volatilize.

The contaminated subsurface soil at the Cantor Brothers site ranges from coarse to medium sands. Measurement of the hydraulic conductive of the soils (measured just north of the property) is 7.5×10^{-2} cm/sec., which corresponds to an air soil permeability of 20 to 30 darcies. The vapor pressure of Xylene (the contaminate) is .0076 atm which is high enough to volatilize effectively for soil gas vapor extraction.

The combination of these conditions justifies the use of a soil vapor extraction system to effectively remove the contamination below the floor of the former manufacturing area.

Parameters measured at the vapor extraction system employed at the Hygrade Metal Moulding Mfg. Corp. site further confirm the effectiveness of soil gas vapor extraction. The following parameters were measured:

- Radius of influence: 60 feet
- Vacuum: 26 inches of water
- Flow rate: 100 to 150 cfm

Information from a publication of Wisconsin Department of Natural Resources further confirmed the basic design approach used at Cantor Brothers. A system operating at 50 cfm using a blower that produces 60 inches of water produced a 90-foot radius of influence in soils that have an air permeability of 10 darcies.

The Cantor Brother's system is capable of producing a vacuum of 78 inches water (6 inches Hg), at a flow rate of 360 SCFM. Thus, it is anticipated that a radius of influence of 80 feet is reasonable. Figure 1 is an attempt to depict the radius of influence as a function of blower vacuum. It should be noted that this depiction is for three different systems having different well depths, etc. However, the soil air permeability is approximately the same for the three systems. Thus, it is anticipated that the Cantor Brothers' system will follow the curve as presented in Figure 1.

Also of importance -- the Wisconsin document Reference One states that if the air permeability ratio between the air permeability in the vertical direction and the horizontal direction is high due to high quality surface seal, clearly the case at Cantor Brothers (concrete floor), the air flow pattern will have a preferred horizontal orientation. In this case, the wells can be placed further apart because there is less vertical recharge near the extraction wells.

2. SYSTEM DESCRIPTION

The system is capable of achieving a flow of 360 SCFM at 6 inches Hg vacuum inlet (at blower). The blower is a positive displacement belt-driven unit (M.D. Model Number 5006). The motor is a 10 HP explosion proof unit. The package includes a vacuum relief valve, inlet filter silencer, an air dilution valve, and discharging muffler. The unit is equipped with temperature and vacuum pressure gauges. A 55-gallon air/water separator is installed on the air inlet line immediately before the blower to remove any liquid entrained in the vapor stream. The separator is equipped with a liquid level sight tube, a manual drain, and a high liquid level shut down that will automatically shut down the VES blower if a high water level develops in the separator. This will prevent water from entering into the positive displacement blower. The control for the SAVE system will be installed in a NEMA 7 box and mounted on the skid. A carbon filter is located after the blower exit. It is anticipated that the unit will operate at 70 cfm per well (210 cfm for the three-extraction wells).

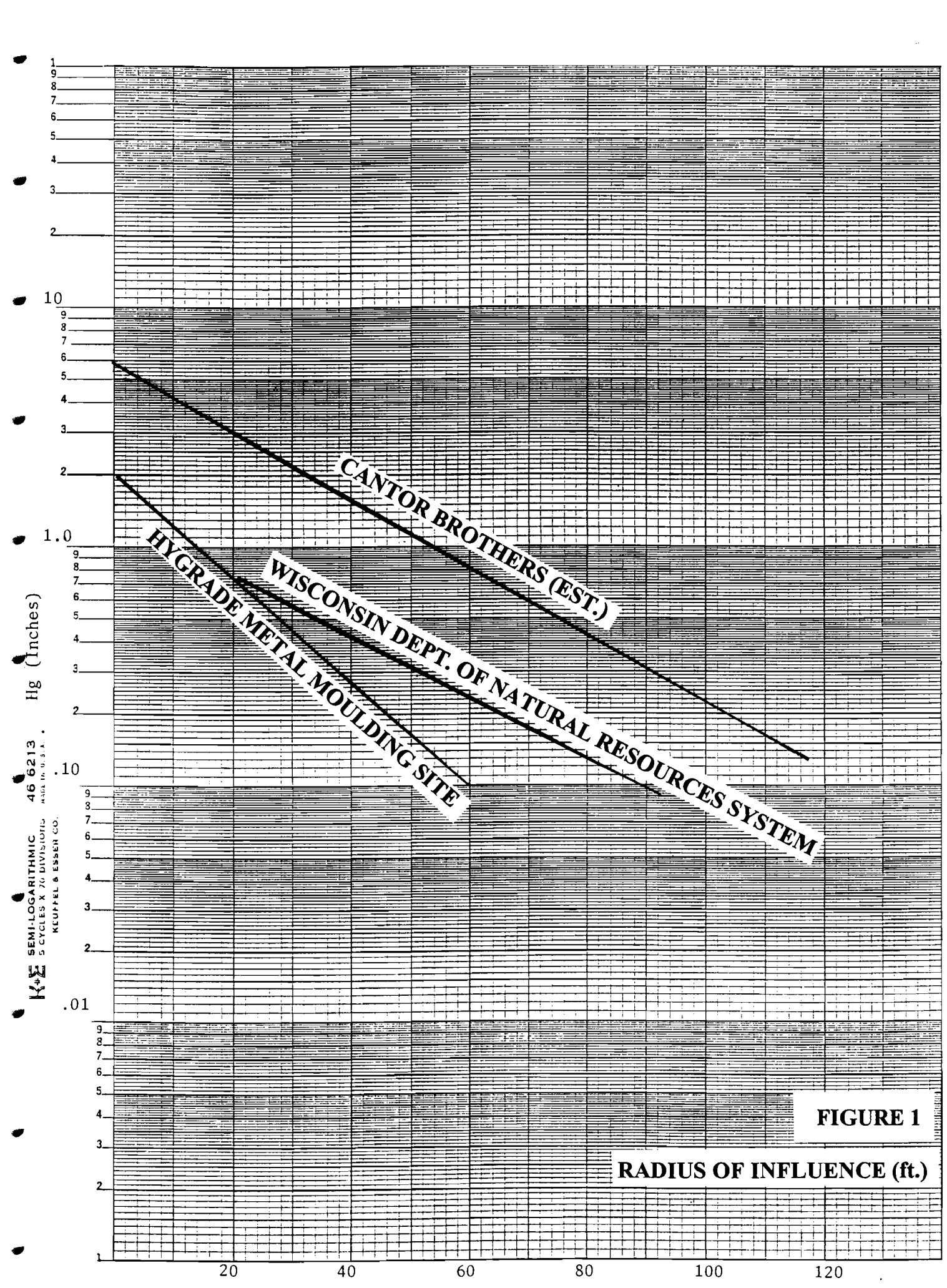


FIGURE 1

RADIUS OF INFLUENCE (ft.)

The following drawings are provided:

- System Schematic Drawing A-1
- System Installed on Skid A-2
- Electrical Design A-3
- Control Panel A-4

3. COMPONENT DESIGN

a. Well Design and Interconnecting Piping

Two wells will be located in the building. The third well will be located outside the building in an area that formerly contained the trash dumpster.

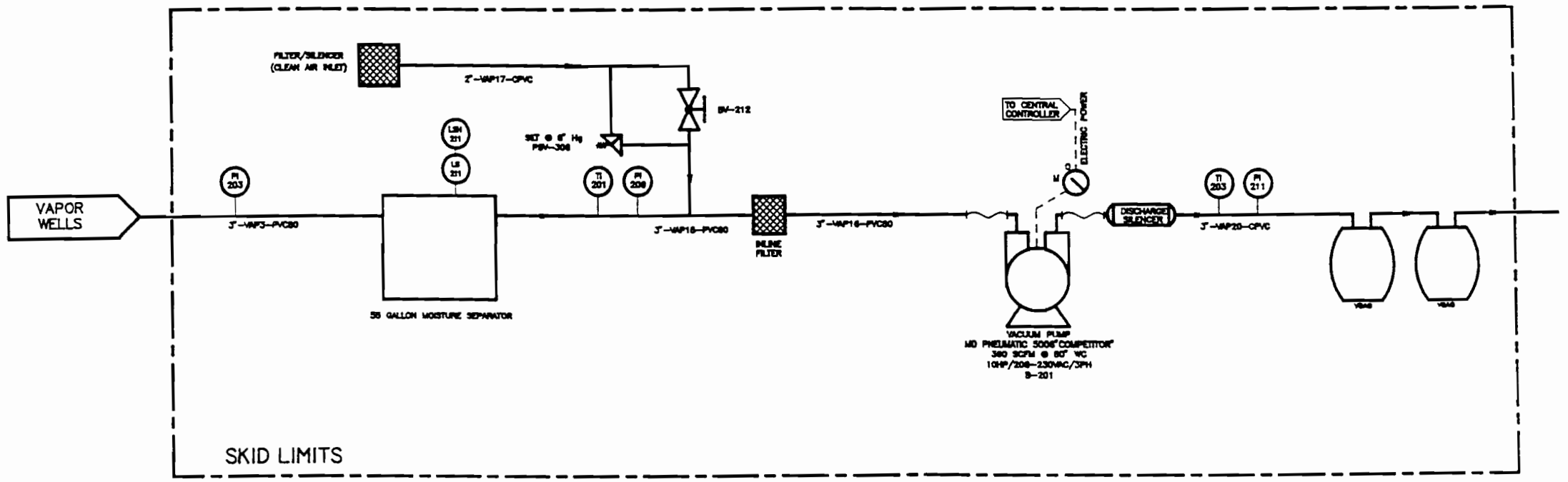
The location of the wells is shown on Figure 2. The effective radius of influence is assumed to be 40 feet (about half the distance of the total radius of influence. Each well will be installed to a depth just above groundwater (approximately 40 feet). Figure 3 is a schematic drawing of the well design. The well will consist of 4-inch diameter well casings. The well screen will extend 20 feet from the bottom plug (as shown on Figure 3).

The screen slot size will be 0.20-inch. A coarse filter pack will be placed around the well screen. The cross of the well is shown on Figure 4. At each well head location, a vacuum gauge, value and sampling port will be installed. The wells have been spaced to provide complete coverage of the former factory area and the dumpster area.

The interconnecting piping and fitting from the well head to the blower will be 3-inch PVC pipe generally utilized for water supply, irrigation systems, sprinkler systems. EEA has utilized PVC tubing when installing high vacuum methane control systems at municipal solid waste landfills. The specifications for the piping are enclosed in Appendix A. The blower characteristics are also presented in Appendix A, as well as the Operation and Maintenance Manual.

b. Carbon Filter (adsorber)

A carbon filter will be located after the blower exit. The filter will be provided by CETCO. The unit is capable of removing (adsorbing 30 grams Xylene per 100 gm of carbon) from a gas stream concentration 1 gm/m^3. A drawing of the filter (VIM) and the adsorption isotherm provided by CETCO are presented in Appendix A.



SYSTEM SCHEMATIC DRAWING A-1

NO.	DATE	BY	REVISION

DATE: 02/04/98
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CHK'D BY: JGW
DRWG:
SCALE:
GRS JOB#: 80023
SHEET: P1

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E.E.A. INC.
5 S. HILTON AVE
GARDEN CITY, NY 11530
CANTOR BROTHERS PNID DRAWING

	SIGNATURE	DATE
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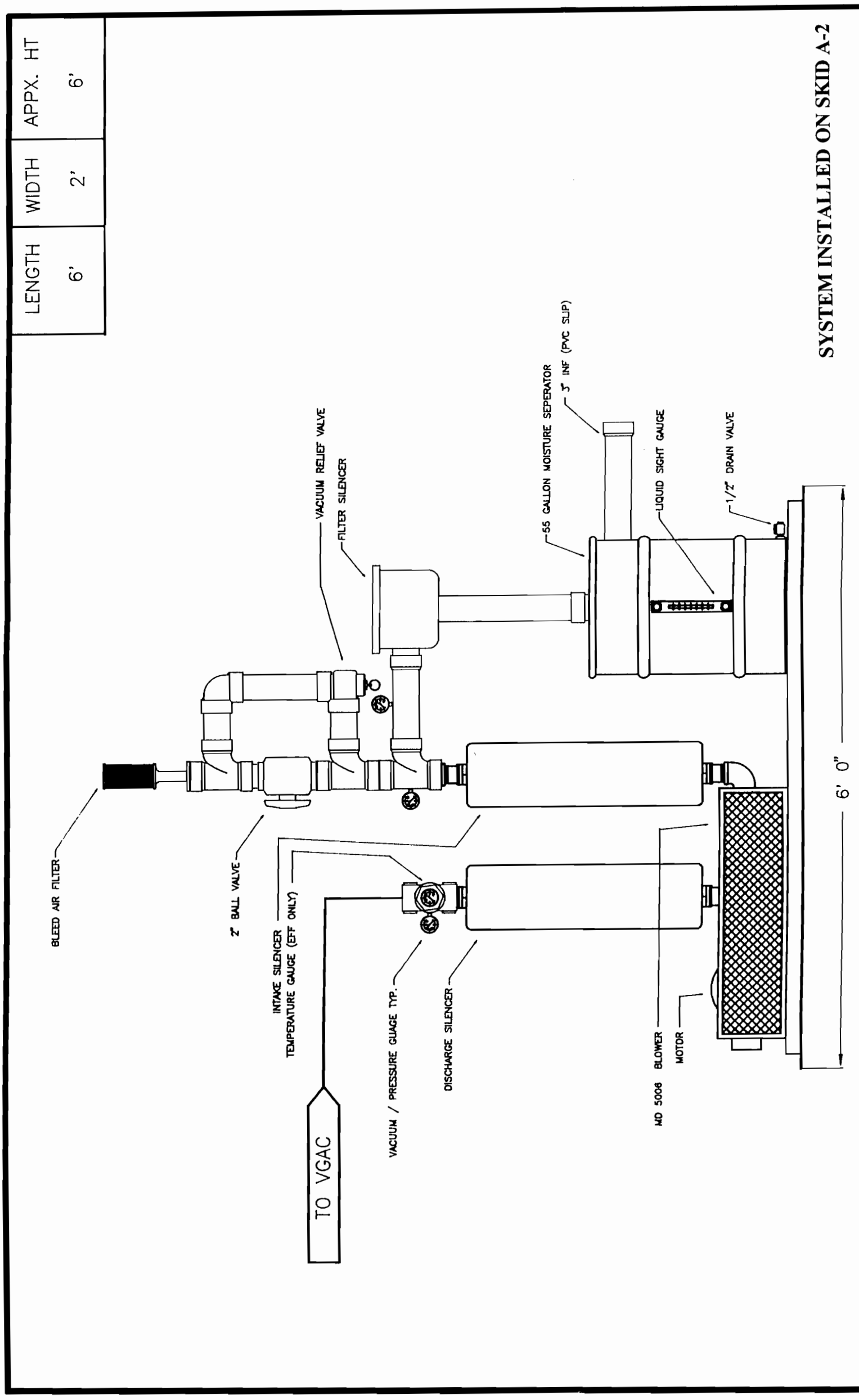
PROJ MGR		
QTI ENGR		

SYSTEM INSTALLED ON SKID A-2

LENGTH	WIDTH	APPX. HT
6'	2'	6'



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CANTOR BROTHERS SVES DRAWING	FINA ENG.		

ORS
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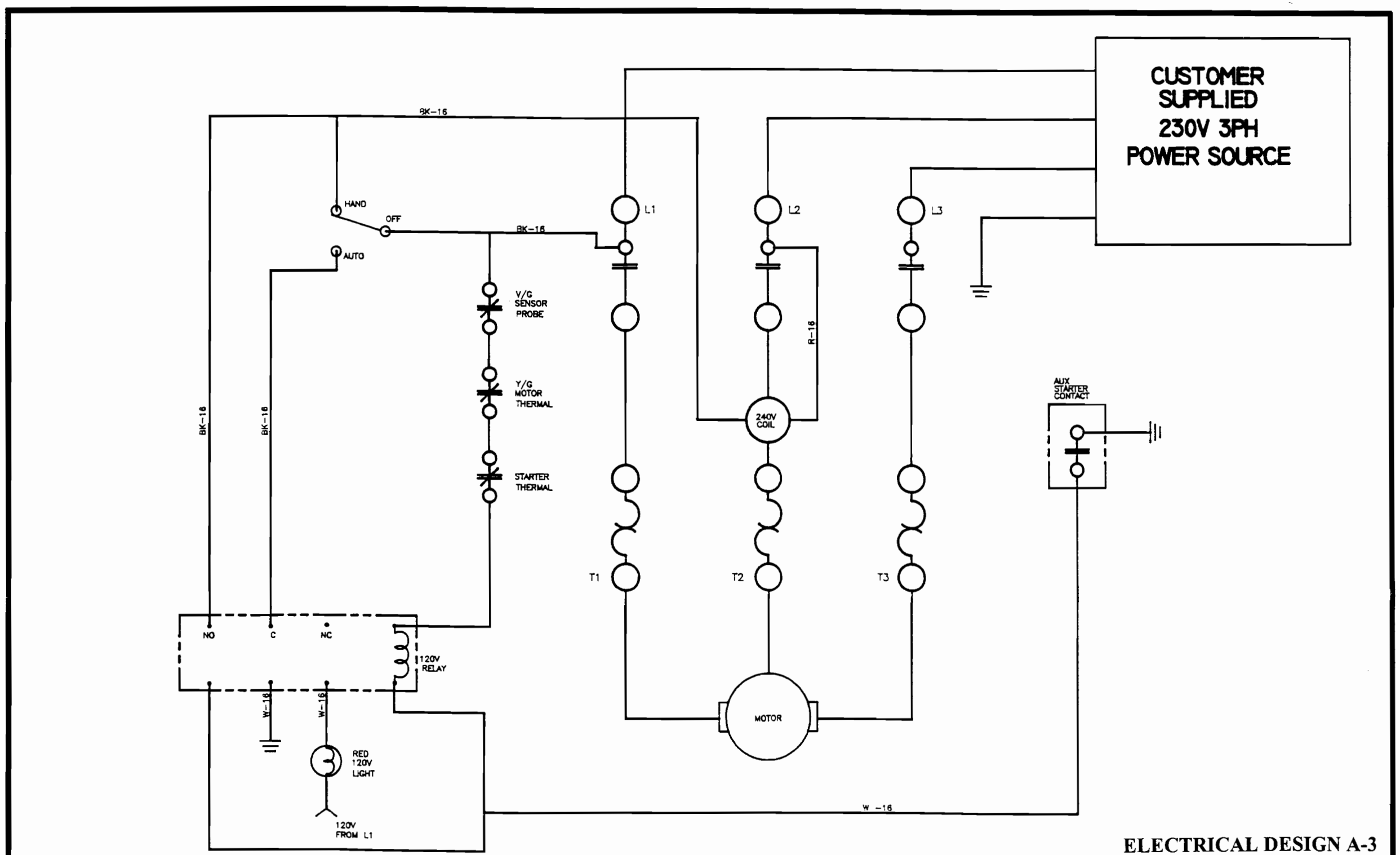

ELECTRICAL DESIGN A-3

NO.	DATE	BY	REVISION

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CANTOR BROTHERS HIGH VOLTAGE DIAGRAM

SIGNATURE	DATE
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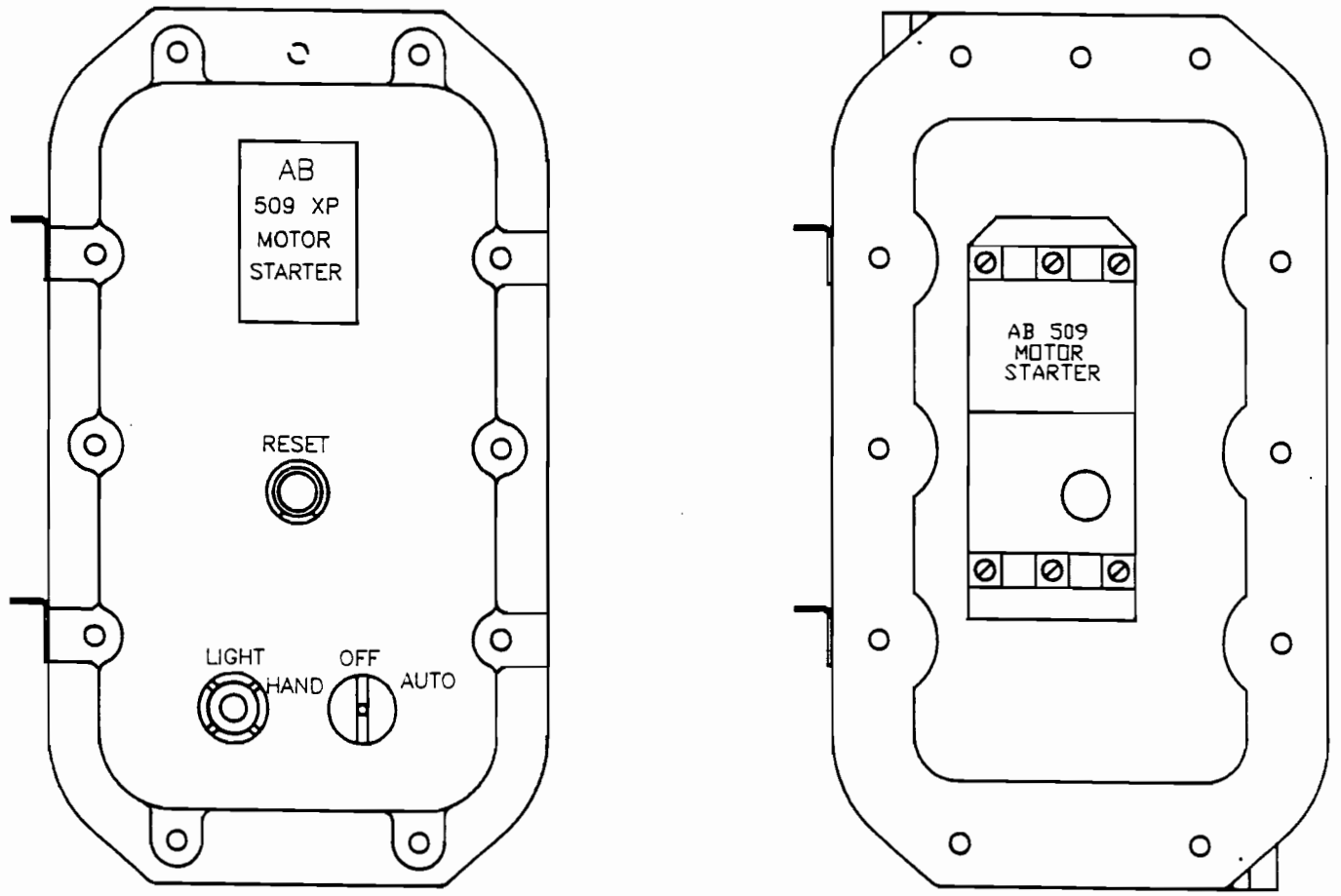
FINA ENG:	



CONTROL PANEL A-4

NO.	DATE	BY	REVISION

DATE: 01/27/98 | SCALE:
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CHK'D BY: | GRS JOB#: 50023
DRWG: | SHEET: 01

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(610) 524-2780

E.E.A. INC.
5 S. HILTON AVE
GARDEN CITY, NY 11530
CANTOR BROTHERS CONTROL PANEL

SIGNATURE	DATE
REVIEW ENG:	
PROJ MGR:	
FINA ENG:	

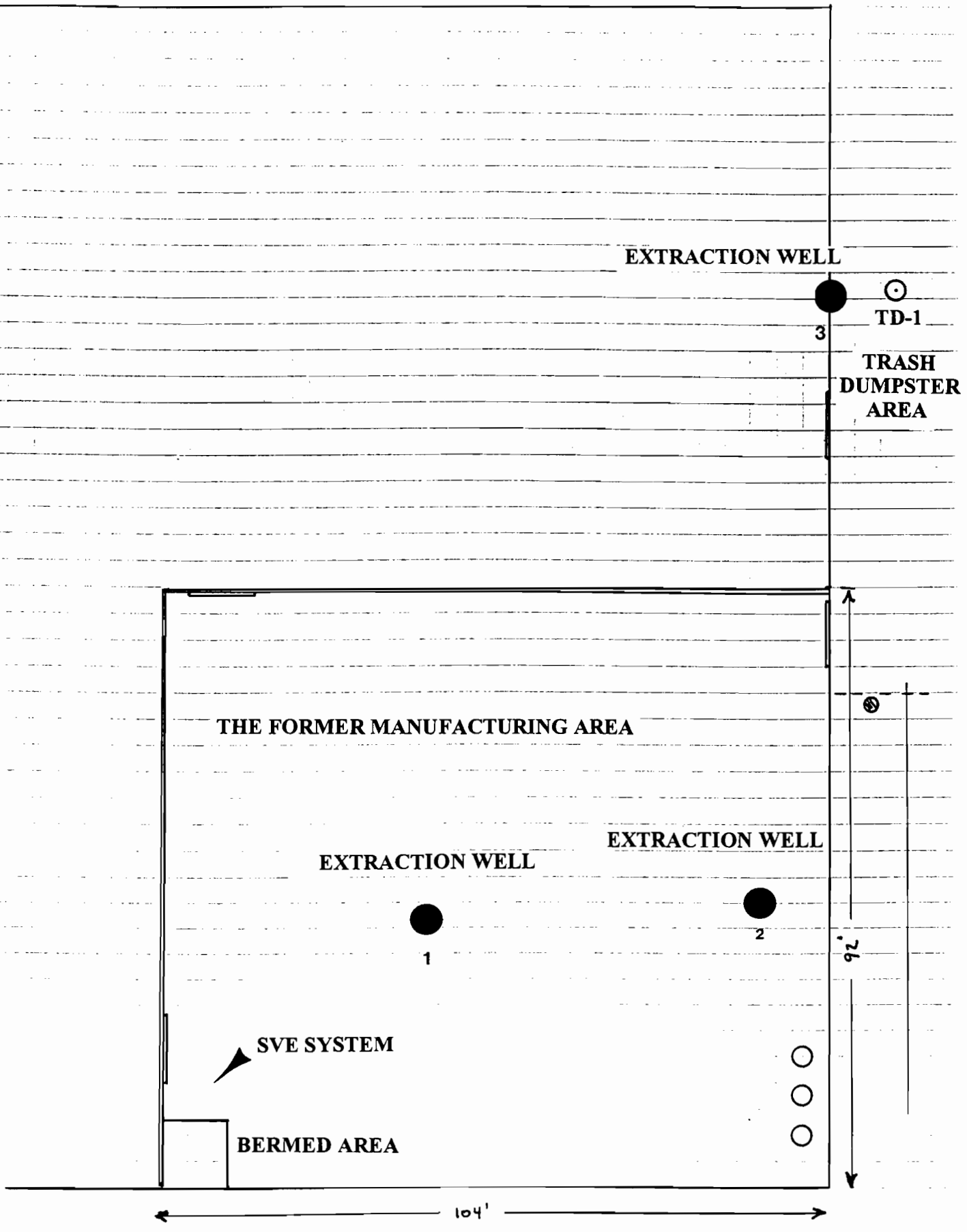
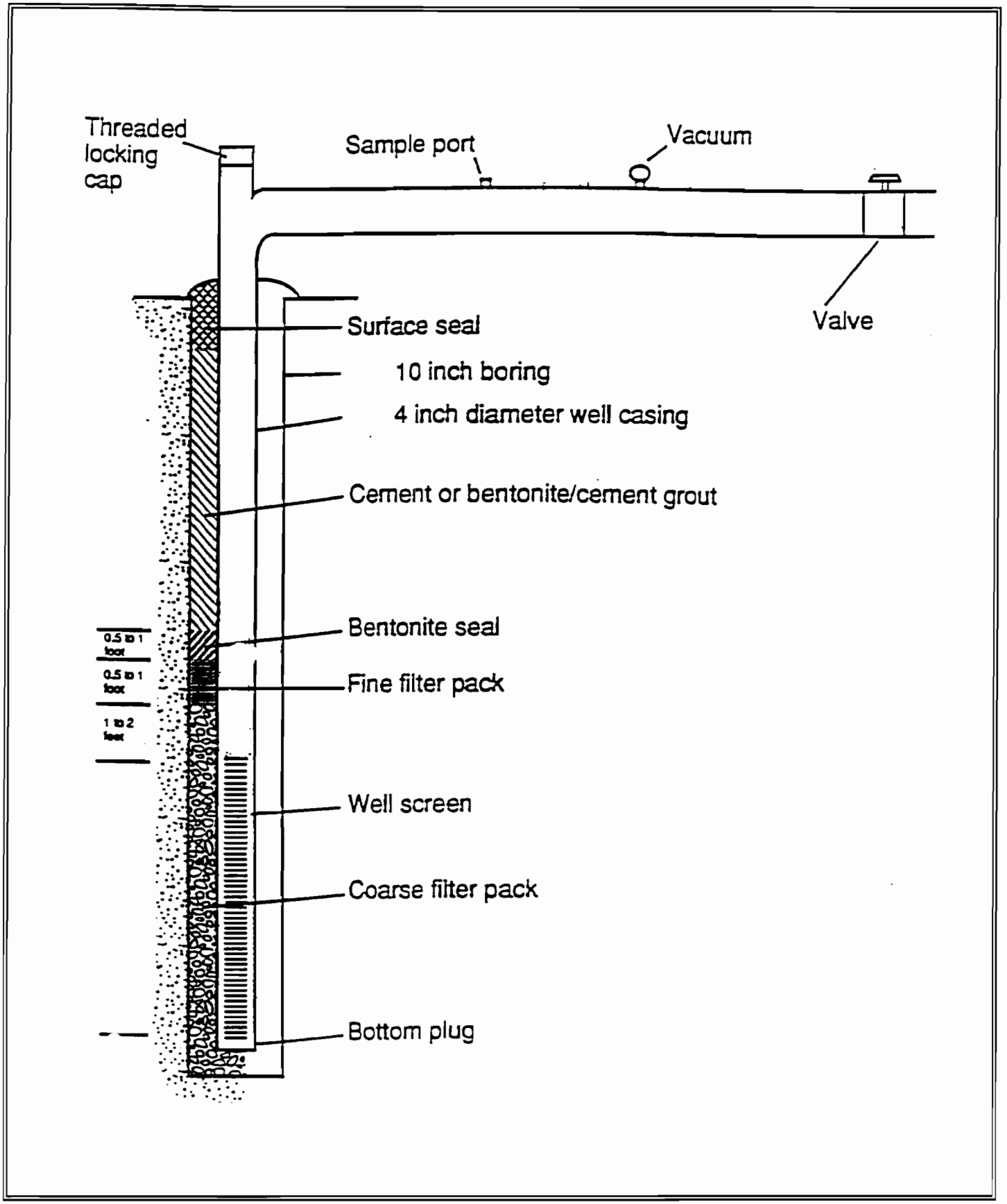
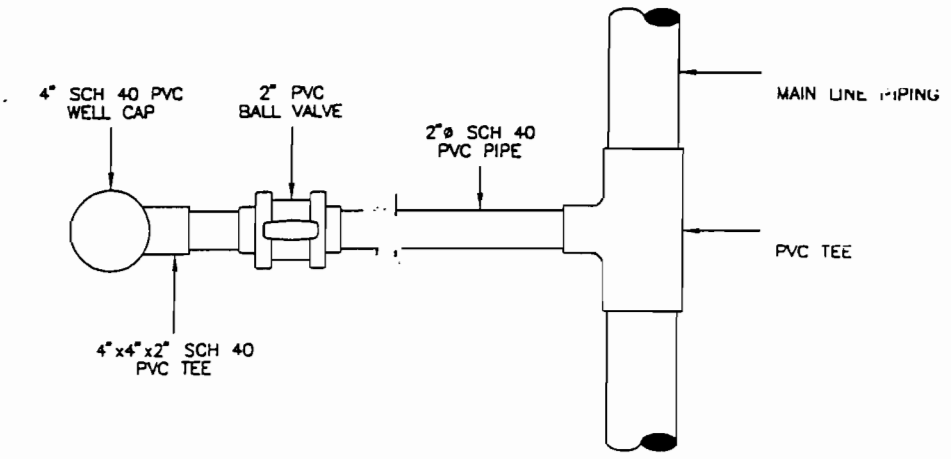

EXTRACTION WELL
TD-1
3
TRASH DUMPSTER AREA
THE FORMER MANUFACTURING AREA
EXTRACTION WELL
EXTRACTION WELL
2
1
92'
SVE SYSTEM
BERMED AREA
104'
FRONT OF BUILDING

FIGURE 2 1" = 25'



AIR EXTRACTION WELL DESIGN

FIGURE 3



PLAN VIEW - EXTRACTION WELL SCHEMATIC

SCALE: 1"=1'

PLAN VIEW - EXTRACTION WELL SCHEMATIC **FIGURE 4**

4. CALCULATIONS

Calculations are presented in Appendix C. The pressure loss has been calculated using the standard methods and information contained in the *Industrial Ventilation Manual*, Reference 1, printed by the American Conferences of Government Hygienists. The pressure loss between the well heads and the inlet to the moisture separator was calculated to be 5 inches water. Another 12 inches of water will be lost through the moisture separator, filter, etc. Thus, it is anticipated a total pressure loss for the system will be in the order of 17 inches of water for the entire system.

The emission rate has been calculated based upon a saturated vapor concentration existing within the subsurface which is not the case. However, this is a very conservative assumption, order of magnitude to high. These numbers have been used in the application for the air permit, an alternative emission rate calculation, mass transfer principle. However, drastic simplifying assumptions were made in applying the methodology. The results are ore realistic (in the order of 16 times less than the saturation vapor assumption calculations). Average properties for Xylene have been assumed is only one small sin. The major assumption required is to determine the actual velocity in the subsurface soils which will be variable, since Reynolds number is only a secondary term in the mass transfer equation. The big assumption lies in weather combination film — surface — renewal theory is valid, which is the basis for most mass transfer equations. However, is some other mechanism is operating, the renewal theory will give more conservative results. Thus, the alternative calculation is presented for information only, and is not intended to be the basis of any design.

