Operation and Maintenance Plan
for
AOC-65 & SWMU B-3 Soil Vapor Extraction Systems
at
Camp Stanley Storage Activity
Boerne, Texas

Prepared For:

Camp Stanley Storage Activity
Boerne, Texas

Prepared By:

Parsons Infrastructure and Technology Group
Austin, Texas

June 2005 Update

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

AOC	Area of Concern
B	burn area
cfm	cubic feet per minute (actual)
CSSA	Camp Stanley Storage Activity
DCE	dichloroethene
FCV	flow control valve
GAC	granular activated carbon
in. H_2O	inches of water column
lb	pound or pounds
lb/hr	pounds per hour
MCL	maximum contaminant level
N/A	not applicable
O&M	operations and maintenance
Parsons	Parsons Infrastructure and Technology Group
PCE	tetrachloroethene
QAPP	Quality Assurance Program Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
rpm	revolutions per minutes
SP/FM	Sample Port/Flow Measurement
SVE	soil vapor extraction
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TCE	trichloroethene
tpy	tons per year
V	volts
VEW	vapor extraction well
VOC	volatile organic compound
VRV	vacuum relief valve

SECTION 1
INTRODUCTION AND SUMMARY OF REMEDIAL DESIGNS

This Operations and Maintenance (O&M) Plan was created as a guide for operating, monitoring and maintaining soil vapor extraction (SVE) equipment and vapor well plumbing installed at Camp Stanley Storage Activity (CSSA) in Boerne, Texas. Three SVE systems were installed to address Area of Concern (AOC)-65 and Solid Waste Management Unit (SWMU) B-3, to remediate soil, fractured rock and groundwater contamination underneath and around Building 90 and the SWMU B-3 trench site.

SVE is the forced evacuation of soil gas from the subsurface using vacuum equipment. Vacuum blowers connected to vapor extraction wells (VEW) with pipe are typically used to evacuate volatile organic compounds (VOC), water vapor, and any air from the subsurface. Contaminated soil gas as well as VOC dissolved in groundwater can be removed using SVE, thereby either remediating contamination or reducing its continued migration.

In 2002, Parsons Infrastructure and Technology Inc. (Parsons) installed seven VEWs on the west side of Building 90 and 12 VEWs beneath Building 90 along with the associated piping and equipment comprising the SVE systems. Two regenerative vacuum blowers were installed and piped to a vessel of granular activated carbon (GAC), designed to remove all VOC emissions prior to discharge to the atmosphere. An SVE pilot test was conducted at SWMU B-3 1996 – 1997 (**SWMU B-3 SVE Test Report**, Parsons, 1997) and a further treatability study was done 2000 – 2001. Based on the findings of this work, in 2003 2 VEWs were installed at SWMU B-3 along with associated piping, a blower unit, GAC vessel, electric supply, and appropriate housing.

The objective of operating these systems is to continue and optimize the removal of VOC vapor to promote remediation and reduce migration of contaminants in the groundwater. The objectives of continued monitoring activities are to gather additional data to allow an evaluation and optimization of the systems' performance. The results of preliminary O&M activities at the AOC-65 site are examined in the **AOC-65 Soil Vapor Extraction Operations and Maintenance Report**, Parsons, October 2003 (Parsons 2003a).

Although SVE systems are relatively simple, routine monitoring and maintenance of the SVE systems is required to keep it operating at its optimum condition. If significant problems are encountered with the operation of the system, the CSSA Environmental Project Manager, Mr. Jeff Aston at (210) 698-5208 should be notified so repairs can be initiated and coordinated. Additional contact individuals include: Parsons Project Manager (Mr. Brian Vanderglas) at (512) 719-6000; Parsons SVE WBS task manager

(Mr. Gary Cobb) at (512) 719-6011; and Parsons Onsite Manager (Mr. Kyle Caskey) at (210) 204-8529.

Site background and current conditions are discussed on Section 2 of this document. Descriptions of the SVE systems including layout drawings and schematics are provided in Sections 3. System operation and monitoring is discussed in Section 4 and system maintenance is included in Section 5 of this plan. Manufacturer's information for SVE monitoring equipment is included in Appendix A and data collection sheets are included in Appendix B.

SECTION 2
SITE CONDITIONS

2.1 BACKGROUND

Chlorinated solvents, which are VOCs, were used in Building 90 cleaning processes for more than 30 years. Chlorinated solvent usage was eliminated by pollution prevention initialization that replaced the process with a citrus-based cleaning solvent in 1995. At SWMU B-3 it is believed that chlorinated solvents were used as accelerants to ignite and burn general waste.

VOCs were first detected at concentrations above drinking water standards in CSSA potable well (CS-Well-16) water in 1991. Groundwater samples collected from monitoring wells installed later at Area of Concern (AOC) 65 and off-post wells south and west of the base have contained VOCs also. This prompted investigations of the probable source areas of contamination. The main potential source near Well 16 was identified as SWMU B-3. Source characterization of the Building 90 vicinity (main portion of AOC-65) included a 2001 survey of 319 soil gas samples collected and analyzed for chlorinated and aromatic organics around and inside Building 90. Tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE) and trans-1,2-DCE were detected. The occurrence of these chlorinated hydrocarbons has implicated Building 90 and its historical processes as a likely source of groundwater contaminants encountered in the southwestern portion of CSSA. Furthermore, the detection of TCE and DCE at both sites indicate that natural degradation of PCE is occurring in the subsurface.

2.1.1 SWMU B-3

Soil and water samples from borings on the site exhibited significant VOC contamination. A subsequent soil-gas survey identified areas of highest concentrations. Based on these data and additional borings, an SVE pilot test was designed and conducted. Later, an SVE treatability study was conducted with an expanded 18-vapor extraction well (VEW) network. Additional soil-gas survey samples and SVE air samples continued to reveal high concentrations of PCE, TCE, and DCE from areas within SWMU B-3 and the surrounding bedrock area. Additional information regarding the investigations and the initial 18-well SVE treatability system is included in following documents: **Soil Gas Survey Technical Report**, **Parsons 2001; Soil Vapor Extraction Test Report for SWMU B-3, Parsons 2001;** and **Final SWMU B-3 Soil Vapor Extraction Operations and Maintenance Report, Parsons, 2003.**

In 2002 a removal actions was initiated at SWMU B-3. During the removal actions the eastern trench at the site was excavated and contaminated soil and waste was disposed off-post. The original SWMU B-3 SVE treatability study equipment was removed from

the western trench area to allow excavation and disposal of a portion of the contaminated waste and soils in that area. In late 2003 two new, deeper VEWs and two new vapor monitoring points (VMP)s were installed and connected to a new blower unit. Sampling showed that mass removal of VOCs could be achieved utilizing SVE directed at the limestone formation underlying the trenches. The location of the SWMU B-3 SVE system blower, VEWs, and VMPs are shown on **Figure 2.1**. Additional information regarding the SVE pilot system installed in 2003 is included in the **Draft Pilot Study for SWMU B-3 Soil Vapor Extraction, Parsons 2004**.

2.1.2 AOC-65

The 2001 soil gas survey was followed by 14 soil borings and numerous groundwater samples collected in and around Building 90, and from monitoring wells and piezometers installed in the vicinity. The final Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report for AOC-65 was completed in September 2002 (Parsons, 2002b). An interim removal action was also completed in 2002 included excavation of contaminated soils underlying the pavement and drainage swale on the west side of the building.

SVE pilot testing was performed at AOC-65 to evaluate removal of VOC contamination from the vadose formation. SVE was demonstrated to be an effective method for source removal in surface formations at CSSA during the earlier pilot and treatability study at SWMU B-3. Two SVE systems were installed at AOC-65 in late 2002, one system designed to remove contaminated vapors from beneath the Building 90 floor slab ("subslab" system) and the other designed to remove vapors from bedrock material west of the building. The primary objectives of the SVE systems were to remove VOC contaminants from the soils, fractured limestone, and groundwater around AOC-65 (both subslab and surrounding Building 90) or at a minimum to stop the migration of contaminants.

2.1.3 Site Delineation

Based on the results of the site investigation and groundwater results from the Westbay section of the **TO 42 Well Installation Report, Volume 5-2.3, CSSA Environmental Encyclopedia**, the area around AOC-65 containing VOCs that could be successfully treated by SVE appears to extend immediately around Building 90 in the apparent down gradient direction to the west/southwest. VOC concentrations above the Safe Drinking Water Act Maximum Contaminant Levels (MCLs) for groundwater have been encountered at depths as deep as 300 feet below grade and at significantly higher levels in monitoring wells screened near the surface (upper 50 feet). The total volume of the treatment area is unknown. The locations of the AOC-65 system SVE wells are shown on **Figure 2.2**.

On the western side of SWMU B-3, geophysical surveys, numerous soil borings, and direct observation have tentatively identified 4 trenches running approximately north - south. The buried waste appears to be limited in extent to the trenches. The VOC contamination affecting groundwater is much more widespread, with a plume extending

Figure 2.1

B-3 SVE System Location Map
Camp Stanley Storage Activity

PARSONS

J:\736071\GIS\B3_soilgas_system.mxd

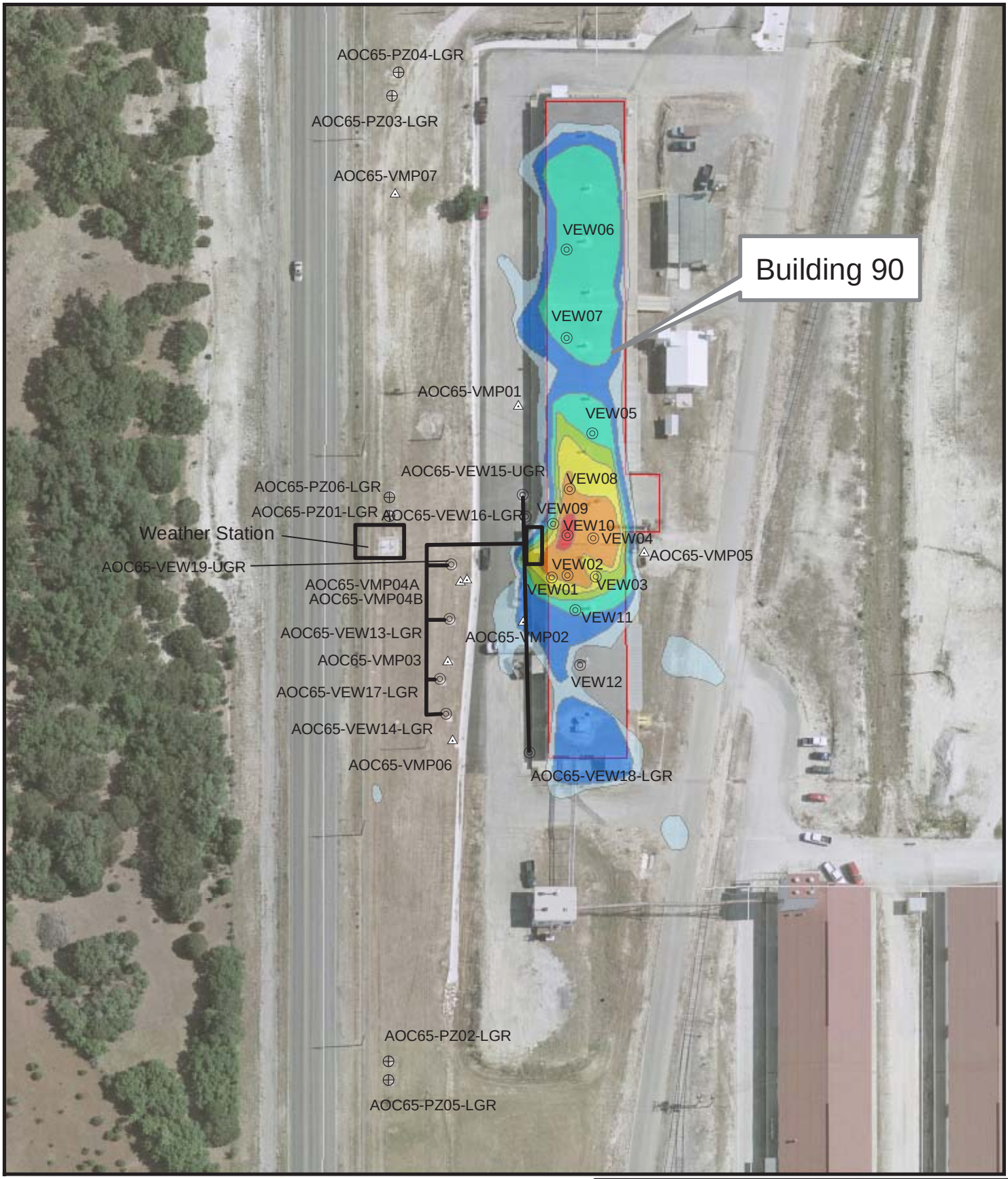


Figure 2.2

AOC-65 SVE System
with Soil Gas Contours

Camp Stanley Storage Activity

PARSONS

J:\740\740999\Treatability Study\vmp_vew_outside.mxd

generally northwestward to southward. Chlorinated compounds are suspected in the pore spaces, numerous fractures, and fault zones of the bedrock formation surrounding the trench extending from the surface to the top of groundwater.

2.1.4 Air Emissions

The Texas Clean Air Act requires a permit to emit any pollutants to the atmosphere. The Act is codified in 30 Texas Administrative Code (TAC) Chapter 116, "Control of Air Pollutants By Permits for New Construction or Modification". SVE systems remove contaminants by negative pressure which induces flow of air containing volatile contaminants to extraction wells where the VOC-laden air can be removed from the subsurface and discharged to the atmosphere. Generally, most soil gas removal systems involve very low air emissions rates. Consequently the systems are generally exempted, under Permit By Rule §106.533, (formerly Standard Exemption 68), as outlined in 30 TAC Chapter 106 Subchapter X.

Rule §106.533 is applicable to "*Equipment used to reclaim or destroy chemicals removed from contaminated materials for the purpose of a remedial action*". Its provisions allow air emissions from treatment of groundwater and soils contaminated with petroleum compounds and chemicals other than petroleum products. The emission of chemicals other than petroleum products must also be compliant with the limitations of the Facilities (Emission and Distance Limitations) rule §106.262(2), (3) and (4). "*New or increased emissions, including fugitives, of chemicals shall not be emitted in a quantity greater than 5 tons per year (tpy) nor in a quantity greater than E as determined using the equation E=L/K*" where K is a parameter corresponding to distance to the nearest receptor and where L (Limit Value) is an emission limit of concentration provided for specific chemicals in Table 262 of §106.262. The maximum emission on an hourly basis of any chemical having an L value in Table 262 is determined by the equation E=L/K. The emission of any chemical not having an L value in Table 262 is one pound per hour (lb/hr), with or without abatement devices. These limitations are applicable only to on-site remediation.

A PBR application for the AOC-65 SVE systems was submitted to TCEQ in September 2002 prior to installation of the SVE equipment. The PBR application was amended in February 2004 to incorporate the SWMU B-3 SVE system in the permitted emissions for CSSA. In the 2004 PBR amendment, maximum allowable emissions were calculated that are combined emissions for the AOC-65 and SWMU B-3 SVE systems. The maximum allowable emission rates for the CSSA SVE systems are summarized in **Table 2.1**. Any future expansions or modifications to the CSSA SVE systems will require an amendment PBR application be prepared and submitted to the TCEQ.

Table 2.1
Permit By Rule Maximum Allowable Emission for CSSA SVE Systems

Chemical Compound	Allowable Emission Rate	
	lb/hr	Tons Per Year
cis-1,2-Dichloroethene	1.0	4.4
trans-1,2-Dichloroethene	1.0	4.4
Tetrachloroethene	6.0	5.0
Trichloroethene	6.0	5.0
Vinyl Chloride	6.0	5.0

Emission samples will be collected as part of O&M activities described in this plan and will be evaluated to verify that allowable emission limits are not exceeded. If the data indicate that the aggregate contaminant levels in the exhausts from SVE systems exceed applicable criteria, then abatement measures may be required to reduce emissions to allowable levels.

SECTION 3
SYSTEM DESCRIPTION

Specifications of major equipment and other pertinent information for the AOC-65 SVE systems (subslab and exterior systems) and the SWMU B-3 systems are provided in **Tables 3.1** and **Table 3.2,** respectively. The SVE schematic and the blower plan and section for the AOC-65 SVE systems are shown on **Figure 3.1** and **Figure 3.2**, respectively. A system schematic and a blower enclosure plan and section for the SWMU B-3 SVE system are shown on **Figure 3.3** and **Figure 3.4**, respectively.

Table 3.1
AOC-65 SVE Equipment Specifications

Unit	Manufacturer/ Model	Rating	Capacity	Motor
Blower (subslab unit)	GAST® R6130Q-50	70 in. H_2O vacuum	215 cubic feet per minute (cfm)	3 horsepower (Hp), 208 volts (V), 3-phase, 3450 revolutions per minute (rpm)
Blower (exterior wells unit)	GAST® R6325A-2	55 in. H_2O vacuum	215 cfm	2.5 Hp, 208V 3 – phase, 3450 rpm
Moisture Separators	GAST® RMS400	Not applicable (N/A)	40 gallon	N/A
Filter Housing	GAST® AJ151G	10 micron	N/A	N/A
Replacement Filters	GAST® AJ135G	10 micron	N/A	N/A
Pressure/Vacuum Reliefs	GAST® AG258	30-200 in. H_2O pressure or vacuum	200 cfm	N/A
Vacuum gauges	GAST® AE134	0-160 in. H_2O vacuum	N/A	N/A
Pressure gauges	GAST® AE133	0-160 in. H_2O	N/A	N/A
GAC Adsorber	Waterlink/Barnebey Sutcliffe V-1M Vapor Phase	1000 lb GAC	675 cfm	N/A

Table 3.2
SWMU B-3 SVE Equipment Specifications

Unit	Manufacturer/ Model	Rating	Capacity	Motor
Blower	GAST® R7 100A-3	110 in. H_2O vacuum	420 cfm	10 hp, 208V 3 – phase, 3450 rpm
Moisture Separator	GAST® RMS400	Not applicable (N/A)	55 gallons	N/A
Filter Housing	GAST® AJ151H	10 micron	N/A	N/A
Replacement Filter	GAST® AJ135C	10 micron	N/A	N/A
Pressure/Vacuum Relief	GAST® R-AG252	30-200 in. H_2O pressure or vacuum	200 cfm	N/A
Vacuum gauge	GAST® AE134	0-160 in. H_2O vacuum	N/A	N/A

3.1.1 Vacuum Blowers

The main component of the SVE system is the device producing the vacuum. The two SVE systems at AOC-65 use regenerative blowers mounted on square steel tubing anchored to the loading dock of Building 90. The SWMU B-3 unit is mounted on a covered concrete slab in a similar manner. The small structure also protects other equipment and electric fuse panels from the weather. Rubber grommets underneath the blowers dampen vibrations. A plan view of the blower areas for AOC-65 and SWMU B-3 are shown on **Figure 3.2** and **Figure 3.4**, respectively.

At AOC-65 two blowers are in use, one existing blower salvaged from the first SWMU B-3 SVE treatability study, and one new blower. The first blower, a GAST R6 Series Regenair® blower, which was used periodically at the SWMU B-3 site for approximately three years, was installed at AOC-65 to vent the subslab VEWs. A second regenerative blower, a GAST Regenair R6 Series unit was procured to produce the vacuum for seven VEWs installed outside or exterior to Building 90. The two R6 Series blowers share the same electrical requirements, and are similar in size and components (gauges, filters, plumbing, etc.). The R6 Series blowers can maintain a vacuum of about 55 to 70 inches of water (in. H_2O) at the blower inlet depending on the flow rate. At SWMU B-3 the blower is a GAST R7 100A-3 unit that can attain a maximum vacuum of about 110 in.H_2O at the blower inlet, depending on the flow rate.

Motor disconnects are used for stopping and starting the units. At AOC-65 they are mounted on west wall of Building 90. All blowers are installed on individual circuits so they operate independently of one another.

740999 CSSA_BlwrSchematic.DWG

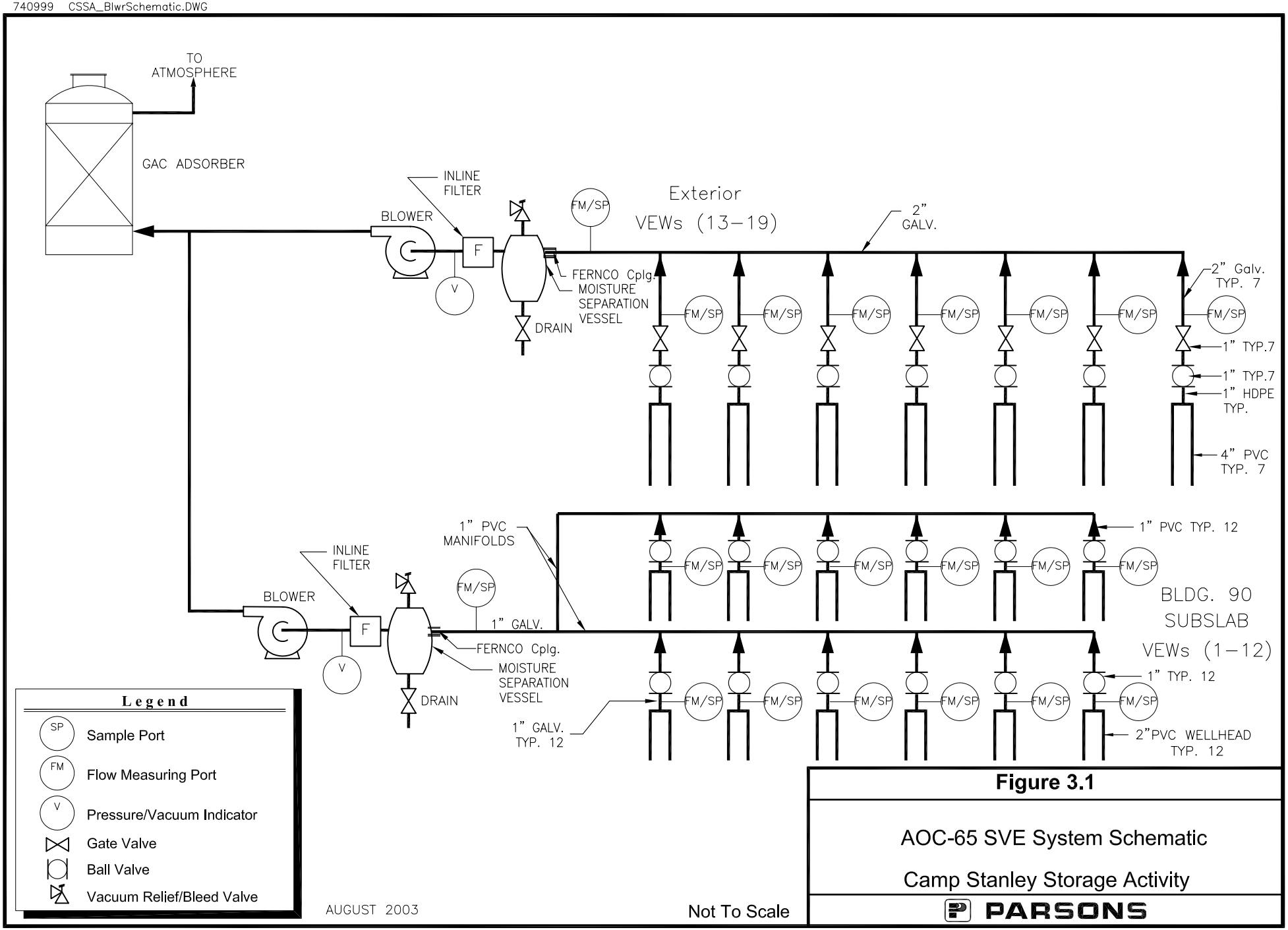


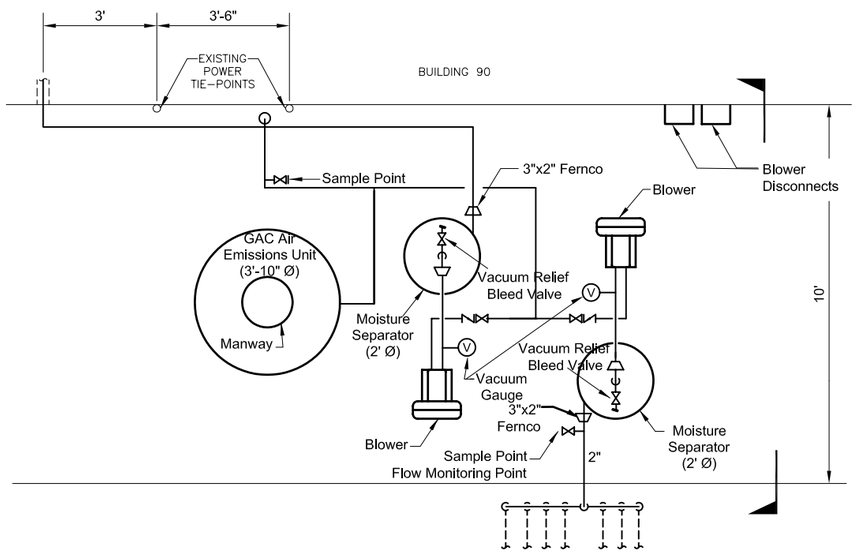
Figure 3.1

AOC-65 SVE System Schematic

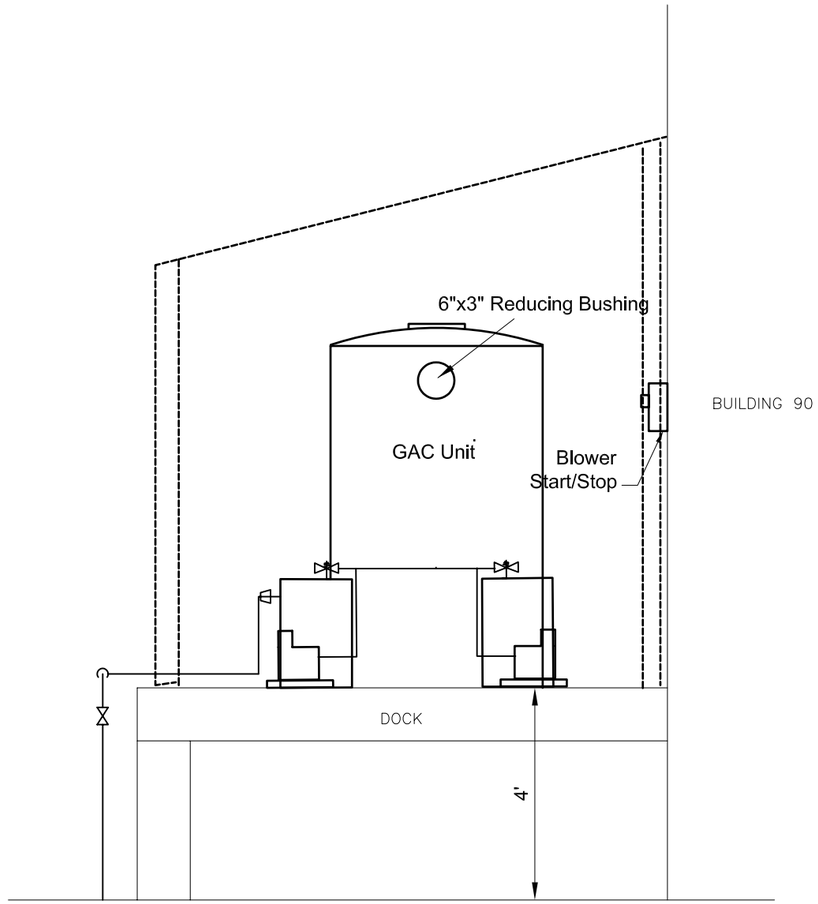
Camp Stanley Storage Activity

PARSONS

0 2 4
scale feet



Plan



Section

Note: Dimensions are approximate.

Figure 3.2

AOC-65 Blower Area Plan & Section

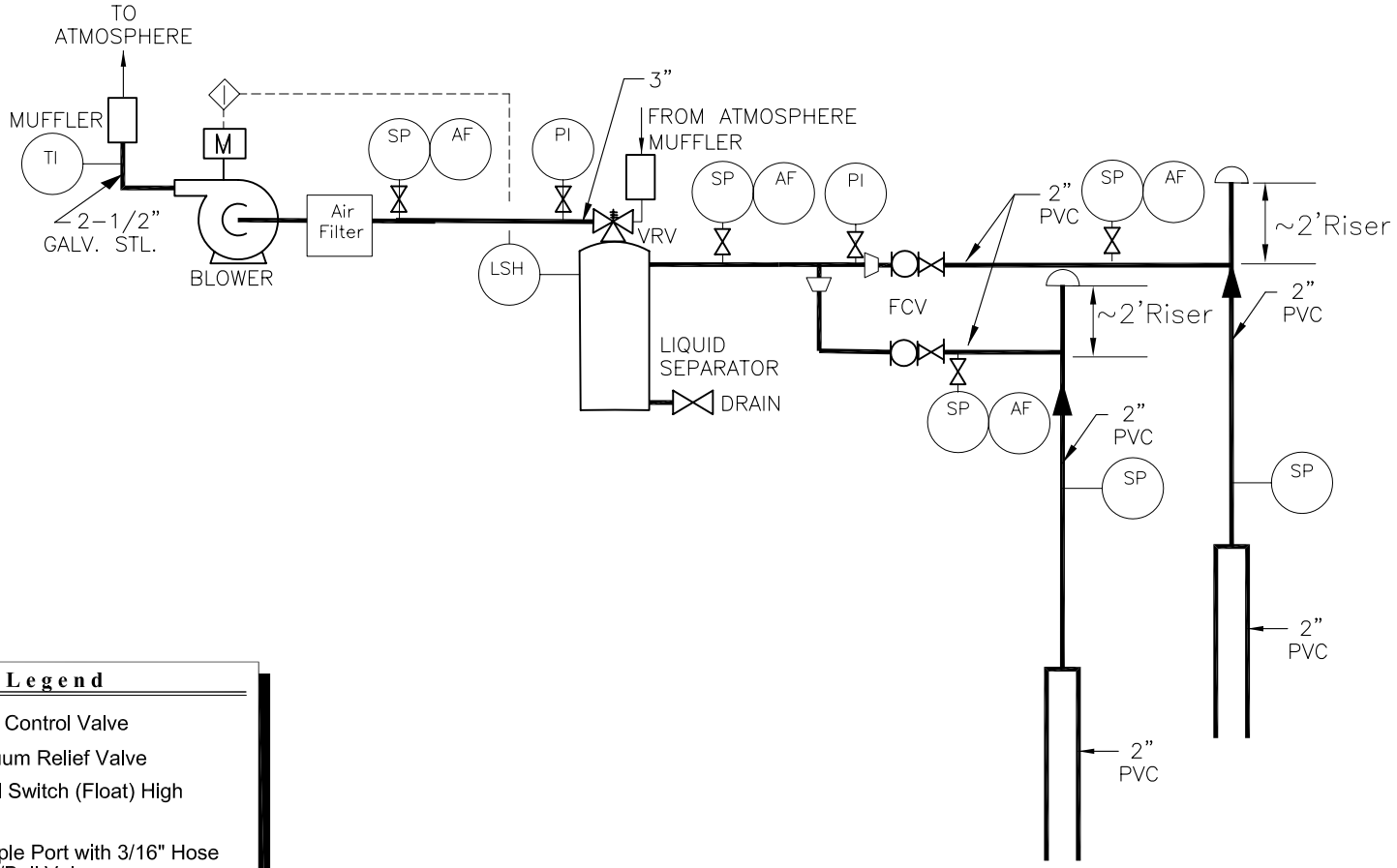
Camp Stanley Storage Activity

PARSONS

APRIL 2005

744223 CSSA_AOC65-BLOWER-PE.DWG

744223 CSSA_B-3 PFD T06.DWG



Legend

FCV	Flow Control Valve
VRV	Vacuum Relief Valve
LSH	Level Switch (Float) High
SP	Sample Port with 3/16" Hose Bard/Ball Valve
AF	Flow Measuring Port
PI	Pressure or Vacuum Indicator
TI	Temperature Indicator

APRIL 2005

Not to Scale

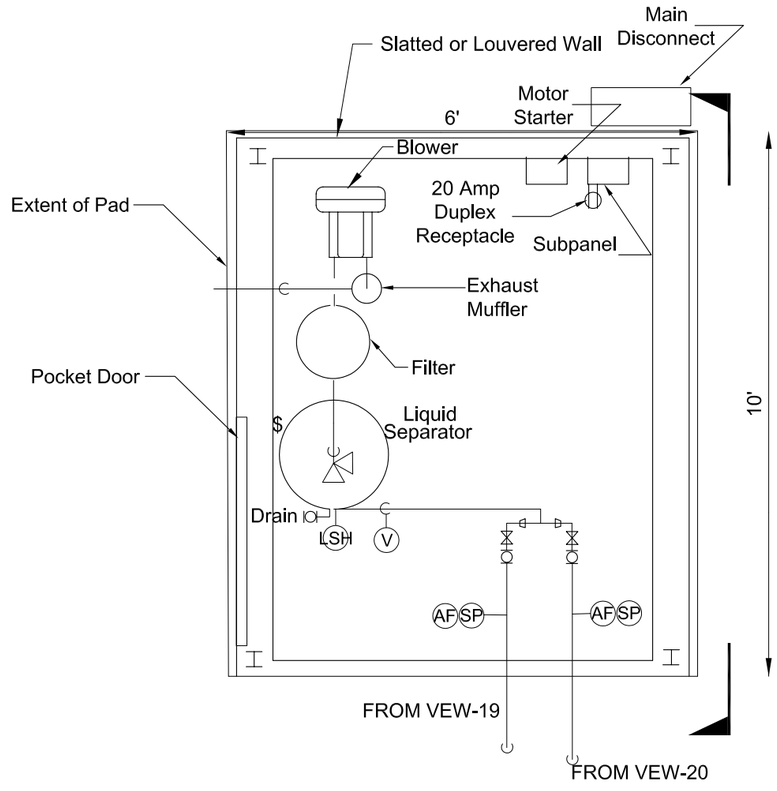
Figure 3.3

SWMU B-3 Blower System Schematic

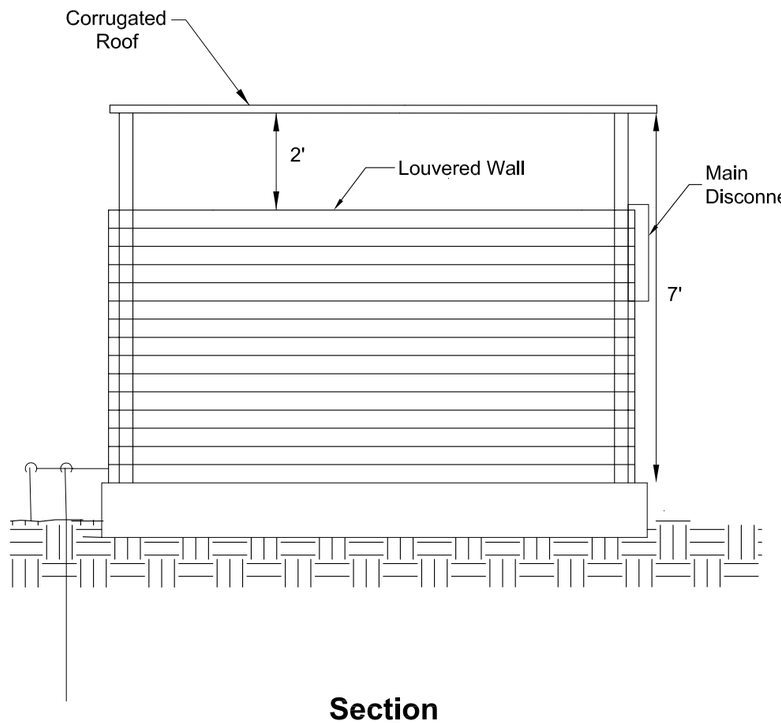
Camp Stanley Storage Activity

PARSONS

0 2 4
scale feet



Plan



Section

AF SP — Sample/Flow Monitoring Port
V — Vacuum Gauge

Note: Dimensions are approximate.

Figure 3.4

SWMU B-3 Blower Enclosure Plan & Section

Camp Stanley Storage Activity

PARSONS

744223 CSSA_B-3 LAYOUT T06.DWG

APRIL 2005

The blowers are relatively maintenance free and should not require any mechanical maintenance during the operational period. Blowers and motors have sealed bearings that do not require periodic lubrication.

Table 3.1 and Table 3.2 show the blower rated flow rates in actual cubic feet per minute (acfm) and vacuum in in.H2O for the AOC-65 and SWMU B-3 systems, respectively. Blower systems include inlet air filters and several valves and monitoring gauges, which will be described later in this section. Blower performance curves and other blower information are provided in Appendix A, Manufacturers' Equipment Information.

3.1.2 Moisture Separators

Two 40-gallon moisture separating knockout tanks were installed between the VEW manifolds and each of the blower inlets at AOC-65. At SWMU B-3 the moisture separating knockout tank is 55-gallon tank. Each knockout tank separates any condensate from the vapor recovered from the VEWs. One separator is installed for on each system. The tanks are piped in parallel with suction provided by the manifolded VEWs and the discharge leading directly into the SVE blowers. Tanks have a floating ball valve that ties into a vacuum relief valve (VRV), which automatically stops VEW evacuation by providing fresh air to the blower on high liquid level in the moisture separator. A high-level float switch shuts down the vacuum blower associated with that knockout tank in the event excess liquid accumulates in the separator. This seemingly redundant instrumentation protects the blowers, minimizes power consumption and alerts operators to a high liquid level in the moisture separators.

Condensate accumulation in the moisture separators should not normally be of concern. However, during the cooler months of the year, weather systems with cooler ambient air, can result in the ambient temperature being considerably below that of the soil vapor. Since the soil vapor has a relative humidity of essentially 100 percent, condensate can readily fall out of the vapor and collect in the separator. This could occur whenever the ambient air temperature is lower than the dew point of the soil vapor.

3.1.3 Blower Inlet Filter

To prevent damage caused by particles entering the blowers, an 8" diameter inlet filter with 2.5-in. diameter pipe connections is installed in-line upstream of each blower at AOC-65. The pressure (or vacuum) drop across a clean filter is approximately 2 in. H_2O at 200 cfm. The filters will slowly accumulate particles. Once the pressure drop across a filter is greater than 6 in. H_2O, the filter element will need to be replaced with a new element. The filter unit at SWMU B-3 is slightly larger but the operating principles are generally the same.

3.2 EMISSIONS CONTROL

3.2.1 Recovered Vapor Treatment

A Waterlink/Barnebey Sutcliffe V-1M vapor phase granular activated carbon (GAC) canister is utilized to control emissions from both blowers of the AOC-65 SVE systems. The vessel has a 16-in. manway on top for removal and refill of absorbent material. The GAC unit captures most VOCs discharging from the blowers. The vessel is movable by forklift but can be emptied and recharged in place. The AOC-65 vessel was installed on the loading dock directly adjacent to the two blowers. Due to the remote location of the SWMU B-3 system, concerns for potential exposure to contaminants in the vapor effluent are low enough that air emissions are released to the atmosphere without being processed through a GAC unit.

Sampling ports on the inlet and the discharge piping of the AOC-65 GAC unit allows sampling of influent and effluent air streams to monitor removal efficiency of the unit and ensure that contaminant break through does not occur. The interval between GAC recharge is estimated at more than one year, depending on quantity of VOC recovered and the operational continuity and usage time of the SVE systems. Recharge intervals will be estimated based on vapor concentrations and flow rates over the operating life of the system.

3.2.2 Recovered Liquid Treatment

Routine recovery of the free liquids that accumulate in moisture separators will be required to prevent automatic shut-down of the systems. The moisture separation vessels are equipped with high-level shut-down sensors that will shut the SVE system down to prevent overfilling of the vessel. To ensure that the SVE systems operate without interruptions, during routine biweekly site visits any liquids in the moisture separators will be transferred to the temporary storage drums located proximal to each separation vessel. Previous operations of the SVE systems indicates that decanting the accumulated liquids in the separation vessels on a biweekly basis should be sufficient to prevent shut-down of the system even during periods of high accumulation (i.e., when the ambient air temperature is below the dew point of the VEW vapor). If the liquid accumulation rate becomes sufficiently high to cause the SVE system to shut-down, decanting of the accumulated liquids should be performed more frequently than the biweekly basis in order to maintain continuous SVE operation.

Liquids that accumulate in the moisture separators will be transferred to temporary storage drums located near the separation vessels. When the drums become full, they will be transported to the CSSA onpost GAC unit and emptied into the GAC unit's temporary storage tank. As the drum is returned and reconnected to SVE system, a new non-hazardous waste label will be affixed to the drum and marked with a new accumulation start date. Testing of accumulated liquid is currently not a requirement since sampling and analysis was already done during initial startup at which time the VOC concentrations measured would not have resulted in a classification as hazardous waste.

3.3 MONITORING AND CONTROL EQUIPMENT

3.3.1 Air Flow Measurement Equipment

Air flow is measured at various points within each SVE system to determine extraction rates and assess system performance. Air-flow rates in cubic feet per minute (cfm) are determined by using direct-read in-line air-flow gauges, or by measuring air speed which is combined with the pipes' cross-sections area to determine volumetric air-flow. Air speed is measured using an anemomoter or a pitot tube and pressure gauge or manometer.