5. TESTING AT STARTUP

It is anticipated that a flow rate of 70 cfm will be established at each well head. Initially, the blower will be turned on without bleed air. The values at each well head will be adjusted to produce a flow rate of 70 cfm at each well. After equilibrium is reached in 48 to 96 hours, the values will be re-adjusted to produce equal flow from each well head at approximately the same vacuum.

It should be noted that the blower can be adjusted by opening the bleed air value on the skid. Further adjustment can be made by changing the blower speed. This can be accomplished by changing the diameter of the pulleys on the blower and motor.

During the initial start-up period, the vacuum at each well head will be measured as well as flow rate. Permanent instrumentation fittings will be built into each well head.

After the equilibrium is reached, the vacuum and flow rate at the blower inlet and at each extraction well will be measured. In this way, the system will be further fine tuned. The following data sheet will be utilized.

Well Location	Temperature °F	Pressure Vacuum (Hg")	Flow Rate (cfm)	Time
1				
2				
3				
Blower				
1				
2				
3				
Blower				
1				
2				
3				
Blower				

The following table provides a summary of the system monitoring plan.

SVE System Monitoring Plan

Phase	Monitoring Frequency	What to Monitor	Where to Monitor
Start-up (5 to 7 days)	Continuous	Flow	Extraction Wells
		Vacuum	Manifold
	Daily	Vapor Concentration	Manifold and after carbon unit
Ongoing	Weekly	Flow	Extraction Wells
	Weekly	Vacuum	Manifold
	Bi-weekly	Vapor Concentration	Manifold and after carbon unit

6. PERFORMANCE TESTING PROTOCOL

a. General Methodologies

A low flow sampling pump will be used to draw air from the locations where vapor concentrations are to be measured. The air will be drawn onto a charcoal sorbent tube at a rate of 40 to 50 ml/min for a one-hour period (longer times may be needed).

The sampling locations are defined in the above table.

A flexible Teflon tube will be inserted into a sampling port (1/4 inch) located after the manifold, before the carbon units, and after the carbon unit. In addition, vapor concentrations will be determined at each well head periodically, as needed. A solid sorbet tube of coconut shell charcoal (100 mg/50 mg) will be used to adsorb the Xylene that will be present in the gas stream. The charcoal will be desorbed using carbon disulfide by the procedure presented by USEPA Method 3550. The Xylene in the air stream will be determined by gas chromatrography/mass spectrometry GC/MS (USEPA Method 8240). It should be noted that sorbet tube contains an additional tube in parallel to determine if the first tube has been saturated by the gas stream. Both tubes will be tested by USEPA Method 8240.

b. **Sampling Procedure**

- Utilize a calibrated sampling pump (see Appendix B) with in-line sampling cartridges with the second cartridge used to determine if breakout has occurred (saturation of the carbon adsorption cartridge).

- Prior to sample collection, ensure that the sampling flow rate has been calibrated over a range, including the rate to be used for sampling, with a "dummy" cartridge in place. Calibration is accomplished using a soap bubble flow meter. The flow calibration device is connected to the flow exit, assuming the entire flow system is sealed (see Appendix B, Calibration of Sampling Pump). The flow rate should be checked before and after each sample collection. Start the pump and record the following parameters on an appropriate data sheet: date, sampling location, time, ambient temperature, barometric pressure, relative humidity, flow rate, rotameter reading, cartridge number, and velocity.

- Allow the sampler to operate for the desired time (three hours), periodically recording the variables listed above. Check flow rate at the midpoint of the sampling interval if longer than four hours. At the end of the sampling period, record the parameters listed above, including the flow rate. If the flows at the beginning and end of the sampling period differ by more than 20 percent, the cartridge should be marked as suspect.

- Remove the cartridges (one at a time) and place in the original container (use gloves for glass cartridges). Seal the cartridges in the friction-top can containing a layer of packing material for immediate shipment to the laboratory for analysis. Store cartridges at reduced temperature (0°F) before analysis, if possible, to maximize storage stability. Calculate and record the average sample rate for each cartridge according to the following equation:

$$Q_A = \frac{Q_1 + Q_2 \cdots Q_N}{N}$$

Where:

Q_A = Average flow rate, ml/min
$Q_{1,}$ $_Q$2, ...Q_N = Flow rates determined at beginning, end, and intermediate points during sampling

N = Number of flow rate sampling points

Calculate and record the total volumetric flow for each cartridge using the following equation:

$$V_m = \frac{T \times Q_A}{1{,}000}$$

Where:

V_m = Total volume sampled in liters at measured temperature and pressure
T = Sampling time = T_2 - T_1, min
T_2 = Stop time
T_1 = Start time

The total volume (V_s) at standard conditions, 25° and 760 mm Hg, is calculated from the following equation:

$$V_s = V_m \times \frac{P_A}{760} x \frac{298}{273 + t_A}$$

Where:
P_A = Average barometric pressure, mm Hg
t_A = Average ambient temperature, °C

c. <u>Sample Preparation (at laboratory)</u>

- Place the front and back sorbent sections of the sampler tube in separate vials. Discard the glass wool and foam plugs.

- Add 1.0 ml CS_2 to each vial. The extraction would proceed according to USEPA Method 3550, and the analyses would be performed by USEPA Method 8240.

d.. <u>Velocity Measurement</u>

It will be necessary to determine the velocity using a anemometer. This instrument records the velocity directly, and is accurate to ± 5 percent of full scale (500 to 2,000 fpm) over an air stream temperature range of 32° F to 180°F.

The description of the major components that comprise the skid-mounted SVE system are presented in Appendix A.

REFERENCES

American Conferences of Government Industrial Hygienists, Industrial Ventilation, a Handbook, 14th Edition, 1987

Guidance for Design, Installation and Operation of Soil Venting System, Wisconsin Department of Natural Resources, July 1993, PUBL - SW 185-93

Soil Vapor Extraction Technology, Reference Handbook, EPA/540/2-91/003, February 1991.

Appendix A: Description of Components

VAPOR EXTRACTION SYSTEM

- Description of Components
- Operation and Maintenance Manual
- Blower Characteristics
- Carbon Absorption Filter
(Manufacturer Data Sheets)

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Groundwater
Recovery Systems, Inc.

Thank you for purchasing a GRS REMEDIATION SYSTEM. Now that you have acquired the most up-to-date system available today you will begin to more fully appreciate the benefits of this total remediation system.

At GROUNDWATER RECOVERY SYSTEMS we are committed to more than just building a state of the art remediation system. We want to ensure that this facet of the remediation program goes as smooth and as trouble free as humanly possible.

To that end, everyone at GROUNDWATER RECOVERY SYSTEMS is dedicated to making sure that we provide the highest standards of company service in the industry today.

We welcome any comments you may have. If you should have any questions or need assistance in any way, please do not hesitate to call us at 1-800-347-1901.

Many talented remediation professionals have devoted a great deal of time, energy, and effort in designing, planning, and building your remediation system. With so many systems available to you today, we are proud that you chose a GRS REMEDIATION SYSTEM.

Again, our most sincere thanks,

George A. Nolan
President

299B National Rd., Exton, PA 19341 • 610-524-2790 • FAX 610-524-2795

INTRODUCTION

This is the Operation and Maintenance Manual for your Groundwater Recovery Systems Remediation System.

The O&M Manual is separated into several sections, each detailing a specific piece of equipment and/or operational phase of the overall system.

It should be noted that any document of this nature should be considered a "Living Document". As each remediation project progresses there are distinct, site specific, anomalous conditions that may occur. It would be impossible to try and predict these conditions without the benefit of periodic "real time" operational data. Therefore, it is essential that this document be modified to account for these characteristics as they become apparent.

It is recommended that this document be reviewed in it's entirety by qualified technical personnel prior to attempting to operate the system.

If there are any questions that may develop, or additional information that may be required, please contact Groundwater Recovery Systems at (800)347-1901 between the hours of 8:00 a.m. and 5:00 p.m., Monday through Friday, Eastern Standard Time.

ELECTRICAL AND PANEL INSTALLATION

Control Panel Installation

If the panel will be outdoors: The Control Panel should be mounted outside of the direct effects of the weather. An outline of the electrical connections for the system are included in the back of this manual.

High Voltage

Please refer to the wiring diagram for power input and outputs under customer connections. A suggested breaker size is given on the power input block. This is located on the high voltage diagram.

Low Voltage

All low voltage sensors are connected to the terminal strip marked LV (Please refer to the wiring diagram for specific hook-ups).

Make sure the breaker supplying the power to the system is off and electrical connections and enclosures leading up to the system are in accordance with local and National Electrical Codes (NEC) for the environment the system is installed in.

PANEL LIGHTS & SWITCHES

The following function descriptions regarding the selector switches, lights, and fault conditions will further explain he systems response to external sensing signals.

Selector Switches

HAND - Manually activates control, over-riding any fault or sensing condition.

OFF - Control is disabled

AUTO - System will respond according to the external sensing signals.

Panel Run Lights

Operation of lights are controlled by external sensing signals and systems circuit boards, not by selector switches. The selector switch enables or disables what it is controlling. The light is indicating that all conditions have been met for the control to operate.

Panel Fault Lights

Operation of lights are controlled by external sensing signals and system circuit boards. The system is designed so that all fault conditions are normally closed under normal operating conditions. If a fault condition occurs there is a problem with that area of the system, the sensor, or a damaged or broken signal cable.

System Faults

All Fault Interlocks are outlined on the Piping and Instrumentation Diagram contained in the back of this manual.

To Start or Reset Your System:

Go To Hand.

System Will Start Up.

Then, Turn Back To Auto.

Your System Will Run In Automatic.

ABSTRACT

This system was manufactured for utilization in the removal of volatile hydrocarbons from the subsurface soil matrix.

Additionally, the system was designed and constructed for a high degree of portability. In brief, the system has been mounted on a 3' x 6' skid to allow for rapid deployment utilizing a forklift or personnel for placement.

Controls for the system are supplied mounted on the skid.

SYSTEM DESCRIPTION

The system supplied consists of several basic components:

1. Mounting Skid
2. Vacuum/Pressure Blower
3. Influent/Effluent Piping System
4. Control Panel

1. Mounting Skid

The mounting skid has been constructed to allow deployment outside in the elements. The base is a primed and painted welded channel steel frame to add rigidity to the skid and to allow the use of a forklift to move the unit.

2. Vacuum/Pressure Blower

The blower functions based upon the regenerative turbine principle. Briefly, the impeller blades panning the inlet port draw air (and other associated gases) into the blower. The impeller blades then, by centrifugal action, accelerate the air outward and forward. The air is then turned back by the annular shaped housing to the base of the following blades where it is once again turned outward. Each regeneration imparts more vacuum/pressure to the air. When the air reaches the stripper section at the outlet, the air is stripped from the impeller and diverted out of the blower. The pressures or vacuums generated by the one spinning, non-contacting, oil free impeller is equal to that obtained by larger multi-stage PD type blowers.

3. Liquid Entrainment Cylinder

The liquid entrainment cylinder is located on the influent side of the blower. The purpose of this unit is the partial elimination of high density vapor (liquid droplets) laden air. The unit works on the basic principle of flow velocity. Generally the air is moving through influent piping at a certain rate of flow measured in FPM or FPS. As the size of the piping is increased radically, the velocity of the airstream is decreased proportionally. As a further enhancement to the removal of liquid droplets an R-4 polypropylene weave material has been utilized inside the cylinder as a coalescing media. A sight glass has been added for viewing of collected liquid level and a drain (boiler type) has also been included for liquid removal. Please note that for liquid removal the blower must be turned off to relieve vacuum on the cylinder. The purpose of the Air Bleed Valve is to let air into the influent side of the blower, through an Allied Witan Atomuffler, to adjust the vacuum placed on the wells.

Influent/Effluent Piping

At the inlet/outlet of the blower, galvanized carbon steel pipe has been utilized. This is keeping within the Manufacturer's recommendations for initial heat dissipation.

4. Optional Performance Monitoring Systems

The VES System could have any combination of the fault sensors and performance monitor options listed below:

A. High Temperature (Exhaust) Sensor - An intrusive bimetallic probe that remains in a normally open position until the temperature rises above a set point of 150 degrees F. Temperatures exceeding this limit will automatically shut down the system and indicate the fault on the control panel. This sensor, located in the effluent line of the blower, can be recalibrated if so desired. It is easily accomplished utilizing a hot water source and temperature stable thermometer. Simply place the sensor in water of the required temperature and allow several minutes for stabilization. Then, utilizing the potentiometer at the top of the sensor, adjust the set point until the bi-metallic connection "closes". Please note a small dab of RTV placed over the potentiometer after calibration is advisable to prevent inadvertent field adjustments by unqualified personnel.

B. High Vacuum (Intake) Sensor - A Barksdale DIH-H18SS sensor continuously monitors the influent vacuum of the blower. This sensor is factory set. If this level should become greater than the factory adjustment, the unit will shut down and the fault will be indicated on the control panel. This level should not be re-set to a higher level without consulting the factory.

C. High Pressure (Exhaust) Sensor - A Barksdale D1H-A3SS sensor is located on the effluent line of the system to continuously monitor the system outlet pressure. In the event of a high pressure condition, the sensor will shut down the system and the fault will be indicated on the control panel.

D. Intake Vacuum and Exhaust Temperature Gauges - a Tel-Tru Industrial thermometer is located on both the influent and effluent side of the blower to allow a user to monitor the process temperature of the vapor stream.

SYSTEM MAINTENANCE

Before starting maintenance make sure main power to the control panel is off and locked out, and control switches on panel are in the off position.

Groundwater Motor and Pump

The Franklin Submersible Motor is designed for trouble free operation. However, it should be inspected and cleaned on a periodic basis for deposit build-up, dependent on well condition. The stainless steel water table depression pump has an intake screen located at the base. This screen will require periodic maintenance dependant on well conditions.

Probe

All probes (recovery well, batch tank, air stripper, etc.) need to be inspected and cleaned weekly or monthly depending on deposit build-up. Probe floats and shaft should be cleaned with soap and water or a mild cleanser (Fantastic or Simple Green). DO NOT USE ANY ABRASIVE MATERIALS ON PROBE FLOATS.

Recovery Well Probe

When cleaning you must remove the screws at the top of the probe. Gently twist and pull aluminum case off of probe top, this will allow you to clean and inspect the floats. When this is complete and floats are free moving, reassemble the probe and deploy back in the well. When cleaning probees do not move or adjust shaft collars. Probes are factory calibrated and should not be changed.

Air Filters

Air filters must be kept clean and free of debris. They should be checked weekly or every 1000 hours of operation. Clean filters by lightly brushing or vacuuming.

Air Strippers

Air strippers initially require very little maintenance. Low Profile units should be checked for deposit build up in and around diffusions tubes. The tubes can be removed by gently unthreading from the tank. Rinse with clean water. Heavy build-ups may require a light brush with mild soap. Be sure that when diffusion tubes are installed, the air holes must be pointing down in the tank. Air stripping towers should be checked for build-up of precipitates on the pack. This can be checked by a gradual reduction in air flow and a gradual increase in air pressure.

Blowers

Blowers are considered to be relatively maintenance free. The motor should be kept free of accumulating dust and dirt. The air inlet on the rear cooling fan must be kept clean.

Oil/Water Separators

Oil/Water Separators should be checked monthly for deposit build-ups around packing material. Simply flush with water to clean.

WARRANTY

Groundwater Recovery Systems, Inc. (Manufacturer) warrants its products to be free from defect in material and workmanship under normal use and service, the remedy under this warranty being exclusively limited to making good at Manufacturer's factory any part or parts thereof which shall be returned to it with transportation charges prepaid; and which its examination shall disclose to its satisfaction to have been thus defective, except for pumps and motors, provided that such part or parts shall be so returned to it no later than 12 months after delivery of its product to the purchaser. Pumps and motors are warranted 3 months after deliver of its product to the original purchaser. THIS LIMITED WARRANTY IS BEING MADE IN PLACE OF ALL OTHER EXPRESS WARRANTIES AND IN PLACE OF ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS. THIS LIMITED WARRANTY IS IN LIEU OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF THE MANUFACTURER FOR DAMAGES INCLUDING, BUT NOT LIMITED TO, CONSEQUENTIAL AND INCIDENTAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE USE OF THE PRODUCT.

Pressure Conversion Chart

in/H_2O	P.S.I.	in/Hg	mm/H_2O	mm/Hg	kg/cm^2	bar	mbar	Pa	kPa
.1	.0036	.0073	2.534	.1863	.0002	.0002	.2482	24.82	.0248
.2	.0072	.0146	5.067	.3726	.0005	.0005	.4964	49.64	.0496
.4	.0144	.0293	10.13	.7452	.0010	.0010	.9928	99.28	.0993
2	.0722	.1470	50.81	3.736	.0051	.0050	4.978	497.8	.4978
3	.1083	.2205	76.22	5.604	.0076	.0075	7.467	746.7	.7467
4	.1444	.2940	101.62	7.472	.0102	.0099	9.956	995.6	.9956
8	.2887	.5878	203.2	14.940	.0203	.0199	19.90	1990	1.990
9	.3248	.6613	228.6	16.808	.0228	.0224	22.39	2239	2.239
10	.3609	.7348	254.0	18.676	.0254	.0249	24.88	2488	2.488
14	.5053	1.029	355.6	26.148	.0355	.0348	34.84	3484	3.484
15	.5414	1.102	381.0	28.016	.0381	.0373	37.33	3733	3.733
16	.5774	1.176	406.4	29.879	.0406	.0398	39.81	3981	3.981
20	.7218	1.470	508.0	37.352	.0507	.0498	49.77	4977	4.977
21	.7579	1.543	533.4	39.22	.0533	.0523	52.26	5226	5.226
22	.7940	1.616	558.8	41.09	.0558	.0547	54.74	5474	5.474
26	.9384	1.910	660.4	48.56	.0660	.0647	64.70	6470	6.470
27	.9745	1.984	685.8	50.43	.0685	.0672	67.19	6719	6.719
28	1.010	2.056	710.8	52.26	.0710	.0696	69.64	6964	6.964
32	1.155	2.352	812.8	59.77	.0812	.0796	79.63	7963	7.963
33	1.191	2.425	838.2	61.63	.0837	.0821	82.12	8212	8.212
34	1.227	2.498	863.5	63.49	.0862	.0846	84.60	8460	8.460
38	1.371	2.791	964.9	70.95	.0964	.0945	94.53	9453	9.453
39	1.408	2.867	990.9	72.86	.0990	.0971	97.08	9708	9.708
40	1.444	2.940	1016	74.72	.1015	.0996	99.56	9956	9.956
44	1.588	3.233	1118	82.18	.1116	.1095	109.5	10949	10.95
45	1.624	3.306	1143	84.04	.1142	.1120	112.8	11197	11.20
46	1.660	3.378	1168	85.90	.1167	.1144	114.5	11445	11.44
50	1.804	3.673	1270	93.35	.1268	.1244	124.4	12438	12.44
51	1.841	3.748	1296	95.27	.1294	.1269	126.9	12693	12.69
52	1.877	3.822	1321	97.13	.1320	.1294	129.4	12941	12.94
56	2.021	4.115	1422	104.6	.1421	.1393	139.3	13934	13.93
57	2.057	4.188	1448	106.4	.1446	.1418	141.8	14182	14.18
58	2.093	4.261	1473	108.3	.1471	.1443	144.3	14431	14.43
62	2.238	4.556	1575	115.8	.1573	.1543	154.3	15430	15.43
63	2.274	4.630	1600	117.7	.1599	.1568	156.8	15679	15.68
64	2.310	4.703	1626	119.5	.1624	.1593	159.3	15927	15.93
68	2.454	4.996	1727	127.0	.1725	.1692	169.2	16920	16.92
69	2.490	5.070	1752	128.8	.1750	.1717	171.7	17168	17.17
70	2.526	5.143	1778	130.7	.1776	.1742	174.2	17416	17.42
74	2.671	5.438	1880	138.2	.1878	.1842	184.2	18416	18.42
75	2.707	5.511	1905	140.1	.1903	.1866	186.6	18664	18.66
76	2.743	5.585	1930	141.9	.1928	.1891	189.1	18912	18.91
80	2.887	5.878	2032	149.4	.2030	.1991	199.1	19905	19.90
81	2.923	5.951	2057	151.2	.2055	.2015	201.5	20153	20.15
82	2.959	6.024	2082	153.1	.2080	.2040	204.0	20402	20.40
86	3.104	6.320	2184	160.6	.2182	.2140	214.0	21401	21.40
87	3.140	6.393	2210	162.5	.2207	.2165	216.5	21650	21.65
88	3.176	6.466	2235	164.4	.2233	.2190	219.0	21898	21.90
92	3.320	6.760	2336	171.8	.2334	.2289	228.9	22890	22.89
93	3.356	6.833	2362	173.7	.2359	.2314	231.4	23139	23.14
94	3.392	6.906	2387	175.5	.2384	.2339	233.9	23387	23.39
98	3.537	7.201	2489	183.0	.2486	.2439	243.9	24387	24.39
99	3.573	7.275	2514	184.9	.2512	.2464	246.4	24635	24.64
100	3.609	7.348	2540	186.8	.2537	.2488	248.8	24883	24.88

P.S.I.	in/H_2O	in/Hg	mm/H_2O	mm/Hg	kg/cm^2	bar	mbar	Pa	kPa
1.0	27.71	2.036	703.1	51.75	.0703	.0689	68.95	6895	6.895
1.1	30.45	2.240	773.4	56.89	.0773	.0758	75.84	7584	7.584
1.2	33.22	2.443	843.7	62.06	.0844	.0827	82.74	8274	8.274
1.6	44.29	3.258	1125	82.74	.1125	.1103	110.3	11030	11.03
1.7	47.06	3.461	1195	87.92	.1195	.1172	117.2	11720	11.72
1.8	49.82	3.665	1266	93.09	.1266	.1241	124.1	12410	12.41
2.2	60.90	4.479	1547	113.8	.1547	.1517	151.7	15170	15.17
2.3	63.67	4.683	1617	118.9	.1617	.1586	158.6	15860	15.86
2.4	66.43	4.886	1687	124.1	.1687	.1655	165.5	16550	16.55
2.8	77.51	5.701	1969	144.8	.1968	.1930	193.0	19300	19.30
2.9	80.27	5.904	2039	150.0	.2039	.1999	199.9	19990	19.99
3.8	83.04	6.108	2109	155.1	.2109	.2068	206.8	20680	20.68
3.4	94.11	6.922	2390	175.8	.2390	.2344	234.4	23440	23.44
3.5	96.88	7.126	2461	181.0	.2461	.2413	241.3	24130	24.13
3.6	99.65	7.330	2531	186.2	.2531	.2482	248.2	24820	24.82
4.0	110.7	8.144	2812	206.9	.2812	.2758	275.8	27580	27.58
4.1	113.5	8.348	2883	212.0	.2883	.2827	282.7	28270	28.27
4.2	116.3	8.551	2953	217.2	.2953	.2896	289.6	28960	28.96
4.6	127.3	9.366	3234	237.9	.3234	.3172	317.2	31720	31.72
4.7	130.1	9.569	3304	243.1	.3304	.3240	324.0	32400	32.40
4.8	132.9	9.773	3375	248.2	.3375	.3310	331.0	33100	33.10
5.2	143.9	10.59	3656	268.9	.3656	.3585	358.5	35850	35.85
5.3	146.7	10.79	3726	274.1	.3726	.3654	365.4	36540	36.54
5.4	149.5	10.99	3797	279.3	.3797	.3723	372.3	37230	37.23
5.8	160.5	11.81	4078	299.9	.4078	.3999	399.9	39990	39.99
5.9	163.3	12.01	4148	305.1	.4148	.4068	406.8	40680	40.68
6.8	166.1	12.22	4218	310.3	.4218	.4137	413.7	41370	41.37
6.4	177.2	13.03	4500	331.0	.4500	.4413	441.3	44130	44.13
6.5	179.9	13.23	4570	336.1	.4570	.4482	448.2	44820	44.82
6.6	182.7	13.44	4640	341.3	.4640	.4550	455.0	45500	45.50
7.8	193.8	14.25	4922	362.0	.4921	.4826	482.6	48260	48.26
7.1	196.5	14.46	4992	367.2	.4992	.4895	489.5	48950	48.95
7.2	199.3	14.66	5062	372.3	.5062	.4964	496.4	49640	49.64
7.6	210.4	15.47	5343	393.0	.5343	.5240	524.0	52400	52.40
7.8	215.9	15.88	5484	403.4	.5484	.5378	537.8	53780	53.78
8.0	221.4	16.29	5625	413.7	.5625	.5516	551.6	55160	55.16
8.4	232.5	17.10	5906	434.4	.5906	.5792	579.2	57920	57.92
8.6	238.0	17.51	6047	444.7	.6046	.5929	592.9	59290	59.29
8.8	243.6	17.92	6187	455.1	.6187	.6067	606.7	60670	60.67
9.0	249.1	18.32	6328	465.4	.6328	.6205	620.5	62050	62.05
9.2	254.7	18.73	6468	475.8	.6468	.6343	634.3	63430	63.43
9.6	265.7	19.54	6750	496.5	.6749	.6619	661.9	66190	66.19
9.8	271.3	19.95	6890	506.8	.6890	.6757	675.7	67570	67.57
10.0	276.8	20.36	7031	517.1	.7031	.6895	689.5	68950	68.95
11.0	304.5	22.40	7734	568.9	.7734	.7584	758.4	75840	75.84
12.0	332.2	24.43	8437	620.6	.8437	.8274	827.4	82740	82.74
13.0	359.8	26.47	9140	672.3	.9140	.8963	896.3	89630	89.63
14.0	387.5	28.50	9843	724.0	.9843	.9652	965.2	96520	96.52
14.7	406.9	29.93	10340	760.2	1.033	1.014	1014	101400	101.4
15.0	415.2	30.54	10550	775.7	1.055	1.034	1034	103400	103.4
16.0	442.9	32.58	11250	827.4	1.125	1.103	1103	110300	110.3
17.0	470.6	34.61	11950	879.1	1.195	1.172	1172	117200	117.2
18.0	498.2	36.65	12660	930.9	1.265	1.241	1241	124100	124.1
19.0	525.9	38.68	13360	982.6	1.336	1.310	1310	131000	131.0
20.0	553.6	40.72	14060	1034	1.406	1.379	1379	137900	137.9
21.0	581.3	42.76	14770	1086	1.476	1.448	1448	144800	144.8
22.0	609.0	44.79	15470	1138	1.547	1.517	1517	151700	151.7
23.0	636.7	46.83	16170	1189	1.617	1.586	1586	158600	158.6
24.0	664.3	48.86	16870	1241	1.687	1.655	1655	165500	165.5
25.0	692.0	50.90	17580	1293	1.758	1.724	1724	172400	172.4

CONVERSION FACTORS

NOTE: CONVERSION FACTORS ROUNDED

P.S.I. x 27.71 = in. H_2O
P.S.I. x 2.036 = in. Hg
P.S.I. x 703.1 = mm/H_2O
P.S.I. x 51.75 = mm/Hg
P.S.I. x .0703 = kg/cm^2
P.S.I. x .0689 = bar
P.S.I. x 68.95 = mbar
P.S.I. x 6895 = Pa
P.S.I. x 6.895 = kPa

TUTHILL CORPORATION/M-D PNEUMATICS DIVISION
4840 W. Kearney St.
Springfield, MO 65803

AUTOMATED BLOWER SIZING (VER. 4.01)

Customer: GRS
File:
Date: 07-24-1997 Selection by: JEG

Initial Conditions:

Gas type:	AIR	
Molecular Weight:	28.970	
K value:	1.398	
Elevation above MSL:	0	feet
Barometric pressure:	14.70	PSIA
Inlet pressure:	11.75	PSIA
Inlet temperature:	70	F
Required volumetric flow:	350	SCFM
Discharge pressure:	14.70	PSIA
Relief valve setting:	11.25	PSIA

Single Stage Vacuum
Calculated Conditions:

Blower selected is M-D COMPETITOR:	5006	
Inlet pressure:	11.75	PSIA
Discharge pressure:	14.70	PSIA
Relief valve setting:	11.25	PSIA
Compression ratio:	1.25	
Actual inlet volume required:	438	ICFM
Blower discharge temperature:	107	F
Gas horsepower:	6.49	
Brake horsepower:	7.19	BHP
Discharge temperature at relief setting:	113	F
Gas horsepower at relief setting:	7.60	
Brake horsepower at relief setting:	8.29	BHP
Nominal rotative speed:	2285	RPM
Gear tip velocity at pitch line:	2991	FPM
Percent of maximum speed:	80.2	%
Estimated noise level at one meter:	88.4	dB(A) *

* Estimated noise level based on blower operating in open field environment with critical grade inlet and discharge silencers.

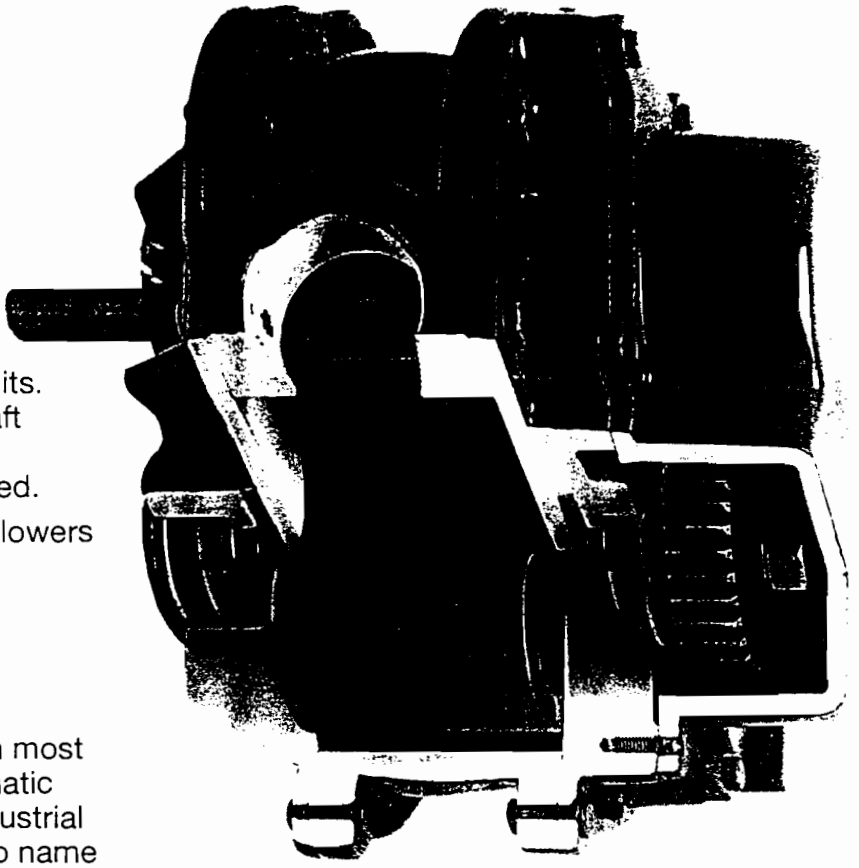
TUTHILL CORPORATION | M-D Pneumatics Division

COMPETITOR®
A-16 Product Brochure

Rotary Positive Blowers

BEST IN THE BLOWER BUSINESS

Proven Performance at a Competitive Price



Interchangeable with Other Popular Makes

COMPETITOR® models are interchangeable with the equivalent Roots Universal RAI® and Sutorbilt® California Series B, F and Legend™ units. Footprint, pipe connections, drive shaft diameter, length and keyway are compatible—no re-engineering required.

Packages including COMPETITOR® blowers are available through authorized M-D distributors and original equipment manufacturers.

A Versatile Performer

COMPETITOR® blowers are utilized in most industrial applications such as pneumatic conveying, wastewater treatment, industrial vacuum and fluidization of powders to name only a few.

Quality Assured

Every COMPETITOR® blower is factory run tested to assure you of high quality.

Factory Warranty

M-D Pneumatics will repair or replace defective equipment or parts, according to the terms of its limited warranty.

Extended term warranty option available in the U.S.A.

Priced Right

COMPETITOR® blowers are designed and built to offer superb performance that meets or exceeds that of competing models—at prices that are hard to match.

Quick Delivery

A worldwide network of sales representatives and distributor stock locations assure you quick availability.

Metric Models Available

All COMPETITOR® models are available with metric pipe connections, footprint and drive shaft for overseas applications.

Outstanding Service

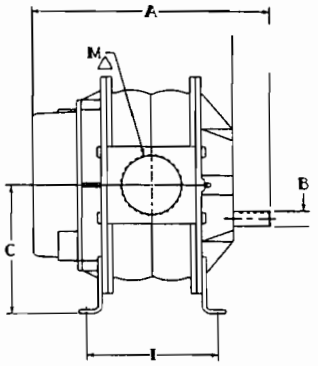
For responsive service, parts, application assistance or special requirements, contact your local M-D sales representative or distributor.

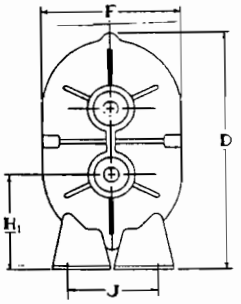
Upgrade to M-D Quality Without Changing Your Piping

- **Taper mounted timing gears**
  Carburized, precision ground timing gears reduce gear noise and provide for long gear life. Gears are taper mounted to rotor shafts with locknuts for easy removal and installation.
- **Oversized bearings**
  Oversized bearings for long operating life. Rotor shafts include ball bearings. Bearing on drive shaft is cylindrical roller type for the load of V-belt drive applications.
- **Effective lubrication and sealing**
  Timing gears and gear end bearings are oil splash lubricated. Drive end bearings are grease lubricated. Lubricant chambers are isolated by Viton® lip seals, and blower end plates are vented to atmosphere to prevent pressure accumulation against the seals. A hypocycloidal gear housing provides extra gear and bearing lubrication.
- **One piece housing**
  Rugged, single piece housing of precision machined grey iron. Integral standard pipe connections for easy installation. Models 4000 through 7000 include extra heavy housings for reduction of noise.
- **Lobe type rotors**
  High strength, ductile iron rotors are dynamically balanced for vibration free, bi-directional rotation.
- **Horizontal or vertical mounting**
  A horizontal or vertical air flow is easily achieved by rearranging the mounting feet positions.
- **Drive shaft**
  Drive shaft is supported by a cylindrical roller bearing to handle greater overhung V-belt loads. Drive shaft location can be specified in any position; top or bottom for horizontal flow machines, left or right for vertical flow machines.