3.3.1.1 Pitot Tube Use

Pitot tubes are specialized tubes permanently installed into the extraction piping and provide a means of accurately measuring air speed when combined with a manometer or pressure gage. Installation of the pitot tubes are model specific and manufacturer's instruction should be followed. Once the tube is installed, the air pressure in inches of water (in. H2O) within the tube is measured using a manamoter or pressure gauge. The air flow speed is then calculated in accordance with the manufacturer's directions.

3.3.1.2 Anemometer Use

To use the anemometer, it is inserted into the measurement port with the probe tip positioned in the center of the pipe. Press the ON/OFF button to turn on the anemometer. Make sure the units for velocity are feet per minute and ºF for temperature. Insert the probe tip into the appropriate port to the center of the pipe. The probe tip is very fragile and must be treated delicately and protected from contact with foreign objects. Record the values in the appropriate place on the O&M Forms. Additional information is provided in Appendix A.

3.3.1.3 Manometer Use

To use the manometer, the barb tube connector is screwed into the port and the tube from the manometer vent is attached thereon. Press the ON/OFF button to power up the digital manometer. Before any measurements are taken, zero the meter by pressing the ZERO/RESTORE key. Keep both meter vents open to the atmosphere without any applied pressure. Within seconds the meter will automatically zero and the screen will return to ready mode. Units should be set to inches of H_2O. Attach the tube from the **+** vent (right side) to the port to be monitored. Leave the vent marked **–** (left side) open to the atmosphere. Read the digital screen. If the vacuum (negative pressure) is operating properly the value should be negative. Record the value in the appropriate place on the O&M Forms. Additional information is provided in Appendix A.

3.3.2 Vacuum Gauges

The SVE systems are equipped with gauges and a flow velocity measurement port at each well. Gauges were installed on the blower units to allow monitoring of operational

conditions. Monitoring will be done in accordance with the schedules and checklists provided in Appendix B.

3.3.3 Flow Control Equipment

Manually operated ball or gate valves were installed in the piping to each VEW to serve as flow control valves (FCVs). This allows the individual flow rate from each VEW to be manually balanced. Initially, the FCVs were set in the fully open position to maximize air flow out of the VEWs. Air flows for each of the subslab VEWs at AOC-65 were all set in open position. Balancing flows from the subslab lines can only be accomplished by taking selective VEWs off-line, which must be done inside Building 90. Access to the inside of Building 90 is strictly controlled and advance requests must be submitted to the Environmental Office prior to any Parsons entrance.

Attainable flowrates were lower than expected for the exterior AOC-65 SVE system due to excessive friction losses in the SVE piping network. To balance the flow rates, some of the FCVs to the higher flow VEWs were partially closed. The optimal flow settings were established during the final site visit on July 30, 2003 for the exterior VEW system. FCVs should probably remain 100 percent open until piping restrictions are reduced or some of the VEWs are selectively taken off line. However, if adjustment is desired to balance the flows from the exterior VEWs, then the FCVs are the proper tool to achieve that objective.

Combination flow measurement and sample collection ports, which consist of brass bushings threaded into the galvanized piping, were installed in line to allow direct measurement of flows and sampling of soil gases. Flow ports were installed at each wellhead and at the blowers. These ports allow the insertion of a thermal anemometer for the measurement of vapor velocity, which can then be converted to estimate the flow of vapor out of each individual VEW. However, the bushings should be plugged during normal system operation when measurements are not being taken. These ports can also be used to take soil gas samples to obtain contaminant concentrations for estimating mass removal rates.

SECTION 4
SYSTEMS OPERATION AND MONITORING

The O&M activities that will be performed at the CSSA SVE systems include system start-up procedures and the system operation and maintenance monitoring. In addition, system optimization and repair activities will be performed prior to implementation of the O&M activities. These O&M and optimization/repair activities are discussed in the following section.

4.1 SYSTEM OPTIMIZATION AND REPAIR

Then following activities will be implemented at the start of the O&M activities.

1) The Building 90 SVE system will be optimized to focus extraction to those VEWs where significant mass removal is occurring. Vacuum levels, air flow measurements and soil gas samples will be collected at each VEW to assess mass removal rates at each VEW. The soil gas samples will be collected at each VEW while the SVE system is operational and the samples will be analyzed for VOCs using method TO-15. Following collection of the samples, the subslab system will be shut-down for at least 30 days to allow vapors beneath the building to rebound. After the system has been idled for approximately 30 days, each VEW will be screened using field instruments (oxygen, carbon dioxide, TVH, etc.) to assess the relative amount vapor accumulation at the VEWs. The dynamic and static screening data will then be evaluated to determine which VEWs can be shut-off from the extraction system.

2) The VEWs west of the drainage ditch at AOC-65 will be evaluated to determine which wells are suitable for continued use as in future SVE operations at the site. To assess the VEWs, each well will be connected to the AOC-65 blower individually so that a vacuum can be to the well and vacuum, air flow and VOC responses can be measured at the well head. The VEWs will be connected to the blower using a length of flexible hdpe piping extended above ground and connected to the SVE manifold piping at one end and to the well head at the other end. The vacuum blower will then be started and a vacuum will be applied to the well for approximately 15 minutes. Vacuum, air flow, and TVH readings will be measured at the VEW well head. Based on the results of the screening, VEWs which do not produce significant air flow or VOC concentrations will not be incorporated into the SVE system when it is reconfigured as planned.

3) The GAST R7 blower at SWMU B-3 that failed in February 2005 will be replaced. A new blower will be procured, installed and prepped for start up. The new blower will be selected based on anticipated vacuum and air flow

requirements for the SWMU B-3 SVE system including planned addition of new VEWs.

4.2 System Start-up

The following items comprise a system start-up list:

- Check that liquid level in the moisture separator(s) – drain and transport fluid to GAC unit as necessary;
- Open FCVs to extract from desired VEWs, and close, if desired, any FCVs to VEWs not desired;
- Check condition and operation of equipment and repair or replace as needed;
- Blow-out moisture from AOC-65 SVE lines with an air compressor.
- Adjust vacuum relief/bleed valve(s) to maximum vacuum allowed (generally 55 inches H_2O at AOC-65, and 70 - 100 in. H_2O at SWMU B-3) to protect blower(s) from mechanical damage; and
- Start-up blower(s) and adjust FCVs to balance flows from VEWs in service, as desired. On the wall panel the black button is *RESET* should there be a power interruption, green is *START*, and red is *STOP*.

4.3 Operation, Maintenance, and Performance Monitoring Data Collection

The primary operating activities include monthly and quarterly monitoring of system performance, and twice-monthly monitoring of equipment operation. Performance data will be used to assess system effectiveness, while equipment operational data will be used as it is gathered to ensure that the equipment is functioning properly and identify need for equipment maintenance and/or repair.

The operation and monitoring work described in this section include:

1) Monthly screening of soil vapor/emissions at the SVE VEWs, blowers, and GAC vessel;
2) Monthly monitoring of flow rates, and vacuum pressures in the individual VEW flow streams, and at the equipment;
3) Twice monthly drive-by system checks of the SVE equipment, piping network and moisture accumulation to adjust, repair and replace components as needed to maintain the systems in good operating condition; and
4) Quarterly monitoring and data collection of individual well flows and air emissions from all systems.

These data will all be recorded and compiled on two data collection sheets shown in Appendix B. Parameters for each well are measured at the corresponding port at the manifold. Parameters may also be collected at the wellhead itself for troubleshooting suspected system problems. Parameters for blowers are taken at the port on the outflow pipe, and for a moisture separator (KO pot) at the port on the pipe just prior to entering the tank.

4.4 Operation/Maintenance Monitoring

4.4.1 Twice Monthly and Monthly Monitoring Visits

Twice monthly system checks will be performed to assure that the systems are operating satisfactorily. A check of the systems includes visual inspection of the equipment and the piping network for cracks, separations, holes and other problems. Where assessable, each of the well-heads and pipe joints will also be inspected for leaks or weakness of structure. Blower operation, filter cleanliness and VRV operation and lubrication will also be addressed. Finally, these visits include assessment and management of any accumulated liquid in the moisture separators. Monthly checks will include flow monitoring, and VEW gas screening in addition to the twice-monthly checks and servicing.

4.4.2 Vent Well Air Flow Rate

The flow rate into each vent well will be calculated using direct measurements of in-line air velocity and pipe size data. Air velocity will typically be measured at the vent wells by placing an anemometer into the air measurement port located on each vent well pipe. The volumetric flow rate is calculated by multiplying the velocity obtained times the cross-sectional area of the pipe. Flow data allow more accurate adjustment of the FCVs at each vent well to balance flows through the system, and is also used top calculate mass removal estimates from each VEW and from the system exhaust.

4.5 Performance Data

To monitor the performance of the blowers, the inlet vacuum, the outlet pressure, and outlet temperature will be monitored on each blower on a twice-monthly basis. All measurements should be taken at the same time, while the system is running. (Note: Because the blowers are noisy, hearing protection should be worn when working around the blowers).

4.5.1 VEW, Exhaust Emissions and Soil Vapor

Blowers and knockout pots will be monitored twice monthly. Every other system check will correspond with the monthly monitoring effort, during which VEWs and equipment points will be checked for VOC, oxygen and carbon dioxide concentrations.

4.5.2 Quarterly Data Collection

Soil vapor emission and/or flux samples will be collected on a quarterly basis for laboratory analyses to confirm trends and field measurements. All such vapor samples

(emissions and flux) will be tested for VOCs by Method TO-15. The CSSA Quality Assurance Program Plan (QAPP) will be followed for sample collection, analysis, and data validation. Samples will be collected in accordance with current work plan and SAP schedules, or as amended by the project manager. Quarterly monitoring events shall include all twice-monthly and monthly checks and servicing. Sample collection at individual VEWs may also be performed during quarterly data collection to assess individual contributions with regard to contaminant mass removal.

4.5.3 Flows and Pressures

During operation of the SVE systems, flows and vacuum pressures from each SVE VEW will be measured and recorded on a biweekly basis. The flow control valves (FCVs) will be adjusted to balance the flow as desired. Each SVE system may be optimized by increasing flows to VEWs producing high levels of VOCs and reducing or shutting-off flow from VEWs producing low VOC concentrations.

4.6 Monitoring Schedule

The following monitoring schedule is planned for the three SVE systems operating at CSSA, and any additional systems added.

Table 4.1
Monitoring Schedule

Item	Frequency
System Visual Check	Twice Monthly
Equipment Checks	Twice Monthly
Vacuum/Pressure	Twice Monthly
VEW Flows	Monthly
VEW Gas Screening	Monthly
Sampling & Mass Removal Rates	Quarterly

SECTION 5
SYSTEM MAINTENANCE

Although the blower systems installed are expected to be very low maintenance, periodic system checks are required to ensure proper operation and long life. Recommended maintenance procedures and schedule are described below. Manufacturers' equipment information is presented in Appendix A.

5.1 VACUUM BLOWER, PIPING AND INSTRUMENTATION

5.1.1 Vacuum Blowers

Two blowers were installed at AOC-65, one existing and one new blower. The used blower was initially installed at SWMU B-3 where it was used periodically for approximately three years. In 2003, a new blower was installed at SWMU B-3; however, this blower stopped operating in February 2005 and was determined to be unrepairable. As such it will be replaced. The approximate operating life of a properly maintained blower may extend up to five years. However, this may be shortened should abrasive particles pass the filter element.

The blowers and motors are relatively low maintenance and may not require any maintenance during the operational period. Both the blower and motor have sealed bearings that do not require periodic lubrication.

The blowers will be checked twice per month to ensure that VRVs respond to adjustments and that they operate smoothly. Apply mineral oil as necessary to lubricate and protect from corrosion.

5.1.2 Piping

The different piping (or plumbing) materials used were selected both for durability and environmental resistance as well as ease of installation. Only periodic visual inspection of aboveground piping is required to make sure the network is intact, tight, and undamaged. Damage to piping could occur due to landscaping, unloading activities or any other work activities in the area.

Occasionally, the subsurface piping from the AOC-65 VEWs to the manifold may need clearing of accumulated condensate. This is achieved by blowing the lines clear with the Campbell/Hausfeld air compressor stored on the Building 90 dock. Since one line is cleared at a time, the system may remain on as long as the line to be cleared is closed at the manifold. The compressor hose is attached to the male quick-release port attached to a ball valve tapped into a VEW's galvanized manifold pipe, below the individual yellow-handled gate valve. The gate valve must be closed for this procedure. The ball valve tapped into the galvanized pipe is closed while the compressor energizes.

The corresponding VEW wellhead cap must be removed to allow for the expulsion of liquid. Start the compressor and allow pressure to build up to 50 psi. Once the compressor is charged, open the small ball valve at the manifold. If present in the piping, liquid should be expelled out of the wellhead. The escaping liquid is under pressure and appropriate eye protection should be worn for this part of the operation. If a large accumulation of condensation is suspected, repeat the procedure. Repeat the procedure for each VEW as necessary. Replace wellhead caps.

5.1.3 Blower Filter

Filter inspection must be performed with the system turned off. Do not change the FCV settings before re-starting a blower unless a rebalancing of the VEWs is desired.

The filter elements should be checked monthly and replaced a minimum of every six months. Typical filter element replacement intervals are estimated at three to six months depending on blower run time.

To remove the filter:

1. turn the system off by pressing the "OFF" button on the wall panel,
2. loosen the three clamps or the wing nut on the filter top,
3. lift the metal top off the filter, and
4. lift the filter element from the metal housing.
5. reinstall new element by reversing order of disassembly.

If a plugged filter is suspected a pressure drop check should also be performed. Attach a vacuum gauge to the Sample Port/Flow Measurement (SP/FM) port upstream of the moisture separator to check pressure drop across filter (also see manometer instructions). A pressure drop across the filter exceeding 6 inches of water may indicate the filter requires replacement.

The replaceable air filter element is manufactured by GAST Manufacturing, Inc. in Benton Harbor, MI (269) 926-6171. Spare filter elements were not purchased. However, replacement filter elements can be obtained directly from the manufacturer or from the supplier Southwestern Controls, San Antonio office, 1-800-444-9369 or Houston office at 1-800-444-9368 (replacement filter elements for R6 blowers are GAST Model AJ 135G, and GAST Model AJ 135C for the R7 blower).

5.2 GRANULAR ACTIVATED CARBON ADSORPTION UNITS

The GAC adsorber at AOC-65 is a Waterlink/Barnebey Sutcliffe V-1M Vapor Phase Adsorber with 16" manway on top for removal and fill of GAC. The unit has no moving parts and does not require any routine maintenance other than replacement of GAC. Breakthrough of VOCs will indicate when the GAC is spent, but this is strictly a function of blower flowrate and VOC concentration, or more precisely the mass quantity of VOC

removed. Periodic monitoring of inlet and outlet concentrations should provide an indication of when GAC will require replacement. In general vapor phase adsorption is fairly efficient so a year or more would not be an excessive period between changeouts especially since removal rates are low and a 1000 lb of GAC is in place. Nonetheless, GAC analysis is proposed at the startup of continued O&M under this plan and after 1 year of operation.

5.3 MAINTENANCE SCHEDULE

In general, SVE systems are very reliable when properly maintained. Occasionally, however, a motor or blower will develop a problem. If a blower fails to start, and an electrician verifies that power is available at the blower or starter, Parsons should be contacted to arrange for repairs.

Twice monthly inspections are recommended (see Section 4) for the blower systems. During the initial operation, more frequent monitoring may be needed to ensure that any startup problems are quickly corrected. See Appendix B data collection sheets for recording maintenance activities.

.

SECTION 6
REPORTING REQUIREMENTS

At the end of the next operations and monitoring period, a Long-Term Operations and Monitoring Report will be prepared. This report will include documentation of any new VEW installations and SVE systems maintenance, analytical data from quarterly sampling events, SVE systems assessments, and a summary of O&M activities carried out during the next operational period.

No Federal or State Agency reporting is required for this project, but the final report will be incorporated into the CSSA Administrative Records (Environmental Encyclopedia).

SECTION 7
BIBLIOGRAPHY AND REFERENCES

Parsons 2005. *Final Interim Treatability Test Report*, Parsons Infrastructure and Technology Group, Austin, Texas, 2005.

Parsons 2003a. *Area of Concern 65 Soil Vapor Extraction Operations & Maintenance Report*, Parsons Infrastructure and Technology Group, Austin, Texas, August, 2003.

Parsons 2003b. *Area of Concern 65 Interim Removal Action*, Parsons Infrastructure and Technology Group, Austin, Texas, August, 2003.

Parsons 2003c. *Westbay Study Report*, Parsons Infrastructure and Technology Group, Austin, Texas, 2003.

Parsons 2002a. *Area of Concern-65 Permit By Rule Application for Removal Action*, Parsons Infrastructure and Technology Group, Austin, Texas, August 2002.

Parsons 2002b. *Area of Concern-65 RCRA Facility Investigation Report*, Parsons Infrastructure and Technology Group, Austin, Texas, September 2002.

APPENDIX A

MANUFACTURERS' EQUIPMENT INFORMATION

Blower System Design Tips

In order to utilize your regenerative blower most efficiently, proper system design is essential. The most important thing to recognize is that by utilizing large diameter plumbing, friction losses in plumbing can be greatly reduced. Here are some guidelines to use when setting up your blower system:

1. The plumbing should at least be the same size as the blower port or ideally one size larger (example - blower has ports that are 1-1/2" NPT, plumbing should be 2" NPT). The plumbing should remain this size until it has reached the location of the work area.
2. Plumbing for Separate Drive Blowers operating above 3500 RPM should be at least one pipe size larger than the blower ports.
3. Elbows create additional friction which causes pressure loss and back pressure. Plumbing at least one pipe size larger than the blower pipe ports minimizes the friction loss they create.
4. The pressure/vacuum relief valve should be installed in a "T" which is at least one pipe size larger than that of the exhaust of the blower. To properly protect a large horsepower blower, set the relief value to limit the blowers duty to 5 in. H_2O below its continuous duty rating.
5. Operating the blowers at high altitude decreases their maximum pressure or vacuum duty rating. If this is a consideration, review the information on Fan Laws in the Application Engineering section of this catalog.
6. The exhaust air temperature of the blowers increases with increasing duty. At duties over 70 in. H_2O it is too hot for most plastic pipe. Metal pipe must be considered. To prevent danger of burns, access to these pipes should be limited, guarded or marked "Danger Hot."

Performance Data

The performance data shown in this catalog was determined under the following conditions:

- Line voltage @ 60 Hz. 230V or 460V for three-phase units. 115V or 230V for single-phase units.
- Line voltage @ 50Hz. 220V for three-phase or single-phase units.
- Units in a temperature stable condition.
- Delivery measurements made with output port throttled.
- Suction measurements made with input port throttled.
- Test Conditions: Inlet air density at 0.075 lbs. per cu.ft. [20°C (68°F), 29.92 in. Hg (14.7 PSIA)].
- Normal performance variations on the resistance curve within ± 10% of supplied data can be expected.

Pictorial and dimensional data is subject to change without notice.

The information presented in this catalog is based on technical data and test results of nominal units. It is believed to be accurate and is offered as an aid in the selection of Gast products. It is the user's responsibility to determine suitability of the product for intended use and the user assumes all risk and liability whatsoever in connection therewith.

Gast can also provide CE compliant blowers with BSP threads, as well as customized blowers for specific applications. Consult a Gast Representative/Distributor for more information.

Environmental and application conditions may affect advertised life.

Warning:
Models Without Explosion-Proof Motors Should Not Pump Combustible Gases or Be Used In Combustible Ambients

R7 Series
MODELS R7100A-3, R7100B-1

MAX. PRESSURE – 125" H_2O (60 Hz), 115" H_2O (50 Hz)
MAX. VACUUM – 110" H_2O (60 Hz), 90" H_2O (50 Hz)
MAX. AIR FLOW – 420 CFM (60 Hz), 350 CFM (50 Hz)

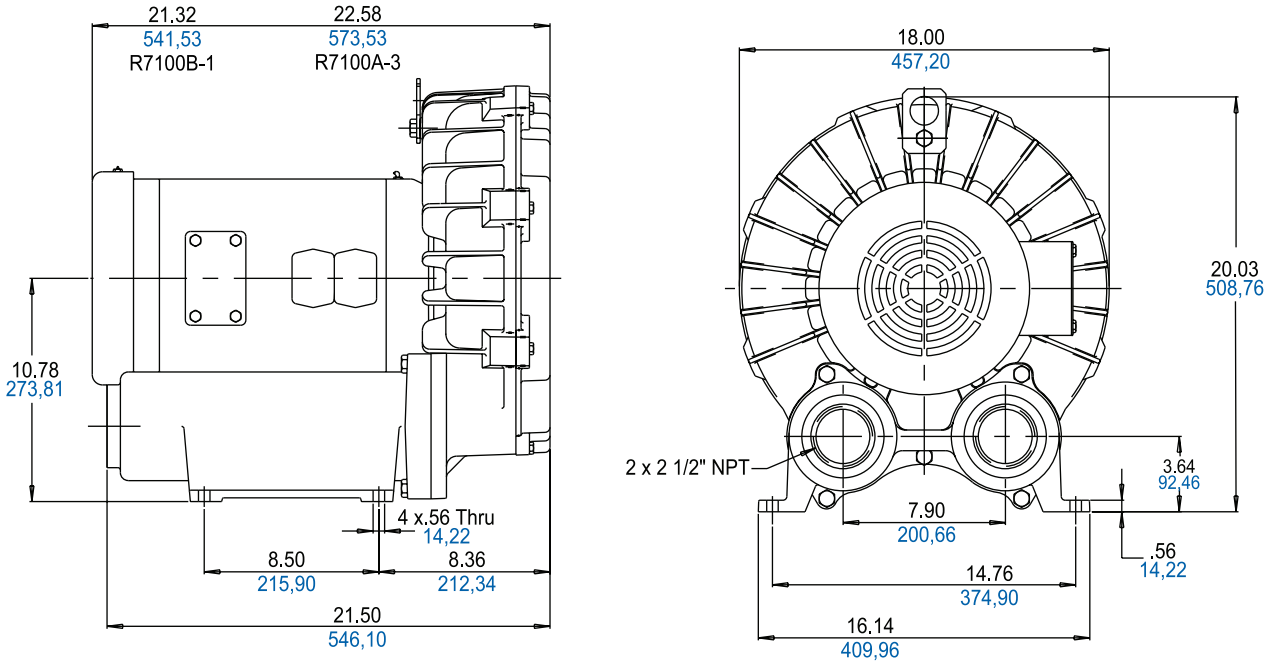
PRODUCT FEATURES

- Rugged construction, low maintenance
- Oilless operation
- UL and CSA approved TEFC motors with permanently sealed ball bearings
- IP54 rated enclosure on motors
- Aluminum impeller; cast iron cover and housing
- Can be mounted in any plane
- Inlet and outlet have internal muffling

RECOMMENDED ACCESSORIES

- Pressure gauge AE133A
- Inlet filter AJ126G (pressure)
- Vacuum gauge AE134
- Vacuum gauge for monitoring inlet filter restriction AJ497
- Pressure/vacuum relief valve AG258
- Silencer for vacuum relief valve AJ121D
- Inline filter AJ151H (vacuum)
- External muffler for additional silencing AJ121G
- Liquid separator RMS400 (vacuum)

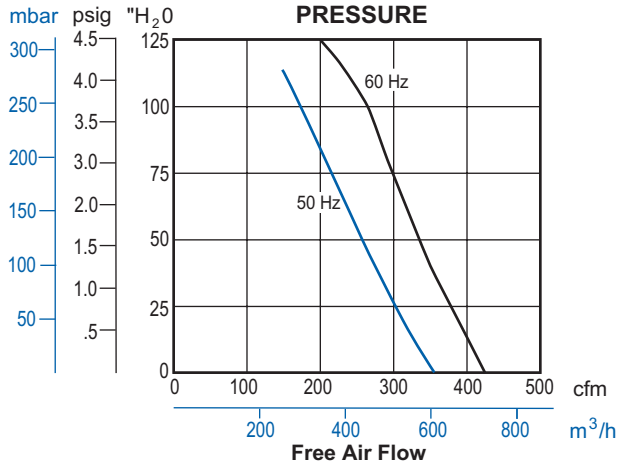
Product Dimensions (in. mm)

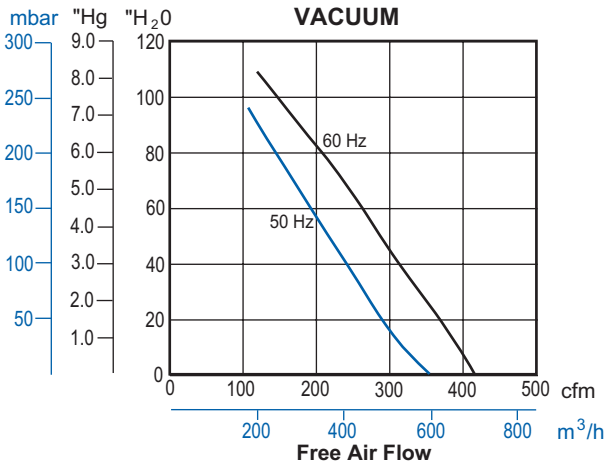


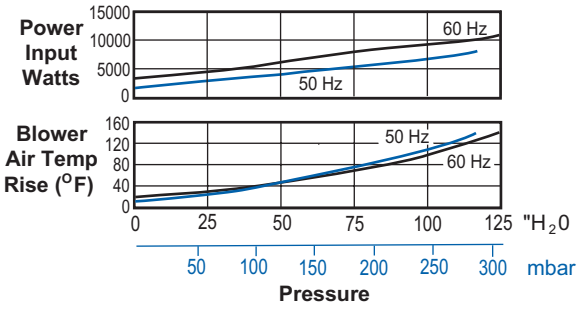
Product Specifications

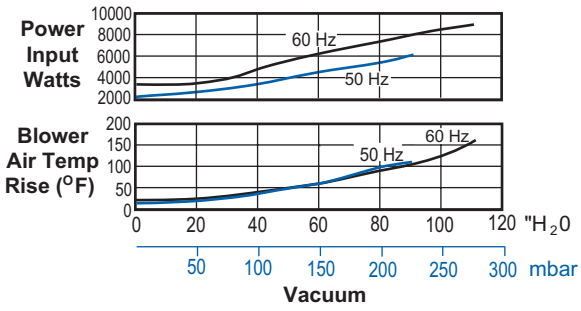
MODEL NUMBER		R7100A-3	R7100B-1
Motor Enclosure		TEFC	TEFC
HP/kW	60 Hz	10/7,5	10/7,5
	50 Hz	8/6	-
Voltage	60 Hz	208-230/460-3	575-3
	50 Hz	190-220/380-440-3	-
Amps	60 Hz	35-29.5/15	9.6
	50 Hz	27-23/13.5-12.3	-
Starting Amps	60 Hz	120 @ 460V	84 @ 575V
	50 Hz	143 @ 380V	-
Insulation Class		F	F
Recommended NEMA Starter Size		2/1	1
Net Weight (lbs/kg)		324/147	290/131

Product Performance





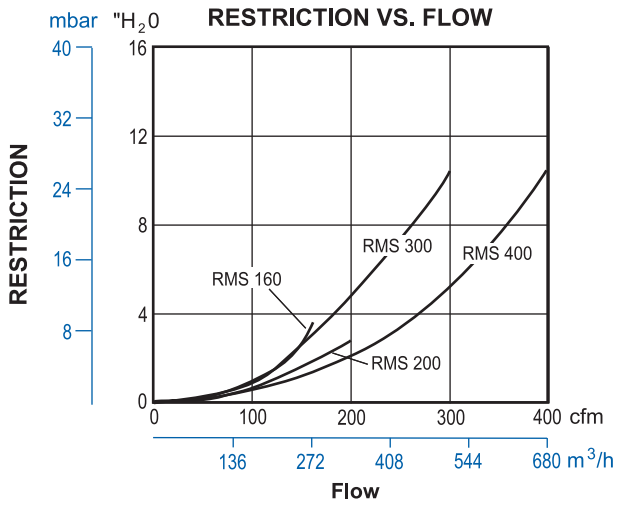




Regenair® Liquid Separator

The separator removes liquids from the gas stream in a soil vapor extraction process, to help protect both blower and vapor treatment system from corrosion and mineral deposit buildup. The separator is located between the extraction wells and the blower. An inline filter is installed between separator and blower.

Cut away to show ball float. Above model shows optional explosion proof float switch AJ213

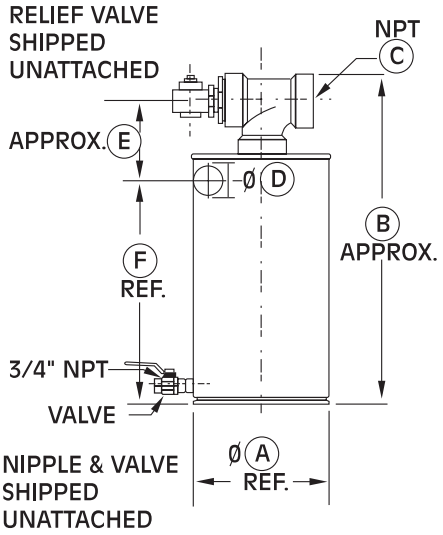


Specifications

Practical Design Engineered to remove and contain moisture ranging from a fine mist to slugs of water from blower inlet air streams, Gast separators incorporate a cyclonic action which results in a very high degree of efficiency.
A floating ball valve which closes when the liquid level becomes too high prevents collected liquid from overflowing back into the air stream. When the float valve closes an integral vacuum relief valve opens, admitting air to cool the blower and prevent overheating.

Rugged Construction Gast separator drums are made from ribbed heavy gauge cold-rolled steel, with heavy steel inlet, drain and float switch ports welded to the drum wall. Drum interiors are epoxy coated to resist abrasion, corrosion and chemicals, while the drum exterior is coated with durable urethane. For ease of connection, the outlet port of female pipe threaded. The heavy-duty 304 stainless steel ball float resists chemicals. Maximum rated vacuum is 22" Hg (299 "H_2O).

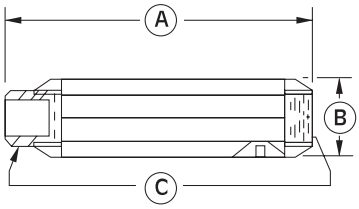
Included is a pilot operated precision relief valve capable of functioning over a wide duty range. This vacuum relief valve is designed and built to proven reliability and durability standards. Moving parts are nickelplated for corrosion resistance and smooth operation. Explosion proof AJ213 float switch is optional; single pole double throw, electrical rating 5 amp @ 125/250 VAC, 1" NPT mounting.



Part No.	Liq. Cap.(gal.)	A(dia.)	Dim. B	C(NPT)	D(dia.)	Dim. E	Dim. F	Used On
RMS160	10	14.8"	37.5"	2"	2"	7.5"	26.6"	R3, R4, R5
RMS200	19	19.7"	35"	2"	2"	7.5"	26.6"	R4, R4H, R4P, R5
RMS300	19	19.7"	35"	2.5"	2.5"	7.5"	26.6"	R4H, R4M, R5, R6, R6P, R6PS, R7H
RMS400	40	24"	44"	3"	3"	9.7"	29"	R6PP, R4M, R6, R6P, R7, R7S, R7P, R7H,R9, R9S

Mufflers

Designed to reduce noise by 5-8 dBa and remove high frequency sound associated with all blowers .



Part No.	Dim. A	Dim. B	Dim. C	Used On
AJ121B	7.46"	2.38"	1" NPT	R1, R2
AJ121C	7.94"	2.62"	1¼" NPT	R3
AJ121D	12.75"	3.25"	1½" NPT	R4, R5, R4P, R4M, R4H, R7
AJ121F	17.05"	3.63"	2" NPT	R4H, R4M, R6, R6P, R6PP, R6PS
AJ121G	17.44"	4.25"	2½" NPT	R7, R7P, R7S, R7H
AJ121H	20.25"	4.75"	3" NPT	R6PP (Exhaust), R9, R9P, R9S
AJ121M	33.50"	6.00"	4" NPT	R7P (Exhaust)
AJ121N	39"	7.00"	5" NPT	R9P

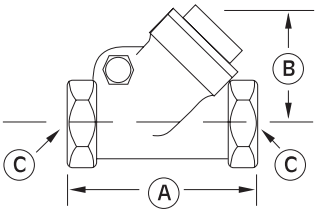
Pressure-Vacuum Gauge

To monitor the system performance so maximum duties are not exceeded. Using two gauges (one on each side of the filter) is a great way to know when the filter needs servicing.

Part No.			Used On
AJ497	Vacuum gauge	0-60" H_2O, 1/4" NPT connection	R1, R2, R3, R4 R4H, R4M, R4P, R5, R7, R7P, R7H, R7S, R9, R9P, R9S
AE134	Vacuum gauge	0-160" H_2O, 1/4" NPT connection	R4P, R6PP, R6PS, R6P, R4M, R6, R7, R7S, R7P, R9, R9P, R9S
AE134F	Vacuum gauge	0-15" Hg, 1/4" NPT connection	R4H, R4M, R7H
AE133	Pressure gauge	0-160" H_2O, 1/4" NPT connection	R6PP, R6P, R5, R4P, R6, R7P, R9, R9P
AE133A	Pressure gauge	0-200" H_2O, 1/4" NPT connection	R4M, R6PS, R7, R7S
AE133F	Pressure gauge	0-15 psi, 1/4" NPT connection	R4H, R7H, R9S
AJ496	Pressure gauge	0-60" H_2O, 1/4" NPT connection	R1, R2, R3, R4

Check Valve

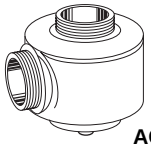
Designed to prevent back-wash of fluids that would enter the blower. Also prevents air back-streaming if needed. Can be mounted with discharge either vertical or horizontal. Valve will open with 3" of water pressure.



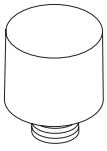
Part No.	Dim. A	Dim. B	Dia. C
AH326B	3.57"	2.32"	1" NPT
AH326C	4.19"	2.69"	1¼" NPT
AH326D	4.50"	2.94"	1½" NPT
AH326F	5.25"	3.82"	2" NPT
AH326G	8.00"	5.07"	2½" NPT

Relief Valve

By setting a relief valve at a given pressure/vacuum you can ensure excessive duties will not harm the blower or products in your application.



AG258 Series



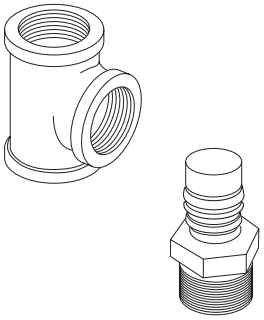
PV Series

Part No.			Used On
AG258	Relief valve	1-1/2" NPT adjustable 30-200" H2O, vac. or press., 200 CFM max.	R4, R4H, R4M, R4P, R5, R6, R6P, R6PS, R7
AG258F	Relief valve	2-1/2" NPT adjustable 25-200" H2Os, vacuum or pressure, 570 CFM	R6PP, R7H, R7P, R7S, R9, R9P, R9S
PV072	Relief valve	For pressure, pre-set for 7.2 psi, 1-1/4" NPT connection (60Hz)	Consult factory
PV098	Relief valve	For pressure, pre-set for 9.8 psi, 1-1/4" NPT connection (50Hz)	R4H, R7H
PV102	Relief valve	For pressure, pre-set for 10.2 psi, 1-1/4" NPT connection (60Hz)	R4H, R7H

Fittings

Gast has a complete line of male hose barbs, tees, common elbows and close nipples for easy hook-up

Pipe Size	1"	1 1/4"	1 1/2"	2"	2 1/2"
Tee	BA415	BA431	BA432	BA433	BA434
Common Elbow	BA220	BA244	BA230	BA247	BA248
Nipple	BA752	BA809	BA783	BA810	BA813
Plastic Male Pipe Hose Barb	AJ117A	AJ117B	-	-	-
Hose I.D.	1.25	1.25	-	-	-
Metal Male Pipe Hose Barb	AJ117D	AJ117F	AJ117C	AJ117G	AJ117H
Hose I.D.	1.00	1.25	1.50	2.50	3.00



Filters

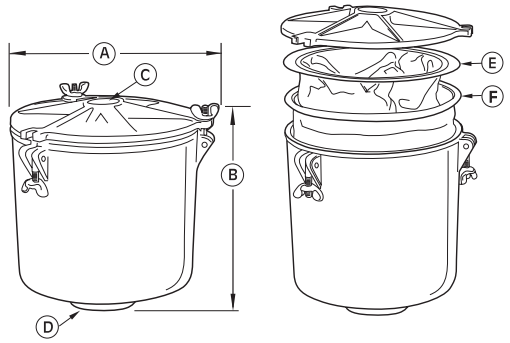
In locations where there are high amounts of dust, powder or dirt suspended in the air, inline filters (for vacuum applications) and inlet filters (pressure applications), should be used. Keeping particulates from entering the blower will ensure smooth operation and trouble free service life.

Inline filters (for vacuum)

AV series

Part No.	Dim. A	Dim. B	Dim. C	Dim. D	Used On
AV460	8 1/4"	8 7/8"	1" FPT	1" FPT	R1, R2
AV460C	8 1/4"	8 7/8"	1 1/4" FPT	1 1/4" FPT	R3

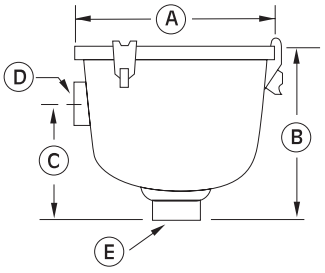
Replacement elements for AV460 and AV460C:
AV469A - Paper filter, 5-10 micron, sold in 12 pack (letter E on diagram).
AV463A - Cloth bag, 50 micron, sold in 3 pack (letter F on diagram).

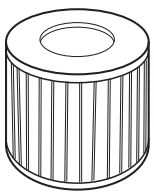


AJ series

Part No.	Dim. A	Dim. B	Dim. C	Dim. D	Dim.E	Filter Replacement	Used On
AJ151A	5.88"	4.50"	2.75"	1" FPT	1" FPT	AJ135D (10 micron)	R1
AJ151B	7.38"	6.81"	4.62"	1" FPT	1" FPT	AJ135E (10 micron)	R2
AJ151C	7.38"	6.81"	4.62"	1 1/4" FPT	1 1/4" FPT	AJ135E (10 micron)	R3
AJ151D	7.38"	6.81"	4.62"	1 1/2" FPT	1 1/2" FPT	AJ135E (10 micron)	R4, R4P
AJ151E	8.75"	10.25"	5.00"	2" FPT	2" FPT	AJ135F (10 micron)	R4H, R4P, R5
AJ151G	8.75"	10.50"	5.50"	2 1/2" FPT	2 1/2" FPT	AJ135G (10 micron)	R4M, R6, R6P, R7H
AJ151H	14.00"	27.13"	18.50"	3" MPT	3" MPT	AJ135C (10 micron)	R6PP, R6PS, R7, R7S
AJ151L	14.00"	27.13"	18.50"	4" MPT	4" MPT	AJ135C (10 micron)	R7P
AJ151M	18.50"	28.13"	19.50"	5" MPT	5" MPT	AJ135H (10 micron)	R7P, R7S, R9, R9P, R9S

MPT = Male Pipe Thread FPT = Female Pipe Thread All are heavy-duty for high amounts of particulates.
Inline filters for REGENAIR® blowers are drip-proof when mounted as shown.





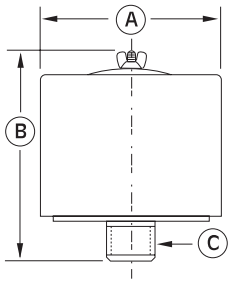
Filter Replacement

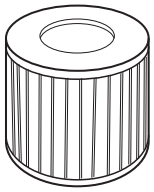
Filters

Inlet filters (for pressure)

Part No.	Dim. A	Dim. B	Dim. C	Filter Replacement	Used On
AJ126B	6.00"	4.62"	1" MPT	AJ134B (10 micron)	R1, R2
AJ126C	6.00"	7.12"	1 1/4" MPT	AJ134C (10 micron)	R3
AJ126D	7.70"	7.25"	1 1/2" MPT	AJ134E (10 micron)	R4, R4H, R4P, R5
AJ126F	10.63"	4.81"	2" MPT	AG340 (10 micron)	R4M, R6, R6P, R6PS, R6PP, R9
AJ126G	10.00"	13.12"	2 1/2" MPT	AJ135A (10 micron)	R7, R7H, R7P, R7S
AJ126L	10.00"	14.62"	4" MPT	AJ135C (10 micron)	Consult factory
AJ126MA	16.00"	14.00"	4" MPT	AJ135H (10 micron)	R9, R9P

MPT = Male Pipe Thread FPT = Female Pipe Thread All are heavy-duty for high amounts of particulates. Inlet filters for REGENAIR® blowers are drip-proof when mounted as shown.

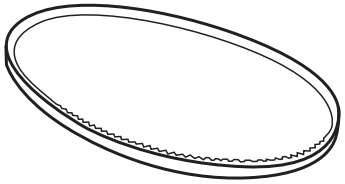




Filter Replacement

Additional Accessories for Separate Drive Blowers

Belts

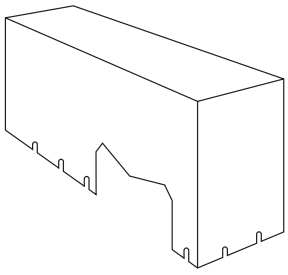


- 39” Gates Poly Chain GT for SDR4-54
  Part #AK371
- 44” Gates Poly Chain GT for SDR5-54
  Part #AK371A

We strongly suggest the use of Gates Poly Chain Drive. If you intend to design a system with V-belts consult the Operating and Maintenance Instructions.