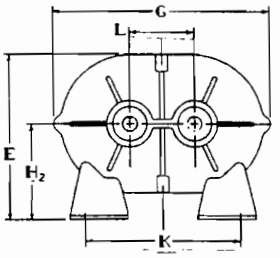
Dimensions

Horizontal Flow Configuration





Vertical Flow Configuration



MODEL	A	B	C	D	E	F	G	H_1	H_2	I	J	K	L	M	WT. (LBS.)
2002 2004	9.75 11.75	0.625	5.00	9.69	6.88	6.25	8.25	3.75	3.75	4.00 6.00	3.50	3.50	2.50	1"NPT 2"NPT	36 48
3003 3006	12.19 14.56	0.750	6.75	12.81	8.88	7.75	11.13	5.00	5.00	6.25 8.62	5.38 5.38	5.38 5.38	3.50	2"NPT 2½"NPT	78 108
4002 4005 4007	12.56 15.31 17.06	0.875	8.25	15.13	10.63 10.63 10.50	8.75	12.63	6.25	6.25	5.06 7.81 9.56	6.13	7.00	4.00	1½"NPT 2½"NPT 3"NPT	90 114 133
5003 5006 5009	14.88 17.50 20.50	1.125	8.75	17.38	11.88 12.25 12.25	11.00	15.75	6.25	6.75	6.13 9.25 12.25	7.00	7.00	5.00	2½"NPT 4"NPT 4"NPT	145 178 215
6005 6008 6015	18.38 21.38 28.38	1.375	11.75	21.69	15.13 15.13 16.25	12.75	19.81	8.75	8.75	7.63 10.63 17.63	8.00	11.00	6.00	3"NPT 5"NPT 6"FLG	240 300 446
7006 7011 7018	19.94 25.19 32.19	1.562	14.50	26.13	20.69 19.50 19.50	19.38 17.00 17.00	23.25	11.00	11.00	9.75 14.75 21.75	11.00	18.00	7.00	4"NPT 6"FLG 8"FLG	425 555 675

All dimensions are approximate and should not be used for construction. Certified drawings are available from your local M-D representative or distributor

Performance Tables

In conjunction with our program of continuous testing and upgrading, all specifications are subject to change without notice.

All data is approximate. Request a quotation for your specific application.

For heavy-duty applications, request information on M-D Model PD PLUS® Rotary Blowers.

Pressure (14.70 PSIA and 70°F Inlet)

MODEL	SPEED	2 PSI		4 PSI		6 PSI		7 PSI		8 PSI		10 PSI		12 PSI		15 PSI		Max Vacuum		
	(RPM)	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	"Hg	CFM	BHP
2002	1170	7	0.3															6	3.1	.03
	3600	46	0.8	41	1.3	38	1.8	36	2.1	35	2.3	32	2.8	29	3.3			14	28	2.1
	5275	73	1.2	68	1.9	64	2.7	63	3.1	61	3.4	59	4.2	56	4.9			14	55	3.0
2004	1170	19	0.4	12	0.8													6	13	0.6
	3600	97	1.3	89	2.3	83	3.3	81	3.8									14	69	3.8
	5275	150	1.9	143	3.4	137	4.9	134	5.6									14	122	5.5
3003	1170	49	0.8	39	1.4	31	2.1	28	2.4									10	27	1.7
	2700	143	1.9	133	3.3	126	4.8	122	5.5	119	6.2	114	7.7	109	9.1			14	107	5.4
	3600	198	2.5	188	4.5	181	6.4	178	7.4	175	8.3	169	10	164	12			14	162	7.2
3006	1170	86	1.2	72	2.3	62	3.3	57	3.8									10	56	2.7
	2700	242	2.8	228	5.2	218	7.6	213	8.9									12	202	7.5
	3600	334	3.8	320	7.0	310	10	305	12									14	283	12
4002	880	34	0.6	26	1.1	19	1.6	17	1.8									10	16	1.3
	1760	87	1.3	79	2.2	73	3.1	70	3.6	67	4.1	63	5.0	59	5.9			14	57	3.5
	3600	198	2.6	190	4.5	184	6.4	181	7.4	179	8.3	174	10	170	12	164	15	14	168	7.3
4005	880	70	1.1	55	2.0	44	3.0	39	3.4									8	47	2.0
	1760	177	2.2	162	4.1	150	5.9	145	6.9	140	7.8	132	9.6					12	132	5.8
	3600	399	4.5	384	8.3	373	12	368	14	363	16	355	20					14	343	14
4007	880	93	1.4	74	2.6	59	3.9	52	4.5									8	63	2.6
	1760	234	2.8	214	5.3	199	7.7	193	8.9									12	176	7.6
	3600	527	5.7	508	11	493	16	486	18									14	454	18
5003	710	64	1.0	52	1.8	43	2.7	39	3.1	35	3.5							10	37	2.2
	1760	203	2.6	191	4.6	181	6.6	177	7.6	173	8.6	167	11	160	13	152	16	14	158	7.5
	2850	346	4.1	334	7.4	325	11	321	12	317	14	310	17	304	21	295	25	14	301	12
5006	710	108	1.6	87	3.0	71	4.3	65	5.0	58	5.7							10	62	3.6
	1760	340	3.9	319	7.3	303	11	297	12	290	14	278	17					14	263	12
	2850	581	6.4	560	12	544	17	537	20	531	23	519	28					14	504	20
5009	710	173	2.2	151	4.2	133	6.2	125	7.2									10	122	5.1
	1760	513	5.5	490	10	472	15	464	18									12	445	15
	2850	865	8.9	842	17	824	25	816	29									14	779	28
6005	710	129	1.8	110	3.3	95	4.9	89	5.6	83	6.4	72	7.9					12	73	4.8
	1760	387	4.5	368	8.3	354	12	347	14	341	16	330	20	160	23	307	29	16	300	16
	2350	532	6.0	513	11	499	16	492	19	486	21	476	26	304	31	452	38	16	445	21
6008	710	207	2.7	176	5.2	153	7.6	143	8.9	133	10	116	13					12	117	7.5
	1760	621	6.8	591	13	568	19	557	22	548	25	530	31	515	37			16	481	25
	2350	854	9.1	824	17	801	25	790	29	781	33	764	41	748	50			16	714	33
6015	710	387	4.9	330	9.5	286	14											8	300	9.3
	1760	1164	12	1107	23	1063	35											12	996	34
	2350	1601	16	1544	31	1500	46											12	1433	46
7006	575	179	2.3	158	4.3	150	5.4	134	7.4	115	10							12	117	6.2
	1400	511	5.7	490	11	481	13	466	18	447	25	441	28	436	30	421	38	16	413	20
	2050	772	8.3	751	16	742	19	727	26	708	37	703	41	697	44	682	55	16	674	29
7011	575	336	4.0	299	7.7	284	9.6	258	13	226	19							12	228	11
	1400	944	9.8	908	19	893	23	867	32	835	46							15	793	34
	2050	1424	14	1387	28	1373	34	1347	47	1315	67							16	1256	53
7018	575	563	6.3	510	12	489	15											10	446	15
	1400	1553	15	1500	30	1479	37											12	1398	44
	2050	2333	23	2280	44	2259	55											12	2178	64

Blower components are manufactured by M-D Pneumatics Division and also sourced from Tuthill Argentina.

Worldwide

Tuthill Europe S.A.
Parc Industriel Wavre Nord
Avenue Vésale 30
B-1300 Wavre Belgium
Tel 32-10/22.83.34
Fax 32-10/22.83.38

Tuthill Argentina
Bernardo De Irigoyen 962
1878 Quilmes, Argentina
Tel (54-1) 253-7007
Fax (54-1) 257-2457

Contact M-D Sales Department for Asian Distributors

How To Order Or Obtain Information

To place an order or obtain additional information, contact your local M-D manufacturer's representative. For the name of our representative in your area, look in the Yellow Pages under "Blowers" or call our sales department.

BEST IN THE BLOWER BUSINESS

Represented/Distributed by:

TUTHILL CORPORATION | M-D Pneumatics Division

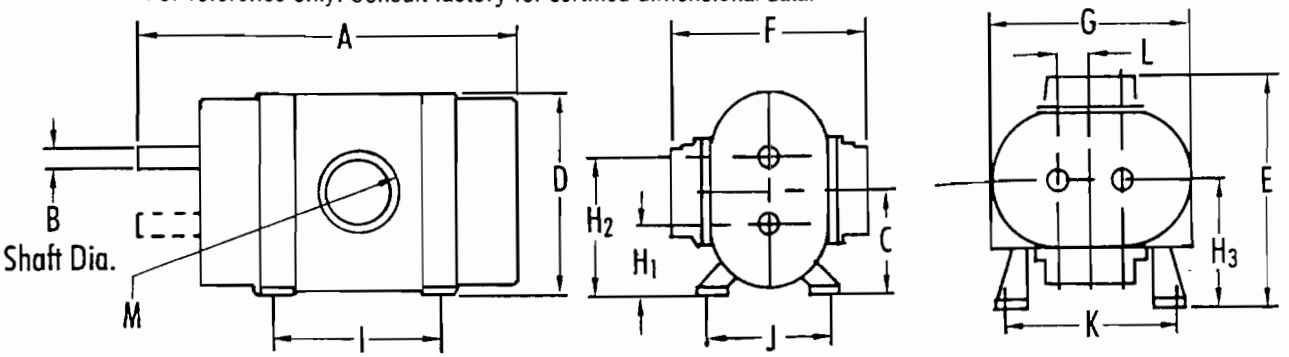
4840 West Kearney Street, P.O. Box 2877
Springfield, Missouri USA 65801-0877
Tel 417 865-8715 Fax 417 865-2950

PRINTED IN USA

4-95

M-D Blowers Dimensions Table

Dimensions shown are for air blowers. Dimensions of certain gastight blowers may vary.
For reference only. Consult factory for certified dimensional data.



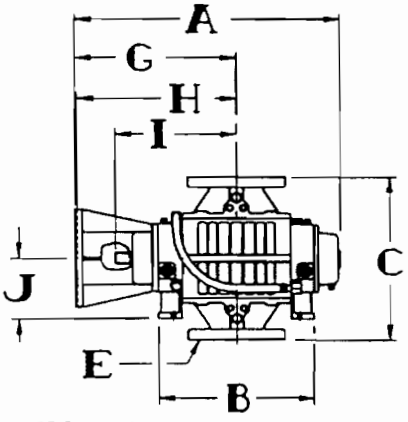
Model	A	B	C	D	E	F	G	DRIVE SHAFT LOC. H_1	H_2	H_3	I	J	K	L	M	Wt. (lbs.)
ACOUSTICAIR™																
4706	20.00	1.500	9.00	16.62	14.75	14.50	16.39	-	11.30	7.50	9.50	5.00	9.50	2.30	4"NPT	290
4709	23.00	1.500	9.00	16.62	14.75	14.50	16.39	-	11.30	7.50	12.50	5.00	9.50	2.30	5"NPT	330
4712	26.00	1.500	9.00	16.62	13.50	13.00	16.39	-	11.30	7.50	15.50	5.00	9.50	2.30	6"FLG*	370
5607	28.94	1.750	8.38	16.38	19.00	17.00	17.00	5.62	11.12	10.50	10.75	11.00	14.50	2.75	4"NPT	420
5611	32.44	1.750	8.38	16.38	19.00	17.00	17.00	5.62	11.12	10.50	14.25	11.00	14.50	2.75	5"NPT	520
5614	35.44	1.750	8.38	16.38	19.00	17.00	17.00	5.62	11.12	10.50	17.25	11.00	14.50	2.75	6"FLG	615
5618	39.44	1.750	8.38	16.38	19.00	17.00	17.00	5.62	11.12	10.50	21.25	11.00	14.50	2.75	8"FLG	690
*INLET PORT IS 6" FLG, DISCHARGE PORT IS 5" FLG																
COMPETITOR®																
2002	9.75	0.625	5.00	9.69	6.88	6.25	8.25	3.75	6.25	3.75	4.00	3.50	3.50	1.25	1"NPT	36
2004	11.75	0.625	5.00	9.69	6.88	6.25	8.25	3.75	6.25	3.75	6.00	3.50	3.50	1.25	2"NPT	48
3003	12.19	0.750	6.75	12.81	8.88	7.75	11.13	5.00	8.50	5.00	6.25	5.38	5.38	1.75	2"NPT	78
3006	14.56	0.750	6.75	12.81	8.88	7.75	11.13	5.00	8.50	5.00	8.62	5.38	5.38	1.75	2½"NPT	108
4002	12.56	0.875	8.25	15.13	10.63	8.75	12.63	6.25	10.25	6.25	5.06	6.13	6.13	2.00	1½"NPT	90
4005	15.31	0.875	8.25	15.13	10.63	8.75	12.63	6.25	10.25	6.25	7.81	6.13	6.13	2.00	2½"NPT	114
4007	17.06	0.875	8.25	15.13	10.63	8.75	12.63	6.25	10.25	6.25	9.56	6.13	6.13	2.00	3"NPT	133
5003	14.88	1.125	8.75	17.38	12.25	11.00	15.75	6.25	11.25	6.75	6.13	7.00	7.00	2.50	2½"NPT	145
5006	17.50	1.125	8.75	17.38	12.25	11.00	15.75	6.25	11.25	6.75	9.25	7.00	7.00	2.50	4"NPT	178
5009	20.50	1.125	8.75	17.38	12.25	11.00	15.75	6.25	11.25	6.75	12.25	7.00	7.00	2.50	4"NPT	215
6005	18.38	1.375	11.75	21.69	15.13	12.75	19.81	8.75	14.75	8.75	7.63	8.00	11.00	3.00	3"NPT	240
6008	21.38	1.375	11.75	21.69	15.13	12.75	19.81	8.75	14.75	8.75	10.63	8.00	11.00	3.00	5"NPT	300
6015	28.38	1.375	11.75	21.69	16.25	15.00	19.81	8.75	14.75	8.75	27.63	8.00	11.00	3.00	6"FLG	446
7006	19.94	1.562	14.50	26.13	20.69	19.38	23.25	11.00	18.00	11.00	9.75	11.00	18.00	3.50	4"NPT	420
7011	25.19	1.562	14.50	26.13	19.50	17.00	23.25	11.00	18.00	11.00	14.75	11.00	18.00	3.50	6"FLG	550
7018	32.19	1.562	14.50	26.13	19.50	17.00	23.25	11.00	18.00	11.00	21.75	11.00	18.00	3.50	8"FLG	670
EQUALIZER®																
4606	20.00	1.500	9.00	16.62	13.50	12.00	16.39	-	11.30	7.50	9.50	5.00	9.50	2.30	4"NPT	270
4607	22.06	1.437	9.09	16.71	12.50	13.75	14.50	-	11.40	5.62	6.88	11.50	17.50	2.30	4"NPT	300
4609	23.00	1.500	9.00	16.62	13.00	11.00	16.39	-	11.30	7.50	12.50	5.00	9.50	2.30	4"NPT	310
4610	25.06	1.437	9.09	16.71	12.50	13.75	14.50	-	11.40	5.62	6.88	11.50	17.50	2.30	4"NPT	340
4612	26.00	1.500	9.00	16.62	13.00	11.00	16.39	-	11.30	7.50	15.50	5.00	9.50	2.30	6"FLG	370
4613	28.06	1.437	9.09	16.71	13.19	15.12	14.50	-	11.40	5.62	9.88	11.50	17.50	2.30	6"NPT	410
6012	27.63	1.562	12.00	21.38	18.00	18.00	18.25	-	15.00	9.00	14.62	8.00	12.00	3.00	8"FLG	588
6016	31.63	1.562	12.00	21.38	16.25	14.50	18.25	-	15.00	9.00	19.50	7.00	13.00	3.00	8"FLG	650
6024	39.63	2.000	12.00	21.38	16.25	14.50	18.25	-	15.00	9.00	27.50	7.00	13.00	3.00	10"FLG	775

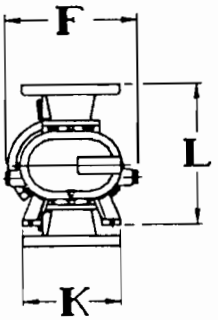
All values are approximate and should not be used for construction. Certified drawings are available through your local M-D representative.
Truck blower models not included above. Consult factory.

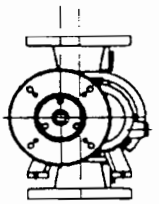
M-D Blowers Dimensions Table

Dimensions shown are for air blowers. Dimensions of certain gastight blowers may vary.
For reference only. Consult factory for certified dimensional data.

Model	A	B	C	D	E	F	G	DRIVE SHAFT LOC. H_1	H_2	H_3	I	J	K	L	M	Wt. (lbs.)
PD PLUS®																
3202	17.66	0.938	5.12	10.06	9.50	8.00	10.75	3.50	6.75	5.50	4.00	6.00	7.50	1.62	1½"NPT	120
3204	19.16	0.938	5.12	10.06	10.50	10.00	10.75	3.50	6.75	5.50	5.50	6.00	7.50	1.62	2"NPT	145
3206	21.16	0.938	5.12	10.06	10.50	10.00	10.75	3.50	6.75	5.50	7.50	6.00	7.50	1.62	2½"NPT	155
3210	25.16	0.938	5.12	10.06	11.00	11.00	10.75	3.50	6.75	5.50	11.50	6.00	7.50	1.62	3"NPT	215
4006	23.18	1.125	6.25	12.25	14.25	12.50	12.50	4.25	8.25	8.00	9.00	8.00	10.50	2.00	3"NPT	160
4009	26.18	1.125	6.25	12.25	14.25	12.50	12.50	4.25	8.25	8.00	12.00	8.00	10.50	2.00	3"NPT	180
4012	29.18	1.125	6.25	12.25	14.25	12.50	12.50	4.25	8.25	8.00	15.00	8.00	10.50	2.00	4"NPT	210
5507	28.94	1.750	8.38	16.38	19.00	17.00	17.00	5.62	11.12	10.50	10.75	11.00	14.50	2.75	4"NPT	380
5509	30.44	1.750	8.38	16.38	19.00	17.00	17.00	5.62	11.12	10.50	12.25	11.00	14.50	2.75	5"NPT	425
5511	32.44	1.750	8.38	16.38	19.00	17.00	17.00	5.62	11.12	10.50	14.25	11.00	14.50	2.75	5"NPT	480
5514	35.44	1.750	8.38	16.38	20.50	20.00	17.00	5.62	11.12	10.50	17.25	11.00	14.50	2.75	6"FLG	575
5516	37.44	1.750	8.38	16.38	20.50	20.00	17.00	5.62	11.12	10.50	19.25	11.00	14.50	2.75	8"FLG	615
5518	39.44	1.750	8.38	16.38	20.50	20.00	17.00	5.62	11.12	10.50	21.25	11.00	14.50	2.75	8"FLG	650
5520	41.44	1.750	8.38	16.38	20.50	20.00	17.00	5.62	11.12	10.50	23.25	11.00	14.50	2.75	8"FLG	700
7010	44.94	2.375	13.62	25.75	25.62	24.00	21.25	10.12	17.12	13.62	14.75	14.50	14.50	3.50	6"FLG	1050
7013	47.69	2.375	13.62	25.75	25.62	24.00	21.25	10.12	17.12	13.62	17.50	14.50	14.50	3.50	8"FLG	1150
7017	51.69	2.375	13.62	25.75	25.62	24.00	21.25	1012	17.12	13.62	21.50	14.50	14.50	3.50	10"FLG	1275
7021	55.69	2.375	13.62	25.75	25.62	24.00	21.25	10.12	17.12	13.62	25.50	14.50	14.50	3.50	12"FLG	1450
7026	60.69	2.375	13.62	25.75	25.62	24.00	21.25	10.12	17.12	13.62	30.50	14.50	14.50	3.50	12"FLG	1600
9012	45.73	3.125	17.42	30.12	30.70	30.70	25.39	12.89	21.94	12.89	23.62	9.06	18.12	4.53	10"FLG	1590
9016	49.66	3.125	17.42	30.12	30.70	30.70	25.39	12.89	21.94	12.89	27.56	9.06	18.12	4.53	12"FLG	1708
9020	54.58	3.125	17.42	30.12	30.70	30.70	25.39	12.89	21.94	12.89	32.48	9.06	18.12	4.53	12"FLG	1952
9027	61.48	3.125	17.42	30.12	30.70	30.70	25.39	12.89	21.94	12.89	39.37	9.06	18.12	4.53	14"FLG	2185
1215	65.75	3.500	22.00	39.12	28.31	26.00	34.25	16.00	28.00	15.31	24.50	14.38	27.75	6.00	12"FLG	4215
1224	74.75	3.500	22.00	39.12	28.31	26.00	34.25	16.00	28.00	15.31	33.50	14.38	27.75	6.00	14"FLG	4926
1230	80.25	3.500	22.00	39.12	28.31	26.00	34.25	16.00	28.00	15.31	39.50	14.38	27.75	6.00	14"FLG	5400
1236	86.75	3.500	22.00	39.12	28.31	26.00	34.25	16.00	28.00	15.31	45.50	14.38	27.75	6.00	18"FLG	5900
1248	98.75	3.500	22.00	39.12	28.31	26.00	34.25	16.00	28.00	15.31	57.50	14.38	27.75	6.00	20"FLG	6850







VB VACUUM BOOSTERS (96 SERIES C-FLANGE)

MODEL	DISPLACEMENT CFM	A	B	C	D SHAFT DIA.	E FLG. SIZE	F	G	H	I	J	K	L	APPROX. WT. LBS.
3204	160	16.00	6.38	13.25	0.875	2"	12.13	10.38	10.19	6.94	5.50	9.00	12.13	165
3206	240	20.00	10.38	14.88	0.875	3"	12.13	12.38	12.19	8.94	5.50	9.00	12.94	180
3210	400	24.00	14.38	14.88	0.875	4"	12.13	14.38	14.19	10.94	5.50	9.00	12.94	210
4009	540	27.62	13.63	15.00	1.000	4"	14.13	16.44	16.25	11.63	8.00	12.00	15.50	240
4012	720	30.62	16.63	15.00	1.000	4"	14.13	17.94	17.75	13.13	8.00	12.00	15.50	270
5509	1000	29.31	14.75	20.00	1.375	6"	18.25	12.25	17.06	12.25	10.50	16.00	20.50	490
5514	1600	34.31	19.75	20.00	1.375	6"	18.25	19.75	19.56	14.75	10.50	16.00	20.50	620
5518	2000	38.31	23.75	20.00	1.375	8"	18.25	21.75	21.56	16.75	10.50	16.00	20.50	700

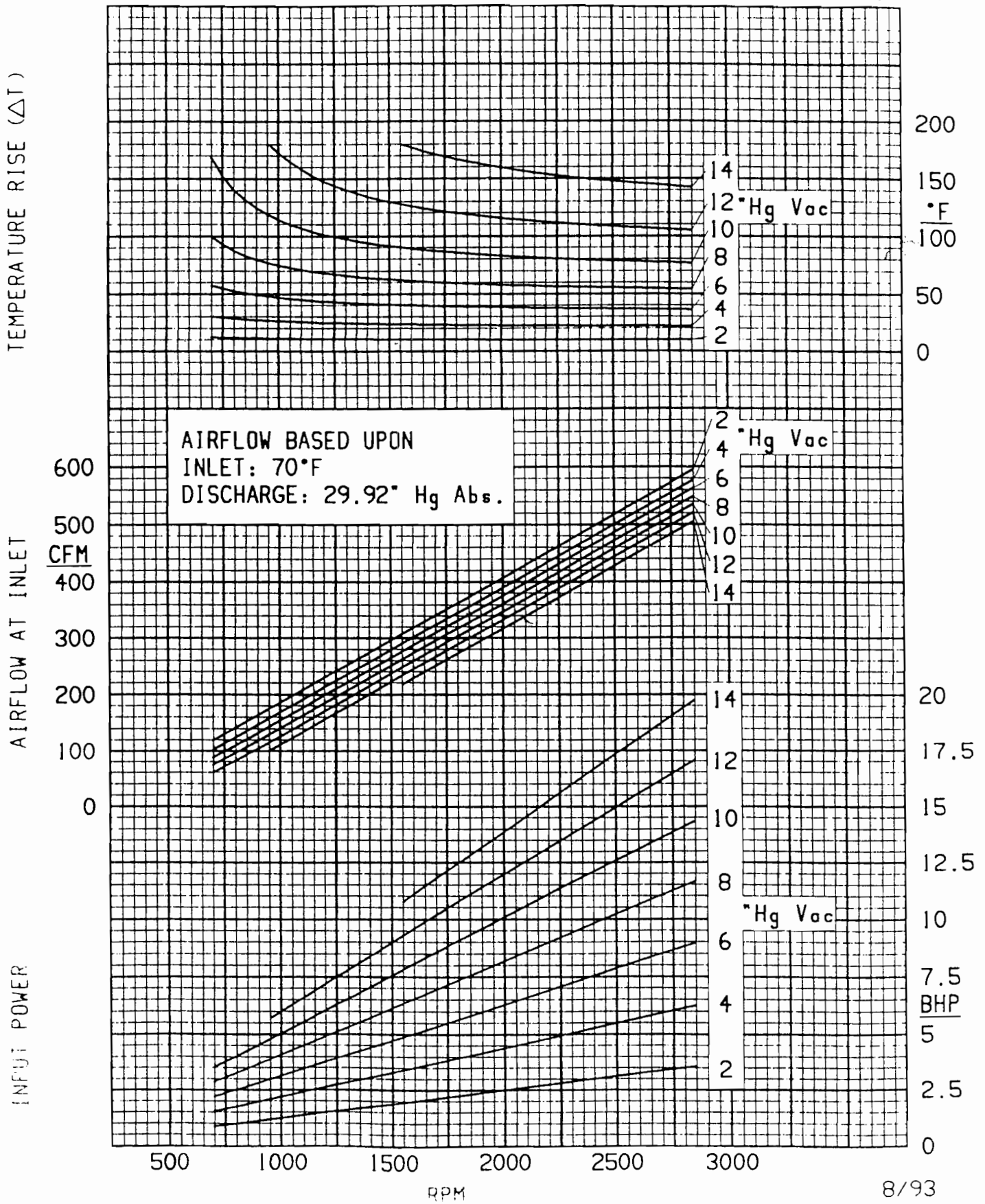
All values are approximate and should not be used for construction. Certified drawings are available through your local M-D representative.

TUTHILL CORPORATION | M-D Pneumatics Division
Springfield Missouri USA

C-1415

5006 COMPETITOR® VACUUM CURVE

(.221 CFR DISPL.)



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NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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A ADD
C CHANGE
D DELETE

READ INSTRUCTIONS CONTAINED IN FORM 76-11-12 BEFORE ANSWERING ANY QUESTION

PROCESS, EXHAUST OR VENTILATION SYSTEM

APPLICATION FOR PERMIT TO CONSTRUCT OR CERTIFICATE TO OPERATE

SECTION A

1. NAME OF OWNER / FIRM	9. NAME OF AUTHORIZED AGENT	10. TELEPHONE	19. FACILITY NAME (IF DIFFERENT FROM OWNER / FIRM)
CANTOR BROTHERS INC.	EEA, INC.	(516) 746-4400	
2. NUMBER AND STREET ADDRESS	**11. NUMBER AND STREET ADDRESS**		**20. FACILITY LOCATION (NUMBER AND STREET ADDRESS)**
50 ENGINEERS LANE	55 HILTON AVENUE		
3. CITY - TOWN - VILLAGE / **4. STATE** / **5. ZIP**	**12. CITY - TOWN - VILLAGE** / **13. STATE** / **14. ZIP**		**21. CITY - TOWN - VILLAGE** / **22. ZIP**
FARMINGDALE / NY / 11735	GARDEN CITY / NY / 11530		
6. OWNER CLASSIFICATON	**15. NAME OF P.E. OR ARCHITECT PREPARING APPLICATION** / **16. N.Y.S. P.E. OR ARCHITECT LICENSE NO.** / **17. TELEPHONE**		**23. BUILDING NAME OR NUMBER** / **24. FLOOR NAME OR NUMBER**
A ☐ COMMERCIAL C ☐ UTILITY F ☐ MUNICIPAL I ☐ RESIDENTIAL	ALLEN SERPER / 52795-1 / (516) 746-4400		
P ☒ INDUSTRIAL D ☐ FEDERAL G ☐ EDUC INST J ☐ OTHER			**25. START UP DATE** 5 / 98 (MO / YR) / **26. DRAWING NUMBERS OF PLANS SUBMITTED**
7. NAME & TITLE OF OWNERS REPRESENTATIVE / **8. TELEPHONE**	**18. SIGNATURE OF OWNERS REPRESENTATIVE OR AGENT WHEN APPLYING FOR A PERMIT TO CONSTRUCT**		**27. PERMIT TO CONSTRUCT** / **28. CERTIFICATE TO OPERATE**
ALLEN SERPER / 746-4400	Allen Serper		A ☒ NEW SOURCE / B ☐ MODIFICATION
VICE PRESIDENT, EEA, INC.			A ☐ NEW SOURCE C ☐ EXISTING SOURCE / B ☐ MODIFICATION

SECTION B

29. EMISSION POINT ID	30. GROUND ELEVATION (FT.)	31. HEIGHT ABOVE STRUCTURES (FT.)	32. STACK HEIGHT (FT.)	33. INSIDE DIMENSIONS (IN.)	34. EXIT TEMP. (°F)	35. EXIT VELOCITY (FT./SEC.)	36. EXIT FLOW RATE (ACFM)
01	85	3	23	12	100	4.45	210

37. SOURCE CODE	38. HRS / DAY	39. DAYS / YR	40. % OPERATION BY SEASON (Winter / Spring / Summer / Fall)
	24	360	25 / 25 / 25 / 25

SECTION C

41. DESCRIBE PROCESS OR UNIT

1. Soil vapor extraction system
2. The spent carbon will be collected and replaced
3. Remove Xylenes from subsurface soils, vapor-laden
4. by CETCO periodically
5. air flows through activated carbon adsorber
6.
7. Model No. V1M, CETCO Industrial Services Group.
8.

SECTION D

42. EMISSION CONTROL EQUIPMENT I.D	43. CONTROL TYPE	44. MANUFACTURER'S NAME AND MODEL NUMBER	45. DISPOSAL METHOD	46. DATE INSTALLED MONTH / YEAR	47. USEFUL LIFE
01	17	V1M, CETCO Industrial Services Group	9	5 / 98	1
48.	49.	50.	51.	52. /	53.

SECTION E

CALCULATIONS

(see attached calculation sheets and manufacturer's specifications.

SECTION F

CONTAMINANT NAME	CAS NUMBER	INPUT OR PRODUCTION	UNIT	ENV. RATING	EMISSIONS ACTUAL	EMISSIONS UNIT	EMISSIONS HOW DET.	EMISSIONS PERMISSIBLE	% CONTROL EFFIC'CY	HOURLY EMISSIONS (LBS/HR) ERP	HOURLY EMISSIONS (LBS/HR) ACTUAL	ANNUAL EMISSIONS (LBS/YR) ACTUAL	ANNUAL EMISSIONS (LBS/YR) 10*	ANNUAL EMISSIONS (LBS/YR) PERMISSIBLE
54. Xylenes	55. 1330-20-7	56. 25	57. 1	58.	59. .00245	60. 1	61. 6	62.	63. 99.99	64. .00245	65.	66.	67.	68.
69.	70.	71.	72.	73.	74.	75.	76.	77.	78.	79.	80.	81.	82.	83.
84.	85.	86.	87.	88.	89.	90.	91.	92.	93.	94.	95.	96.	97.	98.
99.	100.	101.	102.	103.	104.	105.	106.	107.	108.	109.	110.	111.	112.	113.
114.	115.	116.	117.	118.	119.	120.	121.	122.	123.	124.	125.	126.	127.	128.
129.	130.	131.	132.	133.	134.	135.	136	137	138	139	140	141	142	143

SECTION G

SOLID FUEL TYPE	SOLID FUEL TONS / YR	% S	LIQUID FUEL TYPE	LIQUID FUEL THOUSANDS OF GALLONS/YR	% S	GAS TYPE	GAS THOUSANDS OF CF/YR	BTU/CF	APPLICABLE RULE	APPLICABLE RULE
144.	145.	146.	147.	148.	149.	150.	151.	152.	153.	154.

Applicant must sign the statement listed below and forward to the appropriate field representative

THE PROPOSED EXHAUST OR VENTILATION SYSTEM HAS BEEN CONSTRUCTED AND WILL BE OPERATED IN ACCORDANCE WITH STATED PRINCIPLES AND IN CONFORMANCE WITH ALL PROVISIONS OF EXISTING REGULATIONS.

155. SIGNATURE OF AUTHORIZED REPRESENTATIVE OR AGENT / DATE

AGENCY USE ONLY

156. FACILITY TYPE	157. FACILITY ID. NO.	158. U.T.M. (E)	159. U.T.M. (N)	160. SIC NUMBER	161. DATE APPL. RECEIVED	162. DATE APPL. REVIEWED	163. REVIEWED BY
					/ /	/ /	

PERMIT TO CONSTRUCT

164. DATE ISSUED	165. EXPIRATION DATE	166. SIGNATURE OF APPROVAL	167. FEE
/ /	/ /		

166.
1. DEVIATION FROM APPROVED APPLICATION SHALL VOID THIS PERMIT
2. THIS IS NOT A CERTIFICATE TO OPERATE
3. TESTS AND/OR ADDITIONAL EMISSION CONTROL EQUIPMENT MAY BE REQUIRED PRIOR TO THE ISSUANCE OF A CERTIFICATE TO OPERATE

CERTIFICATE TO OPERATE

169. DATE ISSUED	170. EXPIRATION DATE	171. SIGNATURE OF APPROVAL	172. FEE
/ /	/ /		

173
1. ☐ INSPECTED BY _____ DATE _____
2. ☐ INSPECTION DISCLOSED DIFFERENCES AS BUILT VS. PERMIT, CHANGES INDICATED ON FORM
3. ☐ ISSUE CERTIFICATE TO OPERATE FOR SOURCE AS BUILT
4. ☐ APPLICATION FOR C.O. DENIED _____ DATE _____ INITIALED

174. SPECIAL CONDITIONS

1. 2.
3. 4.
5. 6.

APPENDIX C
CALCULATIONS

Calculation of Emission Rates

A carbon absorption unit will be placed after the blower outlet. It is anticipated that the carbon absorber will operate an efficiency of 99.99 percent. It is assumed that Xylene will be the contaminant in the air stream.

Assuming that a saturated vapor condition exists within the subsurface soils, the air stream concentrations can be calculated by Equation 1, assuming the perfect gas relationship.

Since this is not the case, the resulting concentrations calculated are extremely conservative. Actual rates will be at least an order of magnitude lower than the calculated value presented.

Assuming perfect gas relationship:

$$CES = \sum \frac{Xi\ Pv\ M_{wg}}{RT} \qquad (1)$$

for Xylene, the only contaminant present.

Where:

Xi = 1 single constituent
Pv vapor pressure = .00726 atm
R universal gas constant = .082 L/atm/mol^{O}K
T = 293 Kelvin
M_{wg} = 106.2 gm/mole

Substitution in Equation 1:

CES = .0336 gm/L

In order to determine the emission rate, the evaporation rate is multiplied by the total flow rate Q which is 210 CFM, 70 CFM per well.

Emission rate = CES x Q (2)

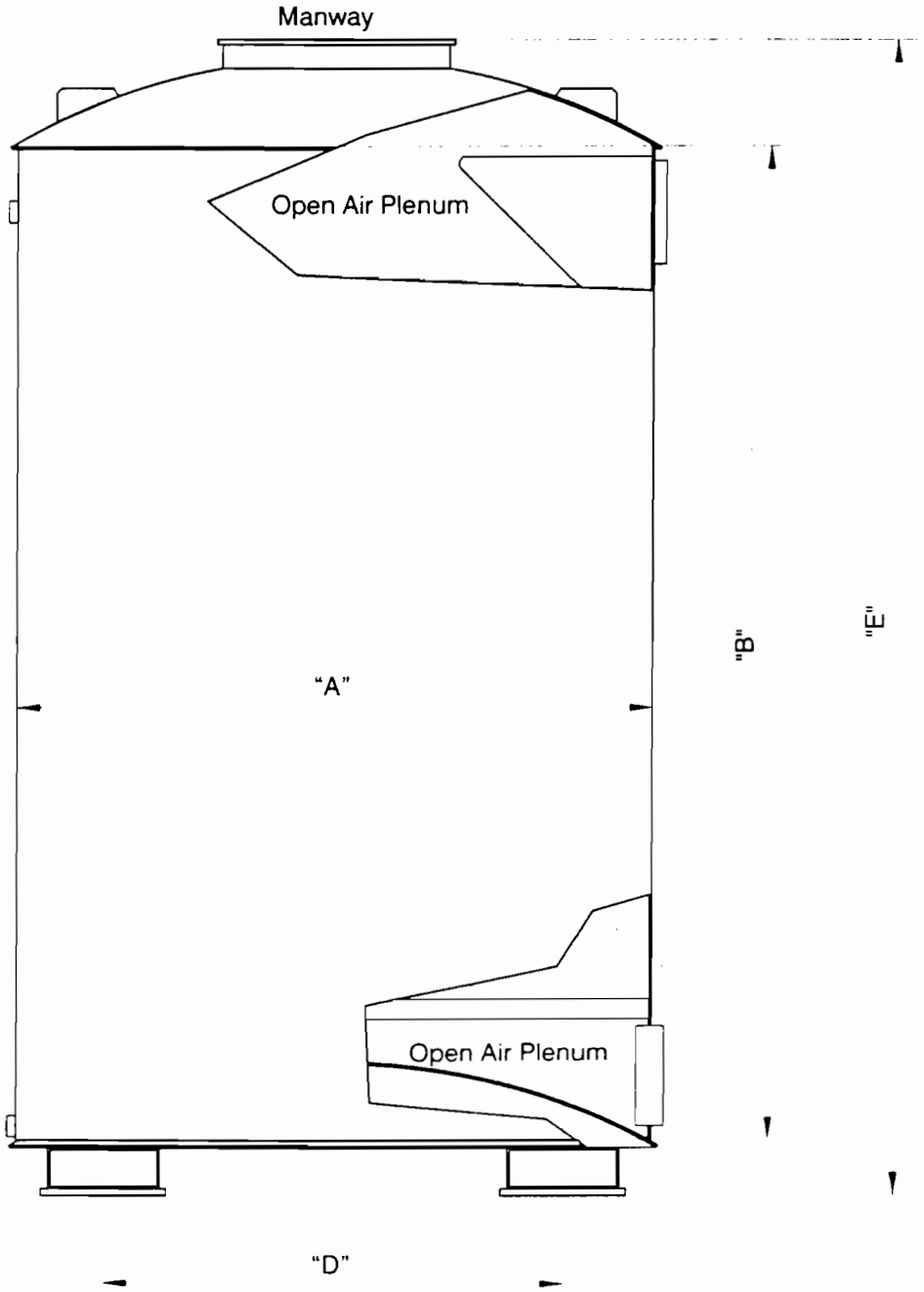
Substitution in Equation 2:

Emission Rate = 11.36 Kg/hr. before adsorber

Emission Rate = (1 - .9999) x 11.36 = .01136 Kg/hr. Or .0245 #/hr. after carbon adsorber

Product Information Bulletin (Aquatec V-Series)

Bulletin No.: V2 3/96 1



Available Options:

- ◊ CETCO Carbon Saturation Indicators
- ◊ FDA Approved & Industrial Use Plasite Linings
- ◊ Custom Linings
- ◊ Custom Colors
- ◊ Stainless Steel Construction
- ◊ Camloc Quick Connects
- ◊ Isolation Butterfly Valves
- ◊ Flanged Inlet/Outlets
- ◊ PRVs
- ◊ Higher operating pressures or vacuums
- ◊ Skid Mounted SVE Systems
- ◊ Call for Your Custom Configuration

CETCO
Industrial Services Group
1-800-527-9948

Drawing not to scale.
Design and specifications subject to change without notice

MODEL #	Diameter "A"	Can Hgt. "B"	Inlet/Outlet "C"	Forklift Guides "D"	Overall Hgt. "E"
V1M	45½"	72"	6" fpt	33"	84±"
V1.5M	48"	84"	6" fpt	33"	95±"
V2M	48"	84"	6" fpt	33"	95±"

Product Information Bulletin

Bulletin No.: V2

CETCO

COLLOID ENVIRONMENTAL TECHNOLOGIES COMPANY

INDUSTRIAL SERVICES GROUP

3/96.1

AQUATEC V-SERIES
Modular Vapor Adsorbers

CETCO Industrial Services Group offers a complete line of modular vapor phase adsorbers. The **Aquatec V-Series** is designed as a low cost, vapor adsorber that is portable and can be easily put into service. The **Aquatec V-Series** adsorbers are designed for a maximum pressure of 15 psi and a vacuum of 10" water column and are available in sizes designed to hold from 500 to 2000 lbs of carbon.

Model #	GAC ft³/lbs	Recommended Max. Flow Rate	Estimated Weight (Empty/Shipping)
V1M	36/1000	675 cfm	1125/2125
V1.5M	54/1500	750 cfm	1250/2750
V2M	72/2000	750 cfm	1250/3250

Important Features

- Durable carbon steel construction.
- Lifting lugs and forklift guides to facilitate moving.
- Upper and lower open-air plenum area designed for maximum carbon utilization.
- Designed for either upflow or downflow.
- Fitting for CETCO Carbon Saturation Indicator or effluent sample port.
- 6" Threaded influent/effluent connections.
- Condensate drain plug.
- Low profile design.
- 16" drum type manway for easy access.
- Rust-inhibitive epoxy primer and acrylic polyurethane top coat exterior.
- Can be filled with any of CETCO's virgin or reactivated granular or extruded carbons.
- Dished top and bottom heads allow higher operating pressures and light vacuum.
- Shipped with carbon & ready for service.
- All models available for lease

For More Information and Pricing

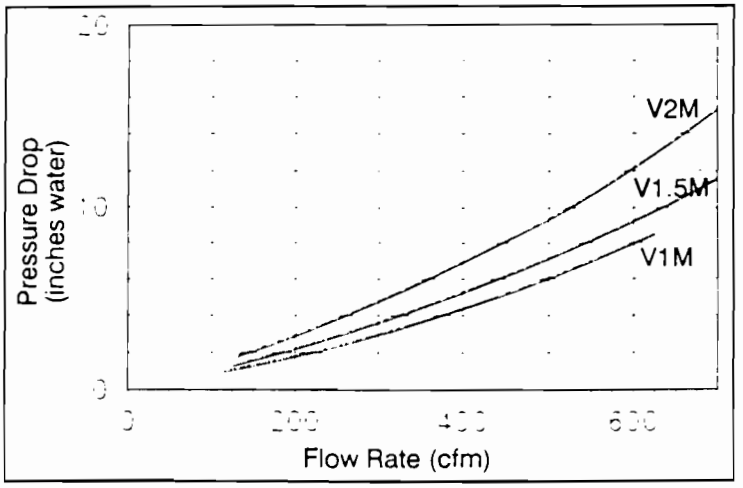
Call

1-800-527-9948

and Talk to One of Our

Knowledgeable Technical

Support Personnel

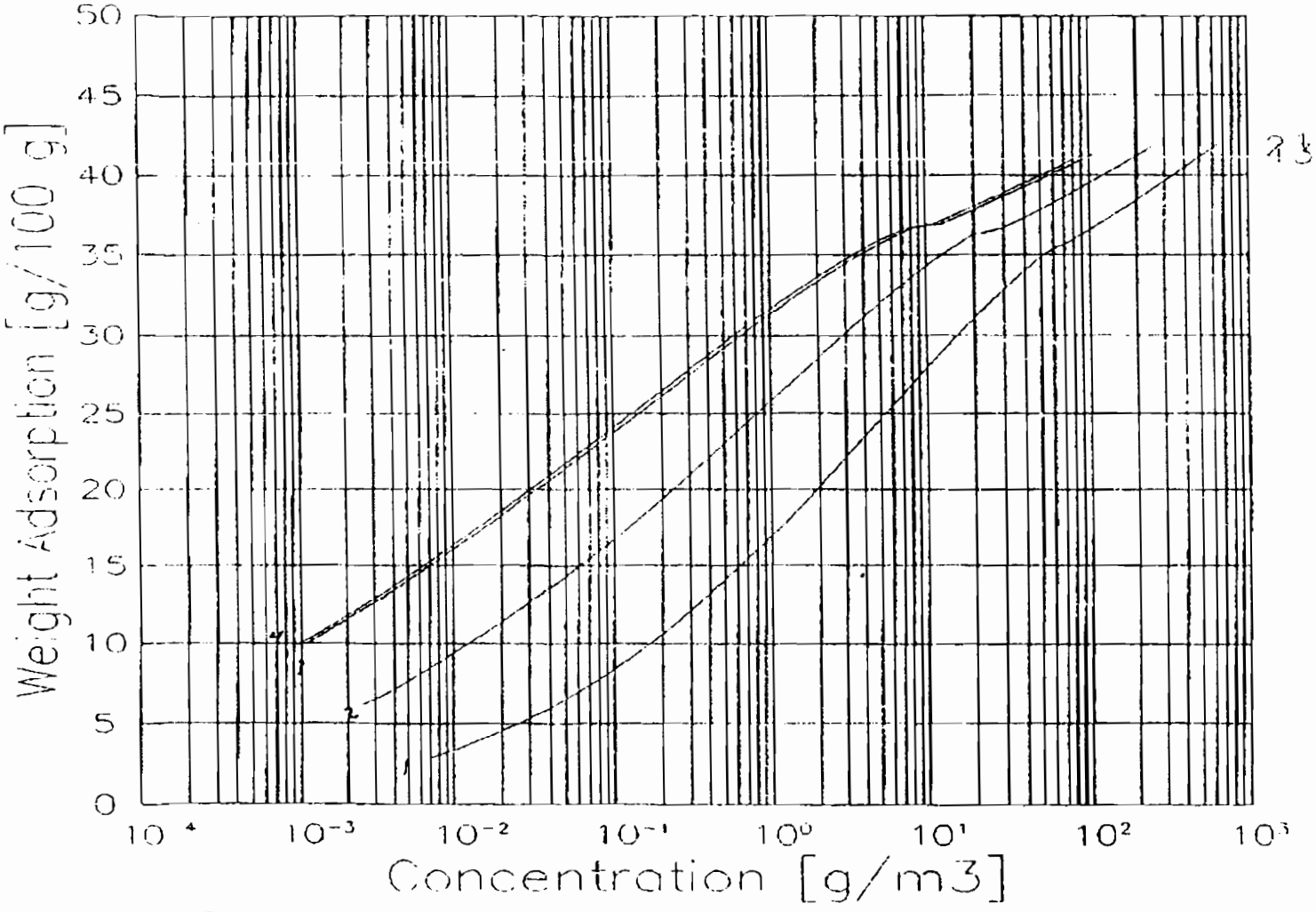


Carbon volume and weight based on Bituminous Carbon @ 30 lbs/ft³.
Estimated pressure drop based on virgin 4x10 carbon.
Design and specifications subject to change without notice.

1350 West Shure Drive • Arlington Heights, IL 60004 • (800) 527-9948 • (847) 392-5800 • Fax (847) 506-6150

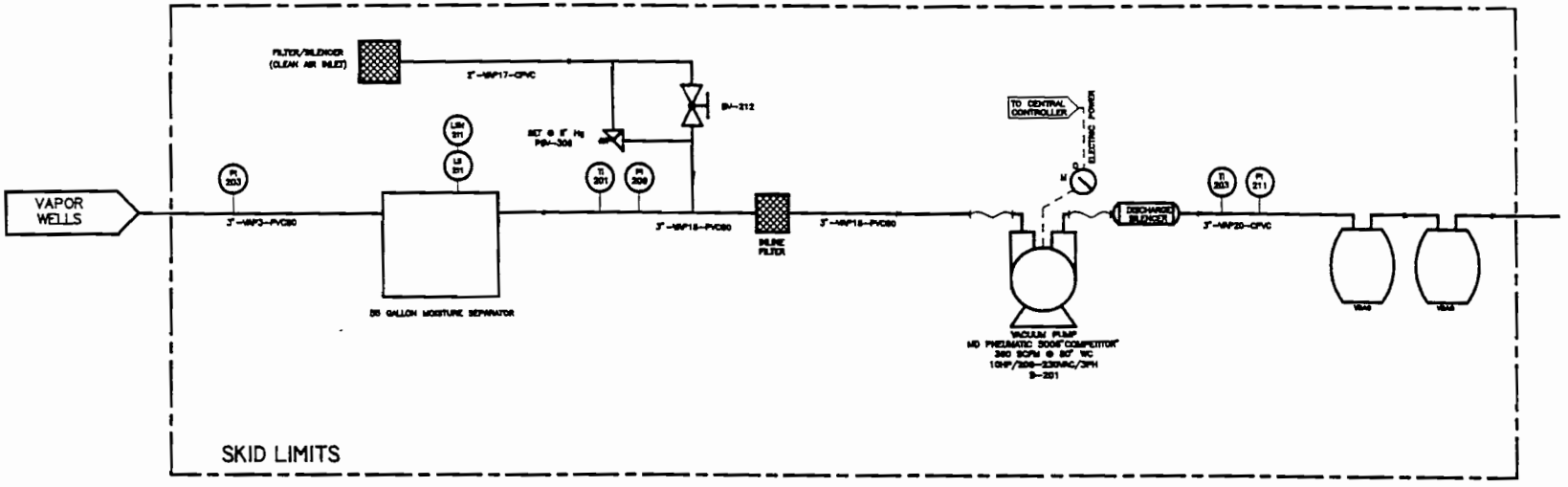
Adsorption Isotherms

American Norit Company, Inc.



1	BENZENE.....DARCO VAPURE	100 F
2	TOLUENE.....DARCO VAPURE	100 F
3	ETHYLBENZENE.....DARCO VAPURE	100 F
4	XYLENE(M).....DARCO VAPURE	100 F

NORIT



SYSTEM SCHEMATIC DRAWING A-1

NO.	DATE	BY	REVISION

DATE: 02/04/98
DRAWN BY: JDE
CHK'D BY: JSW
SCALE:
GRS JOB#: 80023
SHEET: P1

GRS
GROUNDWATER RECOVERY SYSTEMS, INC.
2868 NATIONAL ROAD - EXTON, PENNSYLVANIA 19341
(610) 884-6790

E.E.A. INC.
5 S. HILTON AVE
GARDEN CITY, NY 11530
CANTOR BROTHERS PNID DRAWING

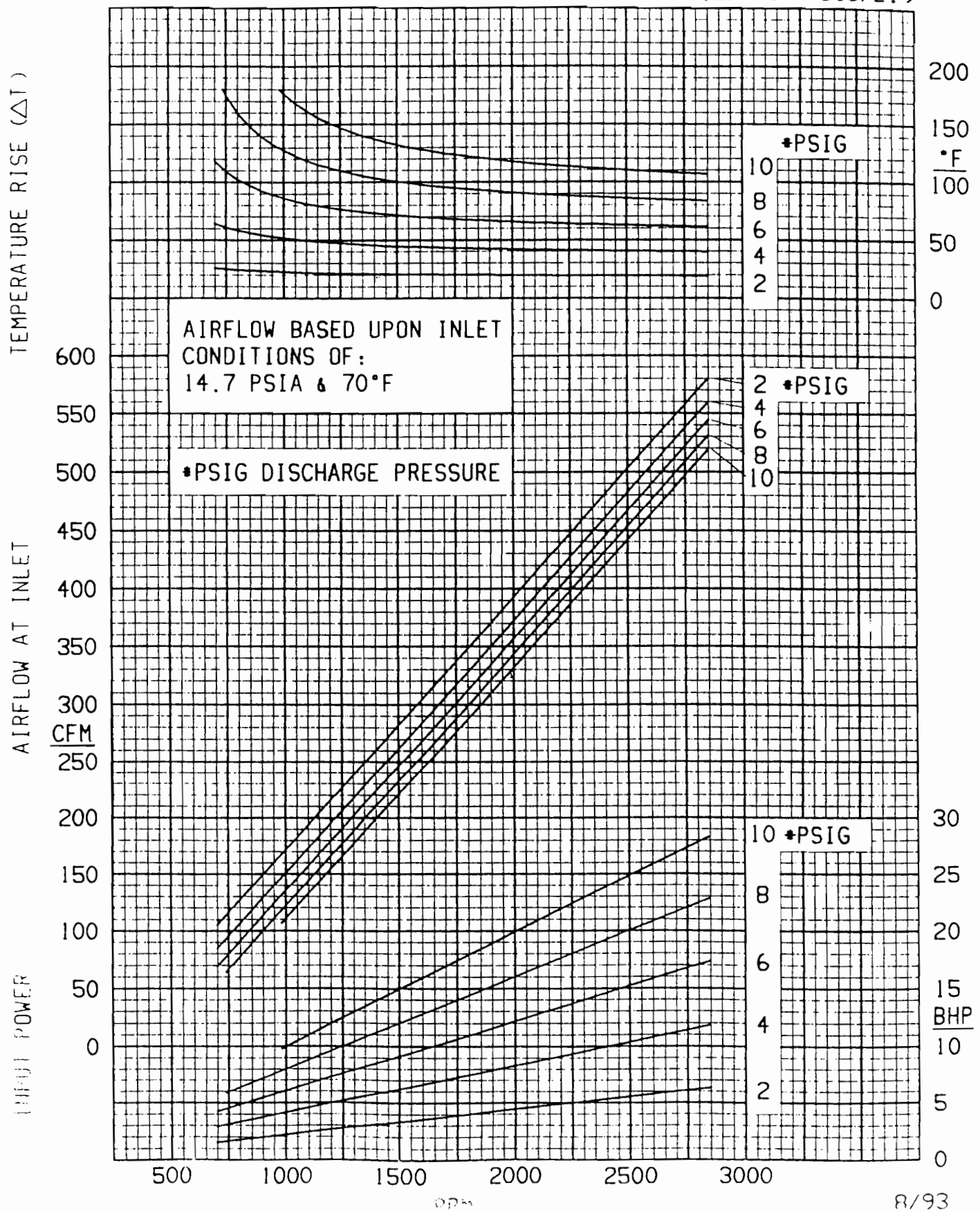
SIGNATURE	DATE
REVIEW ENG:	
PROJ MGR:	
QTI ENG:	

TUTHILL CORPORATION | M-D Pneumatics Division Springfield Missouri USA

C-1411

5006 COMPETITOR® PRESSURE CURVE

(.221 CFR DISPL.)



PRINTED IN MAY 1995

8/93

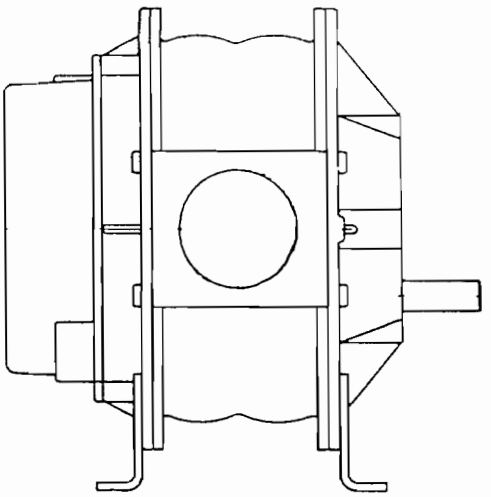
M-D Pneumatics

COMPETITOR™

positive displacement rotary air blower

Model

2002	2004	3003	3006
4002	4005	4007	7006
5003	5006	5009	7011
6005	6008	6015	7018



INSTALLATION
OPERATION
MAINTENANCE
REPAIR

MANUAL

DO NOT OPERATE BEFORE READING MANUAL

TUTHILL CORPORATION | M-D Pneumatics Division
Springfield Missouri USA
4840 W. Kearney / P.O. Box 2877 / Springfield, MO 65801-0877
PHONE 417-865-8715 FAX 417-865-2950

3/96

SAFETY INSTRUCTIONS

1. Do not operate before reading the enclosed instruction manual.
2. Use adequate protection, warning and safety equipment necessary to protect against hazards involved in installation and operation of this equipment.

30989

31355-1

SAFETY WARNING

- Keep hands and clothing away from rotating machinery, inlet and discharge openings.
- Blower and drive mounting bolts must be secured.
- Drive belts and coupling guards must be in place.
- Noise level may require ear protection.
- Blower heat can cause burns if touched.

TUTHILL CORPORATION / M-D PNEUMATICS DIVISION Springfield, MO USA

30585-1

NOTICE

The above safety instruction tags were attached to your unit prior to shipment. Do not remove, paint-over or obscure in any manner.

Failure to heed these warnings could result in serious bodily injury to the personnel operating and maintaining this equipment.

INTRODUCTION

M-D Blowers have been built to exacting standards and if properly installed and maintained will give you many years of reliable service. We urge you to take time to read and follow every step of these instructions when installing and maintaining your blower. We have tried to make these instructions as uncomplicated as possible. We realize getting any new piece of equipment up and running in as little time as possible is imperative to production.

WARNING!! Serious injury can result from operating or repairing this machine without first reading the service manual and taking adequate safety precautions.

IMPORTANT Make a permanent record of the Model and Serial numbers of your machine here. You'll save time and expense by including this reference identification on replacement parts orders.

TABLE OF CONTENTS

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 discharge air stream.
- Avoid extended exposure in close proximity to machinery with high intensity noise levels.
- Use proper care and good procedures in handling, lifting, installing, operating, and maintaining the equipment.
- 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.
- Hearing protection may be required depending on silencing capabilities.

See back panel of manual for important information on safety tags.

INSTALLATION

CONGRATULATIONS on your new **M-D** Positive Displacement Rotary Blower. Please examine the blower for shipping damage(s), and if any are found, report it immediately to the carrier. If the blower is to be installed at a later date make sure it is stored in a clean dry location. Make sure covers are kept on all openings. If blower is stored outdoors be sure to protect it from weather and corrosion.

WARNING

Customers are cautioned to provide adequate protection, warning and safety equipment necessary to protect personnel against hazards involved in the installation and operation of this equipment in the system or facility.

Do not use air blowers on explosive or hazardous gases.

Casing pressure must not exceed 25 PSIG.

Each size blower has limits on pressure differential, running speed, and discharge temperature which ***must not*** be exceeded. These limits are shown on the Specification Sheet "Maximum Operating Limits".

LOCATION

Install the blower in a clean, dry, well lighted area if possible. Leave plenty of room around the blower for inspection and maintenance.

FOUNDATION

We recommend a solid foundation be provided for permanent installation. It is necessary that a suitable base be used, such as a steel combination base under blower and motor, or a separate sole plate under each.

Before tightening the bolts, check to see that both mounting feet are resting evenly on the foundation, shim as necessary to eliminate stress on the base when the bolts are tightened. We suggest a level be used for proper alignment.

Where a solid foundation is not feasible, care must be taken to insure that equipment is firmly anchored to adequate structural members.

DRIVE

When the blower is V-Belt driven the sheaves must be positioned so that the hub face of the blower sheave is not more than ¼" from the blower end cover and the drive sheave is as close to the driver bearing as possible.

Care should be taken when installing sheave onto shaft. The faces of the sheaves should be accurately in line to minimize belt wear.

Adjust the belt tension to the belt manufacturers specifications.

For installations where the blower is to be operated by direct drive, selection of the driver should be such as not to exceed the maximum speed ratings of the blower. (See Specification Sheet "Maximum Operating Limits.)

A flexible type coupling should be used to connect driver and blower shafts. The two shafts must be aligned within .005 T.I.R.

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 clearnaces 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.

PROTECTIVE MATERIALS

Remove protective materials from the shaft.

Remove the protective covers from the inlet and outlet ports and inspect the interior for dirt and foreign material.

WARNING

Keep hands, feet, foreign objects and loose clothes from inlet and outlet openings to avoid injury or damage if lobes are to be rotated at this point.

Caution Do not use acetone MEK, lacquer thinner, etc. Avoid inlet suction and discharge air blast.

LUBRICATION

Caution Do not start-up the blower until you are positive that it has been properly and fully lubricated. (See Lubrication Section.)

PIPING

Inlet and outlet connections on all blowers are large enough to handle maximum volume with minimum friction loss. Maintain same diameter piping. Flexible connectors ***must*** be used between the blower and its inlet and outlet pipes. Silencers must not be supported by the blower.

Be certain all piping is clean internally before connecting to the blower. We recommend placing a 16 mesh wire screen backed with hardware cloth at or near the inlet connections for the first 50 hours of use until the system is clean. Make provisions to clean the screen after a few hours of operation and completely discard it once the system is clean, as it will eventually deteriorate and small pieces going into the blower can cause serious damage.

A horizontal or vertical air flow piping configuration is easily achieved by rearranging the mounting feet position.

WARNING

Do not operate equipment without adequate silencing devices since high noise level may cause hearing damage. (Reference OSHA Standards.)

RELIEF VALVES

We recommend the use of relief valves to protect against excessive pressure or vacuum conditions. These valves should be tested at initial start-up to be sure they are adjusted to relieve at or below the maximum pressure differential rating of the blower.

Caution Upon completion of the installation, and before applying power, rotate the drive shaft by hand. It must move freely. If it does not, look for uneven mounting, piping strain, excessive belt tension or coupling mis-alignment or any other cause for binding.

Read the Lubrication Section before operating more than briefly at this time to insure adequate oil supply.

LUBRICATION

The bearings at the drive shaft end of the blower are grease lubricated. The timing gears and bearings at the other end are lubricated by the lower timing gear (when in the horizontal flow configuration) acting as an oil slinger, carrying oil to the upper timing gear and providing splash lubrication for the bearings. Both timing gears act as slingers when the blower is in the vertical flow configuration.

Use a good grade industrial type anti-rust, oxidation and foam inhibited, non-detergent oil.

FILLING PROCEDURE

To fill the gear housing, remove the oil breather (A) and oil level plug (B) on the gear end. Fill the gear housing until oil drips out of the oil level hole. Replace plugs in their respective holes.

WARNING

Do not start the blower until you are sure oil has been put in the gear housing.

GREASE LUBRICATED BEARINGS

Service drive end bearings at regular intervals. (See "Suggested Lubrication Intervals For Grease Lubricated Bearings".) Use NLGI #2 premium grade, petroleum base grease with high temperature resistance and good mechanical stability. Using a pressure gun, force new grease into each bearing until traces of clean grease come out of the relief fitting.

CAUTION:

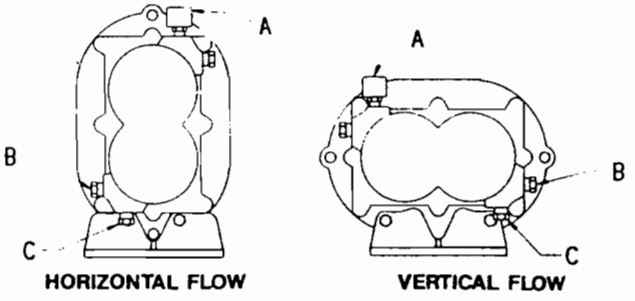
Do not inject grease too fast to avoid blowing out the drive shaft seal.

LUBRICATION INSTRUCTIONS FOR OIL LUBRICATED GEARS AND BEARINGS

Add fresh oil as required to maintain proper level. Drain and refill after the first 100 hours of operation and thereafter every 1,000 hours of operation under normal service, more frequently depending on the type of oil and oil operating temperature. Use a good quality oil.

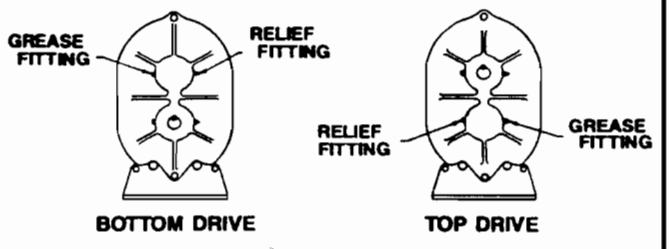
AMBIENT TEMPERATURE	OIL GRADE*	OIL VISCOSITY, RANGE SSU AT 100° F.
Above 90° F	SAE 50	1000-1200
32° F to 90° F	SAE 40	700-1000
0° F to 32° F	SAE 30	500-700
Below 0° F	SAE 20	300-500

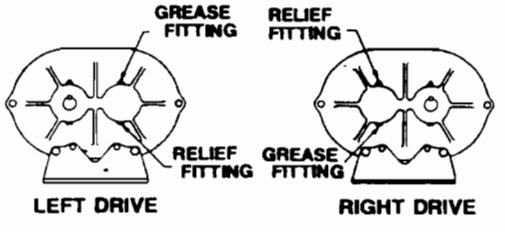
*In applications with extreme variations in ambient temperature a 20W - 50 miltigrade viscosity oil is recommended.



SUGGESTED LUBRICATION INTERVALS FOR GREASE LUBRICATED BEARINGS

SPEED IN RPM	OPERATING HOURS PER DAY		
	8	16	24
	GREASING INTERVALS IN WKS		
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





PREVENTATIVE MAINTENANCE

A good maintenance program will add years of service to your blower.

A newly installed blower should be checked frequently during the first month of operation, especially lubrication. Check oil level in the gear housing and add oil as needed. Complete oil changes are recommended every 1000 operating hours, or more frequent depending on the type of oil and oil operating temperature.

The following is recommended as a minimum maintenance program.

DAILY MAINTENANCE

1. Check and maintain oil level and add oil as necessary.
2. Check for unusual noise or vibration. (See "Trouble-Shooting" Section.)

WEEKLY MAINTENANCE

1. Clean all air filters. A clogged air filter can seriously affect the efficiency of the blower and cause overheating and oil usage.
2. Check relief valve to make sure it is operating properly.

MONTHLY MAINTENANCE

1. Inspect the entire system for leaks.
2. Inspect condition of oil and change if necessary. (See Lubrication Section.)
3. Check drive belt tension and tighten if necessary.

START-UP CHECKLIST

We suggest that these start-up procedures be followed in sequence and checked off (✓) in the boxes provided in any of these cases:

- ★ During initial installation
- ★ After any shutdown period
- ★ After maintenance work has been performed
- ★ After blower has been moved to a new location

				Date Checked

				1. Check the unit for proper lubrication. Proper oil level cannot be over-emphasized. Refer to Lubrication Section.
				2. Check Alignment. For Direct Drive: Check coupling and shaft alignment. For Sheave Drive: Check for proper belt alignment and tension.
				3. Turn the rotors by hand to be certain they do not bind. **WARNING** Disconnect power.
				4. "Bump" the unit with the motor a few times to check rotation and to be certain it turns freely and smoothly.
				5. Start the unit and operate it for 30 minutes at no load. During this time, feel the cylinder for hot spots. If minor hot spots occur, refer to the Troubleshooting Section.
				6. Apply the load and observe the operation of the unit for one hour. Check the unit frequently during the first day of operation.
				7. If minor malfunctions occur, discontinue operation and refer to the Troubleshooting Section.

TROUBLESHOOTING

Although **M-D** blowers are well designed and manufactured, problems may occur due to normal wear and the need for re-adjustment. The chart below lists symptoms that may occur along with probable causes and remedies.