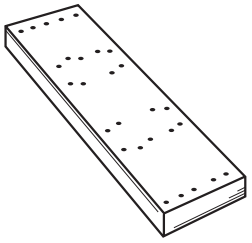
Belt Guard

- V-Belt Guard for Separate-Drive Models R4, R5, R6
  Part #AK372



Base

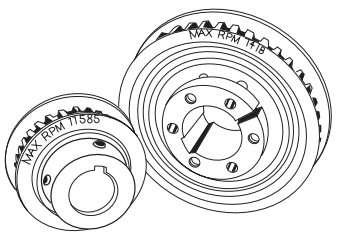
- Metal base for all Separate-Drive Models
  Part #AK367



Sprockets for Poly Chain Drive

Part #	Description	For Use on
AK370A	22 teeth (7/8" shaft)	SDR4-6P, 143T and 145T- frame motors
AK370C	30 teeth (7/8" shaft)	SDR4-6P, 143T and 145T- frame motors
AK370K	38 teeth (needs AK444F bushing to go on 1 5/8" shaft)	254T and 256T-frame motors

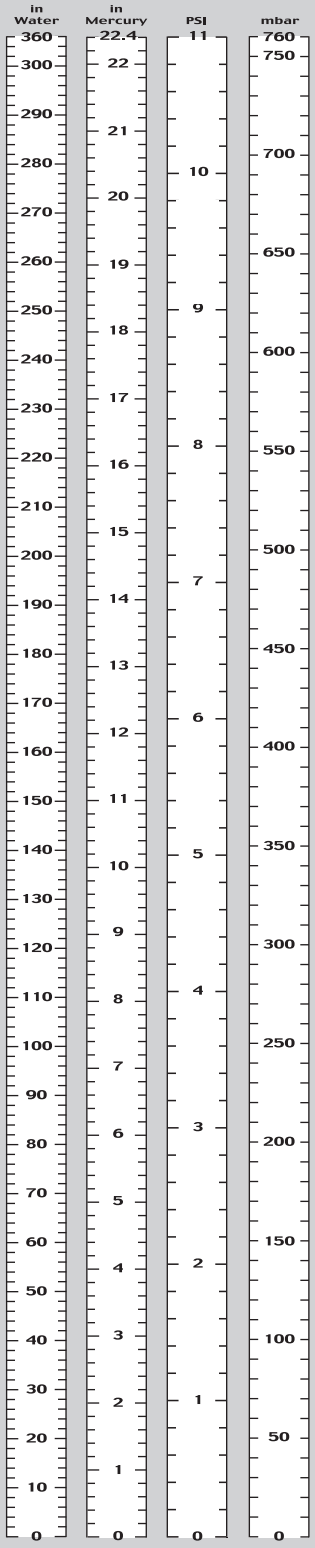
To find blower RPM: $\frac{\text{Number of motor sprocket teeth}}{\text{Number of blower sprocket teeth}}$ x Motor RPM = Blower Speed



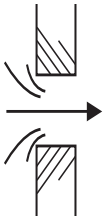
Standard Conversions

Multiply	By	To Get
Atmospheres	29.92	Inches of Mercury
Atmospheres	14.70	Psi
Atomspheres	76.0	Cms of Mercury
Bars	0.9869	Atmospheres
Bars	14.50	Psi
British Thermal Units	3.927×10^{-4}	Horsepower-Hours
British Thermal Units	2.928×10^{-4}	Kilowatt-Hours
Centimeters of Mercury	0.1934	Psi
Cubic Feet	7.481	Gallons
Cubic Feet	28.32	Liters
Cubic Feet/Minute	1.6992	Cubic Meters/Hour
Cubic Meters/Hour	.5886	Cubic Feet/Minute
Cubic Meters	35.31	Cubic Feet
Cubic Meters	61,023	Cubic Inches
Cubic Meters	1.308	Cubic Yards
Horsepower	42.44	British Thermal Units/Min.
Horsepower	745.7	Watts
Horsepower	.746	Kilowatts
Horsepower-Hours	2547	British Thermal Units
Inches	2.540	Centimeters
Inches	25.40	Millimeters
Inches of Mercury	0.03342	Atomspheres
Inches of Mercury	13.60	Inches of Water
Inches of Mercury	0.4912	Psi
Inches of Water	0.07355	Inches of Mercury
Inches of Water	25.40	Kgs/Sq. Meter
Inches of Water	0.03613	Psi
Inches of Water	1.868	Mm of Mercury
Inches of Water	2.491	mbar
Kilograms/Sq. cm	14.22	Psi
Kilopascals (kpa)	0.145	Psi
Kilowatts	1.341	Horsepower
Kilowatts	56.92	British Thermal Units/Min.
Kilowatt-Hours	3415	British Thermal Units
Liters	61.02	Cubic Inches
Liters	0.03531	Cubic Feet
Millibar	.0145	Psi
Millibar	.402	Inches of Water
Mms. of Mercury	0.0394	Inches of Mercury
Mms. of Mercury	0.01934	Psi
Psi	0.06804	Atmospheres
Psi	27.7	Inches of Water
Psi	2.036	Inches of Mercury
Psi	.07031	Kgs/Sq. Centimeter
Psi	6.895	Kilopascals (kpa)
Psi	68.95	mbar
Psi	.069	bar
Pounds of Water	27.68	Cubic Inches
Pounds of Water Evaporated at 212° F	970.3	British Thermal Units
Temp. (Degs.C.) + 273	1	Abs. Temp. (Degs.C.)
Temp. (Degs.C.) + 17.8	1.8	Temp. (Degs. Fahr.)
Temp. (Degs. F.) + 460	1	Abs. Temp. (Degs F.)
Temp. (Degs. F.) - 32	5/9	Temp. (Degs. Cent.)
Watts	0.05692	British Thermal Units/Min.
Watts	1.341×10^{-3}	Horsepower
Watts	10^{-3}	Kilowatts
Watts-Hour	3.415	British Thermal Units
Watts-Hour	1.341 x 10-	Horsepower/Hours
Watts-Hour	10^{-3}	Kilowatt-Hours

VACUUM–PRESSURE EQUIVALENCE TABLE



Air Flow Through An Orifice (in CFM)



•Downstream pressure = 14.7 psia (standard atmospheric pressure)
•Air Temperature = 70°F (21°C)
•Cd (discharge coefficient) = 0.65 (for sharp edge orifice — See drawing

Up Stream Pressure — **Orifice Diameters (in Inches)**

in. H_2O	1/32	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3
1.00	0.014	0.054	0.217	0.489	0.869	1.36	1.96	2.66	3.48	7.82	13.9	21.7	31.3	42.6	55.6	70.4	86.9	105	125
2.00	0.019	0.077	0.307	0.691	1.23	1.92	2.76	3.76	4.92	11.1	19.7	30.7	44.2	60.2	78.6	99.5	123	149	177
3.00	0.024	0.094	0.376	0.846	1.50	2.35	3.39	4.61	6.02	13.5	24.1	37.6	54.2	73.7	96.3	122	150	182	217
4.00	0.027	0.109	0.434	0.977	1.74	2.71	3.91	5.32	6.95	15.6	27.8	43.4	62.6	85.1	111	141	174	210	250
5.00	0.030	0.121	0.486	1.09	1.94	3.04	4.37	5.95	7.77	17.5	31.1	48.6	69.9	95.2	124	157	194	235	280
10.00	0.043	0.172	0.686	1.54	2.75	4.29	6.18	8.41	11.0	24.7	43.9	68.6	98.9	135	176	222	275	332	395
15.00	0.053	0.210	0.840	1.89	3.36	5.25	7.56	10.3	13.4	30.3	53.8	84.0	121	165	215	272	336	407	484
20.00	0.061	0.242	0.970	2.18	3.88	6.06	8.73	11.9	15.5	34.9	62.1	97.0	140	190	248	314	388	469	559
25.00	0.068	0.271	1.08	2.44	4.34	6.77	9.76	13.3	17.3	39.0	69.4	108	156	212	277	351	434	525	624
30.00	0.074	0.297	1.19	2.67	4.75	7.42	10.7	14.5	19.0	42.7	76.0	119	171	233	304	385	475	574	684
35.00	0.080	0.320	1.28	2.88	5.13	8.01	11.5	15.7	20.5	46.1	82.0	128	185	251	328	415	513	620	738
40.00	0.086	0.342	1.37	3.08	5.48	8.56	12.3	16.8	21.9	49.3	87.6	137	197	268	351	444	548	663	789
45.00	0.091	0.363	1.45	3.27	5.81	9.07	13.1	17.8	23.2	52.3	92.9	145	209	285	372	470	581	703	836
50.00	0.096	0.382	1.53	3.44	6.12	9.56	13.8	18.7	24.5	55.1	97.9	153	220	300	392	496	612	740	881
55.00	0.100	0.401	1.60	3.61	6.41	10.0	14.4	19.6	25.7	57.7	10.3	160	231	314	411	520	641	776	924
60.00	0.105	0.419	1.67	3.77	6.70	10.5	15.1	20.5	26.8	60.3	107	167	241	328	429	542	670	810	964
65.00	0.109	0.435	1.74	3.92	6.97	10.9	15.7	21.3	27.9	62.7	111	174	251	341	446	564	697	843	1003
70.00	0.113	0.452	1.81	4.06	7.23	11.3	16.3	22.1	28.9	65.0	116	181	260	354	463	585	723	874	1041
75.00	0.117	0.467	1.87	4.21	7.48	11.7	16.8	22.9	29.9	67.3	120	187	269	366	479	606	748	905	1077
80.00	0.121	0.482	1.93	4.34	7.72	12.1	17.4	23.6	30.9	69.5	124	193	278	378	494	625	772	934	1112
85.00	0.124	0.497	1.99	4.47	7.95	12.4	17.9	24.4	31.8	71.6	127	199	286	390	509	644	795	962	1145
90.00	0.128	0.511	2.04	4.60	8.18	12.8	18.4	25.1	32.7	73.6	131	204	294	401	524	663	818	990	1178
95.00	0.131	0.525	2.10	4.73	8.40	13.1	18.9	25.7	33.6	75.6	134	210	302	412	538	680	840	1016	1210
100.00	0.135	0.538	2.15	4.85	8.61	13.5	19.4	26.4	34.5	77.5	138	215	310	422	551	698	861	1042	1241
105.00	0.138	0.551	2.21	4.96	8.82	13.8	19.9	27.0	35.3	79.4	141	221	318	432	565	7151	882	1068	1271
110.00	0.141	0.564	2.26	5.08	9.03	14.1	20.3	27.6	36.1	81.2	144	226	325	442	578	731	903	1092	1300

Regenair® Filter Restrictions with Clean Element

Inlet Filters

Blower Size	Filter Number	Restriction in Inches of H_2O at CFM Flow Indicated
R1	AJ126B	2.2” @ 27 CFM
R2	AJ126B	4.5” @ 40 CFM
R3	AJ126C	2.5” @ 50 CFM
R4H	AJ126D	8” @ 120 CFM
R4	AJ126D	4” @ 85 CFM
R4P	AJ126D	8” @ 120 CFM
R5	AJ126D	11” @ 146 CFM
R4M	AJ126F	10” @ 240 CFM
R6	AJ126F	7” @ 200 CFM
R6P/R6PS	AJ126F	11” @ 265 CFM
R7H	AJ126F	7” @ 200 CFM
R6PP	(2) AJ126F	10” @ 240 CFM
R7/R7S	AJ126G	12” @ 400 CFM
R7P	(2) AJ126G	12”@ 400 CFM
R9	AJ126L	4” @ 600 CFM
R9S	AJ126M	Consult factory
R9P	AJ126M	Consult factory

Inline Filters

Blower Size	Filter Number	Restriction in Inches of H_2O at CFM Flow Indicated
R1	AJ151A	1” @ 25 CFM
	AV460	2” @ 25 CFM
R2	AJ151B	2” @ 40 CFM
	AV460	5” @ 40 CFM
R3	AJ151C	2” @ 50 CFM
	AV460C	3” @ 50 CFM
R4	AJ151D	3” @ 100 CFM
R4P	AJ151E	3” @ 100 CFM
R4H	AJ151E	3” @ 120 CFM
R5	AJ151E	4” @ 160 CFM
R6	AJ151G	2” @ 200 CFM
R4M	AJ151G	2.5 @ 240 CFM
R7H	AJ151G	2” @ 200 CFM
R6P/R6PS	AJ151G	3” @ 300 CFM
R7/R6PP	AJ151H	8”@ 400 CFM
R9	AJ151L	2” @ 600 CFM
R9S	AJ151 M	Consult factory
R9P	AJ151 M	Consult factory

Technical Information and Definitions

Definitions:

CFM–cubic feet of air per minute
SP–static pressure inches of water
HP–horsepower
RPM–speed in revolutions per minute
d–density in pounds per cubic foot
1–known conditions
2–desired conditions

Standard Air-air at 68°F (absolute temperature 528°) and 29.92" Hg. (barometric pressure at sea level). The density of such air is 0.075 lbs./cu.ft. and the specific volume is 13.29 cu. ft./lb. The specific gravity is 1.0.

H_2O CFM vs SCFM
The difference between "Cubic Feet Per Minute" and "Standard Cubic Feet Per Minute" is simply one of air density. The word "Standard", in this unit of measure, refers to the air being at standard temperature and pressure. In this case it will have standard air density. Regenair blowers performance is stated in terms of CFM, the volume of air they move.

Fan Laws

The following fan laws apply for the range of air performance where induction motor-driven blowers operate, that is, under 100 inches of water static pressure or vacuum (where it may be assumed that air is incompressible). The fan laws may also be used if the pressure of both fan conditions is over 100 inches of water but the pressure change is less than 30%.

1. Effect Of A Speed Change

CFM is proportional to Speed	$CFM_2 = CFM_1 \times (RPM_2/RPM_1)$
(The volume changes in direct ratio to the speed)	
SP is proporational to Speed^2	$SP_2 = SP_1 \times (RPM_2/RPM_1)^2$
(The pressure changes as the square of the speed ratio)	
HP is proportional to Speed^3	$HP_2 = HP_1 \times (RPM_2/RPM_1)^3$
(The horsepower changes as the cube of the speed ratio)	(Also known as the 1-2-3 rule of blowers)

2. Altitude And Temperature Change The Density Of Air

CFM is constant	$CFM_2 = CFM_1$
SP is proportional to density	$SP_2 = SP_1 (d_2/d_1)$
HP is proportional to density	$HP_2 = HP_1 (d_2/d_1)$

Volume Changes In Direct Ratio To Speed

For example, a blower is operating at 3500 RPM and delivering 800 cfm. If the speed is reduced to 3000 RPM, what is the new volume?

Let:

V_1 –original volume	RPM_1 –orginal speed
V_2 –new volume	RPM_2 –new speed

$V_2 = V_1 \times (RPM_2/RPM_1)^1$ $V_2 = 800 \times (3000/3500)^1 = 800 \times .857 = 686$ CFM

Pressure Changes As The Square Of The Speed Ratio

For example, a blower is operating at a speed of 3500 RPM and delivering air at 3 psi. If the speed is reduced to 3000 RPM, what is the new pressure?

Let:
P_1 –orginal pressure (3 psi)
P_2 –new pressure
RPM_1 –original speed
RPM_2 –new speed

$P_2 = P_1 \times (RPM_2/RPM_1)^2$ $P_2 = 3 \times (3000/3500)^2 = 3 \times .735 = 2.21$ psig = 83 inches of water pressure

Air Density Varies In Inverse Proportion To Absolute Temperature

For example, a blower is to handle 150°F air at 40 inches of water pressure. What pressure (standard air) blower is required?

Let:

P_1 –pressure hot air (40 inches of water)

P_2 –pressure standard air

AT_1 –absolute temperature hot air (150+460=610°)

AT_2 –absolute temperature standard air (68+460=528°)

$P_2 = P_1 X (AT_1/AT_2)$

$P_2 = 40 X (610/528) = 40 X 1.15 = 46$ inches of water

Temperature in Degrees of Fahrenheit	% Of Change In Air Density Compared to 70°
100	–5
90	–4
70	0
60	+2
50	+4
40	+6
30	+8
20	+10
10	+13

If a blower is capable of delivering 30 inches of water pressure with standard air, what pressure will it develop handling 150°F inlet air?

$P_1 = P_2 X (AT_2/AT_1)$

$P_1 = 30 X (528/610) = 30 X.866 = 26$ inches of water pressure

Relation Of Density To Inlet Volume

At high altitudes it is frequently specified that a specific blower must be capable of handling a given volume of "standard air". For example, a blower is to operate at 5000 feet and is to handle 500 CFM of standard air. To determine the equivalent volume of air the blower must handle at the higher altitude:

Let:

V_1 –volume of standard air (500 CFM)

V_2 –volume of thinner air

Hg_1 –barometric pressure sea level (29.92)

Hg_2 –barometric pressure at altitude (24.89 for 5000 feet)

$V_2 = V_1 X (Hg1/Hg2)$

$V_2 = 500 X (29.92/24.89) = 601$ CFM of air at 5000 feet altitude

Pressure Varies In Direct Proportion To Density

For example, a blower operating at 80 inches of water with standard air is to be used to handle air having a specific gravity of 0.8. What pressure does the blower create when handling the air?

Let:

Pa – air pressure

Pg – gas pressure

SG – specific gravity of gas

$Pg = Pa X SG$

$Pg = 80 X 0.8 = 64$ inches of water

Horsepower Changes As The Cube Of The Speed Ratio

For example, a blower is operating at a speed of 3500 RPM and requiring 5 horsepower. If the speed is reduced to 3000 RPM, what is the new required horsepower?

Let:

HP_1 –original horsepower

HP_2 –new horsepower

RPM_1 –original speed

RPM_2 –new speed

$HP_2 = HP_1 X (RPM_2/RPM_1)^3$

$HP_2 = 5 X (3000/3500)^3 = 5 X .630 = 3.15$ horsepower

Calculating System Friction Loss

Friction causes pressure loss in all systems. Plumbing design and length affect this loss in air flow.

1. Determine total straight pipe equivalent.
List number of each fitting in system. Circle the column under the supply pipe size. Multiply the number of each item by the pipe size conversion factor to find the equivalent amount of straight pipe. Add equivalent figures to actual straight pipe figures.

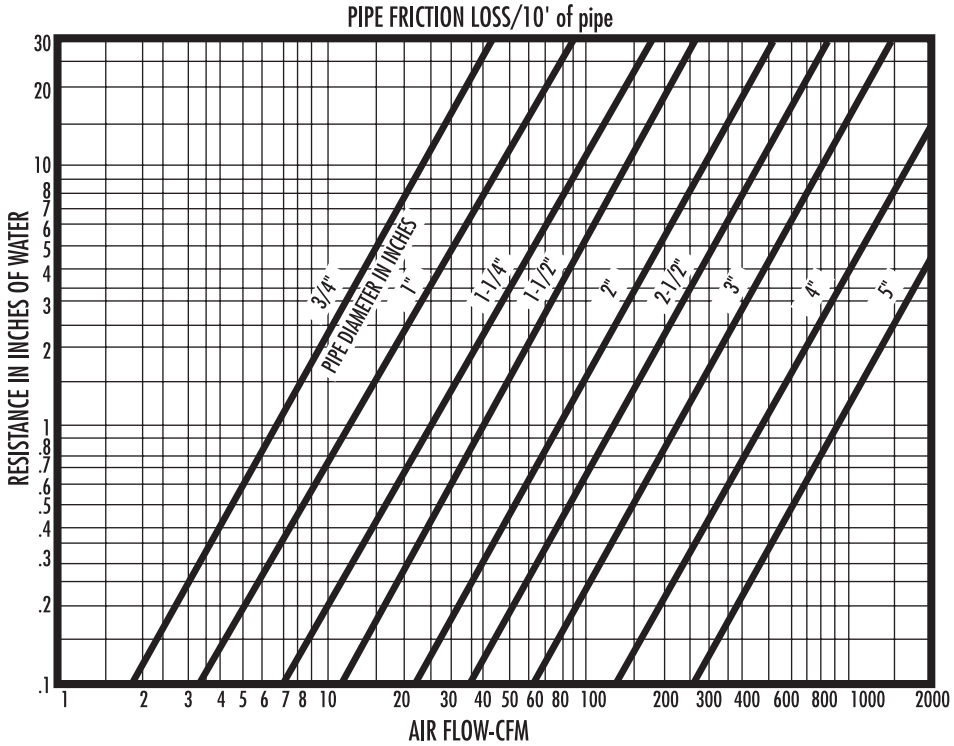
Friction loss in pipe fittings equivalent length of straight pipe

Fitting	#	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	5"	Equivalent Ft.
90° Elbows	___x	2.0	3.0	3.5	4.0	5.0	6.0	8.0	10.0	12.6	= _____
Std. through tees	___x	1.5	2.0	2.5	3.0	3.5	4.0	5.0	7.0	8.4	= _____
Std. branch tees	___x	4.0	5.0	7.0	8.0	10.5	12.5	15.5	20.0	25.2	= _____
Check valves	____x	7.0	9.0	11.5	13.5	17.0	20.5	25.5	34.0	42.0	= _____
Gate Valves	____x	0.55	0.7	0.9	1.0	1.5	2.0	2.0	3.0	3.4	= _____

Total length of straight pipe = _____ft.