SYMPTOMS	PROBABLE CAUSE	REMEDIES
Loss of oil	Gear housing not tightened properly.	Tighten gear housing bolts.
	Lip seal failure.	Disassemble and replace lip seal.
	Insufficient sealant.	Remove gear housing and replace sealant. (See Disassembly and Inspection Section.)
Excessive Bearing or Gear Wear	Improper lubrication.	Correct oil level. Replace dirty oil. (See Lubrication Section.)
	Excessive belt tension.	Check belt manufacturer's specifications for tension and adjust accordingly.
	Coupling misalignment.	Check carefully, realign if necessary.
Lack of Volume	Slipping belts.	Check belt manufacturer's specifications for tension and adjustment.
	Worn lobe clearances.	Check for proper clearances. (See Specification Sheet "Assembly Clearances".)
	Speed too low.	Increase blower speed within limits.
	Obstruction in piping.	Check system to assure an open flow path.
Knocking	Unit out-of-time.	Retime.
	Distortion due to improper mounting or pipe strains.	Check mounting alignment and relieve pipe strains.
	Excessive pressure differential.	Reduce to manufacturer's recommended pressure. Examine relief valve. Reset if necessary.
	Worn gears.	Replace timing gears. (See Disassembly and Inspection Section.)
Excessive Blower Temperature	Too much or too little oil in gear reservoir.	Check oil level. (See Lubrication Section.)
	Too low operating speed.	Increase blower speed within limits.
	Clogged filter or silencer.	Remove cause of obstruction.
	Excessive pressure differential.	Reduce pressure differential across the blower.
	Elevated inlet temperature.	Reduce inlet temperature.
	Worn lobe clearances.	Check for proper clearances. (See Specification Sheet "Assembly Clearances.)
Rotor End or Tip Drag	Insufficient assembled clearances.	Correct clearances. (See Specification Sheet "Assembly Clearances".)
	Case or frame distortion.	Check mounting and pipe strain.
	Excessive operating pressure.	Reduce pressure differential.
	Excessive operating temperature.	Reduce pressure differential or reduce inlet temperature.
Vibration	Belt or coupling misalignment.	Check carefully, realign if necessary.
	Lobes rubbing.	Check cylinder for hot spots then check for lobe contacts at these points.
		Correct clearances. (See Specification Sheet "Assembly Clearances".)
	Worn bearings/gears.	Check condition of gears and bearings, replace if necessary.
	Unbalanced or rubbing lobes.	Possible build-up on casing or lobes, or inside lobes. Remove build-up and restore clearances.
	Driver or Blower loose.	Check mounting and tighten if necessary.
	Piping Resonace	Check pipe supports, check resonance of nearby equipment, check foundation.

DISASSEMBLY & INSPECTION

With proper maintenance and lubrication, normal life expectancy for the gears, bearings, and seals can be achieved. However, over a period of time these parts must be repaired or replaced to maintain the efficiency of your blower. This section is written in a way that will allow you to completely disassemble your blower. The inspection of certain repairable or replaceable parts is referred to at the point of disassembly where these parts are exposed. If, at any point of inspection, repair or replacement is deemed necessary, appropriate instruction will be given to achieve these repairs or replacements.

WARNING Before performing any repair or replacement, disconnect power.

Gear Housing Removal

Remove the oil drain plug (18) in the bottom of the gear housing (5) and drain the oil. Take out all eight capscrews (16) and remove the gear housing. It may be necessary to tap the sides with a mallet or wooden block to break the seal joint.

Gears are now exposed for visual inspection.

Inspect the gears for the following:

- Broken Teeth
- Chipped Teeth
- Uneven Wear
- Excessive Wear
- Any Other Abnormalities

Timing Gear Removal

WARNING Wear safety glasses and gloves.

To insure the lobes will be returned to their original positions reach through either the inlet or outlet and place a chalk mark on the strip of one lobe and the mating waist of the other.

Mark both drive gear and driven gear at their point of contact so they may be returned to this same contact point at time of reassembly.

WARNING Do not remove gearnut (21) completely before unseating the gears.

Wedge the lobes as shown in Figure D-1. Unseat gear nuts (21) and back them off about ¼".

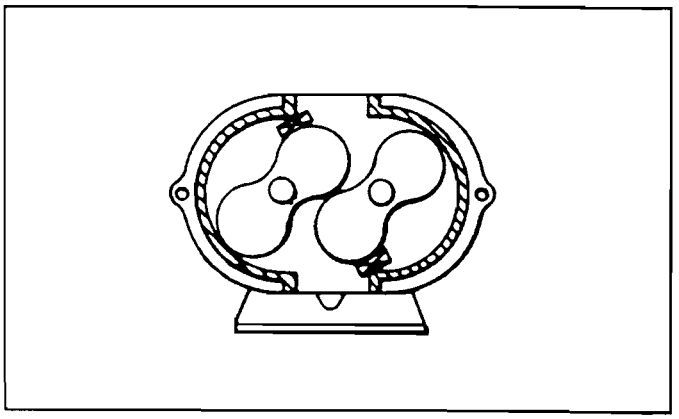


FIGURE D-1

Position an appropriate gear puller around the gear as shown in Figure D-2. Torque the set screw to unseat the gear. Remove gear nuts (21), lockwasher (26) and the gear. Repeat the procedure for the other gear.

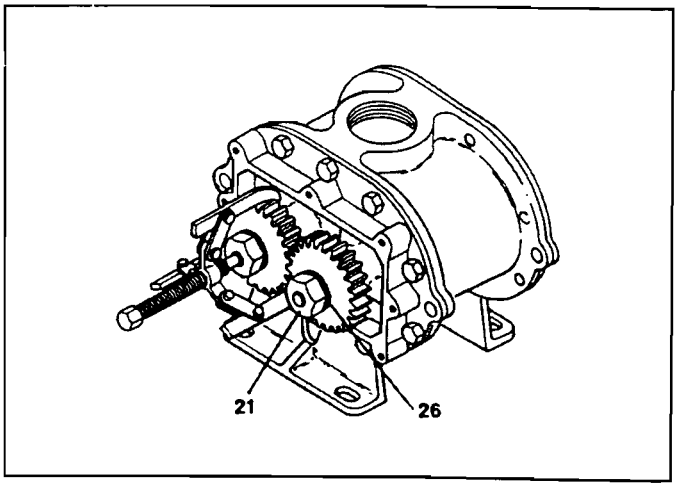


FIGURE D-2

If you have disassembled for the purpose of replacing the gears and do not wish to continue with disassembly, proceed to "Timing Gear Mounting" in the Assembly Section.

End Plate And Cylinder Separation

Remove bearing cover plate (10) on the drive end and bearing retainers (22) on the gear end.

Mark the mating edges of end plate and cylinder flanges at both ends of the blower to insure they will be returned to this same position upon reassembly.

Drive out the dowel pins (9) and remove the capscrews (15) holding the front end plate (3) to the cylinder (1) on the drive end. To separate the front end plate from the cylinder insert the appropriate size screws into the two threaded holes in the front end plate flange and alternately tighten them against the cylinder. The endplate will separate from the cylinder and bring the bearings with it. (Refer to Figure D-3.)

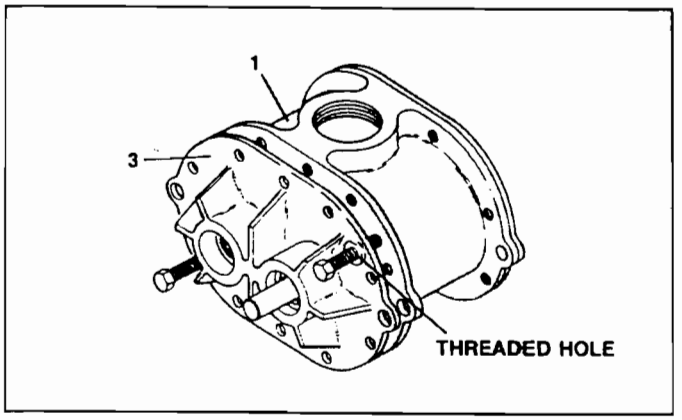


FIGURE D-3

Support the back end plate (4) on the underside. Place a wooden or soft metal block against the shafts and drive them out of the back end plate, protect them from damage if they are to be reused. (Refer to Figure D-4.)

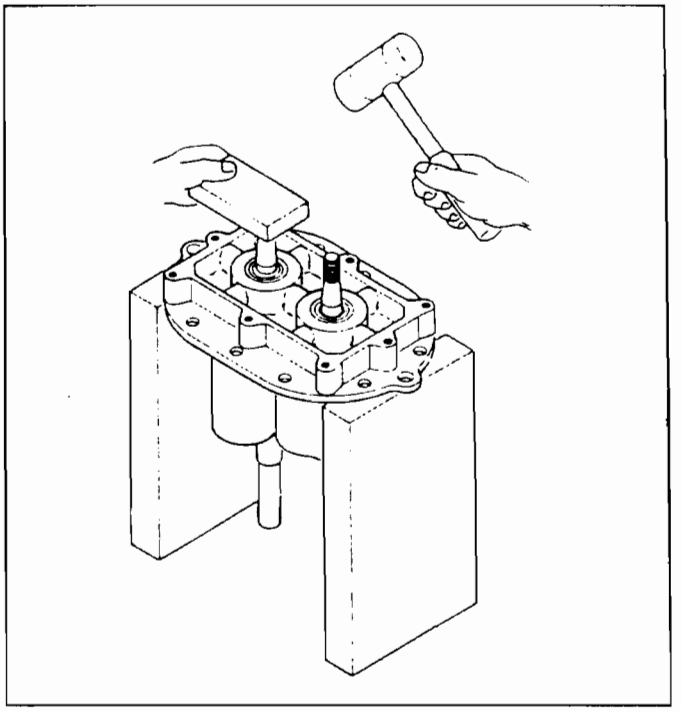


FIGURE D-4

Bearing Removal and Inspection

Using a tube or round bar of a slightly smaller diameter than the shaft clearance holes in the end plates, tap the bearings and seals out of both the front and back end plates from the back or flat side. (Refer to Figure D-5.)

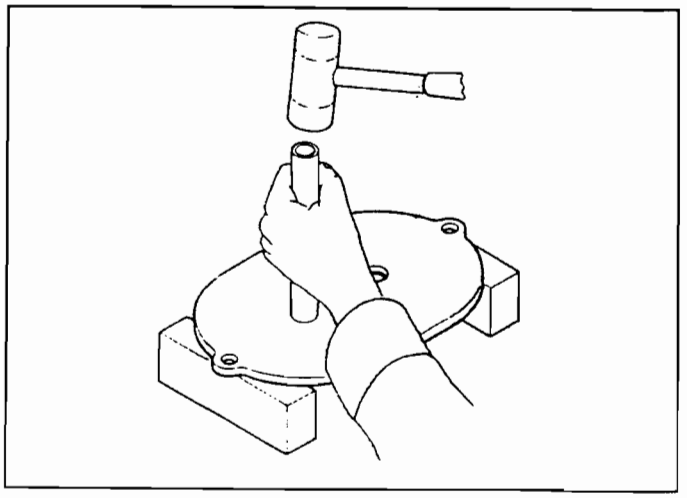


FIGURE D-5

The lip seals (23) and (24) will be damaged during removal and must be replaced.

Clean the bearings thoroughly and inspect for signs of wear. If any marks, scratches or indentations are found on the bearing races, replace the bearing.

If replacement is deemed necessary, consult the Parts List to obtain the proper part numbers for ordering.

Refer to the Assembly Section for proper mounting of the bearings.

ASSEMBLY

This section assumes that your blower has been completely disassembled. Before beginning assembly it is imperative that all parts be cleaned thoroughly with a high quality solvent cleaner to remove all dust, grease and foreign material.

Seal Replacement

Thoroughly clean the bearing and seal pockets in both end plates (4). Apply a thin coat of sealant on the outside diameter of the new seals (24) and press them into the back end plate using a round tube with recessed end that will bear on the outer metal edge of the seal. (Refer to Figure A-1.) Seals should be flush with the outboard bore face with seal lips pointing outward. Apply a thin coat of oil or grease to the seal lips.

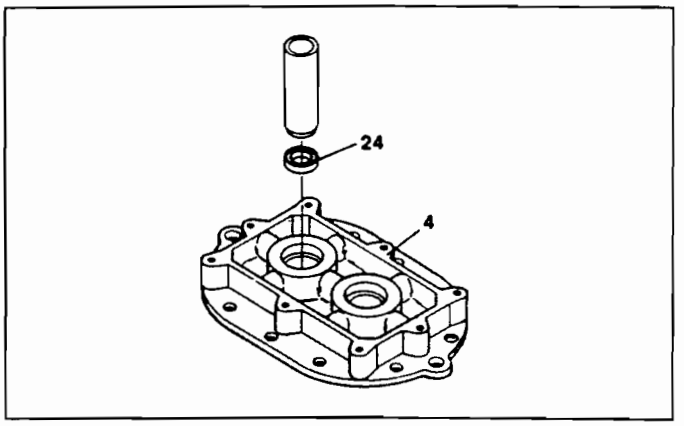


FIGURE A-1

Lobe Assembly

Place the cylinder (1) on a flat surface. Fasten the back end plate (4) to the cylinder (be sure end plate is in the same position as before disassembly). Drive in the locator pins (9) before securely tightening the capscrews (15). The gear end mounting foot may be attached at this time.

Block the assembly horizontally with the back end plate facing downward. Slide the lobes into the cylinder with the drive shaft in the same position as before disassembly. Make sure the shaft ends have no rough edges that may damage the lip seals. (Refer to figure A-2.)

Position the lobes in the cylinder as previously marked (if reinstalling the original lobes). Assemble the front end plate and feet in the same manner as the back end plate.

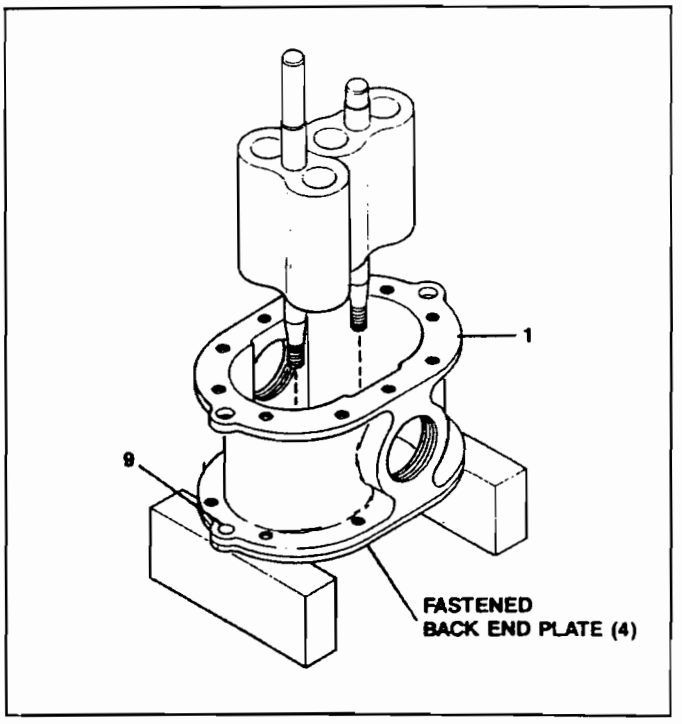


FIGURE A-2

Bearing Replacement

Note: We recommend using new bearings for rebuild. Consult the Parts List to obtain proper part numbers.

Apply a thin coating of machine oil to the shafts, the inside diameter of the bearings and the bearing recesses in the front end plate. Tap the two bearings (11 & 12) into place using a tube with a flanged end that will contact both inner and outer bearing faces. (Refer to Figure A-3.)

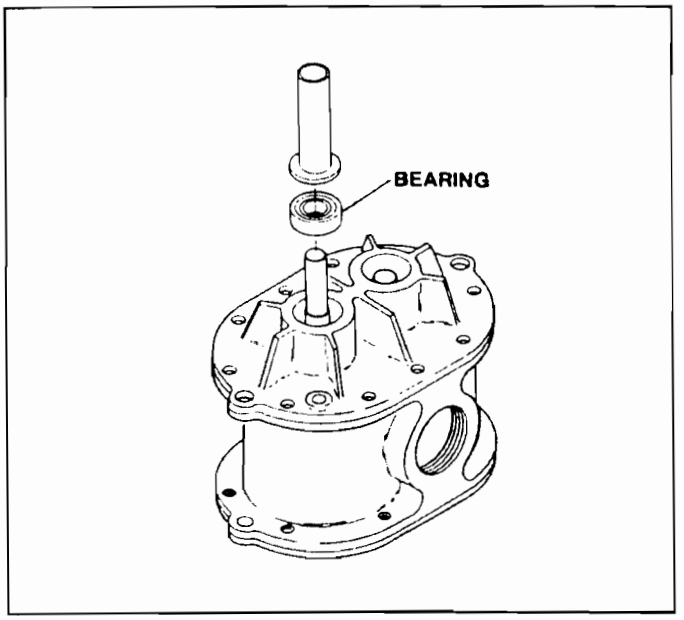


FIGURE A-3

Caution Place the blower on its feet on a level surface and make sure it stands square. Loosen foot screws (17) if necessary to square up blower. Re-tighten screws (17) and clamp blower to a solid base before continuing assembly.

Install the gear end bearings (12) in the same manner as the drive end bearings making them flush with the back end plate bearing shoulders. Attach bearing retainers (22) using screws (25).

Timing Gear Mounting

Note: Blower must be securely fastened down during gear mounting procedures.

Make sure the lobes are in the same position as previously marked. Block the lobes as shown in Figure A-4.

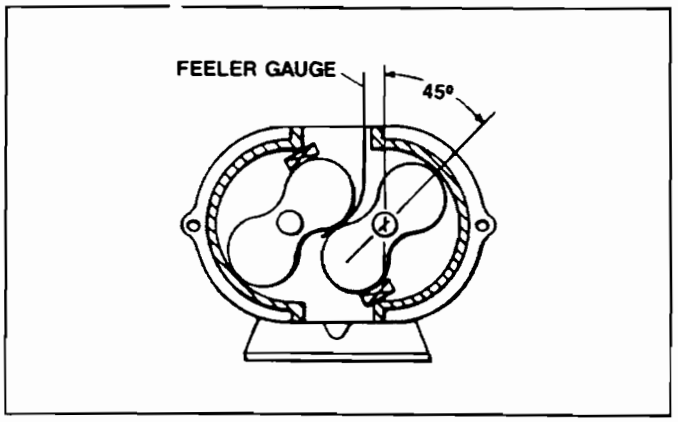


FIGURE A-4

Make sure shafts and gear lobes are clean and free of scratches.

Slip power drive gear (8) onto the shaft followed by lockwasher (26) and gear nut (21). Make sure the mark on the gear teeth is in the proper line of engagement. Tighten gear nut to the proper torque (See Specification Sheet "Gear Nut Torque").

Insert a long metal feeler gauge between the lobes as shown in Fig A-4. Feeler gauge thickness should be a median value for the clearance between lobes. (See Specification Sheet "Assembly Clearances".)

Tighten the gear nut lightly and check lobe clearances at each 45° position. If clearances are not within the specified tolerance, adjust the gear position. (Refer to Figure A-4.)

Insert the proper feeler gauge, block the lobes as shown in Figure A-4 and tighten the gear nut to the proper torque. (See Specification Sheet "Gear Nut Torque".)

Remove feeler gauge and blocks. Rotate lobes by hand to make sure gears are not binding or lobes making contact.

WARNING Keep hands and loose clothing **away from** lobes and gears.

Check the lobe to end plate clearances (See Specification Sheet "Assembly Clearances") and adjust if necessary per instructions in the Lobe Clearance Procedure Section.

Lubrication, Final Assembly And Mounting

Pack the bearing cavities with suitable grease. Install bearing cover plate (10). Replace front lip seal (23) taking care not to damage the lip as it passes over the keyway. Lip must point inward toward the bearing. Apply a good quality RTV silicone sealant to the inner surface of the gear housing (5). Install the gear housing with cap screws (16) and tighten evenly.

Fill gear housing with oil and grease front end bearings. Refer to the Lubrication Section in this manual for oil and grease specification and filling procedures.

To insure blower has not been distorted during mounting in the installation, turn the lobes by hand to make sure they are not making contact prior to connecting to the driver.

Lobe Clearance Procedures

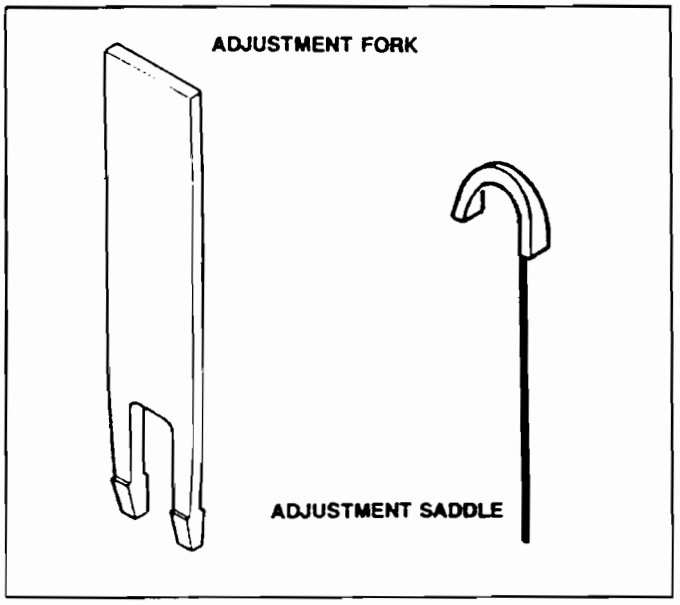
This procedure requires the use of the clearance adjustment fork and saddle.*

Position the adjustment tools as shown in Figure C-1. Make sure the flat side of the adjustment saddle is resting against the inner race of the bearing and the flat side of the adjustment fork is resting against the back of the gear.

Place a feeler gauge of thickness equal to the gear end clearance (see Specification Sheet "Assembly Clearances") between the lobe and the back end plate. Tap on top of the adjustment fork until the gauge becomes snug. Remove the gauge and check the clearance at the gear end. To increase the gear end clearance, tap on the end of the gear end shaft with the soft metal mallet.

End plate clearances should never be less than the minimums listed in the "Assembly Clearances" chart on the Specifications Sheet.

*NOTE: Refer to drawings on page 10 for dimensions of clearance adjustment tools.



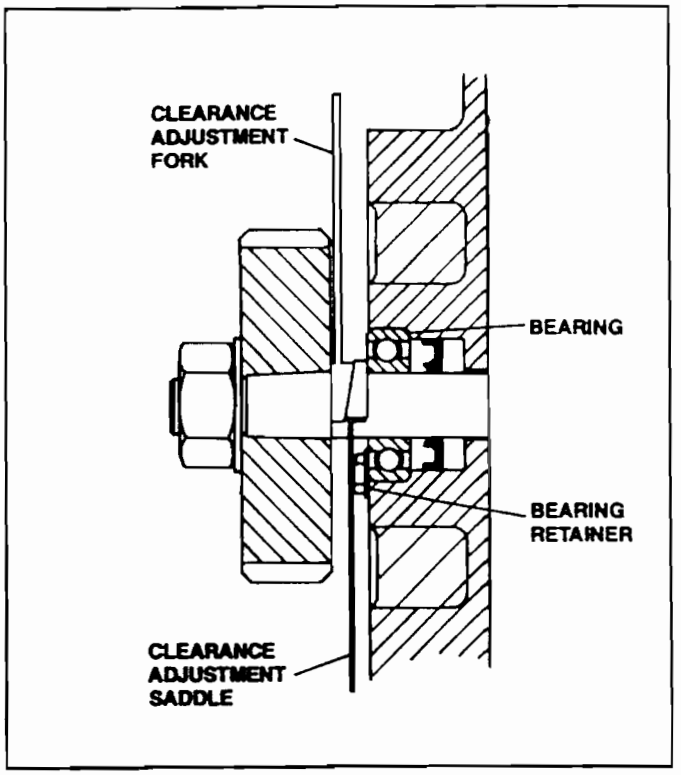
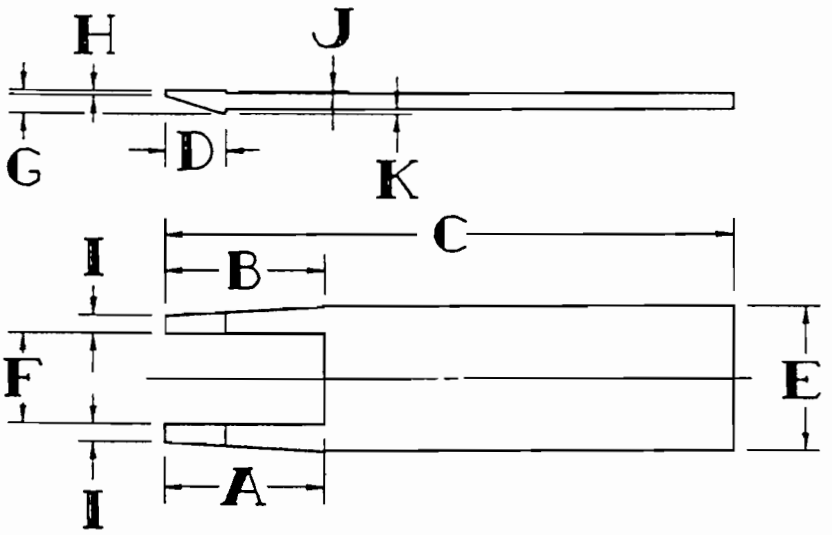


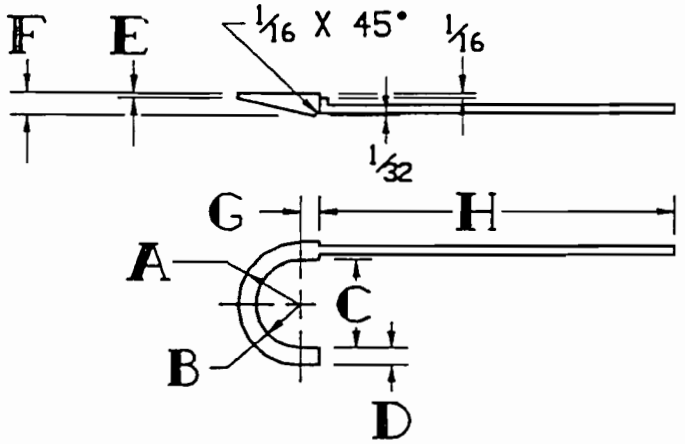
FIGURE C-1

Listed lobe clearances are used in the factory assembly of M-D blowers. These clearances may change slightly in service, but should never be less than the minimum listed. Measurement of these clearances for comparison to the listed data should be performed by qualified personnel only.



BLOWER SIZE	A	B	C	D	E	F	G	H	I	J	K
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
3 1/2	2	2	7	7/8	1 1/2	13/16	5/16	1/16	7/32	1/32	1/16
4	2	2	7 1/2	1	1 3/4	1 1/32	3/8	1/16	1/4	1/32	1/32
5	2 1/4	2 1/4	8	7/8	2	1 1/4	5/16	1/16	1/4	1/32	1/16
6	2 1/2	2 1/4	10	7/8	2 3/16	1 7/16	13/32	3/16	1/4	1/32	1/16

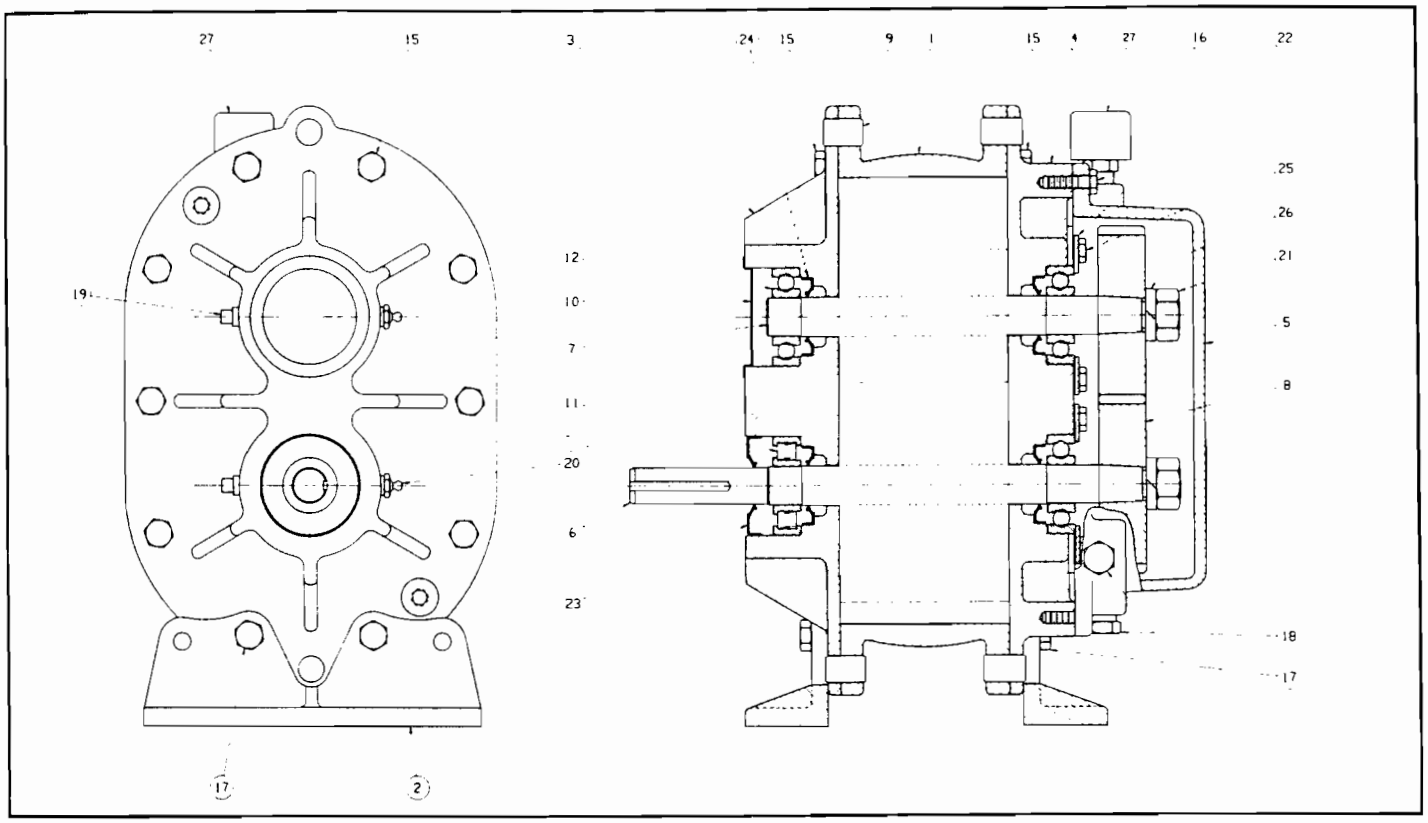
ADJUSTMENT FORK



BLOWER SIZE	A	B	C	D	E	F	G	H
2 1/2	15/32	11/32	11/16	1/8	1/16	1/4	3/16	3
3 1/2	5/8	13/32	13/16	7/32	1/16	5/16	3/16	3 1/2
4	49/64	33/64	1 1/32	1/4	1/8	7/16	1/4	4
5	7/8	5/8	1 1/4	1/4	1/16	5/16	1/4	5
6	31/32	23/32	1 7/16	1/4	1/8	7/16	1/4	6

ADJUSTMENT SADDLE

COMPETITOR™ PARTS LIST



ITEM	DESCRIPTION	QTY.	ITEM	DESCRIPTION	QTY.
1	Casing/Cylinder	1	15	Screw, Hex Hd.	16
2	Mounting Feet	2	16	Screw, Hex Hd.	8*
3	Front End Plate	1	17	Screw, Hex Hd.	4
4	Back End Plate	1	18	Plug, Oil	3
5	Gear Cover	1	19	Relief Fitting	2
6	Drive Rotor	1	20	Grease Fitting	2
7	Driven Rotor	1	21	Gear Nut	2
8	Timing Gear	2	22	Bearing Retainer	4
9	Dowel Pin	4	23	Lip Seal, Drive Shaft	1
10	Bearing Cover Plate	1	24	Lip Seal	4
11	Roller Bearing, Drive Shaft	1	25	Screw, Hex Hd.	4
12	Bearing	3	26	Lockwasher, Gear Nut	2
			27	Breather	1

*Quantity (6) for 5" Gear

When ordering parts use the item number shown plus your model and serial number.