Total straight pipe equivalent = _____ft.

2. Determine total friction loss in pipe system.
On bottom line of the pipe friction loss chart, mark the air flow needed. Using a ruler, scan vertically from the CFM figure to the diagonal line for the proper pipe size. Mark the intersection and then scan to the left (vertical) axis to find the friction loss figure.



3. Divide the Total straight pipe equivalent from step 1 by 10; multiply by friction loss figure just determined to get the total friction loss in the pipe system.

_____ ÷ 10 x _____ = _____

Total feet of pipe in system | Friction loss factor | Total friction loss in system in inches of H_2O

Sound Data

OSHA Regulation Occupational Noise Exposure 1910.95 provides that protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table 1 when measured on the A scale of a standard sound level meter at slow response.

Table 1

Duration per day, hours	Sound level dBa slow response
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115

The Sound Pressure Levels Of Various Common Noises And Typical Quantitative Evaluation By The Human Ear

Noise Source	Sound Pressure Level (dB)	Human Evaluation
Jet Engine	130	Threshold of feeling
Thunder	120	Deafening
Jackhammer	110	
Heavy Machinery Factory	100	
Lound street noise		Very loud
Noisy factory	90	
Referee's whistle	80	
Noisy office		Loud
Average street noise	70	
Average radio		
Average factory	60	
Noisy home		Moderate
Average office	50	
Average conversation		
Quiet radio	40	
Quiet home		
Private Office	30	Faint
Average auditorium		
Quiet conversation	20	
Rustle of leaves	10	Very faint
Whisper	0	<– Threshold of audibility

Sound Pressure Level Decreases With Distance According To This Formula:

(SPL)2 = (SPL)1 - 20LOG (d2/d1)

Where:

(SPL)2 = New Sound Pressure Level
(SPL)1 = Original Sound Pressure Level
d2 = New distance from sound generator
d1 = Original distance from sound generator

Thus, each doubling of distance results in 6 dBa reduction in Sound Pressure Level

NOTE: this formula assumes that no noise is reflected. In a room that reflects most sound energy (having walls with a low noise reduction co-efficient) much less reduction in noise level with increased distance will be observed than is predicted with this formula.

Noise Q & A

Q. How do I decrease blower noise?

A. Common methods used to decrease blower noise include:

- Having the cover side face where you want the reduction in noise to be and having sound absorbing material diminish sound reflected from the motor side of the blower
- Checking the supporting structure for rattling
- Controlling reflected noise with sound absorbing material
- Moving the blower away from the operator, in another room, possibly in a different area or outside.

Q. Typically how much does the noise output of Gast blowers vary with changes in pressure or vacuum?

A. This varies a lot from model to model with some models little or no change and with others, as much as 9 dBa.

Q. Tyically how much does the noise output of Gast blowers change between 60 Hz and 50 Hz?

A. Generally 50 Hz is 3 dBa quieter than 60Hz but this varies from model to model.

Q. On Gast dual blowers when do I need the large accessory muffler?

A. These blowers provide silencing for either the inlet or exhaust but not both. If, for example, the discharge of the blower is underwater or in some location where the noise passing through the pipe is contained and not objectionable no additional silencer is needed. Where this ringing noise is not contained and noise control is needed, we manufacture accessory mufflers to greatly reduce noise levels.

Q. What happens to the noise when I locate two blowers close together?

A. If the blowers are of the same design they produce sound frequencies that are close together. These may cause a “beating” change in volume of the blower noise. This is because the units are not synchronized. If two small blowers are needed this change in volume can be reduced by moving tham further apart. With larger blowers a dual blower with two blowers on one motor will solve this problem.

Q. What causes the noise relief valves make?

A. Air rush through the valve.

Q. How do I control relief valve or bleed off valve noise?

A. Attach AJ121 series silencer on the port of the relief valve that is open to atmosphere.

Contact Gast at 616-926-6171 or www.gastmfg.com with any further questions you may have on reducing blower noise in your application.

Noise Reduction and Absorption Coefficients for Common and Specialty Noise Reduction Materials

	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	NRC
Brick, unglazed	.03	.03	.03	.04	.05	.07	.04
Carpet 1/4 in pile height	.05	.10	.15	.30	.50	.55	.26
Fabric Heavy Velour 18 oz per sq. yd draped to 1/2 area	.14	.35	.55	.72	.70	.65	.62
Hardwood Plywood Paneling 1/4 in thick wood frame	.58	.22	.07	.04	.03	.07	.09
Tecnifoam* TFP4 Pyramind shape	.39	.60	1.21	1.14	1.16	1.13	1.05
Tecnifoam* TFW4000 Anaechoic Wedge shape	.64	1.10	1.34	1.23	1.24	1.21	1.25

Source: Mechancial Engineering Reference Manual

*TFP4 and TFW4000 are products of Tecnifoam, Inc., 7145 Boone Avenue North, Minneapolis, MN., 55428

Blower Sound Levels of Gast Blowers

Data is highest sound level out of 4 places around the blower at 1 meter.

Data represents average of several units run at nominal voltage.

Lowest to highest maximum dba level throughout performance range is shown.

Readings at other than the maximum around the blower at 1 meter may be from 2 to 10 dba less than data shown.

Readings taken in a laboratory sound room that does not reflect much noise.

Note: For comparison purposes, some blower manufacturers show sound data from 1–1/2 meters instead of from 1 meter; also, some blower manufacturers show an “average” sound level across performance instead of the full range between minimum and maximum sound levels; either of these methods will provide different and usually lower sound levels compared to Gast’s sound level method.

60Hz	dBa at Pressure	50Hz	dBa at Pressure
R1	59-67	R1	59-64
R2	66	R2	61-63
R3	67-70	R3	63-68
R4	69-73	R4	64-69
R4P	69-75	R4P	64-71
R5	73-77	R5	71-77
R6	73-79	R6	70-79
R6P	82-83	R6P	77-80
R6PP	77-79	R6PP	73-76
R6PS	76-77	R6PS	72-75
R7	82-84	R7	77-79
R7P	77-80	R7P	74-79
R7S	75-77	R7S	72-76
R9	82-85	R9	78-85
R9P	81-88	R9P	79-86
R9S	79-81	R9S	77-81
R4H	80-82	R4H	75-81
R4M	82-83	R4M	78-79
R7H	83	R7H	79-81

60Hz	dBa at Vacuum	50Hz	dBa at Vacuum
R1	58-63	R1	54-60
R2	67	R2	63-64
R3	67-71	R3	64-69
R4	70-72	R4	66-70
R4P	73-74	R4P	68-71
R5	75-76	R5	71-73
R6	78-80	R6	74-77
R6P	81-85	R6P	79-81
R6PP	81-83	R6PP	78-79
R6PS	79-81	R6PS	76-77
R7	85-87	R7	79-84
R7P	84-86	R7P	80-83
R7S	82-83	R7S	78-80
R9	85-90	R9	83-84
R9P	88-90	R9P	84-87
R9S	87-88	R9S	83-86
R4H	82-89	R4H	79-88
R4M	85-89	R4M	80-85
R7H	82-91	R7H	80-90

GAST CERTIFIED SERVICE CENTER®

GAST Manufacturing, Incorporated is making pump repair and maintenance a little easier.

If you want to keep your pneumatic pumps running at peak performance and with lower operating costs, contact one of our GAST Certified Service Centers listed below for more details:

Gast Manufacturing Inc.
2550 Meadowbrook Road
Benton Harbor, MI 49022
TEL: 616-926-6171
FAX: 616-925-8288
www.gastmfg.com

Gast Manufacturing Inc.
505 Washington Avenue
Carlstadt, NJ 07072
TEL: 201-933-8484
FAX: 201-933-5545
www.gastmfg.com

Hydraulic & Pneumatic Sales
11100 Park Charlotte Blvd.
Charlotte NC 28273
TEL: 704-588-3234
FAX: 704-588-1569
www.hpsales.com

D & F Distributors
1144 Indy Court
Evansville, IN 47725
TEL: 812/867-2441
FAX: 812/867-6822
www.dfdistrib.com

John Henry Foster Co.
4700 Lebourget Drive
St. Louis, MO 63134-0820
TEL: 314-427-0600
TEL: 1-800-444-0522
FAX: 314-427-3502
www.jhf.com

Brenner Fiedler & Assoc
13824 Bentley Place
Cerritos, CA 90701
TEL: 800-843-5558
TEL: 310-404-2721
FAX: 310-404-7975
www.brenner-fiedler.com

Air-Oil Products Corporation
301 30th Street NE 31, #112
Auburn, WA 98002
TEL: 800-282-2672
FAX: 877-808-4601
www/air-oilproducts.com

Wainbee Limited
5789 Coopers Avenue
Mississauga, Ontario
Canada L4Z 3S6
TEL: 905-568-1700
FAX: 905-568-0083
http://www.wainbee.ca

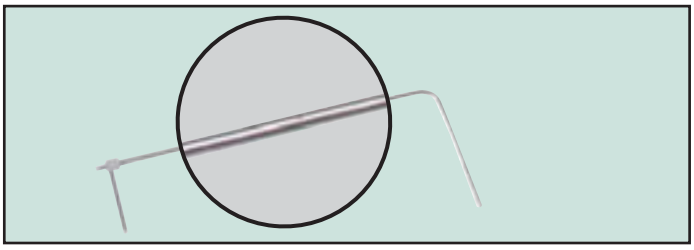
Wainbee Limited
215 boul Brunswick
Pointe Claire, Quebec
Canada H9R 4R7
TEL: 514-697-8810
FAX: 514-697-3070
http://www.wainbee.ca

Gast Manufacturing Co., Ltd.
Beech House
Knaves Beech Business Centre
Loudwater, High Wycombe
Bucks, England HP10 9SD
TEL: 011-44 1628 532600
FAX: 011-44 1628 532470
http://www.gastltd.com

Japan Machinery Co., Ltd
Central PO Box 1451
Tokyo, 100-91 Japan
TEL: 813 3573 5421
FAX: 813 3571 7865
or: 81-3-3571-7896
www.japanmachinery.com

Series 160 Stainless Steel Pitot Tubes

ASME Design Meets AMCA and ASHRAE Codes



Standard Model 160 Pitot Tube

Ideal for use with our precision manometers and air velocity gages, Dwyer Pitot Tubes are constructed from corrosion resistant stainless steel for a lifetime of service. ASME design meets AMCA and ASHRAE specifications for maximum accuracy over a wide variety of flow conditions. No correction factors required as ASHRAE tip design yields a calibration factor of 1. ASHRAE design needs no calibration! Permanent, stamped insertion depth graduations on sides of 160 series facilitate accurate positioning. Static pressure port is parallel to sensing tube allowing quick, easy alignment of tube with air flow. Low sensitivity to misalignment gives accurate reading even when tube is misaligned up to 15 degrees. Various standard sizes are available for use in ducts as small as 4" dia. or as large as 36 ft. dia. A universal model fits user supplied ¾" schedule 40 (standard) pipe in any length. Several convenient mounting options are available for permanent installations.

- No calibration needed.
- Precisely located, burr-free static pressure holes.
- Hemispherical tip design, best for accuracy if imperfectly aligned and nearly impossible to damage.
- Long lasting 304 stainless steel construction.
- Silver soldered connections for leak-proof operation.
- ASME design meets AMCA and ASHRAE specifications.
- Coefficient of "1."
- 5⁄16" models rated to 1500°F.
- Extended static connection helps guide tip within recommended 15° of air flow direction.
- Inch graduations on sides of 160 series to quickly determine exact insertion depth.
- Dwyer Air Velocity Calculator, direct reading flow charts and instructions included.
- Use ⅛" models in ducts as small as 4", 5⁄16" models in ducts 10" or larger.
- Optional mounting gland or split flange make permanent installation fast and simple.

A-158 Split Flange Mounting

ACCESSORIES

No. A-158 Split Flange Mounting can be added to any Dwyer No. 160 Standard Pitot Tube. Cadmium plated steel. Gasket is pattern for mounting holes. Secure flange loosely to tube, adjust tube depth and tighten screws. Gasket of 1⁄16" Neoprene fits tightly around tube and against duct for leak-proof seal. Nuts, washers included.

No. A-159 Mounting Gland — No. A-159 Mounting Gland — Versatile adapter slips on any Series 160, 5/16˝ standard Pitot tube made after Dec. 1990. Two-part stainless steel fitting slides over tube and provides permanent, secure mounting. Where duct interior is accessible, use the washers and jam nut supplied. For blind applications or in thicker materials, use model A-156 flange mounting plate. Once tube is adjusted to proper depth and angle, tighten smaller hex bushing to lock position. Graphite bushing inside assures leak-proof seal even at higher temperatures. Teflon® bushing also available. **NOTE:** For full insertion with this fitting, order next longer Pitot tube.

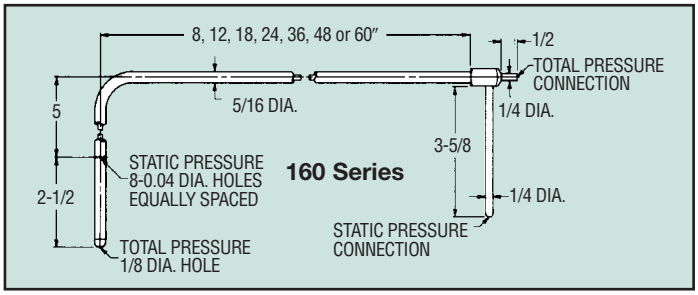
No. A-397 Step Drill. For fast, convenient installation of Pitot tubes in sheet metal ducts. No center punch needed; automatic de-burring. Drills six sizes from 3⁄16"-½" in 1⁄16" increments.

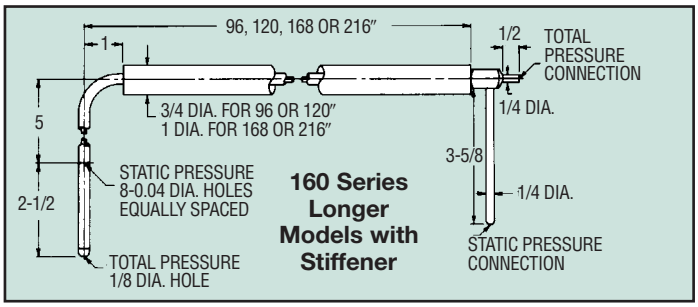
A-159 Mounting Gland is used for both duct mounting and flange mounting. To flange mount, the A-159 must be used with the A-156 flange mounting plate.

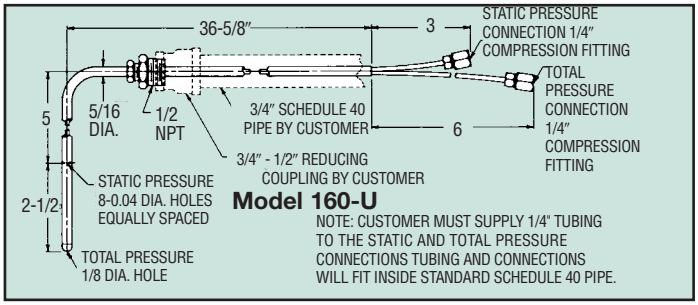
A-159 Duct Mounting Gland

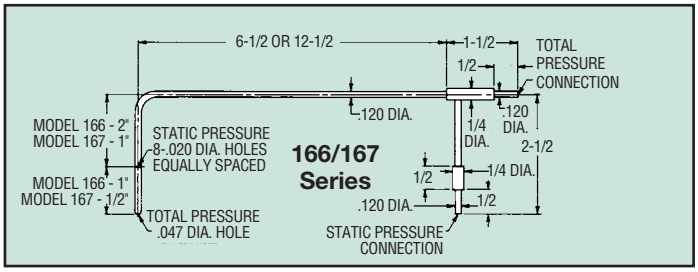
A-156 Flange Mounting Plate

A-397 Step Drill









STOCKED MODELS in bold

Standard 5⁄16" Dia.		Longer Length w/ Stiffener	
Model Number	**Insertion Length**	**Model Number**	**Insertion Length**
160-8	8"	160-96	96"
160-12	12"	160-120	120"
160-18	18"	160-168	168"
160-24	24"	160-216	216"
160-36	36"	**Pocket Size ⅛" Dia.**	
160-48	48"	**166-6**	6"
160-60	60"	**166-12**	12"
Universal Model for ¾" Pipe		**167-6**	6"
160-U	*	**167-12**	12"

Accessories & Options	
A-156 Flange Mounting Plate 1/2˝ female NPT **A-158 Split Flange** **A-159 Mounting Gland** **A-397 Step Drill**	**Compression Fitting** mounting option for 166/167 Series. Add -CF suffix (166-6-CF). Add to prices above

*Universal model for permanent installation and connection to metal tubing. Make any length Pitot tube with ¾" schedule 40 pipe, ¾" to ½" reducing bushing and ¼" metal tubing.

See also: Ellipsoidals "S" Type Pitot Tubes - page 179

Series 477

Handheld Digital Manometer

Selectable Pressure Units, ±0.5% Accuracy, FM Approved Intrinsically Safe for Hazardous Locations, Class 1, Div. 1, Group A, B, C, D, T4

- Instant Selection from up to Nine English/Metric Units.
- Stores 20 Readings in Memory for Later Reference.
- Measure Positive, Negative or Differential Pressures.
- Large Easy-to-Read 0.4" LCD Display Includes Switchable Backlight for Great Visibility — Anywhere!
- Both Audible and Visual Overpressure Alarms.
- Includes + and - Indicators plus Low Battery Warning.
- Operates up to 100 Hours on a Single 9 Volt Battery.
- FM Approved

Series 477 Handheld Digital Manometers are packed with features you need to make pressure measurement and recording faster, easier and more accurate than ever. First, you can instantly select from up to nine of the most widely used pressure units without having to waste time and risk mistakes with tedious conversions. Next, a non-volatile memory function enables storage of up to 20 readings – perfect for HVAC technicians making Pitot tube traverses of airflow readings across a duct. The Series 477 is FM approved intrinsically safe for hazardous locations, Class 1, Div. 1, Group A, B, C, D, T4. When working in poorly lighted areas, just switch on the handy backlight feature. It automatically shuts itself off after 2 minutes to minimize battery drain. Electronic zeroing means you simply touch a single key to perfectly null out any minor pressure differences. A display HOLD key freezes the current pressure for those all-too-common situations where readings fluctuate. We even included an audible alarm to warn you of overpressure plus a visual alarm warning in case ambient noise levels are too high to hear the alarm. Audible alarm also confirms a value has been stored, eliminating the need to observe display during a duct traverse.

Clear, concise operating instructions for all functions are printed on the rear of the rugged extruded aluminum case for quick reference. One-piece front membrane fully protects all keys from dust and moisture; wipes clean in seconds. Detailed written instructions, a wrist strap and 9 volt alkaline battery are included.

Now FM Approved

SPECIFICATIONS

Service: Air and combustible, compatible gases.
Wetted Materials: Consult Factory.
Accuracy: : ±0.5% F.S., 60 to 78°F (15.6 to 25.6°C); ±1.5% F.S. from 32 to 60°F and 78 to 104°F (0 to 15.6°C and 25.6 to 40°C).
Pressure Hysteresis: ±0.1% of full scale.
Pressure Limits: See Chart.
Temperature Limits: 32 to 104°F (0 to 40°C).
Storage Temperature Limits: -4 to 176°F (-20 to 80°C).
Display: 0.42" (10.6 mm) 4-1/2" digit liquid crystal.
Resolution: See chart.
Power Requirements: 9 volt alkaline battery. Battery included but not connected.
Weight: 10.2 oz. (289 g).
Connections: Two barbed connections for use with 1/8" (3.18 mm) or 3/16" (4.76 mm) I.D. tubing. Two compression fittings for use with 1/8" (3.18 mm) I.D. x 3/16" (4.76 mm) O.D. tubing for 477-6-FM & 477-7-FM only.
Agency Approvals: FM, CE.

A-402A CARRYING CASE – Tough gray nylon pouch protects any Series 477 Manometer. Double zippered for quick and easy access. With belt loop that snaps closed.
7½"H x 3"W x 2¼"D
(191 x 76 x 57 mm)

STOCKED MODELS in bold

Model Number	English Range	Metric Range	Maximum Pressure
477-1-FM	0-20.00 in. w.c.	0-5 kPa	11 psi (0.75 bar)
477-2-FM	0-40.00 in. w.c.	0-10 kPa	11 psi (0.75 bar)
477-3-FM	0-200.0 in. w.c.	0-50 kPa	29 psi (1.99 bar)
477-4-FM	0-10.00 psid	0-70 kPa	58 psi (3.99 bar)
477-5-FM	0-30.00 psid	0-200 kPa	58 psi (3.99 bar)
477-6-FM	0-100.0 psid	0-700 kPa	150 psi (10.3 bar)
477-7-FM	0-150.0 psid	0-1000 kPa	200 psi (13.7 bar)

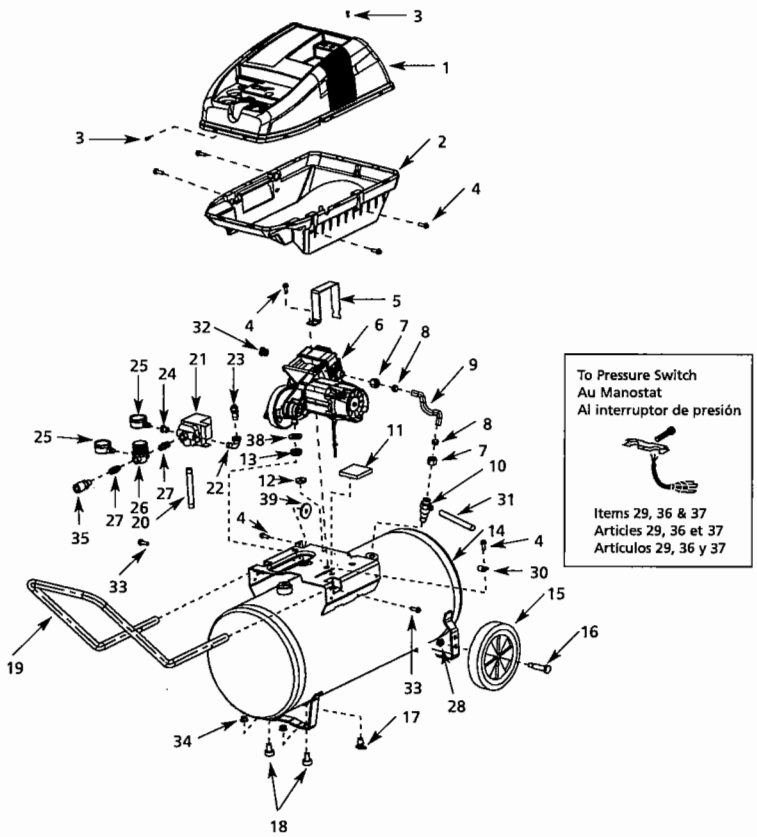
PRESSURE UNITS AVAILABLE

Model Number	PSID	IN. H-0	MM H-0	IN. Hg	MM Hg	Pa	kPa	bar	Mbar
477-1-FM	▲	▲	▲	▲	▲	▲	▲	▲	▲
477-2-FM	▲	▲	▲	▲	▲	▲	▲	▲	▲
477-3-FM	▲	▲	▲	▲	▲		▲	▲	▲
477-4-FM	▲	▲	▲	▲	▲		▲	▲	▲
477-5-FM	▲	▲		▲	▲		▲	▲	▲
477-6-FM	▲	▲		▲	▲		▲	▲	▲
477-7-FM	▲	▲		▲	▲		▲	▲	▲

Oilless Air Compressors
Compresseurs D'Air Sans Huile
Compresores Sin Aceite

Replacement Parts List
Lista de Repuestos
Liste de Pièces de Rechange

WL650000, WL650100, WL604010, WL650200, WL650300, WL650400



For Replacement Parts, Call 1-800-543-6400

Please provide the following information:
-Model number
-Serial number (if any)
-Part description and number as shown in parts list

Address parts correspondence to:

The Campbell Group
Attn: Parts Dept.
100 Production Drive
Harrison, OH 45030 USA

Ref. No.		Description	Part Number WL650000	WL650100	WL604010	Qty.
1		Top cover	WL008600AV	WL008600AV	WL008600AV	1
2		Lower cover	WL008500AV	WL008500AV	WL008500AV	1
3		Screw	ST074420AV	ST074420AV	ST074420AV	2
4		Screw	ST074415AV	ST074415AV	ST074415AV	7
5		Motor bracket	BA018300AV	BA018300AV	BA018300AV	1
6		Pump/motor assembly	WL390000AJ	WL390000AJ	WL390000AJ	1
7		Compression nut	ST033001AV	ST033001AV	ST033001AV	2
8		Rubber sleeve	ST067300AV	ST067300AV	ST067300AV	2
9		Exhaust tube	WL011200AP	WL011200AP	WL011200AP	1
10		Check valve	CV221506AJ	CV221506AJ	CV221506AJ	1
11	▲	Motor pad	WL007800AV	WL007800AV	WL007800AV	1
12	▲	Isolator	WL008100AV	WL008100AV	WL008100AV	1
13	▲	Grommet	WL008000AV	WL008000AV	WL008000AV	1
14		Tank	AR045000CG	AR045000CG	AR045000CG	1
15		Wheel	WA004700AV	WA004700AV	WA004700AV	2
16		Axle bolt	ST033400AV	ST033400AV	ST033400AV	2
17		Drain cock	D-1401	D-1401	D-1401	1
18		Foot	ST162600AV	ST162600AV	ST162600AV	2
19		Handle	HL004300AV	HL004300AV	HL004300AV	1
20		Pipe nipple	ST070307AV	ST070307AV	ST070307AV	1
21		Pressure switch	CW207589AV	CW207589AV	CW207589AV	1
22		Elbow	ST071202AV	ST071202AV	ST071202AV	1
23		Safety valve	V-215100AV	V-215100AV	V-215100AV	1
24		Adapter	ST071407AV	ST071407AV	ST071407AV	1
25		Gauge	GA016303AV	GA016303AV	GA016303AV	2
26		Regulator	RE206202AV	RE206202AV	RE206202AV	1
27		Nipple	HF007300AV	—	—	2
		Nipple	—	HF007300AV	HF007300AV	1
28		Nut	ST033500AV	ST033500AV	ST033500AV	2
29		Power cord with plug	EC012601AV	EC012601AV	EC012601AV	1
30		Clip	ST166800AV	ST166800AV	ST166800AV	1
31		Flexible tube	ST117804AV	ST117804AV	ST117804AV	1
32		Inlet tube	WL011800AV	WL011800AV	WL011800AV	1
33		Screw	ST073273AV	ST073273AV	ST073273AV	2
34		Nut	ST146000AV	ST146000AV	ST146000AV	2
35		Coupler	MP288300AV	—	—	1
36		Strain relief	CW000703AV	CW000703AV	CW000703AV	1
37		Strain relief screw	ST074418AV	ST074418AV	ST074418AV	1
38		Washer	ST070933AV	ST070933AV	ST070933AV	1
39		Washer	ST077311AV	ST077311AV	ST077311AV	1
REPLACEMENT PARTS KITS						
	▲	Isolator kit (Includes #11, 12, 13)	WL211300AJ	WL211300AJ	WL211300AJ	1

For Replacement Parts, Call 1-800-543-6400

Please provide the following information:
-Model number
-Serial number (if any)
-Part description and number as shown in parts list

Address parts correspondence to:

The Campbell Group
Attn: Parts Dept.
100 Production Drive
Harrison, OH 45030 USA

Ref. No.		Description	Part Number WL650200	WL650300	WL650400	Qty.
1		Top cover	WL008600AV	WL008600AV	WL008600AV	1
2		Lower cover	WL008500AV	WL008500AV	WL008500AV	1
3		Screw	ST074420AV	ST074420AV	ST074420AV	2
4		Screw	ST074415AV	ST074415AV	ST074415AV	7
5		Motor bracket	BA018300AV	BA018300AV	BA018300AV	1
6		Pump/motor assembly	WL390000AJ	WL390000AJ	WL390000AJ	1
7		Compression nut	ST033001AV	ST033001AV	ST033001AV	2
8		Rubber sleeve	ST067300AV	ST067300AV	ST067300AV	2
9		Exhaust tube	WL011200AP	WL011200AP	WL011200AP	1
10		Check valve	CV221506AJ	CV221506AJ	CV221506AJ	1
11	▲	Motor pad	WL007800AV	WL007800AV	WL007800AV	1
12	▲	Isolator	WL008100AV	WL008100AV	WL008100AV	1
13	▲	Grommet	WL008000AV	WL008000AV	WL008000AV	1
14		Tank	AR045300CG	AR045400CG	AR045500CG	1
15		Wheel	WA004700AV	WA004700AV	WA004700AV	2
16		Axle bolt	ST033400AV	ST033400AV	ST033400AV	2
17		Drain cock	D-1401	D-1401	D-1401	1
18		Foot	ST162600AV	ST162600AV	ST162600AV	2
19		Handle	HL004300AV	HL004300AV	HL004300AV	1
20		Pipe nipple	ST070307AV	ST070307AV	ST070307AV	1
21		Pressure switch	CW207589AV	CW207589AV	CW207589AV	1
22		Elbow	ST071202AV	ST071202AV	ST071202AV	1
23		Safety valve	V-215100AV	V-215100AV	V-215100AV	1
24		Adapter	ST071407AV	ST071407AV	ST071407AV	1
25		Gauge	GA016303AV	GA016303AV	GA016303AV	2
26		Regulator	RE206202AV	RE206202AV	RE206202AV	1
27		Nipple	HF007300AV	HF007300AV	HF007300AV	1
28		Nut	ST033500AV	ST033500AV	ST033500AV	1
29		Power cord with plug	EC012601AV	EC012601AV	EC012601AV	1
30		Clip	ST166800AV	ST166800AV	ST166800AV	1
31		Flexible tube	ST117804AV	ST117804AV	ST117804AV	1
32		Inlet tube	WL011800AV	WL011800AV	WL011800AV	1
33		Screw	ST073273AV	ST073273AV	ST073273AV	2
34		Nut	ST146000AV	ST146000AV	ST146000AV	2
35		Coupler	—	—	—	1
36		Strain relief	CW000703AV	CW000703AV	CW000703AV	1
37		Strain relief screw	ST074418AV	ST074418AV	ST074418AV	1
38		Washer	ST070933AV	ST070933AV	ST070933AV	1
39		Washer	ST077311AV	ST077311AV	ST077311AV	1
REPLACEMENT PARTS KITS						
	▲	Isolator kit (Includes #11, 12, 13)	WL211300AJ	WL211300AJ	WL211300AJ	1

Para Ordenar Repuestos, Sírvase Llamar al Distribuidor más Cercano a su Domicilio

Sírvase darnos la siguiente información:
-Número del modelo
-Número de serie (de haberlo)
-Descripción y número del repuesto según la lista de repuestos

Puede escribirnos a:
The Campbell Group
Attn: Parts Dept.
100 Production Drive
Harrison, OH 45030 USA

No. de Ref.		Description	Número de Pieza WL650000	WL650100	WL604010	Ctd.
1		Cubierta superior	WL008600AV	WL008600AV	WL008600AV	1
2		Cubierta inferior	WL008500AV	WL008500AV	WL008500AV	1
3		Tornillo	ST074420AV	ST074420AV	ST074420AV	2
4		Tornillo	ST074415AV	ST074415AV	ST074415AV	7
5		Soporte del motor	8A018300AV	8A018300AV	8A018300AV	1
6		Ensamble bomba/motor	WL390000AJ	WL390000AJ	WL390000AJ	1
7		Tuerca de compresión	ST033001AV	ST033001AV	ST033001AV	2
8		Manga de caucho	ST067300AV	ST067300AV	ST067300AV	2
9		Tubo de escape	WL011200AP	WL011200AP	WL011200AP	1
10		Válvula de chequeo	CV221506AJ	CV221506AJ	CV221506AJ	1
11	▲	Almohadilla del motor	WL007800AV	WL007800AV	WL007800AV	1
12	▲	Aislador	WL008100AV	WL008100AV	WL008100AV	1
13	▲	Ojal	WL008000AV	WL008000AV	WL008000AV	1
14		Tanque	AR045000CG	AR045000CG	AR045000CG	1
15		Rueda	WA004700AV	WA004700AV	WA004700AV	2
16		Perno del eje	ST033400AV	ST033400AV	ST033400AV	2
17		Llave de drenaje	D-1401	D-1401	D-1401	1
18		Pata	ST162600AV	ST162600AV	ST162600AV	2
19		Mango	HL004300AV	HL004300AV	HL004300AV	1
20		Niple para tuberías	ST070307AV	ST070307AV	ST070307AV	1
21		Presostato	CW207589AV	CW207589AV	CW207589AV	1
22		Codo	ST071202AV	ST071202AV	ST071202AV	1
23		Válvula de seguridad	V-215100AV	V-215100AV	V-215100AV	1
24		Adaptador	ST071407AV	ST071407AV	ST071407AV	1
25		Manómetro	GA016303AV	GA016303AV	GA016303AV	2
26		Regulador	RE206202AV	RE206202AV	RE206202AV	1
27		Niple	HF007300AV	—	—	2
		Niple	—	HF007300AV	HF007300AV	1
28		Tuerca	ST033500AV	ST033500AV	ST033500AV	2
29		Cordón eléctrico con enchufe	EC012601AV	EC012601AV	EC012601AV	1
30		Sujetador	ST166800AV	ST166800AV	ST166800AV	1
31		Tubo flexible	ST117804AV	ST117804AV	ST117804AV	1
32		Tubo de entrada	WL011800AV	WL011800AV	WL011800AV	1
33		Tornillo	ST073273AV	ST073273AV	ST073273AV	2
34		Tuerca	ST146000AV	ST146000AV	ST146000AV	2
35		Acoplador	MP288300AV	—	—	1
36		Relevo de tensión	CW000703AV	CW000703AV	CW000703AV	1
37		Tornillo del relevo de tensión	ST074418AV	ST074418AV	ST074418AV	1
38		Arandela	ST070933AV	ST070933AV	ST070933AV	1
39		Arandela	ST077311AV	ST077311AV	ST077311AV	1
LISTA DE REPUESTOS						
	▲	Kit de aislador (Incluye #11, 12, 13)	WL211300AJ	WL211300AJ	WL211300AJ	1

Para Ordenar Repuestos, Sírvase Llamar al Distribuidor más Cercano a su Domicilio

Sírvase darnos la siguiente información:
-Número del modelo
-Número de serie (de haberlo)
-Descripción y número del repuesto según la lista de repuestos

Puede escribirnos a:
The Campbell Group
Attn: Parts Dept.
100 Production Drive
Harrison, OH 45030 USA

No. de Ref.		Description	Número de Pieza WL650200	WL650300	WL650400	Ctd.
1		Cubierta superior	WL008600AV	WL008600AV	WL008600AV	1
2		Cubierta inferior	WL008500AV	WL008500AV	WL008500AV	1
3		Tornillo	ST074420AV	ST074420AV	ST074420AV	2
4		Tornillo	ST074415AV	ST074415AV	ST074415AV	7
5		Soporte del motor	BA018300AV	BA018300AV	BA018300AV	1
6		Ensamble bomba/motor	WL390000AJ	WL390000AJ	WL390000AJ	1
7		Tuerca de compresión	ST033001AV	ST033001AV	ST033001AV	2
8		Manga de caucho	ST067300AV	ST067300AV	ST067300AV	2
9		Tubo de escape	WL011200AP	WL011200AP	WL011200AP	1
10		Válvula de chequeo	CV221506AJ	CV221506AJ	CV221506AJ	1
11	▲	Almohadilla del motor	WL007800AV	WL007800AV	WL007800AV	1
12	▲	Aislador	WL008100AV	WL008100AV	WL008100AV	1
13	▲	Ojal	WL008000AV	WL008000AV	WL008000AV	1
14		Tanque	AR045300CG	AR045400CG	AR045500CG	1
15		Rueda	WA004700AV	WA004700AV	WA004700AV	2
16		Perno del eje	ST033400AV	ST033400AV	ST033400AV	2
17		Llave de drenaje	D-1401	D-1401	D-1401	1
18		Pata	ST162600AV	ST162600AV	ST162600AV	2
19		Mango	HL004300AV	HL004300AV	HL004300AV	1
20		Niple para tuberías	ST070307AV	ST070307AV	ST070307AV	1
21		Presostato	CW207589AV	CW207589AV	CW207589AV	1
22		Codo	ST071202AV	ST071202AV	ST071202AV	1
23		Válvula de seguridad	V-215100AV	V-215100AV	V-215100AV	1
24		Adaptador	ST071407AV	ST071407AV	ST071407AV	1
25		Manómetro	GA016303AV	GA016303AV	GA016303AV	2
26		Regulador	RE206202AV	RE206202AV	RE206202AV	1
27		Niple	HF007300AV	HF007300AV	HF007300AV	1
28		Tuerca	ST033500AV	ST033500AV	ST033500AV	2
29		Cordón eléctrico con enchufe	EC012601AV	EC012601AV	EC012601AV	1
30		Sujetador	ST166800AV	ST166800AV	ST166800AV	1
31		Tubo flexible	ST117804AV	ST117804AV	ST117804AV	1
32		Tubo de entrada	WL011800AV	WL011800AV	WL011800AV	1
33		Tornillo	ST073273AV	ST073273AV	ST073273AV	2
34		Tuerca	ST146000AV	ST146000AV	ST146000AV	2
35		Acoplador	—	—	—	1
36		Relevo de tensión	CW000703AV	CW000703AV	CW000703AV	1
37		Tornillo del relevo de tensión	ST074418AV	ST074418AV	ST074418AV	1
38		Arandela	ST070933AV	ST070933AV	ST070933AV	1
39		Arandela	ST077311AV	ST077311AV	ST077311AV	1
LISTA DE REPUESTOS						
▲		Kit de aislador (Incluye #11, 12, 13)	WL211300AJ	WL211300AJ	WL211300AJ	1

Pour Pièces de Rechange, Composer le 1-800-543-6400

S'il vous plaît fournir l'information suivante:
-Numéro du modèle
-Numéro de série (s'il y en a un)
-Description de la pièce et son numéro sur la liste

Correspondance:

The Campbell Group
Attn: Parts Dept.
100 Production Drive
Harrison, OH 45030 USA

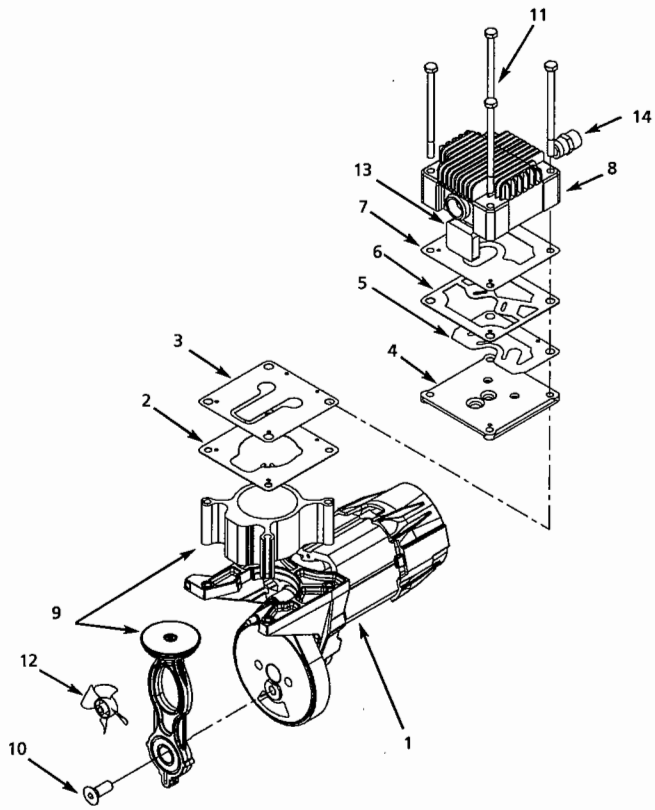
			Numéro de Piece			
N°. Réf.		Descripción	WL650200	WL650300	WL650400	Qté.
1		Couvercle supérieur	WL008600AV	WL008600AV	WL008600AV	1
2		Couvercle inférieur	WL008500AV	WL008500AV	WL008500AV	1
3		Vis	ST074420AV	ST074420AV	ST074420AV	2
4		Vis	ST074415AV	ST074415AV	ST074415AV	7
5		Support de moteur	BA018300AV	BA018300AV	BA018300AV	1
6		Montage de pompe/moteur	WL390000AJ	WL390000AJ	WL390000AJ	1
7		Écrou de compression	ST033001AV	ST033001AV	ST033001AV	2
8		Manchon en caoutchouc	ST067300AV	ST067300AV	ST067300AV	2
9		Tuyau d'échappement	WL011200AP	WL011200AP	WL011200AP	1
10		Clapet	CV221506AJ	CV221506AJ	CV221506AJ	1
11	▲	Tampon de moteur	WL007800AV	WL007800AV	WL007800AV	1
12	▲	Isolateur	WL008100AV	WL008100AV	WL008100AV	1
13	▲	Anneau	WL008000AV	WL008000AV	WL008000AV	1
14		Réservoir	AR045300CG	AR045400CG	AR045500CG	1
15		Roue	WA004700AV	WA004700AV	WA004700AV	2
16		Boulon d'arbre de roue	ST033400AV	ST033400AV	ST033400AV	2
17		Robinet de vidange	D-1401	D-1401	D-1401	1
18		Pied	ST162600AV	ST162600AV	ST162600AV	2
19		Manche	HL004300AV	HL004300AV	HL004300AV	1
20		Mamelon de tuyau	ST070307AV	ST070307AV	ST070307AV	1
21		Manostat	CW207589AV	CW207589AV	CW207589AV	1
22		Coude	ST071202AV	ST071202AV	ST071202AV	1
23		Soupape de sûreté	V-215100AV	V-215100AV	V-215100AV	1
24		Adaptateur	ST071407AV	ST071407AV	ST071407AV	1
25		Manomètre	GA016303AV	GA016303AV	GA016303AV	2
26		Régulateur	RE206202AV	RE206202AV	RE206202AV	1
27		Raccord	HF007300AV	HF007300AV	HF007300AV	1
28		Écrou	ST033500AV	ST033500AV	ST033500AV	2
29		Cordon d'alimentation avec fiche	EC012601AV	EC012601AV	EC012601AV	1
30		Attache	ST166800AV	ST166800AV	ST166800AV	1
31		Tuyau flexible	ST117804AV	ST117804AV	ST117804AV	1
32		Tuyau d'arrivée	WL011800AV	WL011800AV	WL011800AV	1
33		Vis	ST073273AV	ST073273AV	ST073273AV	2
34		Écrou	ST146000AV	ST146000AV	ST146000AV	2
35		Raccord	—	—	—	1
36		Soulagement de tension	CW000703AV	CW000703AV	CW000703AV	1
37		Vis de soulagement de tension	ST074418AV	ST074418AV	ST074418AV	1
38		Rondelle	ST070933AV	ST070933AV	5T070933AV	1
39		Rondelle	ST077311AV	ST077311AV	ST077311AV	1
NÉCESSAIRES DE PIÈCES DE RECHANGE						
	▲	Nécessaire d'isolation (#11, 12, 13 compris)	WL211300AJ	WL211300AJ	WL211300AJ	1