EXAMPLE: ITEM-Gear Housing for 3003A
ITEM-Front Lip Seal for 4005A

M-D COMPETITOR™ BLOWERS
MAINTENANCE & SERVICE SPECIFICATIONS SHEET

Assembly Clearance

MODEL	LOBES — END PLATES			LOBE — CASING		BETWEEN LOBES
	TOTAL	DRIVE END MIN.	GEAR END MIN.	MIN.	MAX.	MIN.
2002, 4	.005/.010	.003	.002	.004	.008	.006
3003, 6	.005/.010	.003	.002	.004	.008	.008
4002, 5, 7	.007/.012	.004	.003	.005	.009	.010
5003, 6, 9	.007/.012	.004	.003	.005	.009	.012
6005, 8, 15	.011/.015	.008	.003	.006	.010	.010
7006	.012/.018	.008	.004	.006	.010	.012
7011, 18	.014/.020	.010	.004	.006	.010	.012

Oil Reservoir Capacity

MODEL	FLUID OUNCES	
	HORIZ. FLOW	VERT. FLOW
2002, 4	3.5	6.0
3003, 6	6.0	16.0
4002, 5, 7	7.0	22.8
5003, 6, 9	16.0	27.6
6005, 8, 15	28.0	52.0
7006, 11, 18	45.0	83.0

Gear Nut Torque

MODEL	GEAR SIZE	TORQUE LB-FT
2002, 4	2.5	60
3003, 6	3.5	100
4002, 5, 7	4.0	125
5003, 6, 9	5.0	210
6005, 8, 15	6.0	300
7006, 11, 18	7.0	450

Maximum Operating Limits

MODEL	R.P.M.	PRESSURE PSI	INLET VACUUM	TEMP. RISE DEG. F
2002	5275	12	14	225
2004	5275	7	14	185
3003	3600	12	14	170
3006	3600	7	14	115
4002	3600	15	14	240
4005	3600	10	14	170
4007	3600	7	14	130
5003	2850	15	14	195
5006	2850	10	14	180
5009	2850	7	14	115
6005	2350	15	16	250
6008	2350	12	16	240
6015	2350	6	12	130
7006	2050	15	16	250
7011	2050	10	16	210
7018	2050	6	12	130

TUTHILL CORPORATION | M-D Pneumatics Division
4840 West Kearney Street, P.O. Box 2877
Springfield, Missouri USA 65801-0877
Tel 417 865-8715 Fax 417 865-2950

SERVICE BULLETIN #9

METRIC CONVERSIONS
COMPETITOR™
2002 - 2004 - 3003 - 3006 - 4002 - 4005 - 4007
5003 - 5006 - 5009 - 6005 - 6008 - 6015

ASSEMBLY CLEARANCE

MODEL	Lobes - End Plate			Lobe - Casing		Between Lobes
	Total	Drive End Min	Gear End Min	Min	Max	Min
2002, 4	.13–.25	.08	.05	.10	.20	.15
3003, 6						.20
4002, 5, 7	.18/.30	.10	.08	.13	.23	.25
5003, 6, 9						.30
6005, 8, 15	.28/.38	.20		.15	.25	.25
7006	.012/.018	.008	.004	.006	.010	.012
7011, 18	.014/.020	.010		.006	.012	

GEAR NUT TORQUE

Model	Gear Size	Torque N-m
2002, 4	63.5	81
3003, 6	88.9	136
4002, 5, 7	101.6	170
5003, 6, 9	127	285
6005, 8, 15	152.4	407

OIL RESERVOIR CAPACITY

Model	Liters	
	Horiz. Flow	Vert. Flow
2002,4	.11	.18
3003, 6	.18	.48
4002, 5, 7	.21	.68
5003, 6, 9	.48	.83
6005, 8, 15	.84	1.56
7006, 11, 18	.84	1.56

MAXIMUM OPERATING LIMITS

Model	RPMs	Press. Rise m Bars	In. Vacuum m Bar.	Temp Rise C°
2002	5275	.830	475	107
2004		.480		85
3003	3600	.830		76
3006		.480		46
4002		1.030		115
4005		.700		76
4007		.480		54
5003	2850	1.030		90
5006		.700		82
5009		.480		46
6005	2350	1.030	540	121
6008		.830		115
6015		.410	400	54
7006	575-2050	15		121
7011		10		99
7018		6		54

- NOTES -

Tear out at perforation and mail pre-paid postcard for warranty consideration.

TUTHILL CORPORATION | M-D Pneumatics Division

GENERAL TERMS OF SALE

1. GENERAL

This order together with any additional writings signed by Seller shall represent the final, complete and exclusive statement of the Agreement between the parties and may not be modified, supplemented, explained or waived by parol evidence, Buyer's purchase order, a course of dealing, Seller's performance of delivery, or in any other way except in writing signed by an authorized employee of the Seller. These terms are intended to cover all activity of Seller and Buyer hereunder, including sales and use of products, parts and work and all related matters (references to products include parts and references to work include construction, installation, and start-up). Any reference by Seller to Buyer's specification and similar requirements are only to describe the products and work covered hereby, and no warranties or other terms therein shall have any force or effect. Catalogs, circulars and similar pamphlets of the Seller are issued for general information purposes only and shall not be deemed to modify the provisions hereof.

2. 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 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.

3. 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 FOB 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.

4. PATENTS

Seller agrees to assume the defense of any suit for infringement of any United States patents brought against Buyer to the extent such suit charged infringement of an apparatus or product claim by Seller's product in and of itself, provided (i) said product is built entirely to Seller's design, (ii) Buyer notifies Seller in writing of the filing of such suit within ten (10) days after the service of process thereof, and (iii) Seller's given complete control to the defense of such suit, including the right to defend, settle and make changes in the product for the purpose of avoiding infringement. Seller assumes no responsibility for charges of its infringement of any process or method claims, unless infringement of such claims is the result of following specific instructions furnished by Seller.

5. TERMS OF PAYMENT

A. Unless other terms are specified, all payment shall be in US dollars and shall become due in 30 days after shipment. All shipments, unless otherwise specified, shall be FOB manufacturer's plant. If delivery is delayed by purchaser, date of readiness for delivery shall be deemed date of delivery for payment purposes. If manufacture is delayed by purchaser, a payment shall be due based on purchase price and percentage of completion. Balance payable in accordance with terms stated herein.

B. If Seller has not received full payment within thirty (30) days after such payment is due then Buyer's outstanding balance will be subject to an interest charge equal to two (2) percentage points above the prime rate.

6. TAXES

Any sales, use or other similar type taxes imposed on this sale or on this transaction are not included in the price. Such taxes shall be billed separately to the Buyer. Seller will accept a valid exemption certificate from the Buyer if applicable, however, if an exemption certificate previously accepted is not recognized by the governmental taxing authority involved and the Seller is required to pay the tax covered by such exemption certificate, Buyer agrees to promptly reimburse Seller for taxes paid.

7. CANCELLATION

Following approval by Seller, Buyer may not cancel except upon payment of twenty percent (20%) to one hundred percent (100%) of the total price of the product and work depending on the status of completion, plus Seller's nonrecoverable costs (including incidental and consequential damages) attributable to this order.

8. SECURITY INTEREST

Buyer represents that the product is to be used for business, and shall remain personalty. Buyer grants Seller a security interest in the product to secure the payment of the purchase price. Buyer will not sell, lease, transfer or encumber the product and will keep it free from any and all liens and security interests. Upon default, Seller shall have all the remedies available to it under the Uniform Commercial Code and other applicable laws of the state in which the product is located and shall be entitled to all legal costs, reasonable attorney's fees, and all other reasonable expenses and costs permitted by law which are incurred by Seller in enforcing its remedies. The security interest herein granted shall be in Buyer's interest in the product and shall be fully discharged upon receipt by Seller of the unpaid balance of the purchase price. Buyer agrees (a) to sign all financing statements and other instruments or documents that Seller may reasonably believe are necessary to protect this security interest (b) if movement of the product to another location is allowed under any other documents relating to this proposal to give Seller at least thirty (30) days advance written notice of any such change in location, (c) to inform Seller of any change in the law of jurisdiction in which the product is located whether such change is statutory or otherwise, which change could affect the continued status of the product as personalty and (d) to procure and maintain insurance on the product for its full purchase price, the policy to name Seller as loss payee.

9. CONFIDENTIALITY

Technical data and layouts supplied by Seller in connection herewith are confidential pending Buyer's acceptance of this proposal.

10. OSHA LAWS

Seller has taken the Occupational Safety and Health Act of 1970 (OSHA) and like state and local laws into account in the design of its products with the objectives that when such equipment is placed in appropriate environment it will enable the operator or user to comply with the applicable OSHA and similar requirements, however, because compliance is significantly affected by many factors over which Seller has little control (such as installation, plant lay out, building acoustics, materials processed, processing procedures and supervision and training of employees), Seller does not represent or warrant that equipment sold by it complies with OSHA or any like state or local law or regulation and the cost for modifications and responsibility for compliance are the Buyer's responsibility.

WARRANTY AND LIMITATION OF LIABILITY

Subject to the terms and conditions hereinafter set forth and set forth in General Terms of Sale, Tuthill Corporation, M-D Pneumatics Division (the Seller) warrants products and parts of its manufacture, when shipped, and its work (including installation and start-up) when performed, will be of good quality and will be free from defects in material and workmanship. This warranty applies only to Seller's equipment, under use and service in accordance with seller's written instructions, recommendations and ratings for installation, operating, maintenance and service of products, for a period within one (1) year after date of shipment for all new products and six (6) months for all rebuilt or remanufactured products which are not supplied for warranty situations. On warranty repairs, the warranty period will be either whatever time was left on the original warranty at time of removal or three (3) months, which ever is greater. Because of varying conditions of installation and operation, all guarantees of performance are subject to plus or minus 5% variation.

THIS WARRANTY EXTENDS ONLY TO BUYER AND/OR ORIGINAL END USER, AND IN NO EVENT SHALL THE SELLER BE LIABLE FOR PROPERTY DAMAGE SUSTAINED BY A PERSON DESIGNATED BY THE LAW OF ANY JURISDICTION AS A THIRD PARTY BENEFICIARY OF THIS WARRANTY OR ANY OTHER WARRANTY HELD TO SURVIVE SELLER'S DISCLAIMER.

All accessories furnished by Seller but manufactured by others bear only that manufacturer's standard warranty.

All claims for defective products, parts, or work under this warranty must be made in writing immediately upon discovery and, in any event within one (1) year from date of shipment of the applicable item and all claims for defective work must be made in writing immediately upon discovery and in any event within one (1) year from date of completion thereof by Seller. Unless done with prior written consent of Seller, any repairs, alterations or disassembly of Seller's equipment shall void warranty. Installation and transportation costs are not included and defective items must be held for Seller's inspection and returned to Seller's F.O.B. point upon request.

THERE ARE NO WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

After Buyer's submission of a claim as provided above and its approval, Seller shall at its option either repair or replace its product, part, or work at the original F.O.B. point of shipment, or refund an equitable portion of the purchase price.

The products and parts sold hereunder are not warranted for operation with erosive or corrosive material or those which may lead to build up material within the product quoted. The Buyer shall have no claim whatsoever and no product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action nor for problems resulting from build-up of material within the unit.

Any improper use, operation beyond capacity, substitution of parts not approved by Seller, or any alteration or repair by others in such manner as in Seller's judgment affects the product materially and adversely shall void this warranty.

No employee or representative of Seller other than an officer of the Company is authorized to change this warranty in any way or grant any other warranty.

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 General Terms of Sale in the sections on 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, WITHOUT REGARD TO WHETHER ANY DEFECT WAS DISCOVERED OR LATENT AT THE TIME OF DELIVERY OF THE PRODUCT OR WORK. In no event shall Buyer be entitled to incidental or consequential damages. Any action for breach of this agreement must commence within one (1) year after the cause of action has occurred.

January, 1989

TUTHILL CORPORATION | M-D Pneumatics
A Tuthill Subsidary

P.O. Box 2877, Springfield, MO 65801-0877 • (417) 865-8715 • TWX 910-775-4704 • FAX 417-865-2950

MAINTENANCE:

1. Check pop off pressure every 2 to 6 months.
2. Inspect for dirt build up in bodies frequently.
3. Remove yearly for testing, inspection, and overhaul.

Valve failure may be caused by seizing of parts, scored or wire drawn seats and corroded or eroded springs. The first case may be corrected by careful cleaning followed by light sanding of the seating surfaces. For correction of the second, the seating surface may be remachined or carefully hand lapped if damage is less severe. Springs rarely required replacement, but may be purchased from manufacturer should replacement be necessary.

DISASSEMBLY

1351 & 1361 Series - Refer to Relief Valve Assembly Drgs. 1351 & 1361.

1. Remove Regulator Ring Set Screw.
2. Remove hood and mark relative positions of pressure screws, lockn t and cap.
3. Loosen pressure screw locknut and pressure screw to release pressure of spring.
4. Remove Cap.
5. Remove spring and spring plates, spindle and spindle retainer.
6. Mark location of regulator ring and remove.

1352 Series - Refer to Pressure Relief Valve Assembly Drg. 1352.

1. Remove fillister head machine screw.
2. Remove roll pin, washer, lever and pressure screw.
3. Remove the spring and disc assembly.
4. Disassemble the disc assembly.

1362 Series - Refer-to Vacuum Relief Valve Assembly Drg. 1362

1. Remove fillister head machine screw.
2. Remove pressure screw.
3. Remove the spring and disc assembly.
4. Disassemble the disc assembly.

To Reassemble: Reverse the above procedures - being careful to return parts to their marked positions.
After reassembly, reset valves according to instructions under adjustment, setting and testing.

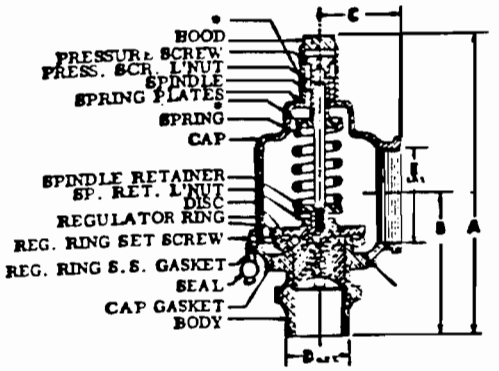
ADJUSTMENT, SETTING AND TESTING

Popping Pressure: I351 & 1361 Series
Refer to Relief Valve Test Set Ups.
Make sure of gauge accuracy before beginning. Remove hood - exposing pressure screw and locknut. Loosen locknut and raise pressure or vacuum until valve opens or pops. If opening pressure or vacuum is too low, turn down on pressure screw. If pressure or vacuum is too high, back-off pressure screw. After proper pressure has been reached, securely tighten locknut and replace hood.

1352 & 1362 Series
Refer to Relief Valve Test Set Ups.
Make sure of gauge accuracy before beginning. Remove filister head machine screws. Raise pressure or vacuum until valve opens or pops. If opening pressure or vacuum is too low, turn down on pressure screw. If pressure or vacuum is too high, back-off pressure screw. After proper setting has been reached, replace filister head screws, making sure they align with slots provided in pressure screw.

BLOWDOWN ADJUSTMENT

1351 & 1361 Series
When popping pressure is changed, a slight adjustment in blow down may be required. Raising the popping pressure or vacuum lengthens the blow down, and lowering the popping pressure or vacuum shortens the blow down. Raising the regulator ring - towards the disc - will increase blowdown and should be made a notch at a time as the adjustment is sensitive. The normal position would be three or four notches down from touching the disc, but this figure will vary with conditions.
CAUTION: Retighten regulator ring set screw.



1351 & 1361 RELIEF VALVE

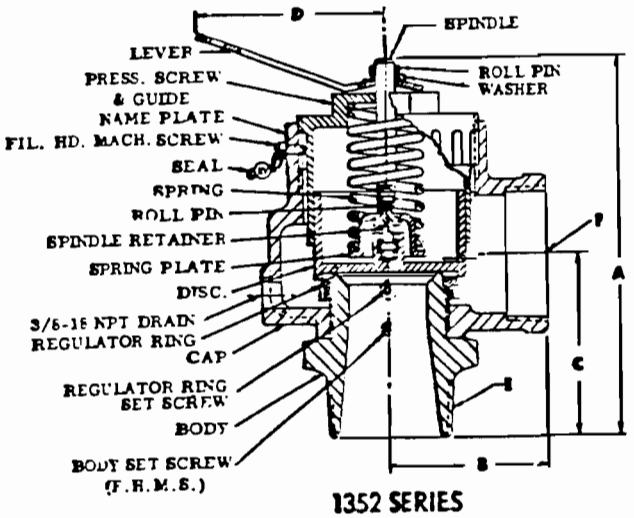
1351 Denotes Pressure Valve
1361 Denotes Vacuum Valve
*Joints sealed on 1361 Vacuum Valves with Crane Pipe Compound or equiv.

PART NO.	SEAT DIA.	VALVE SIZE	WT. LBS.	A	B	C	D	E
1351-1	1/2	1/2	1-3/8	4.63	2.38	1.12	3/2	3/4
1351-2	3/4	3/4	3-1/4	6.66	2.53	1.50	3/4	1-1/4
1351-3	1	1	3	6.97	2.75	1.81	1	1-1/2
1351-4	1-1/4	1-1/4	5-1/2	8.59	3.97	2.18	1-1/4	2
1351-5	1-1/2	1-1/2	7-3/4	9.59	4.31	2.31	1-1/2	2-1/2
1351-6	2	2	11-1/2	10.91	4.88	2.62	2	3
1351-7	2-1/2	2-1/2	20-1/2	13.75	6.09	3.50	2-1/2	3
1351-8	3	3	29	14.75	7.06	4.12	3	4

NOTE: SERVICE RECOMMENDATIONS
AIR OR GAS MAX. 60 PSIG AT 450° F.

INSTRUCTIONS:

1. AVOID OVERTIGHTENING OF VALVE DURING INSTALLATION.
2. VACUUM SETTING MAY BE VARIED APPROX. ± 10% OF ORIGINAL SETTING BY REMOVING HOOD AND RUNNING PRESSURE SCREW IN OR OUT AS DESIRED. (CAUTION: RETIGHTEN LOCKNUT AFTER EACH ADJUSTMENT)
3. VALVE MAY BE CLEANED BY REMOVING DISC AND CLEANI NG SEAT SURFACE WITH A SOFT CLOTH. SEATING SURFACE MAY BE LAPPED IN CASE OF LEAKAGE BY USING A FINE GRIT COMPOUND.



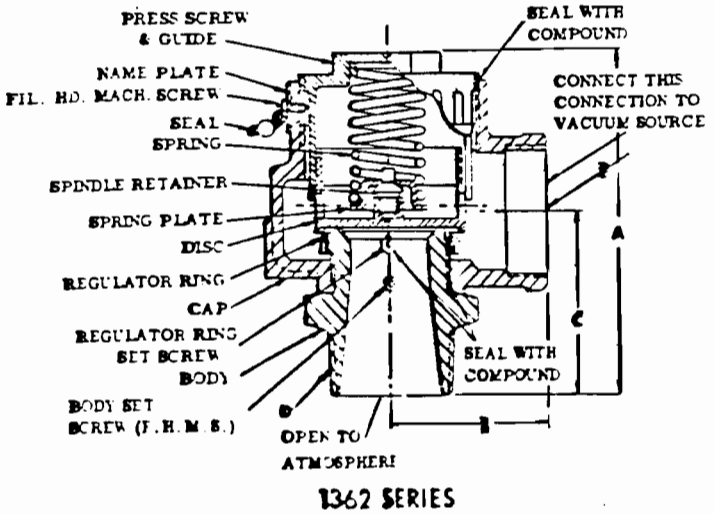
1352 SERIES

PART NO.	SEAT DIA.	VALVE SIZE	Wt. LBS.	A	B	C	D	E	F
1352-6	2	2	7-1/2	7.18	2.94	3.18	3.38	2	2
1352-7	2-1/2	2-1/2	12-1/4	8.00	3.50	3.75	4.12	2-1/2	2-1/2
1352-8	3	3	18-3/4	9.00	4.0	4.18	4.18	3	3

NOTE: SERVICE RECOMMENDATIONS
AIR OR GAS MAX. 60 PSIG AT 450° F.

INSTRUCTIONS:

1. AVOID OVERTIGHTENING OF VALVE DURING INSTALLATION.
2. VACUUM SETTING MAY BE VARIED APPROX. ± 10% OF ORIGINAL SETTING BY REMOVING HOOD AND RUNNING PRESSURE SCREW IN OR OUT AS DESIRED. (CAUTION: RETIGHTEN LOCKNUT AFTER EACH ADJUSTMENT)
3. VALVE MAY BE CLEANED BY REMOVING DISC AND CLEANING SEAT SURFACE WITH A SOFT CLOTH. SEATING SURFACE MAY BE LAPPED IN CASE OF LEAKAGE BY USING A FINE GRIT COMPOUND.



1362 SERIES

PART NO.	SEAT DIA.	VALVE SIZE	WT. LBS.	A	B	C	D	E
1362-6	2	2	7	5.88	3.18	2.94	3	2
1362-7	2-1/2	2-1/2	11-3/4	6.94	3.50	3.75	2-1/2	2-1/2
1362-8	3	3	18-1/2	7.88	4.00	4.18	3	3

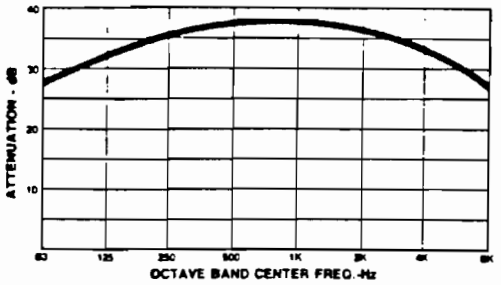
NOTE: SERVICE RECOMMENDATIONS
AIR OR GAS MAX. - 30 HG AT 450° F.

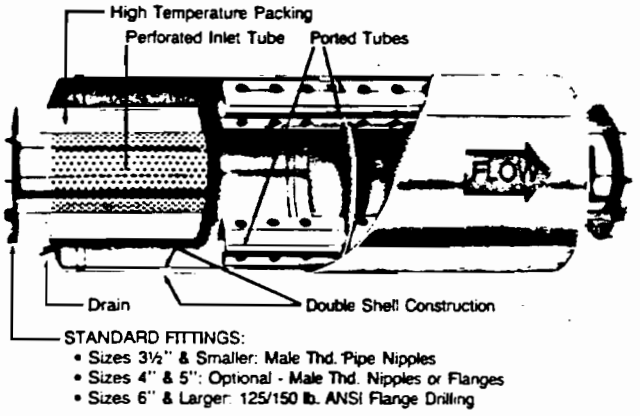
INSTRUCTIONS.

1. AVOID OVERTIGHTENING OF VALVE DURING INSTALLATION.
2. PRESSURE SETTING MAY BE VARIED APPROX ± 10% OF ORIGINAL SETTING BY REMOVING AND LOOSENING THE FILLISTER HEAD MACHINE SCREW AND THEN RUNNING THE PRESSURE SCREW IN OR OUT AS DESIRED.
3. VALVE MAY BE CLEANED BY REMOVING DISC AND CLEANING SEAT SURFACE WITH A SOFT CLOTH SEATING SURFACE MAY BE LAPPED IN CASE OF LEAKAGE BY USING A FINE GRIT COMPOUND.

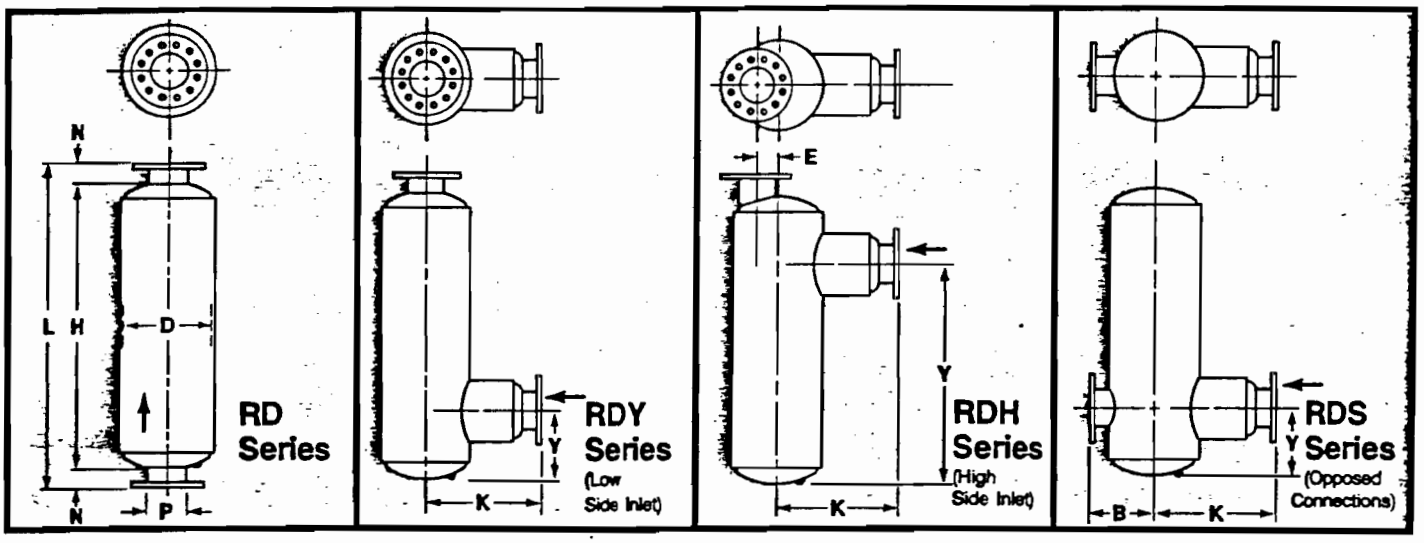
Specifications
RD Group

Combination Chamber–
Absorptive Type
Discharge Silencer





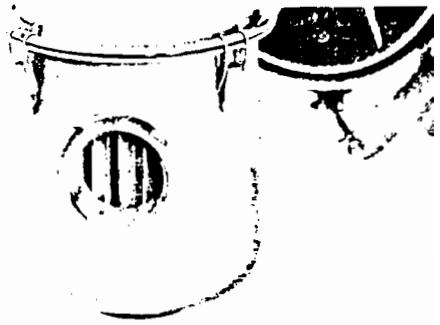
The RD Series Discharge Silencer is a heavy-duty, all welded unit constructed of carbon steel sheet and plate. It provides excellent pulse control and is equipped with an acoustically treated inlet for use on critical PLV applications. Pulse control and noise attenuation provided by the RD Series is the ultimate and is usually necessary for only the most demanding installations. Sizes 4" and larger are equipped with flanged connections drilled to 125/150 lb. ANSI specifications. Smaller sizes are standard with male threaded pipe nipples. Exterior surfaces receive a shop coat of rust inhibitive primer and may be finish painted in the field if desired. The RD Series is the basic, end inlet/end outlet configuration. A low side inlet version is designated the RDY Series; high side inlet, RDH Series; and low opposed connections, RDS Series. The four types are fundamentally alike and the performance is identical. Mounting brackets and other options are available — see page 11.



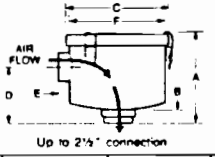
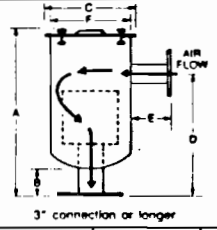
P (SIZE)	D	L	N	H	K			B	E	Y						WGT.
					RDY	RDH	RDS			RDY		RDS		RDH		
										MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
1 1½	SIZES 1"-1½": USE URB SERIES - PAGE 8 OR U5 SERIES - CATALOG #245															
2	8	33	3	27	9	—	—	—	—	FIXED AT 6		—	—		—	25
2½	10	34	3	28	10	—	—	—	—	FIXED AT 7		—	—		—	35
3	10	46	3	40	10	—	—	—	—	FIXED AT 7		—	—		—	40
3½	12	52	3	46	11	—	—	—	—	FIXED AT 8		—	—		—	60
4	14	53	3	47	14½	16	14½	10	4	8	20	8	14	33	39	80
5	16	65	3	59	16½	18	16½	11	4½	9	26½	9	16½	43½	51	130
6	18	72	3	66	20½	22½	20½	12	5	10	30	10	20	46	56	160
8	22	97	3½	90	24½	28½	26	14½	6	12	45	12	26	65	79	410
10	26	122	3½	115	28½	34	32	16½	7	14	60½	14	37½	79½	103	600
12	30	135	3½	128	35	42	39½	18½	8	15½	66	15½	39	91	114½	900
14	36	161	3½	154	40½	47½	45½	21½	10½	17½	78	17½	46	110	138	1400
16	42	181	3½	174	44½	52½	50	24½	12½	19½	89½	19½	52½	122½	155½	1800
18	48	188	3½	181	47	54	52½	27½	14½	21½	95	21½	53½	129½	161½	2550
20	48	202	4½	193	53½	65	63½	28½	13½	22½	100	22½	58	137	172½	2750
22	54	204	4½	195	59½	72	70	31½	15½	24½	100	24½	57	140	172½	3300
24	54	239	4½	230	66	81½	79½	31½	14½	25½	123	25½	73½	159½	207½	3850
26	60	259	4½	250	72	87	85	34½	16½	27	130	27	76	177	226	5000
28	66	279	4½	270	78	93½	91	37½	18½	31	140	31	81	192	242	6950
30	72	304	4½	295	78	95½	94	40½	20½	32	158	32	93	205	266	8100

Dimensions In Inches Weight In Lbs

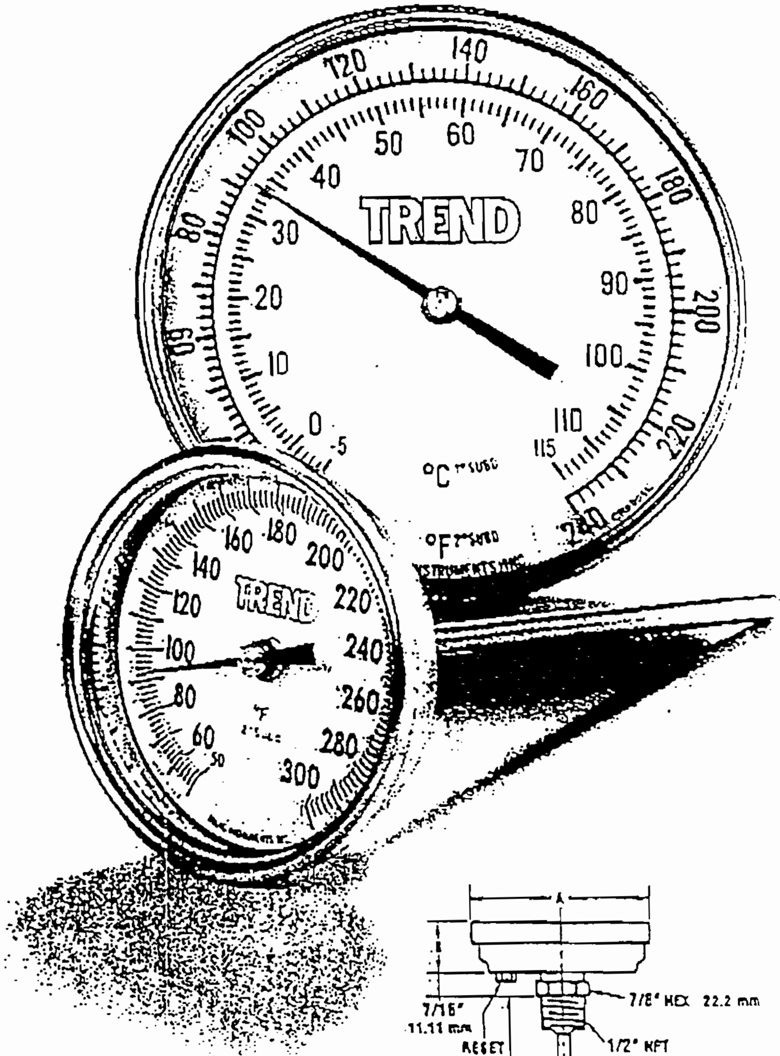
NOTE: Dimensions and weights are nominal and may vary slightly with production models. Request certified drawings of specific models for exact dimensions.



Inline Filter (Dual Connection)

SMI MODEL NUMBERS - CSL Series		EFFECTIVE SURFACE AREA OF ELEMENT IN SQUARE FEET		CONNECTION		Flow CFM	Approx. Shipping Wt. Lbs.	DIMENSIONS					
								 Up to 2½" connection			 3" connection or longer		
W/Polyester Element	W/Paper Element	Polyester	Paper	Size	Type			A	B	C	D	E	F
THREADED CONNECTIONS													
CSL-E275387-050HC	CSL-C275387-050HC	.6	1.75	1/2"	FPT	10	3	4-3/8"	3/8"	5-7/8"	2-5/8"	9/16"	5"
CSL-E275387-075HC	CSL-C275387-075HC	.6	1.75	3/4"	FPT	20	3	4-3/8"	3/8"	5-7/8"	2-5/8"	9/16"	5"
CSL-E275387-100HC	CSL-C275387-100HC	.6	1.75	1"	FPT	25	3	4-3/8"	5/8"	5-7/8"	2-5/8"	3/4"	5"
CSL-E475500-100HC	CSL-C475500-100HC	2.0	4.5	1"	FPT	40	5	6-1/2"	3/4"	7-5/16"	4-1/2"	3/4"	6-13/16"
CSL-E275387-125HC	CSL-C275387-125HC	.6	1.75	1-1/4"	FPT	45	3	4-3/8"	5/8"	5-7/8"	2-5/8"	3/4"	5"
CSL-E475500-125HC	CSL-C475500-125HC	2.0	4.5	1-1/4"	FPT	60	5	6-1/2"	3/4"	7-5/16"	4-1/2"	3/4"	6-13/16"
CSL-E475500-150HC	CSL-C475500-150HC	2.0	4.5	1-1/2"	FPT	80	5	6-1/2"	3/4"	7-5/16"	4-1/2"	3/4"	6-13/16"
CSL-E875587-200HC	CSL-C875587-200HC	4.5	13.75	2"	FPT	150	15	10-1/4"	3/4"	8-3/4"	5-1/2"	1-1/4"	7-5/8"
CSL-E875587-250HC	CSL-C875587-250HC	4.5	13.75	2-1/2"	FPT	195	15	10-1/4"	3/4"	8-3/4"	5-1/2"	1-1/4"	7-5/8"
CSL-235P-300	CSL-234P-300	8.3	22.8	3"	MPT	300	47	27-1/8"	3"	14"	18-1/2"	3"	13"
CSL-335P-300	CSL-334P-300	12.0	34.0	3"	MPT	300	50	27-1/8"	3"	14"	18-1/2"	3"	13"
CSL-235P-400	CSL-234P-400	8.3	22.8	4"	MPT	520	52	27-1/8"	3"	14"	18-1/2"	3"	13"
CSL-335P-400	CSL-334P-400	12.0	34.0	4"	MPT	520	55	27-1/8"	3"	14"	18-1/2"	3"	13"
CSL-245P-500	CSL-244P-500	14.0	35.5	5"	MPT	800	82	28-1/8"	3"	18-1/2"	19-1/2"	3"	17"
CSL-345P-500	CSL-344P-500	22.1	57.0	5"	MPT	800	88	28-1/2"	3"	18-1/2"	19-1/2"	3"	17"
CSL-275P-600	CSL-274P-600	19.0	45.4	6"	MPT	1100	95	28-1/8"	4"	18-1/2"	20-1/2"	4"	17"
CSL-375P-600	CSL-374P-600	28.0	68.1	6"	MPT	1100	97	28-1/8"	4"	18-1/2"	20-1/2"	4"	17"
FLANGED CONNECTIONS													
CSL-235P-400F	CSL-234P-400F	8.3	22.8	4"	FLG	520	62	27-1/8"	3"	14"	18-1/2"	3"	13"
CSL-335P-400F	CSL-334P-400F	12.0	34.0	4"	FLG	520	64	27-1/8"	3"	14"	18-1/2"	3"	13"
CSL-245P-500F	CSL-244P-500F	14.0	35.5	5"	FLG	800	90	28-1/8"	3"	18-1/2"	19-1/2"	3"	17"
CSL-345P-500F	CSL-344P-500F	22.1	57.0	5"	FLG	800	88	28-1/2"	3"	18-1/2"	19-1/2"	3"	17"
CSL-275P-600F	CSL-274P-600F	19.0	45.4	6"	FLG	1100	110	28-1/8"	4"	18-1/2"	20-1/2"	4"	17"
CSL-375P-600F	CSL-374P-600F	28.0	68.1	6"	FLG	1100	113	28-1/8"	4"	18-1/2"	20-1/2"	4"	17"
CSL-377P-800F	CSL-376P-800F	50.0	125.0	8"	FLG	1800	185	38"	4"	22-1/2"	25-1/2"	4"	21"
CSL-685P-1000F	CSL-384P(2)-1000F	100.0	280.0	10"	FLG	2900	380	57-1/2"	4"	26-13/32"	45"	4"	25"
CSL-685P-1200F	CSL-384P(2)-1200F	100.0	280.0	12"	FLG	3300	390	57-1/2"	4"	26-13/32"	45"	4"	25"
CSL-485P(2)-1200F	CSL-484P(2)-1200F	150.0	400.0	12"	FLG	4950	465	70"	4"	26-13/32"	57"	4"	25"

90° BACK ANGLE FORM DIAL SIZES: 3" • 5" Model 30 & 50 Bi-Metal Thermometers

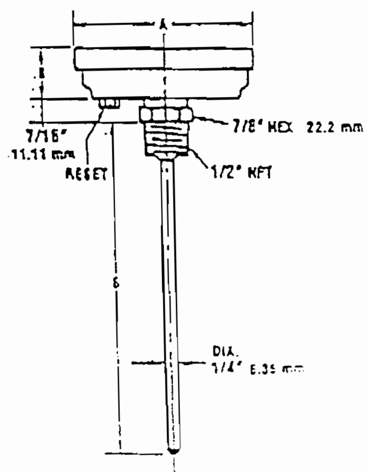


Dial Size	A	B	S (stem length)
3" 76.2 mm	3 1/4" 82.55 mm	15/16" 23.81 mm	as specified
5" 127 mm	5 1/4" 133.35 mm	15/16" 23.81 mm	as specified

ALL DIMENSIONS ± 1/16" (1.58 mm)

Catalog Numbers

Stem Length Inches	Stem Length Millimeters	MODEL 30 Dial Size 3" 76.2 mm	MODEL 50 Dial Size 5" 127 mm
2 1/2	63.5	30025	50025
4	101.6	30040	50040
6	152.4	30060	50060
9	228.6	30090	50090
12	304.8	30120	50120
15	381.0	30150	50150
18	457.2	30180	50180
24	609.6	30240	50240



Standard Ranges — Dual Scale (*Other Ranges Available*)

Fahrenheit (outer scale) Range	Fig. Interval	Div.	Celsius (inner scale) Range	Fig. Interval	Div.
-100 to 150°	20°	2°	-70 to 70°	10°	1°
- 40 to 120°	20°	2°	-40 to 50°	10°	1°
25 to 125°	10°	1°	- 5 to 50°	5°	1/2°
0 to 140°	10°	1°	-20 to 60°	5°	1/2°
0 to 200°	20°	2°	-15 to 90°	10°	1°
0 to 250°	20°	2°	-20 to 120°	10°	1°
20 to 240°	20°	2°	- 5 to 115°	10°	1°
50 to 300°	20°	2°	10 to 150°	10°	1°
50 to 400°	50°	5°	10 to 200°	20°	2°
50 to 500°	50°	5°	10 to 260°	20°	2°
150 to 750°	100°	10°	65 to 400°	50°	5°
*200 to 1000°	100°	10°	*100 to 540°	50°	5°

*Not recommended for continuous use over 800°F or 425°C.

For complete list of available ranges, including Celsius only and Fahrenheit only, please see pag...

How to Order

The catalog number shown indicates only the dial size, angle form and stem length. For complete, descriptive part number please use the tables listed [illegible] page 13

See General [illegible] construction features [illegible] accessories and other [illegible]

30 Back Angle Form

Page ____ of ____

Bi-Metal Thermometers — Model 30 & 50

Date ____ File No. ____

Engineering Specification
Submittal Data

Dimensions:

Certified Correct:

By: ____

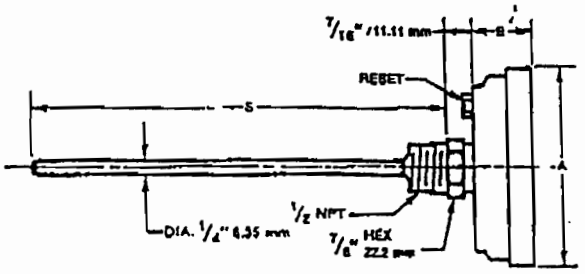
SPECIFICATION APPROVAL

Notes:

Standard Ranges — Dual Scale

Fahrenheit (outer scale) Range			Fig. Interval	Div.	Celsius (inner scale) Range			Fig. Interval	Div.
−100	to	100°	20°	2°	−70	to	40°	10°	1°
− 40	to	120°	20°	2°	−40	to	50°	10°	1°
**25	to	125°	10°	1°	− 5	to	50°	5°	½°
0	to	200°	20°	2°	−15	to	90°	10°	1°
0	to	250°	20°	2°	−20	to	120°	10°	1°
20	to	240°	20°	2°	− 5	to	115°	10°	1°
50	to	300°	20°	2°	10	to	150°	10°	1°
50	to	400°	50°	5°	10	to	200°	20°	2°
50	to	500°	50°	5°	10	to	260°	20°	2°
150	to	750°	100°	10°	65	to	400°	50°	5°
*200	to	1000°	100°	10°	*100	to	540°	50°	5°

* Not recommended for continuous use over 800°F or 425° C.
** Not available with 2.5"/63.5mm stem.
Celsius only and Fahrenheit only dials are available.



DIAL SIZE	A	B	S (stem length)
3" 76.2 mm	3¼" 82.55 mm	15/16" 23.81 mm	as specified
5" 127 mm	5¼" 133.35 mm	15/16" 23.81 mm	as specified

ALL DIMENSIONS ± 1/16" 1.58 mm

CUSTOMER: ____

ORDER NO: ____

ENG'R: ____

PROJECT: ____

LOCATION: ____

Catalog Numbers

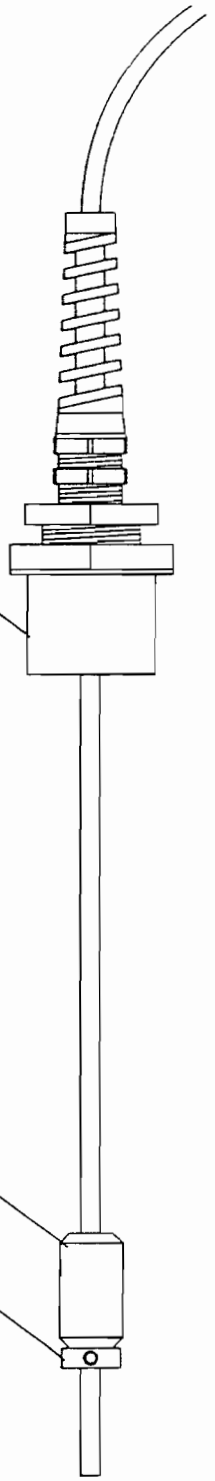
Stem Length Inches	Stem Length Millimeters	MODEL 30 Dial Size 3" 76.2 mm	MODEL 50 Dial Size 5" 127 mm
2½	63.5	30025	50025
4	101.6	30040	50040
6	152.4	30060	50060
9	228.6	30090	50090
12	304.8	30120	50120
15	381.0	30150	50150
18	457.2	30180	50180
24	609.6	30240	50240

See general specification sheet for construction and features

TREND instruments, inc.
887 S. Matlack St. • P.O. Box 2047
West Chester, Pa. 19380 • 610 431 1780

LIQUID ENTRAINMENT CYLINDER PROBE

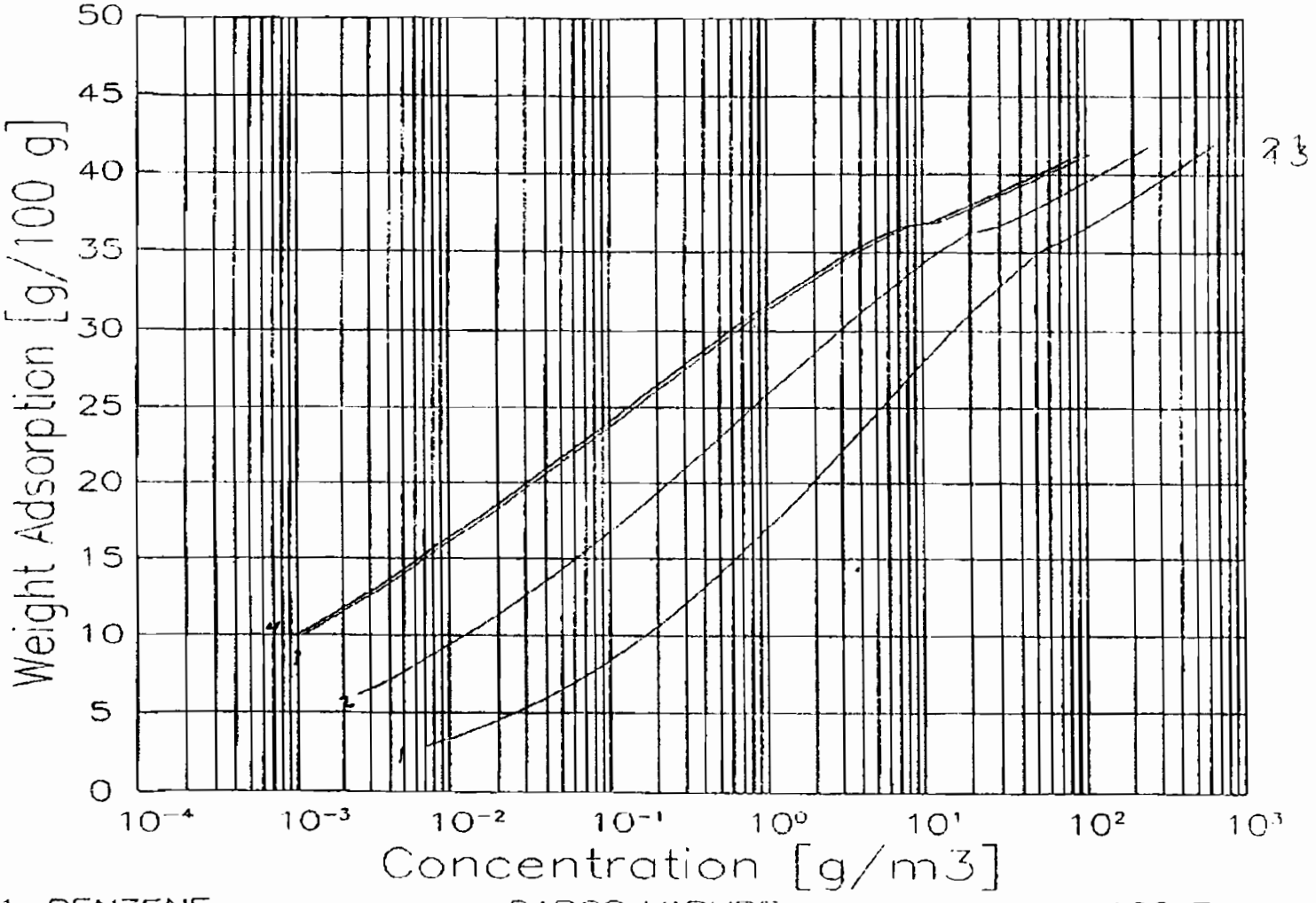
COMMON – GREEN
N.C. – RED
N.O.– BLACK



PROBES

Adsorption Isotherms

American Norit Company, Inc.



1: BENZENE.....DARCO VAPURE 100 F
2: TOLUENE.....DARCO VAPURE 100 F
3: ETHYLBENZENE.....DARCO VAPURE 100 F
4: XYLENE(M).....DARCO VAPURE 100 F

NORIT

Product Information Bulletin

Bulletin No.: V2

CETCO
COLLOID ENVIRONMENTAL TECHNOLOGIES COMPANY
INDUSTRIAL SERVICES GROUP

3/96.1

AQUATEC V-SERIES
Modular Vapor Adsorbers

CETCO Industrial Services Group offers a complete line of modular vapor phase adsorbers. The **Aquatec V-Series** is designed as a low cost, vapor adsorber that is portable and can be easily put into service. The **Aquatec V-Series** adsorbers are designed for a maximum pressure of 15 psi and a vacuum of 10" water column and are available in sizes designed to hold from 500 to 2000 lbs of carbon.

Model #	GAC ft^3/lbs	Recommended Max. Flow Rate	Estimated Weight (Empty/Shipping)
V1M	36/1000	675 cfm	1125/2125
V1.5M	54/1500	750 cfm	1250/2750
V2M	72/2000	750 cfm	1250/3250

Important Features

- Durable carbon steel construction.
- Lifting lugs and forklift guides to facilitate moving.
- Upper and lower open-air plenum area designed for maximum carbon utilization.
- Designed for either upflow or downflow.
- Fitting for CETCO Carbon Saturation Indicator or effluent sample port.
- 6" Threaded influent/effluent connections.
- Condensate drain plug.
- Low profile design.
- 16" drum type manway for easy access.
- Rust-inhibitive epoxy primer and acrylic polyurethane top coat exterior.
- Can be filled with any of CETCO's virgin or reactivated granular or extruded carbons.
- Dished top and bottom heads allow higher operating pressures and light vacuum.
- Shipped with carbon & ready for service.
- All models available for lease

For More Information and Pricing

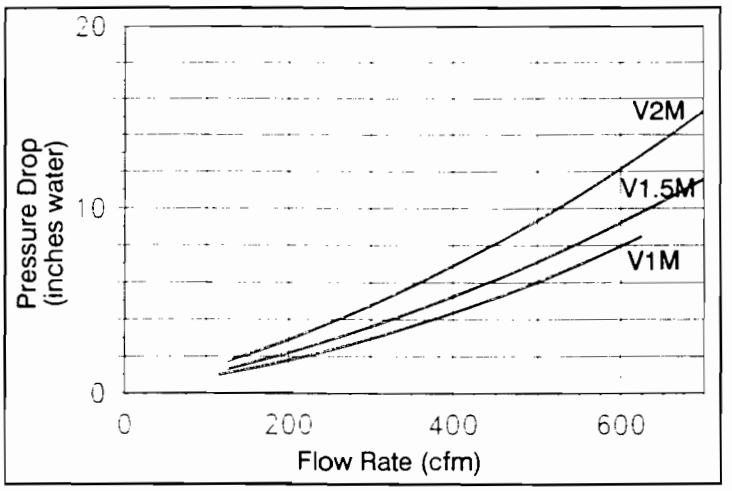
Call

1-800-527-9948

and Talk to One of Our

Knowledgeable Technical

Support Personnel



Carbon volume and weight based on Bituminous Carbon @ 30 lbs/ft^3.
Estimated pressure drop based on virgin 4x10 carbon.
Design and specifications subject to change without notice.

1350 West Shure Drive • Arlington Heights, IL 60004 • (800) 527-9948 • (847) 392-5800 • Fax (847) 506-6150

CERTA-LOK™ YELOMINE™ LIST PRICES

RESTRAINED JOINT PVC PRESSURE PIPING SYSTEM

GENERAL INFORMATION

CertainTeed's Certa-Lok™ Yelomine™ Restrained Joint PVC Pressure Pipe meets the dimensional requirements of ASTM (American Society for Testing Materials) D2241 "Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)."

Certa-Lok Yelomine pipe and couplings are manufactured from a specially formulated PVC compound which contains impact modifiers and ultraviolet inhibitors, to give higher impact strength over an extended period of time. CertainTeed Certa-Lok Yelomine compound (in accordance with ASTM D1784) utilizes only type 1, grade 1 2,000 psi hydrostatic design stress material.

The Certa-Lok restrained joint provides a non-corrosive restrained joint by utilizing precision machined grooves on the pipe and in the coupling which, when aligned, allow a nylon spline to be inserted, resulting in a 360° restrained joint that locks the pipe and coupling together. A flexible elastomeric seal (O-ring) in the coupling provides a hydraulic pressure seal.

Certa-Lok Yelomine couplings are boxed and shipped with splines and O-rings (gaskets) factory installed. Note: Specify permanent or non-permanent joint when ordering.

PACKAGING AND WEIGHTS

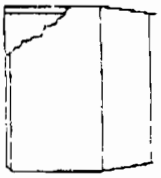
SIZE (IN.)	SDR	PSI	APP WT. LBS/ FT.	FT. PER T/L	FAST-PAKS/ T/L	FT. PER FAST-PAK	APPROX. WT. LBS/ FAST PAK	FAST PAK % OF T/L
2"	17	250	.69	58,800	28	2100	1449	3.57
3"	17	250	1.47	25,760	28	920	1352	3.57
4"	21	200	2.00	17,920	28	640	1280	3.57
4"	17	250	2.41	17,920	28	640	1542	3.57
4"	13.5	315	3.17	17,920	28	640	2029	3.57
6"	32.5	125	2.97	8,000	20	400	1188	5.00
6"	26	160	3.57	8,000	20	400	1428	5.00
6"	21	200	4.27	8,000	20	400	1708	5.00
6"	17	250	5.13	8,000	20	400	2052	5.00
6"	13.5	315	6.63	8,000	20	400	2652	5.00
8"	41	100	4.13	4,480	16	280	1156	6.25
8"	32.5	125	4.97	4,480	16	280	1392	6.25
8"	26	160	6.07	4,480	16	280	1700	6.25
8	21	200	7.24	4,480	16	280	2027	6.25
8"	17	250	8.72	4,480	16	280	2442	6.25
8"	13.5	315	9.76	4,480	16	280	2733	6.25
10"	41	100	6.33	2,560	16	160	1013	6.25
10"	32.5	125	7.49	2,560	16	160	1198	6.25
10"	26	160	9.19	2,560	16	160	1470	6.25
10"	21	▵160	10.98	2,560	16	160	1757	6.25
12"	41	100	8.61	2,240	*12/4	160/80	1,378/689	8.16/3.57
12"	32.5	125	10.57	2,240	*12/4	160/80	1,691/846	8.16/3.57
12"	26	160	12.88	2,240	*12/4	160/80	2,061/1,030	8.16/3.57
12"	21	▵160	15.64	2,240	*12/4	160/80	2,502/1,251	8.16/3.57
14"	26	160	16.67	1,440	12	120	2000	8.33
16"	26	▵90	20.39	1,440	12	120	2,446	8.33

★ Includes special "topping off" fast-paks

▵PSI on these items is limited by the pressure rating of the coupling. These heavy wall products are used in special applications where additional wall thickness or structural strength is required. For additional information on availability or application contact your CertainTeed representative.

DEFINITIONS AND ABBREVIATIONS

C/L: Certa-Lok™
C/LF: Certa-Lok Gasketed (female)
C/LM: Certa-Lok Grooved (male) Pipe End
MIPT: IPS (male) Pipe Thread (NPT)
FIPT: IPS (female) Pipe Thread (NPT)
PE: Plain End
SW: Solvent Weld
SWBE: Solvent Weld Bell End
T/L: Truck Load
HP: High Pressure
IRR: Irrigation
DT: Double Tapped



SHIPMENTS

Certa-Lok Yelomine pipe is shipped in convenient 20-foot lengths and is packaged in Fast-Paks, which are palletized units for easy handling.

All T/L orders are shipped F.O.B. Plant, freight pre-paid and allowed to distributors yard. Note: Delivery to other than distributors yard requires written approval from CertainTeed sales personnel.

TERMS OF PAYMENT

For shipments 1st-15th, 1½% ADF, 10th prox, net 15th prox. For shipments 16th-month-end, 1½% ADF, 25th prox, net 30th prox. Distributor price is the price in effect at the time of shipment.

SHIPPING QUANTITIES

No Fast-Paks will be broken to distributor stock. Minimum shipping quantity (1) Fast-Pak. The prices in this catalog are based on direct shipment of one or more T/L to distributor stock.

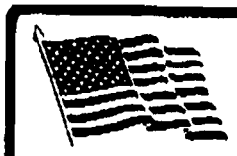
CertainTeed

Hydraulic comparison of HDPE vs. Yelomine

Outside Diameter	Size	HDPE Class 265 SDR-7.3	PVC-Yelo Class 250 SDR-17	HDPE Class 200 SDR-9	PVC-Yelo Class 200 SDR-21	HDPE Class 160 SDR-11	PVC-Yelo Class 160 SDR-26	HDPE Class 130 SDR-13.5	PVC-Yelo Class 125 SDR-32.5	HDPE Class 110 SDR-15.5	PVC-Yelo Class 80 SDR-41
2.375	ID. 2"	1.724	2.096	1.847		1.943		2.023		2.069	Max.ID
	Wt	0.91	0.70	0.76		0.64		0.53		0.47	Lb/Ft
	Q	36.5	53.9	41.8		46.3		50.2		52.5	GPM
	f	53.842	42.896	49.691		46.842		44.692		43.551	ft/1000ft
4.500	4"	3.267	3.971	3.500	4.071	3.682	4.154	3.833		3.919	
		3.27	2.46	2.74	2.04	2.30	1.66	1.90		1.67	
		130.9	193.3	150.2	203.3	166.2	211.6	180.2		188.4	
		25.565	20.367	23.593	19.781	22.241	19.324	21.220		20.678	
6.625	6"	4.810	5.846	5.153	5.994	5.420	6.115	5.644	6.217	5.770	
		7.09	5.24	5.93	4.31	4.97	3.46	4.13	2.62	3.64	
		283.7	419.0	325.6	440.6	360.3	458.6	390.6	474.0	408.3	
		16.288	12.977	15.032	12.603	14.170	12.312	13.520	12.077	13.175	
8.625	8"	6.262		6.708	7.804	7.057	7.962	7.347	8.094	7.512	
		12.01		10.05	7.25	8.42	5.94	7.00	4.45	6.16	
		480.9		551.9	746.8	610.7	777.3	662.0	803.4	692.0	
		11.977		11.053	9.267	10.420	9.053	9.941	8.880	9.687	
10.750	10"	7.805		8.361		8.795	9.923	9.157	10.088	9.363	10.226
		18.66		15.62		13.09	9.15	10.87	6.90	9.59	5.44
		747.0		857.3		948.7	1207.5	1028.4	1248.1	1075.0	1282.3
		9.265		8.551		8.061	7.003	7.691	6.870	7.494	6.763
12.750	12"	9.257		9.917		10.432	11.769	10.861	11.965	11.105	12.128
		26.25		21.97		18.42	13.00	15.30	9.76	13.47	7.66
		1050.8		1206.0		1334.5	1698.6	1446.6	1755.7	1512.2	1803.8
		7.594		7.009		6.607	5.740	6.304	5.631	6.143	5.543
14.000	14"	10.164		10.889		11.455	12.353	11.926	12.923	12.194	
		31.64		26.49		22.20	21.80	18.44	14.66	16.24	
		1267.0		1454.0		1609.0	1871.3	1744.1	2048.0	1823.3	
		6.810		6.285		5.925	5.426	5.653	5.148	5.508	
16.000	16"	11.616		12.444		13.091		13.630	*14.769	13.935	
		41.34		34.61		29.00		24.09	20.50	21.21	
		1654.8		1899.1		2101.5		2278.1	2674.9	2381.5	
		5.829		5.379		5.071		4.838	4.406	4.714	
18.000	18"					14.727		15.333		15.677	
						36.69		30.48		26.3	
						2659.8		2883.2		3014.0	
						4.420		4.217		4.110	

Outside Diameter is the same for Certa-Lok™ Yelomine™ and HDPE
Q & f calculated at a velocity of 5 ft/sec
*16" Yelomine is rated at 125 PSI SDR 26 pipe

For additional information on Certa-Lok Yelomine contact your local CertainTeed representative or write CertainTeed Pipe & Plastics Group, P.O. Box 860, Valley Forge, PA 19482, or call (215) 341-7000.



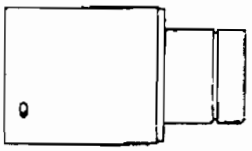
HOLBROOK
PLASTIC PIPE SUPPLY, INC.
361 Tate Street
Holbrook, NY 11741
(516) 588-6880

RESTRAINED JOINT PVC PRESSURE PIPING SYSTEM

CERTA-LOK REDUCER

C/L FEMALE x C/L MALE

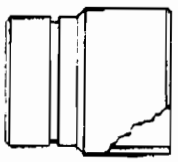
SIZE (IN.)	PSI	WT. (LBS.)	PRICE EA.	PART NO. NON PERM.	PART NO. PERM USE
4" x 2"	250	5.00	$62.19	70614	71614
4" x 3"	250	5.70	$65.42	70615	71615
6" x 2"	250	10.40	$135.56	70616	71616
6" x 3"	250	11.00	$138.48	70631	71631
6" x 4"	250	11.10	$108.45	70617	71617
8" x 2"	250	11.10	$250.09	70618	71618
8" x 4"	250	24.10	$220.92	70619	71619
8" x 6"	250	24.60	$181.29	70620	71620
10" x 8"	160	42.00	$424.23	70621	71621
12" x 8"	160	54.00	$624.22	70622	71622



CERTA-LOK X CAST IRON ADAPTER NIPPLE

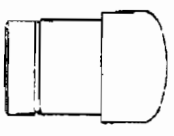
C/L MALE x CAST IRON O.D. • C-900 PVC MUNICIPAL WATER PIPE

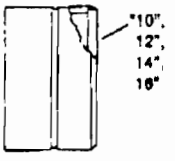
SIZE (IN.)	PSI	CAST IRON O.D.	WT./PC. (LBS.)	PRICE EA.	PART NO.
4"	250	4.80	2.62	$21.06	70885
6"	250	6.90	6.25	$32.05	70886
8"	250	9.05	12.52	$53.50	70887
10"	160	11.10	21.50	$117.07	70781
12"	160	13.20	23.00	$129.54	70782



CERTA-LOK END PLUG

SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	250	0.90	$9.37	70626
3"	250	2.00	$15.70	70627
4"	250	3.70	$89.24	70628
4" HP	315	4.40	$85.74	70663
6"	250	8.50	$151.18	70629
8"	250	16.20	$205.63	70630
*10"	160	8.30	$138.22	70775
*12"	160	12.70	$210.44	70776
*14"	160	28.30	$283.24	70787
*16"	160	34.70	$333.52	70788

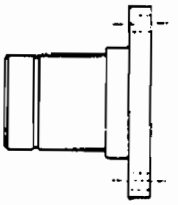




CERTA-LOK FLANGE ADAPTER

C/L MALE x FLANGE

SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	150	1.60	$24.48	70574
3"	150	3.20	$38.74	70575
4"	150	5.00	$48.05	70576
6"	150	9.30	$82.32	70577
8"	150	16.00	$124.80	70578
10"	150	25.40	$216.36	70777
12"	150	36.70	$265.44	70778
14"	150	75.00	$717.54	70647
16"	150	105.00	$954.62	70648



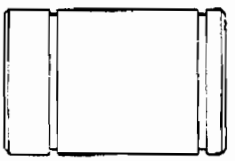
CERTA-LOK TRANSITION FITTING

C/L MALE x VIC GROOVE*

SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	△	0.60	$6.98	71031
3"	△	1.60	$10.02	71032
4"	△	2.50	$12.80	71033
4" HP	△	3.10	$18.51	70652
6"	△	5.20	$19.35	71034
6" HP	△	7.20	$29.28	70653
8"	△	9.00	$29.20	71035
10"	△	11.07	$54.70	70783
12"	△	19.20	$66.22	70784

CAUTION: "Vic Groove" to Certa-Lok Adaptors when assembled with the proper Victaulic or similar coupling, have long-term hydrostatic strengths equal to all other Certa-Lok fittings. However, the resistance of the grooved adaptor and coupling assembly to thrust loads is significantly less than that of Certa-Lok couplings. Therefore, these adaptors must be supported against thrust loads.

△ Unrestrained pressure rating (PSI) to be determined by the Victaulic coupling or similar coupling manufacturer as each manufacturer's rating may be different due to design.

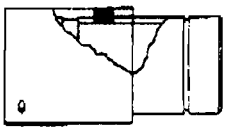


CERTA-LOK™ YELOMINE™ LIST PRICES

CERTA-LOK TAPPED COUPLING

C/L FEMALE x C/L MALE • FIPT OUTLET

SIZE (IN.)	OUTLET SIZE	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO. NON PERM	PART NO. PERM USE
2" x 2"	3/4"	250	1.60	$23.11	70065	71065
2" x 2"	1"	250	1.50	$23.11	70066	71066
3" x 3"	1 1/2"	250	3.60	$33.34	70568	71568
4" x 4"	1 1/2"	250	5.80	$39.88	70569	71569
6" x 6"	1 1/2"	250	11.50	$70.75	70056	71056
6" x 6"	2"	250	11.40	$70.75	70057	71057
8" x 8"	1 1/2"	200	20.60	$98.64	70572	71572
8" x 8"	2"	200	21.40	$98.64	70573	71573
10" x 10"	2"	160	27.00	$130.23	70566	71566
12" x 12"	2"	160	33.00	$142.26	70567	71567

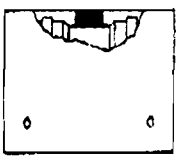


CERTA-LOK TAPPED COUPLING

C/L FEMALE x C/L FEMALE•FIPT OUTLET

SIZE (IN.)	OUTLET SIZE	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO. NON PERM	PART NO. PERM USE
2" x 2"	3/4"	200	1.50	$12.34	70540	71540
2" x 2"	1"	200	1.40	$12.34	70544	71544
3" x 3"	3/4"	200	2.60	$22.02	70541	71541
3" x 3"	1"	200	2.90	$22.02	70545	71545
3" x 3"	1 1/2"	160	2.70	$22.02	70546	71546
4" x 4"	3/4"	200	4.10	$29.74	70542	71542
4" x 4"	1"	200	4.10	$29.74	70547	71547
4" x 4"	1 1/2"	160	4.00	$29.74	70548	71548
4" x 4" HP	1 1/2"	300	8.50	$44.09	70658	71658
6" x 6"	3/4"	200	7.90	$53.59	70543	71543
6" x 6"	1"	200	7.90	$53.59	70549	71549
6" x 6"	1 1/2"	200	7.90	$53.59	70550	71550
6" x 6" HP	1 1/2"	300	14.00	$86.27	70659	71659
6" x 6"	2"	160	7.90	$53.59	70554	71554
6" x 6"	2" DT	200	10.80	$57.59	70555	71555
8" x 8"	1"	200	15.00	$88.84	70551	71551
8" x 8"	1 1/2"	200	15.00	$88.84	70552	71552
8" x 8"	2"	160	15.00	$88.84	70553	71553
8" x 8"	2" DT	160	17.30	$92.84	70556	71556
8" x 8"	3"	130	19.50	$120.20	70558	71558
8" x 8"	3" DT	130	19.50	$124.20	70557	71557
10" x 10"	1 1/2"	160	18.90	$127.56	70785	71785
10" x 10"	2"	160	19.00	$127.56	70779	71779
10" x 10"	2" DT	160	19.60	$131.56	70789	71789
10" x 10"	3"	130	27.30	$147.10	70559	71559
12" x 12"	1 1/2"	160	29.90	$134.27	70786	71786
12" x 12"	2"	160	30.60	$134.27	70780	71780

DT-Double Tapped



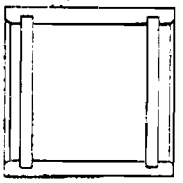
IPS CLOSURE/ REPAIR COUPLING*

STANDARD LENGTH (FEMALE x FEMALE)

SIZE IN.	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	250	1.52	$11.11	74202
3"	250	2.32	$14.80	74204
4"	250	3.38	$22.80	74206
6"	250	8.12	$38.44	74208
8"	250	10.17	$68.84	74209
10"	160	14.25	$127.51	74210
12"	160	21.50	$188.31	74211

** When used with Certa-Lok Yelomine system, which is a restrained system, repair/closure couplings must be externally restrained.*

NOTE: IPS Closure and Repair Couplings are not a restrained joint. If a restrained joint is required it must be applied externally. Contact your local CertainTeed Sales representative for assistance.



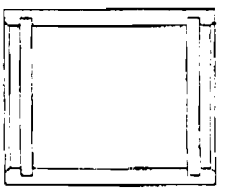
IPS CLOSURE/ REPAIR COUPLING*

LONG LENGTHS 18"(FEMALE x FEMALE)

SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	250	3.81	$47.22	74102
3"	250	5.76	$87.07	74104
4"	250	7.91	$80.29	74106
6"	250	14.13	$103.89	74108
8"	250	24.38	$144.66	74109
10"	160	34.46	$201.18	74110
12"	160	45.78	$227.62	74111

** When used with Certa-Lok Yelomine system, which is a restrained system, repair/closure couplings must be externally restrained.*

NOTE: IPS Closure and Repair Couplings are not a restrained joint. If a restrained joint is required it must be applied externally. Contact your local CertainTeed Sales representative for assistance.