Oilless Single Cylinder Pump
Pompe Monocylindrique Sans Huile
Bomba De Un Cilindro Sin Aceite

Replacement Parts List
Liste de Pièces de Rechange
Lista de Repuestos

WL390000

For parts, products & service information visit POWER XPERT www.campbellhausfeld.com



For parts, product & service information
visit **www.campbellhausfeld.com**

Replacement Parts List
Liste de Pièces de Rechange
Lista de Repuestos

WL390000

For Replacement Parts, Call 1-800-543-6400
Pour Pièces de Rechange, Composer le 1-800-543-6400
Para Ordenar Repuestos, Sírvase Llamar al Distribuidor más Cercano a su Domicilio

Please provide the following information:
-Model number
-Serial number (if any)
-Part description and number as shown in parts list

S'il vous plaît fournir l'information suivante:
-Numéro du modèle
-Numéro de série (s'il y en a un)
-Description de la pièce et son numéro sur la liste

Sírvase darnos la siguiente información:
-Número del modelo
-Número de serie (de haberlo)
-Descripción y número del repuesto según la lista de repuestos

Address parts correspondence to:
Correspondance:
Puede escribirnos a:

The Campbell Group
Attn: Parts Dept.
100 Production Drive
Harrison, OH 45030 USA

Ref. No. N°. de Réf. No. de Ref.		Description Description Description	Part Number Numéro de Pièce Número de Pieza	Qty. Qté. Ctd.
1		Pump/motor assembly (with belt) Montage de pompe/moteur (avec courroie) Conjunto bomba/motor (con correa)	WL210900AJ	1
2	▲	Cylinder gasket Joint d'étanchéité de cylindre Empaque del cilindro	XA012400AV	1
3		Intake valve Soupape d'admission Válvula de entrada	▲	1
4		Valve plate Plaque de soupape Placa de la válvula	▲	1
5		Exhaust valve Soupape d'échappement Válvula de salida	▲	1
6	▲	Head gasket Joint d'étanchéité de culasse Empaque de la culata	XA010800AV	1
7	▲	Exhaust valve gasket Joint de soupape d'échappement Empaque de la válvula de salida	XA012500AV	1
8		Head Culasse Culata	WL010500AV	1
9		Piston assembly (Includes #10) Montage de piston (#10 compris) Ensamblaje de pistón (Incluye #10)	WL211000AJ	1
10		3/8" Flat head screw Vis à tête plate de 3/8 po Tornillo de cabeza plana de 9,5 mm (3/8")	ST071802AV	1
11	●	1/4"-20 x 4" Hex. head cap screw Vis a tete hex. de 1/4 po-20 x 4 po Tornillo hex. de 6,4 mm (1/4")-20 x 10,16 cm (4")	ST074319AV	4
12		Fan Ventilateur Ventilador	WL008400AV	1
13	▲	Muffler Silencieux Silenciador	WL011100AV	1
14		Compression connector Raccord de compression Conector de compresión	ST159001AV	1
REPLACEMENT PARTS KITS - JEUX DE PIÈCES DE RECHANGE - KIT DE PIEZAS DE REPUESTO				
	●	Head bolt kit (Set of 4 ea., part #11) Jeu de boulons à tête (4 chaque, pièce #11) Kit de prisioneros (Juego de 4 cada uno., pieza #11)	WL211100AJ	1
	▲	Valve plate kit (Includes #2-7, 13) Jeu de plaque de soupape (#2-7, 13 compris) Kit de placa de válvula (Incluye #2-7, 13)	WL211200AJ	1

BULLETIN NO. H-11

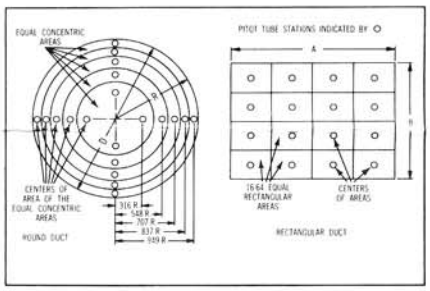
AIR VELOCITIES WITH THE DWYER PITOT TUBE

AIR VELOCITY

The total pressure of an air stream flowing in a duct is the sum of the static or bursting pressure exerted upon the sidewalls of the duct and the impact or velocity pressure of the moving air. Through the use of a pitot tube connected differentially to a manometer, the velocity pressure alone is indicated and the corresponding air velocity determined.

For accuracy of plus or minus 2%, as in laboratory applications, extreme care is required and the following precautions should be observed:

1. Duct diameter 4" or greater.
2. Make an accurate traverse per sketch at right, calculate the velocities and average the readings.
3. Provide smooth, straight duct sections a minimum of 8½ diameters in length upstream and 1½ diameters downstream from the pitot tube.
4. Provide an egg crate type straightener upstream from the pitot tube.



In making an air velocity check select a location as suggested above, connect tubing leads from both pitot tube connections to the manometer and insert in the duct with the tip directed into the air stream. If the manometer shows a minus indication reverse the tubes. With a direct reading manometer, air velocities will now be shown in feet per minute. In other types, the manometer will read velocity pressure in inches of water and the corresponding velocity will be found from the curves in this bulletin. If circumstances do not permit an accurate traverse, center the pitot tube in the duct, determine the center velocity and multiply by a factor of .9 for the approximate average velocity. Field tests run in this manner should be accurate within plus or minus 5%.

The velocity indicated is for dry air at 70°F., 29.9" Barometric Pressure and a resulting density of .075#/cu. ft. For air at a temperature other than 70°F. refer to the curves in this bulletin. For other variations from these conditions, corrections may be based upon the following data:

$$\text{Air Velocity} = 1096.2 \sqrt{\frac{P_V}{D}}$$

where P_V = velocity pressure in inches of water
D = Air density in #/cu. ft.

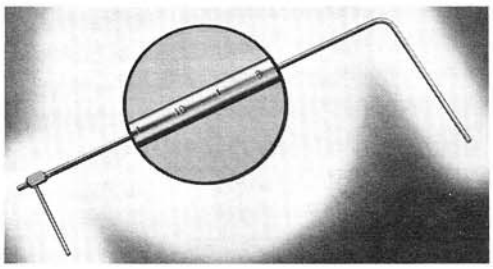
$$\text{Air Density} = 1.325 \times \frac{P_B}{T}$$

where P_B = Barometric Pressure in inches of mercury
T = Absolute Temperature (indicated temperature °F plus 460)

Flow in cu. ft. per min. = Duct area in square feet x air velocity in ft. per min.

AIR VELOCITY CALCULATOR

Computes velocity based on air density corrected for conditions of temperature and pressure. Eliminates tedious calculations. Ranges from .01 to 10" water corresponding to 400 to 20,000 FPM. Furnished with each pitot tube.

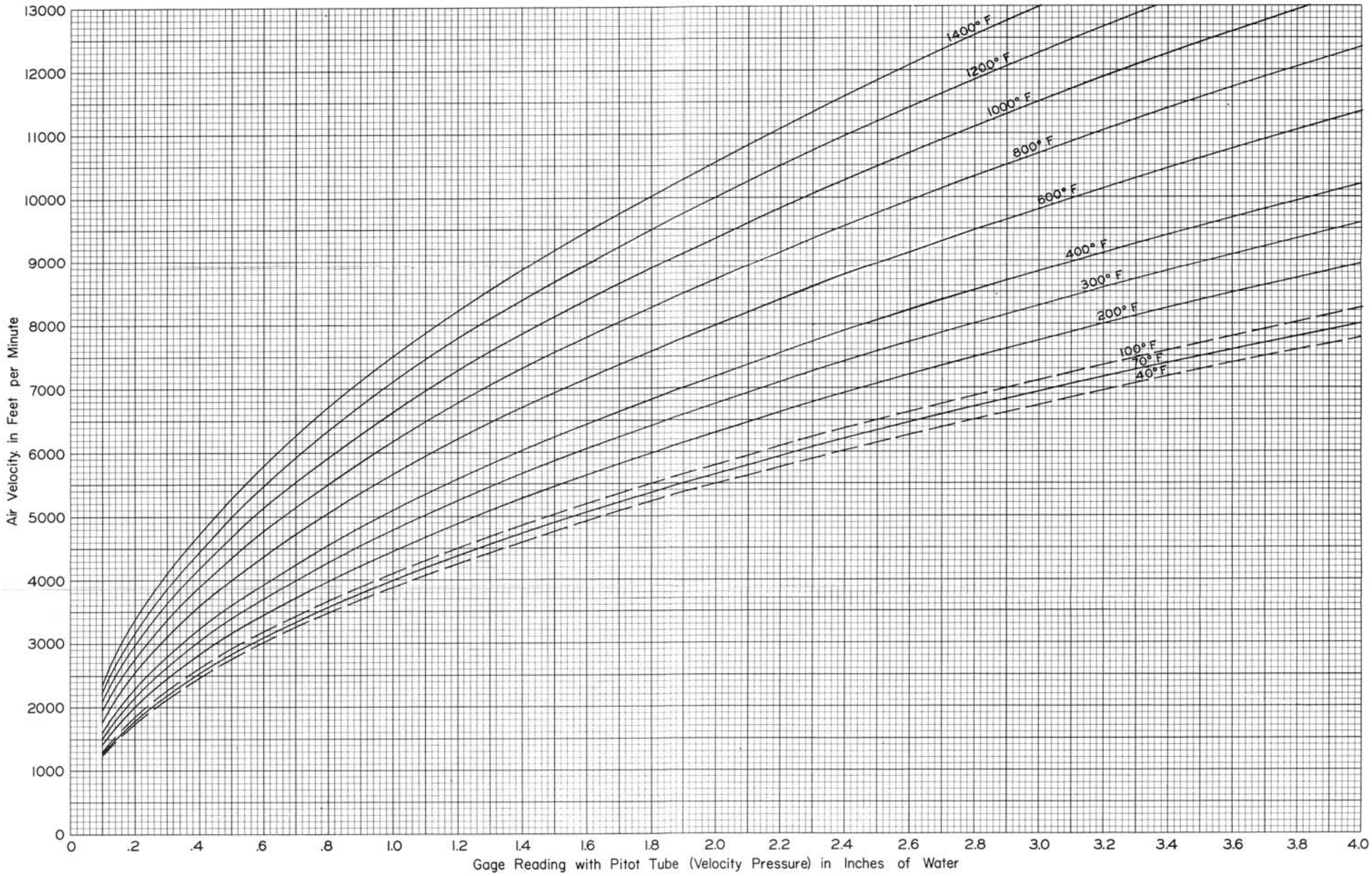


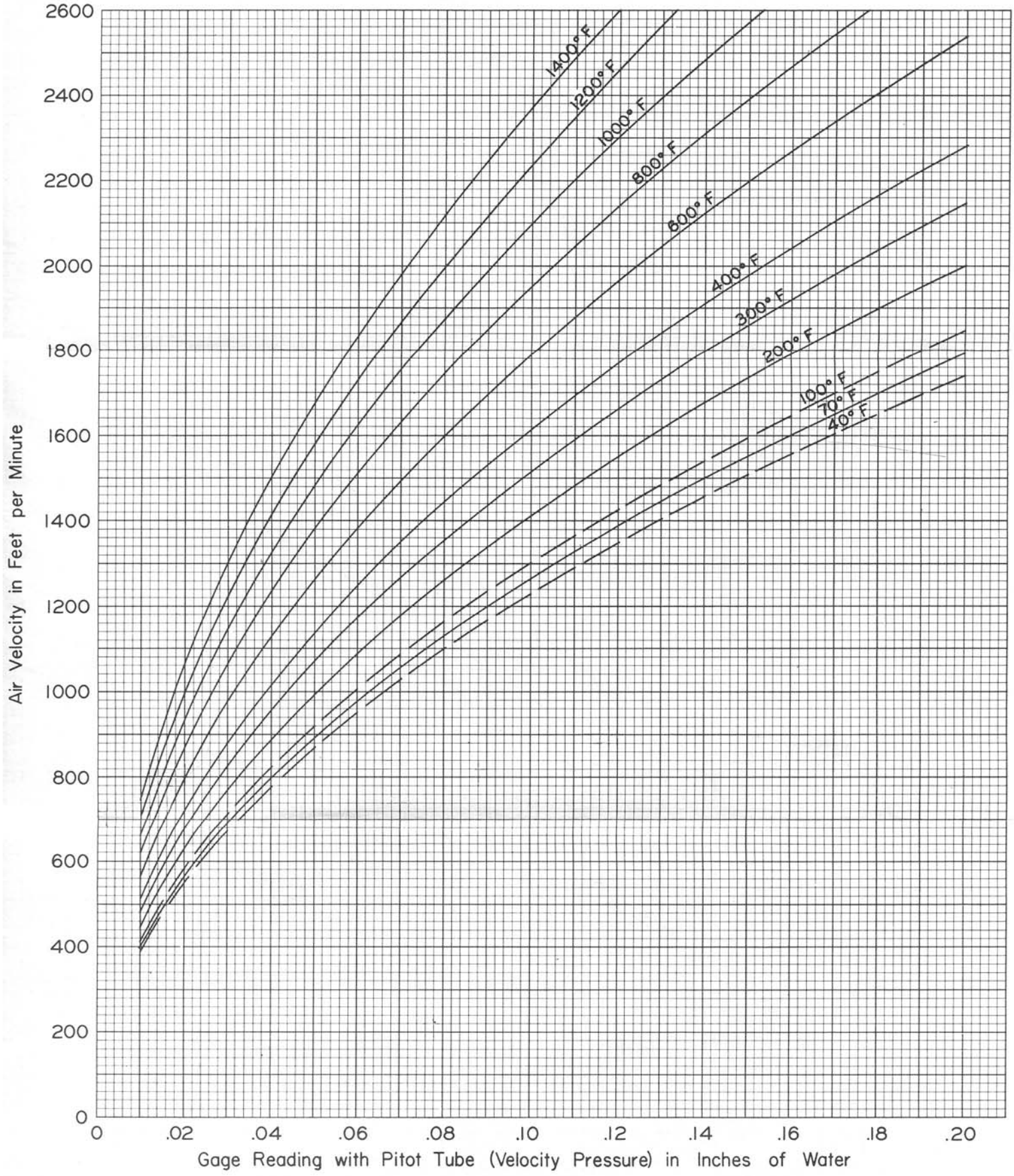
STAINLESS STEEL PITOT TUBES

Test confirmed unity coefficient and lifetime construction of No. 304 stainless steel. Inch graduations show depth of insertion for traversing. Complies with AMCA and ASHRAE specifications. Sizes 12" to 60" long. Hand or fixed mounting types.

Printed in U.S.A. 8/92

DWYER INSTRUMENTS, INC.
P. O. BOX 373 • MICHIGAN CITY, INDIANA 46360, U.S.A.
Telephone 219/879-8000
Fax 219/872-9057


Air Velocity, in Feet per Minute
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1400° F
1200° F
1000° F
800° F
600° F
400° F
300° F
200° F
100° F
70° F
40° F
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
Gage Reading with Pitot Tube (Velocity Pressure) in Inches of Water



FR 72-440226-00

APPENDIX B

DATA COLLECTION SHEETS

AOC-65 SVE Inspection and Monitoring Form
Camp Stanley Storage Activity, Texas

Date/Time :_____ ***Operator:_____*** ***Ambient T (°F) _____***

Monitoring Event (circle one): ***Biweekly / Monthly / Quarterly / Other _____***

Monitoring Point	***Vac in.H_2O***	***Flow fpm***	***Temp °F***	***VOC ppm***	***O_2 vol %***	***CO_2 vol%***	***Soil Gas Sample ID***	***Comments***
AOC65-VEW13								
AOC65-VEW14								
AOC65-VEW15								
AOC65-VEW16								
AOC65-VEW17								
AOC65-VEW18								
AOC65-VEW19								
Blower Intake								
Blower Exhaust								

Blower Information	**Pre Adjustment**			**VRV**		**Post Adjustment**	
	Intake Pressure	**Blower On**	**Hour Meter**	**Check**	**Lube**	**Blower Reset**	**Intake Pressure**
		Y / N		Y / N	Y / N	Y / N	

Moisture Separator Information	**Inspected**	**Emptied**	**Amount Xfered (gals)**	***GAC Information***	**fluent Pressure (p**		**Soil Gas Sample ID**
	Y / N	Y / N			**Influent**		
					Effluent		

Observations/Notes:

in.H_2O: inches of water fpm: feet per minute ppm: parts per million VRV: vacuum relief valve psi: pounds per square inch

Building 90 SVE Inspection and Monitoring Form
Camp Stanley Storage Activity, Texas

Date/Time :_____ ***Operator:_____*** ***Ambient T (°F) _____***

Monitoring Event (circle one): ***Biweekly / Monthly / Quarterly / Other _____***

Monitoring Point	***Vac in.H_2O***	***Flow fpm***	***Temp °F***	***VOC ppm***	***O_2 vol %***	***CO_2 vol%***	***Soil Gas Sample ID***	***Comments***
AOC65-VEW1								
AOC65-VEW2								
AOC65-VEW3								
AOC65-VEW4								
AOC65-VEW5								
AOC65-VEW6								
AOC65-VEW7								
AOC65-VEW8								
AOC65-VEW9								
AOC65-VEW10								
AOC65-VEW11								
AOC65-VEW12								
Blower Intake								
Blower Exhaust								

Blower Information	Pre Adjustment			VRV		Post Adjustment	
	Intake Pressure	Blower On	Hour Meter	Check	Lube	Blower Reset	Intake Pressure
		Y / N		Y / N	Y / N	Y / N	

Moisture Separator Information	Inspected	Emptied	Amount Xfered (gals)
	Y / N	Y / N	

GAC Information	fluent Pressure (p	Soil Gas Sample ID
Influent		
Effluent		

Observations/Notes:

in.H_2O: inches of water fpm: feet per minute ppm: parts per million VRV: vacuum relief valve psi: pounds per square inch

SWMU B-3 SVE Inspection and Monitoring Form
Camp Stanley Storage Activity, Texas

Date/Time :_____ ***Operator:_____*** ***Ambient T (°F) _____***

Monitoring Event (circle one): ***Biweekly / Monthly / Quarterly / Other _____***

Monitoring Point	***Vac in.H_2O***	***Flow fpm***	***Temp °F***	***VOC ppm***	***O_2 vol %***	***CO_2 vol%***	***Soil Gas Sample ID***	***Comments***
CS-B3-VEW19								
CS-B3-VEW20								
Blower Intake								
Blower Exhaust								

Blower Information	**Pre Adjustment**			**VRV**		**Post Adjustment**	
	Intake Pressure	**Blower On**	**Hour Meter**	**Check**	**Lube**	**Blower Reset**	**Intake Pressure**
		Y / N		Y / N	Y / N	Y / N	

Moisture Separator Information	**Inspected**	**Emptied**	**Amount Xfered (gals)**	
	Y / N	Y / N		

Observations/Notes:

in.H_2O: inches of water fpm: feet per minute ppm: parts per million VRV: vacuum relief valve psi: pounds per square inch