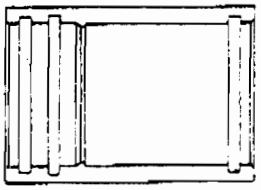
RESTRAINED JOINT PVC PRESSURE PIPING SYSTEM

CERTA-LOK YELOMINE X IPS*

EXPANSION COUPLING - 18"

SIZE (IN.)	PSI	WT PC (LBS.)	PRICE EA.	PART NO.
2"	250	3.32	$62.23	71642
3"	250	5.00	$77.28	71643
4"	250	6.98	$91.12	71644
6"	250	12.69	$115.56	71645
8"	200	21.30	$144.45	71646
10"	160	28.13	$215.56	71647
12"	160	37.45	$240.00	71648

** IPS Couplings are not a restrained joint. If a restrained joint is required it must be applied externally. Contact your local CertainTeed Sales representative for assistance.*

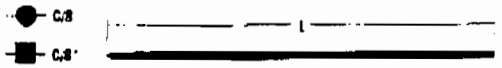


CERTA-LOK SPLINES

C/S • C/S*

SIZE (IN.)	PRICE EA.	PART NO.
2	$1.06	86460
3	$1.68	86461
4	$1.92	86462
4* HP	$3.66	86488
6	$2.38	86463
6* HP	$4.92	86506
8	$6.39	86464
8* HP	$6.39	86464
10*	$11.07	86465
10* IRR	$12.31	86487
12*	$11.11	86466
12* IRR	$12.73	86489
14*	$12.46	86490
16*	$12.54	86491

** Square Spline*



CERTA-LOK ACID-RESISTANT SPLINES

SIZE (IN.)	PRICE EA.	PART NO.
2"	$1.59	86450
3"	$2.36	86451
4"	$2.72	86452
6"	$3.33	86454
8"	$6.46	86455

LUBRICANT

PACKAGING AND WEIGHTS

When pipe is ordered with couplings, sufficient lubricant (per table below) will be furnished at no charge. Additional lubricant can be purchased as shown below.

CONTAINER SIZE	WT LBS. CAN	CARTON QTY	PART NO.	PRICE EA.	PRICE/ CARTON
1 Pint	1.2 lbs.	24	86002	$4.44	$106.56
1 Quart	2.5 lbs.	12	86005	$6.67	$80.04

LUBRICANT

JOINTS/FOOTAGE PER CAN

NOM. SIZE (IN.)	NO. JOINTS/FOOTAGE PER PINT	NO. JOINTS/FOOTAGE PER QUART
2"	71/1420"	142/2840
3"	48/960	96/1920
4"	33/660	66/1320
6"	23/460	46/920
8"	16/320	32/640
10"	13/260	26/520
12"	8/160	22/440
14"	7/140	18/360
16"	6/120	16/320

NOTE: Lubricant is required to assemble 8", 10" - 16" Non-Permanent Use Joint, and all sizes 2" - 16" Permanent Use Joint.

CERTA-LOK GROOVING TOOL

DESCRIPTION	PRICE EA.	PART NO.
1½ HP Portable Router (110 volt)	$163.55	86007
1½ HP Portable Router (220 volt)	$173.53	86031
4" Jig Fixture	$190.00	86010
6" Jig Fixture	$205.00	86011
8" Jig Fixture	$215.00	86012
10" Jig Fixture	$230.00	86013
12" Jig Fixture	$240.00	86014
14" Jig Fixture	$245.00	86041
16" Jig Fixture	$250.00	86042
3/8" Bit(1)	$26.54	86017
1/2" Bit(2)	$33.20	86018

(1) for 4"-8" diameter
(2) for 10" and 12" diameter

CERTA-LOK SPLINE INSERTION TOOL

FOR 8" AND LONGER SIZES

SIZE (IN.)	PRICE EA.	PART NO.
2"-8"	$38.00	70797
10"-16"	$42.50	70799

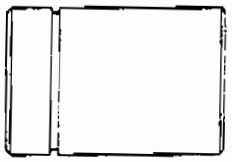
CAUTION: Care must be taken not to overlap the spline when using insertion tool

CERTA-LOK™ YELOMINE™ LIST PRICES

CERTA-LOK NIPPLE

C/L MALE x PLAIN END

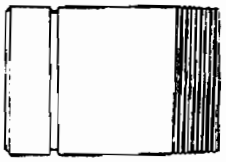
SIZE (IN.)	PSI	WT/PC (LBS.)	PRICE EA.	PART NO.
2"	250	0.60	$4.09	70584
3"	250	1.40	$6.21	70585
4"	250	2.30	$8.51	70586
4" HP	350	3.10	$13.23	70664
6"	250	5.20	$14.87	70587
6" HP	350	7.20	$23.13	70665
8"	250	9.70	$23.04	70588
8" HP	350	13.80	$38.93	70666
10"	160	11.07	$34.84	70632
12"	160	15.50	$42.70	70633



CERTA-LOK NIPPLE

C/L MALE x MALE PIPE THREADS (NPT)

SIZE (IN.)	PSI	WT/PC (LBS.)	PRICE EA.	PART NO.
2"	200	0.60	$9.89	70599
3"	190	1.30	$12.81	70600
4"	160	2.40	$18.45	70601
6"	140	5.20	$32.06	70602
8"	120	9.00	$45.86	70603



CERTA-LOK NIPPLE

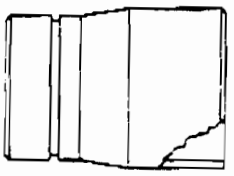
PLAIN END X MALE PIPE THREADS (NPT)

SIZE (IN.)	PSI	WT/PC (LBS.)	PRICE EA.	PART NO.
2"	200	0.60	$7.16	70589
3"	190	1.25	$11.49	70590
4"	160	2.50	$12.48	70591
6"	140	5.70	$29.97	70592
8"	120	10.25	$46.22	70593

CERTA-LOK ADAPTER

C/L MALE x SOLVENT WELD BELL

SIZE (IN.)	PSI	WT/PC (LBS.)	PRICE EA.	PART NO.
2"	250	0.50	$6.36	70530
3"	250	1.40	$9.22	70531
4"	250	2.30	$12.92	70532
4" HP	350	6.10	$26.67	70649
6"	250	5.30	$21.71	70533
6" HP	350	10.70	$41.70	70650
8"	250	9.00	$35.25	70534
8" HP	350	18.60	$60.48	70651
10"	160	11.00	$52.25	70516
12"	160	15.00	$65.91	70517



CERTA-LOK X SOLVENT WELD COUPLING

C/L FEMALE x SW SOCKET END

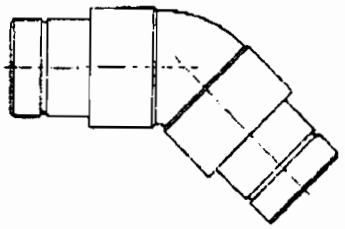
SIZE (IN.)	PSI	WT. (LBS.)	PRICE EA.	PART NO. NON PERM	PART NO. PERM USE
2"	250	1.00	$8.83	70535	71535
3"	250	2.20	$13.77	70536	71536
4"	250	3.50	$17.73	70537	71537
6"	250	6.40	$24.65	70538	71538
8"	250	11.30	$44.91	70539	71539
10"	160	16.00	$74.24	70508	71508
12"	160	17.80	$85.98	70509	71509

RESTRAINED JOINT PVC PRESSURE PIPING SYSTEM

CERTA-LOK 45° ELLS

C/L MALE x C/L MALE

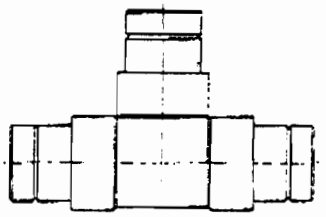
SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	160	1.60	$19.14	70480
2"	250	1.60	$30.18	70494
3"	160	3.90	$33.81	70481
3"	250	3.90	$58.03	70495
4"	250	7.10	$92.37	70482
4" HP	315	8.60	$119.47	70661
6"	250	16.10	$131.84	70483
8"	250	30.90	$256.93	70484
10"	160	37.00	$531.97	70478
12"	160	65.00	$802.41	70479
14"	160	82.00	$1,015.79	70500
16"	160	144.00	$1,296.23	70501



CERTA-LOK TEE

C/L MALE x C/L MALE x C/L MALE

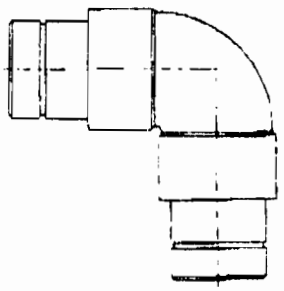
SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2" x 2" x 2"	160	2.30	$26.36	70460
2" x 2" x 2"	250	2.30	$44.25	70491
3" x 3" x 3"	160	5.80	$44.35	70461
3" x 3" x 3"	250	5.80	$61.08	70492
4" x 4" x 4"	250	10.70	$75.03	70462
4" x 4" x 4" HP	315	12.90	$101.19	70660
6" x 6" x 6"	250	25.00	$189.13	70463
8" x 8" x 8"	200	48.00	$379.30	70464
10" x 10" x 10"	160	63.00	$978.31	70458
12" x 12" x 12	160	86.00	$1,345.05	70459
14" x 14" x 14"	160	164.30	$2,268.34	70452
16" x 16" x 16"	160	216.00	$2,991.55	70453



CERTA-LOK 90° ELLS

C/L MALE x C/L MALE

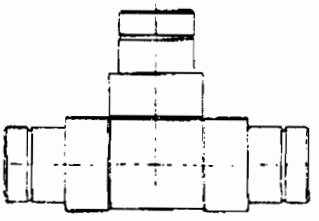
SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	160	1.60	$18.75	70486
2"	250	1.70	$22.26	70496
3"	160	4.10	$31.30	70487
3"	250	4.10	$38.26	70497
4"	250	7.50	$52.41	70488
4" HP	315	10.00	$122.81	70662
6"	250	17.40	$118.55	70489
8"	200	33.70	$267.14	70490
10"	160	65.00	$900.43	70476
12"	160	83.00	$1,158.22	70477
14"	160	141.50	$1,243.75	70474
16"	160	172.40	$1,594.84	70475



CERTA-LOK REDUCING TEE

C/L MALE x C/L MALE x C/L MALE

SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
3" x 3" x 2"	160	4.50	$43.94	70466
3" x 3" x 2"	250	5.00	$55.51	70493
4" x 4" x 2"	250	10.10	$109.20	70467
4" x 4" x 3"	250	10.80	$111.53	70468
6" x 6" x 2"	250	23.83	$275.91	70469
6" x 6" x 3"	250	24.20	$273.22	70470
6" x 6" x 4"	250	24.40	$252.68	70471
8" x 8" x 6"	200	50.90	$384.34	70472
10" x 10" x 6"	160	62.10	$703.52	70454
12" x 12" x 4	160	87.00	$816.24	70450
12" x 12" x 6	160	89.40	$865.68	70456
12" x 12" x 8"	160	98.60	$955.81	70457

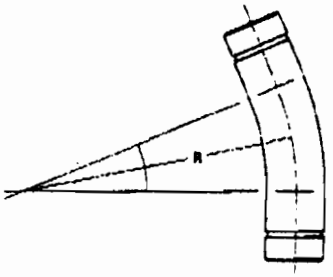


CERTA-LOK™ YELOMINE™ LIST PRICES

CERTA-LOK 22½° SWEEP BENDS

C/L MALE x C/L MALE

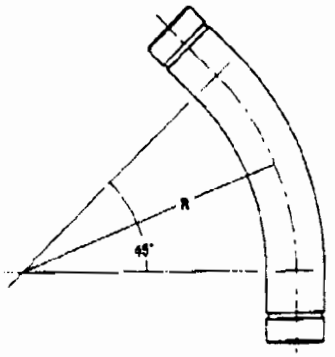
SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	250	2.00	$50.86	71078
3"	250	4.90	$65.27	71079
4"	250	7.50	$76.79	71080
6"	250	18.30	$111.71	71081
8"	250	35.00	$132.79	71082
10"	160	87.00	$297.29	70523
12"	160	105.00	$406.00	70524
14"	160	110.00	$439.99	70641
16"	90	119.00	$549.44	70642



CERTA-LOK 45° SWEEP BENDS

C/L MALE x C/L MALE

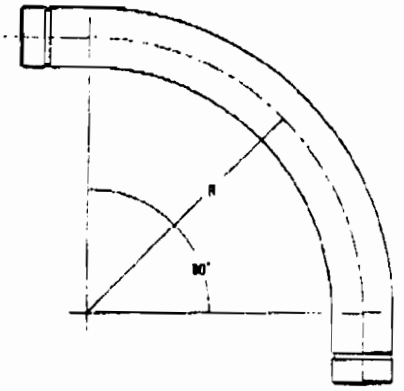
SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	250	2.00	$53.17	71083
3"	250	4.90	$69.33	71084
4"	250	7.50	$75.65	71085
4" HP	350	11.60	$93.96	70656
6"	250	18.30	$111.71	71086
6" HP	350	26.20	$169.67	70657
8"	250	35.00	$132.79	71087
10"	160	87.00	$297.30	70525
12"	160	105.00	$499.93	70527
14"	160	150.00	$655.63	70643
16"	90	162.00	$745.30	70644



CERTA-LOK 90° SWEEP BENDS

C/L MALE x C/L MALE

SIZE (IN.)	PSI	WT./PC. (LBS.)	PRICE EA.	PART NO.
2"	250	2.40	$53.16	71088
3"	250	6.40	$69.33	71089
4"	250	12.70	$75.82	71090
4" HP	350	14.90	$100.83	70654
6"	250	31.00	$188.91	71091
6" HP	350	45.30	$265.06	70655
8"	250	59.00	$233.40	71092
10"	160	120.00	$437.69	70526
12"	160	165.00	$655.63	70528
14"	160	217.00	$739.25	70645
16"	90	234.00	$835.15	70646



Appendix B: Calibration of Sampling Pump

APPENDIX B

CALIBRATION OF SAMPLING PUMP

A primary standard airflow measurement is to be employed. The instrument recommended is a Gilibrator electronic bubble flow meter that provides instantaneous air flow readings and a cumulative averaging of multiple samples.

Theory of Operation

1. Primary Airflow Standard

To be a primary standard, all values must be absolute and measured as absolute. A primary standard airflow measurement is a volume divided by a time interval as performed by the Control Unit of the Gilibrator. The volume, V, is measured volume of space between two infrared sensors. The time is that interval needed for a soap film bubble to traverse between the two sensors which bound the volume. Therefore, V/t, the volume per unit of time, becomes the airflow and is prime because all measurements are basic... volume and time. In today's technology, time is measured by an electronic clock whose accuracy exceeds that of volume measurements by orders of magnitude, hence, the control accuracy volume resides solely with volume measurements.

2. Bubble Generation and measurement

a) The Gilibrator consists of two elements, the Flow Cell Assembly and the Control Unit (base). The function of the Flow Cell Assembly is to generate a clean consistent bubble which traverses up the flow tube. Measurement of the traverse time is done by infrared sensor pairs which are mounted at the bottom and the top of the Sensor Block. The volume bound by these sensors is specifically adjusted to a volume standard by allowing the upper sensor blocks to move in unison so as to enable this calibration to be set accurately to a primary volume standard. A second function of the sensor block provides the interfacing code to define the cell volume as well as sensitivity adjustments for the optical sensor systems.

b) As the bubble traverses between the sensors, first one and then the second, sensors are tripped thereby providing the time for the bubble traverse. This timing information is sent to the micro processor of the control base which in turn provides the crystal control time base for the system. The timing information along with the volume information are then sent to the micro processor which in turn does the necessary mathematical calculations which allow the flow to be displayed directly on the LCD readout. In order to insure the highest accuracy possible, a Delete and Average function are provided on the Control Unit. The Delete allows for subtracting out an obvious malformed bubble and the average allows the user to obtain average information without pencil or paper. A printer interface allows connection of a Printer Module so that hard copy can be produced.

Operating Procedures

1. Initial Set-up

This covers all steps necessary to bring the Gilibrator into operating status. This includes charging, cell mounting, installing soap solution, connecting the printer (optional) and connecting the sampling source.

A) Charging the Gilibrator

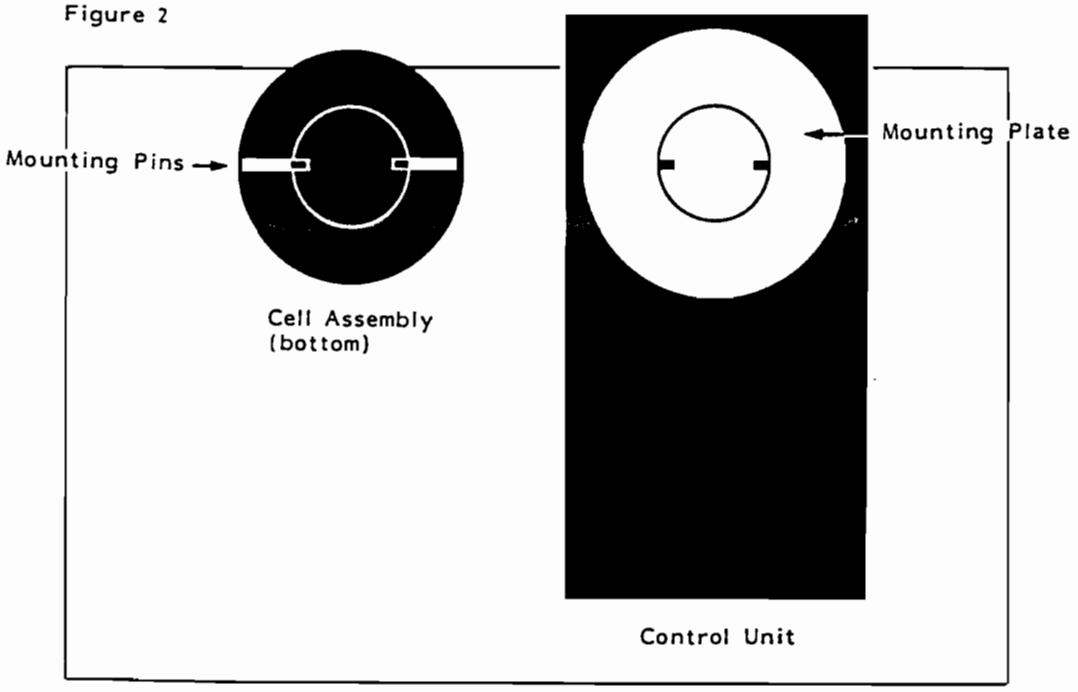
1. Prior to operation, plug the 120V charger into the wall and connect to the Charging Jack (13) on the right side of the Control Unit. The unit's Charging LED (11) will light indicating that the unit is charging properly. Allow the battery system to charge for 14 hours prior to operation.

B) Mounting the Flow Cell Assembly (See fig. 2)

1. Select the Flow Cell Assembly to cover the flow range required.

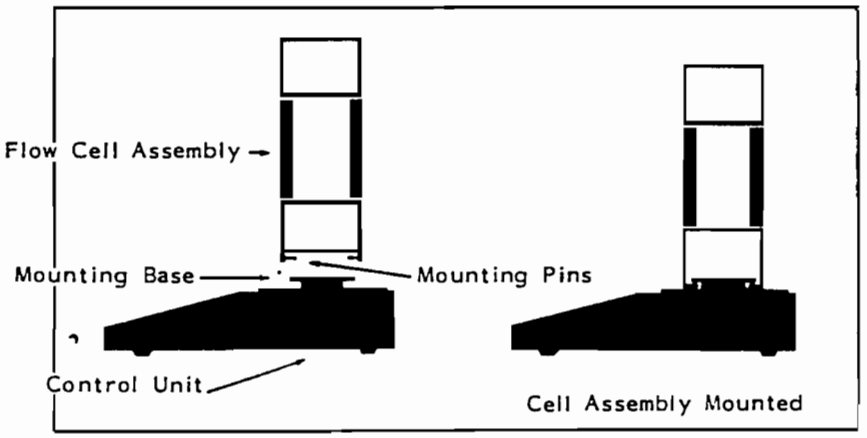
2. The bottom of the Flow Cell Assembly employs a quick mount feature. The base of the Flow Cell Assembly is positioned onto the mounting plate (10) of the Control Unit (14).

Figure 2



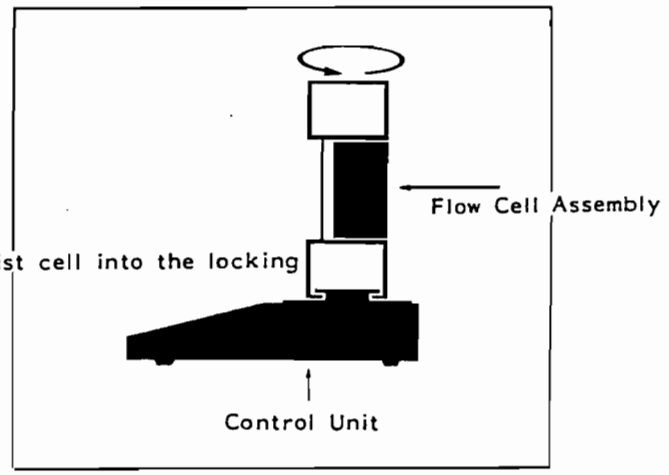
3. Engage the pin of the cell assembly base into the mounting plate of the Control Unit. When the Flow Cell Assembly is properly engaged, the base of the cell will be flush to the mounting plate and the cell assembly will face towards either the right or left side. (See fig. 3)

Figure 3



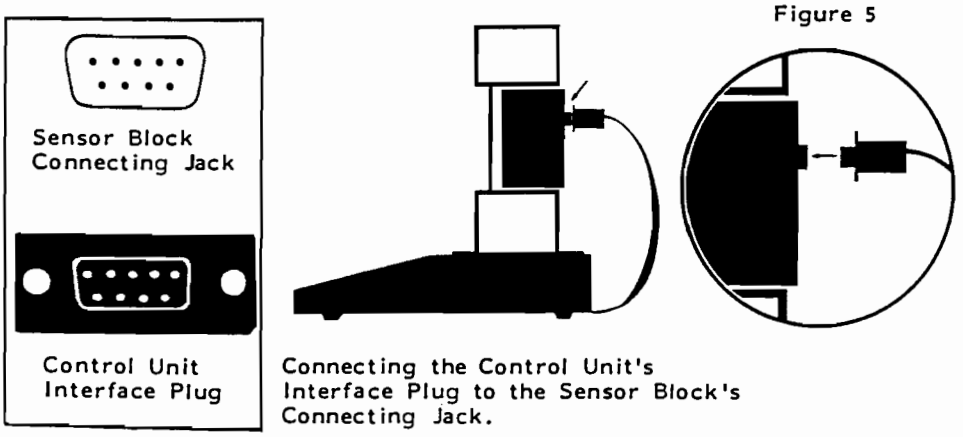
4. Grasp the bottom cell chamber and rotate the cell until it clicks in. **CAUTION: Always engage & disengage the cell by grasping and rotating only the bottom cell chamber.** The cell assembly will now face forward. (see Fig. 4)

Figure 4



5. Insert the Control Unit's Cable Assembly (5) into the Sensor Block Connecting Jack (6) located on the back of the Sensor Block (8). (See fig. 5)

Figure 5



Connecting the Control Unit's Interface Plug to the Sensor Block's Connecting Jack.

C) Adding the Gilibrator Soap Solution

1. Remove the Storage Tubing (25) from the upper Outlet Boss 26) of the upper cell. Fill the dispenser bottle provided with Gilibrator soap solution. Using the rubber Storage Tubing as a funnel, slowly add soap solution from the dispenser.

2. The amount of soap needed is determined by depressing the Bubble Initiate Button (22) and holding it down in the lower position. Continue to add enough soap solution until the angled edge at the bottom of the Bubble Generator Ring (21) is immersed in the solution. **Do Not Overfill!** (See fig. 6)

3. After filling is completed, the rubber Storage Tubing (25) may be removed completely. Recap the soap dispenser bottle for later use. **NOTE: If the Flow Cell Assembly is not going to be used for a prolonged period of time, reinstall the rubber Storage Tubing between the inlet and outlet bosses (23 & 26). This will prevent evaporation from occurring which may cause the solution's concentrations to alter.**

D) Printer Connection (if applicable)

1. Connect printer cable to Printer Jack connector (18) on the left side of the Control Unit. Be sure to properly match up connectors before engaging.

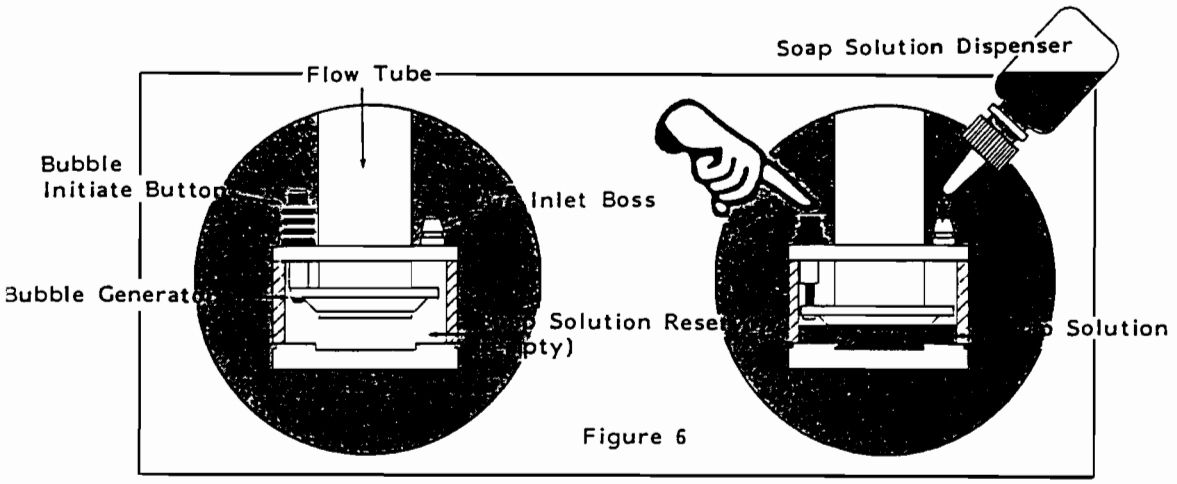


Figure 6

E) Connect the Sampler

1. Connect the air sampler to be calibrated to the Upper Outlet Boss (26) of the Flow Cell Assembly with 1/4" ID tubing. NOTE: An auxillary liquid trap between sampler and flow cell is recommended to prevent moisture carry over into the sampler during continuous calibration periods.

2. Operation

A) Conditioning the Flow Tube

1. Turn on the sampler. Depress the Bubble Initiate Button (22) several times to wet the inner walls of the flow tube (24). You will not be able to initiate a timing bubble without first "Priming" the flow tube. The operator will develop a feel for bubble generation with practice.

B) Power Up

2. After the Flow Tube walls have been "primed", turn on the Power Switch (12) of the Gilibrator Control Unit (base) and the Printer Module if one is being used. Wait approximately 10 seconds while the system runs through it's check sequence. The Run LED (20) will light at this time as well as a Lo Battery indication and a series of five dashes displayed on the LCD Readout (19). Do not operate the Gilibrator until the Run LED signal extinguishes. Ready operation is indicated by a series of 4 dashes.

C) Bubble Generation

1. For optimum bubble generation, depress the Bubble Initiate Button (22) and hold to initiate 1 bubble up the flow tube. Release the button to initiate a second bubble up the flow tube. This will be the standard procedure to making clean, consistent bubbles at High and Medium flow ranges.

2. As the bubble rises up the Flow Tube (24), it will initiate a timing sequence when it passes the lower sensor (Run LED will light) and culminate the timing sequence upon passing the upper sensors (Run LED will extinguish). The timing information is then transmitted to the control unit which will perform all the necessary calculation. A flow reading will instantaneously appear on the LCD display (19).

However, if a bubble breaks before the time sequence is completed, timing will continue until another bubble is generated to trip the second sensors. This will cause an erroneous reading and should be subtracted from the average by hitting the Delete Button (16).

If a Printer Module is used, be sure the printer has completed it's printing sequence before pressing the Delete Button. When the Delete Button is activated, a negative symbol will be displayed on the LCD of the Control Unit and the printer will initiate a line showing this subtraction.

Appendix C: Pressure Drop Calculations, Emission Rate Calculations, and Alternative Emission Rate Calculations (based on Mass Transfer Principles)

APPENDIX C
CALCULATIONS

Calculation of Emission Rates

A carbon absorption unit will be placed after the blower outlet. It is anticipated that the carbon absorber will operate an efficiency of 99.99 percent. It is assumed that Xylene will be the contaminant in the air stream.

Assuming that a saturated vapor condition exists within the subsurface soils, the air stream concentrations can be calculated by Equation 1, assuming the perfect gas relationship.

Since this is not the case, the resulting concentrations calculated are extremely conservative. Actual rates will be at least an order of magnitude lower than the calculated value presented.

Assuming perfect gas relationship:

$$CES = \sum \frac{Xi\ Pv\ M_{wg}}{RT} \qquad (1)$$

for Xylene, the only contaminant present.

Where:

Xi = 1 single constituent
Pv vapor pressure = .00726 atm
R universal gas constant = .082 L/atm/mol^{o}K
T = 293 Kelvin
M_{wg} = 106.2 gm/mole

Substitution in Equation 1:

CES = .0336 gm/L

In order to determine the emission rate, the evaporation rate is multiplied by the total flow rate Q which is 210 CFM, 70 CFM per well.

Emission rate = CES x Q (2)

Substitution in Equation 2:

Emission Rate = 11.36 Kg/hr. before adsorber

Emission Rate = (1 - .9999) x 11.36 = .01136 Kg/hr. Or .0245 #/hr. after carbon adsorber

The pressure drop calculations are based upon the information contained in the *Industrial Ventilation Manual of Recommended Practices,* American Conference of Government Industrial Hygienists, 15 Edition, 1991, Figure 6-15B Nomograph

Well No. 1 to Blower Skid (moisture separator entrance)

CFM = 70
3" I.D. tubing
V = 1,423 fpm, Vel. Pressure .013 in H_2O
Length of tubing = 300 feet
Pressure loss from nomograph, 1.5" water per 100 feet
Total Pressure Loss = 4.5"H_2O

(A) 90° elbow, assume six

90° R/D = 2, Loss = .27 x Vel. Pressure

Six (.27 x .13) = .216" H_2O

(B) Exit and entrance loss, two

2 [.15 (VP) + .89 (VP) = 1.04 (.13) = .27" H_2O

Total loss 4.9" H_2O, say 5.00" H_2O

Well #2 to Blower (most sep inlet)

Q = 70 CFM
3" ID Tubing
V = 1,423 fpm
Length of tubing 150 feet
Pressure loss from nomograph
Pressure loss 1.5" H_2O per 100 feet
Pressure loss 1.5 x 1.5" = 2.25" H_2O

(A) Six 90° elbows, R/D = 2 same as in Well 1, calculation

(B) Exit and entrance loss two same as Well 1 calculation

Total loss estimated to be 2.75" H_2O

Well 3 to Blower Skid is also approximately 2.75" H_2O

Entrance to moisture sep. to Exhaust Vent (exit) Flow rate 210 CFM

		$H_20"$
(A)	Moisture sep. pressure drop exit and plenium loss and acceleration loss	2.5"
	In line filter loss	1.5"
	Blower exit loss and diffuser loss At 2,400 fpm Vel. Pressure, .36" H_2O 2.5 x V.P.	.9"
	Pressure drop across carbon adsorber (Vendor information)	2.5"
	Pressure drop silencer (Vendor information)	1.5"
	Exit to discharge one Vel. Pressure	.36"
	Fitting elbows, etc.	2.5"
	Stack exit loss	3.0"
	Total Pressure Drop	14.76" H_2O, Assume 15" H_2O

Alternative Calculations for Emission rate applying basic mass transfer theory and applying some drastic simplifications, the evaporation rate for non-saturated conditions can be calculated.

The general equation for an evaporation rate is given by Equation 1

$$E = D_{v-A}\ Sh\ \frac{1}{L} \times \rho^{*} \qquad (1)$$

Where:

D_{v-a} is the diffusivity of Xylene in air cm^2/sec.

Sh is the sherwood number

ρ^* is saturated vapor volume where ρ^* is given by the following

$$\rho^* = \frac{P_r \left[Z_c + .26 P_r + (.74 - Z_c) \Big/ (2 - P_r^{3})^{6.33}\right]}{T_r} \qquad (1a)$$

Where:

P_r and T_r are the reduced vapor pressure

Z_c is the critical compressibility factor

Using the perfect gas law and reduced and critical properties, ρ^* can be calculated

$$D_{v-A} = .0043 T^{3/2} \cdot \frac{\sqrt{\frac{1}{M_1} + \frac{1}{M_2}}}{P\left[V_1^{1/3} + V_2^{1/3}\right]} \qquad (2)$$

From *Chemical Engineering Handbook* McGraw-Hill Page 14.24, Table 14.47

Where:

$D_{v\text{-}a}$ as defined in Equation 1
T = absolute temperature 296° K
P = absolute pressure, 1 atm
V_i = atomic or molecular volume
M = molecular weight

Subscript 1 refers to Xylene
Subscript 2 refers to air

Substitution in equation (2)

$D_{v\text{-}a}$ for Xylene is calculated to be

7.48×10^{-6} m²/sec.

From *Treybol Mass Transfer Operations*, Second Ed. Page 55, Equation 3.41

$$Sh = \frac{hd}{D_{V\text{-}A}} = .664 \sqrt[3]{\nu/D_{v\text{-}A}} \cdot \sqrt{Re} \qquad (3)$$

Where:

Re = Reynold Number $\frac{UL}{V}$

ν = Viscosity 1.48×10^{-5} M²/sec air at 70°F

hd = mass transfer coefficient

L = length assumed radius of influence 12.2 M

$\bar{V}$ = Velocity - average velocity through the subsurface area effected by the SVE, radius of influence.

Substitution in Equation (3), the Sherwood No. is calculated Sh = 85.2

ϱ^* = 5.22×10^{-8} cm³ from Equation 1a

Thus, from Equation (1)

$$E = 7.48 \times 10^{-6} \times 85.2 \frac{1}{12.2} \times 5.22 \times 10^{-8}$$

Conversion factor: $106 \frac{gm}{Mol} \times 100^3 \frac{cm^3}{M^3}$

$E = .2859 \times 10^3 \text{ gm/M}^2$

The effective area of the three wells, based upon the radius of influence is assumed to be 700 M^2

Thus, E = .200 gm/sec., or .720 Kgm/hr., about 16 times less than the sat. Vapor case.