Operation and Maintenance Manual for the Former Lilyblad Petroleum Site, Tacoma, Washington

Prepared for

Washington State Department of Ecology

April 2011

Prepared by

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Acronyms and Abbreviations

acfm	atmospheric cubic feet per minute
AHA	Activity Hazard Analysis
CAP	Corrective Action Plan
CatOx	catalytic oxidizer
cfm	cubic feet per minute
CoC	constituents of concern
CULs	cleanup levels
DPE	dual phase extraction
DRE	destruction removal efficiency
GAC	granular activated carbon
gpm	gallons per minute
Hg	Mercury
HP	Horsepower
HSP	Health and Safety Plan
KO	knockout
LEL	Lower Explosive Limit
Lilyblad	Lilyblad Petroleum Inc.
MCC	Motor Control Center
NoC	Notice of Construction
O&M	operation and maintenance
PFF	Pacific Functional Fluids
PLC	programmable logic controller
PPE	personal protection equipment
PSCAA	Puget Sound Clean Air Agency
psi	pounds per square inch
psig	pounds per square inch gauge
PTSP	Pre-Task Safety Plan(s)

RAWP	Remedial Action Work Plan
SBO	safe behavior observations
scfm	standard cubic feet per minute
SVOC	semi-volatile organic compound(s)
TPH	total petroleum hydrocarbon
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
VOC	volatile organic compound(s)

1.0 Introduction

This Operation and Maintenance (O&M) Manual outlines procedures and protocols for the remediation system at the former Lilyblad site (site). The purpose of this manual is to aid operators in performing O&M activities, including startup, operation, maintenance, troubleshooting, system inspections, shutdown, sampling, and reporting. The treatment system primarily consists of a dual phase extraction (DPE) system; however, the DPE system will be augmented with nutrient injections to enhance biodegradation processes and chemical oxidant injections to oxidize recalcitrant contamination in accordance with the Remedial Action Work Plan (RAWP) (CH2M HILL 2009). The O&M performance objectives are established with the aim of achieving site cleanup in a reasonable time frame.

The O&M Manual may be revised in the future on an as-needed basis. The version number of the O&M Manual located at the top of each page shall be numerically increased by one for every manual revision and the revision date will also be included at the top of each page.

1.1 Purpose and Scope of this Operation and Maintenance Manual

The primary objective of this O&M Manual is to provide the information required to perform the O&M services for the former Lilyblad site remediation system. The following performance objectives will serve as a guideline for operation of the remediation system on a day-to-day basis. O&M personnel can help assure successful operation of the system by keeping these objectives in mind:

- Maintain DPE system extraction (blowers operating) run time of greater than 85 percent. This 85 percent operational goal indicates that the fluids/vapors are being extracted from the subsurface for 85 percent of the total time in a particular time period (for example, in 90 days, total time would be 2,160 hours and 85 percent run time would be 1,836 hours)
- Comply with the parameters outlined in the City of Tacoma Industrial Wastewater Discharge Permit No. TAC-039-2009 (Appendix A)
- Maintain monitoring of air emissions from vapor phase granular activated carbon (GAC), air stripper, and/or catalytic oxidizer to meet the guidelines established by Puget Sound Clean Air Agency (PSCAA) Notice of Construction (NoC) No. 9367 (Appendix B)
- Continuously adjust operation to optimize mass removal rate
- Routinely adjust O&M procedures to optimize operational cost
- Maintain open and efficient communications within the project team (CH2M Hill and Ecology representatives) and regulatory stakeholders (e.g., City of Tacoma) to achieve project efficient system evaluation process from data collection to response action

- Maintain zero health and safety incidents

1.2 Points of Contact

Figure 1 shows the O&M Program Organization for the former Lilyblad site, which illustrates the team's communication pathways.

FIGURE 1
O&M Program Organization

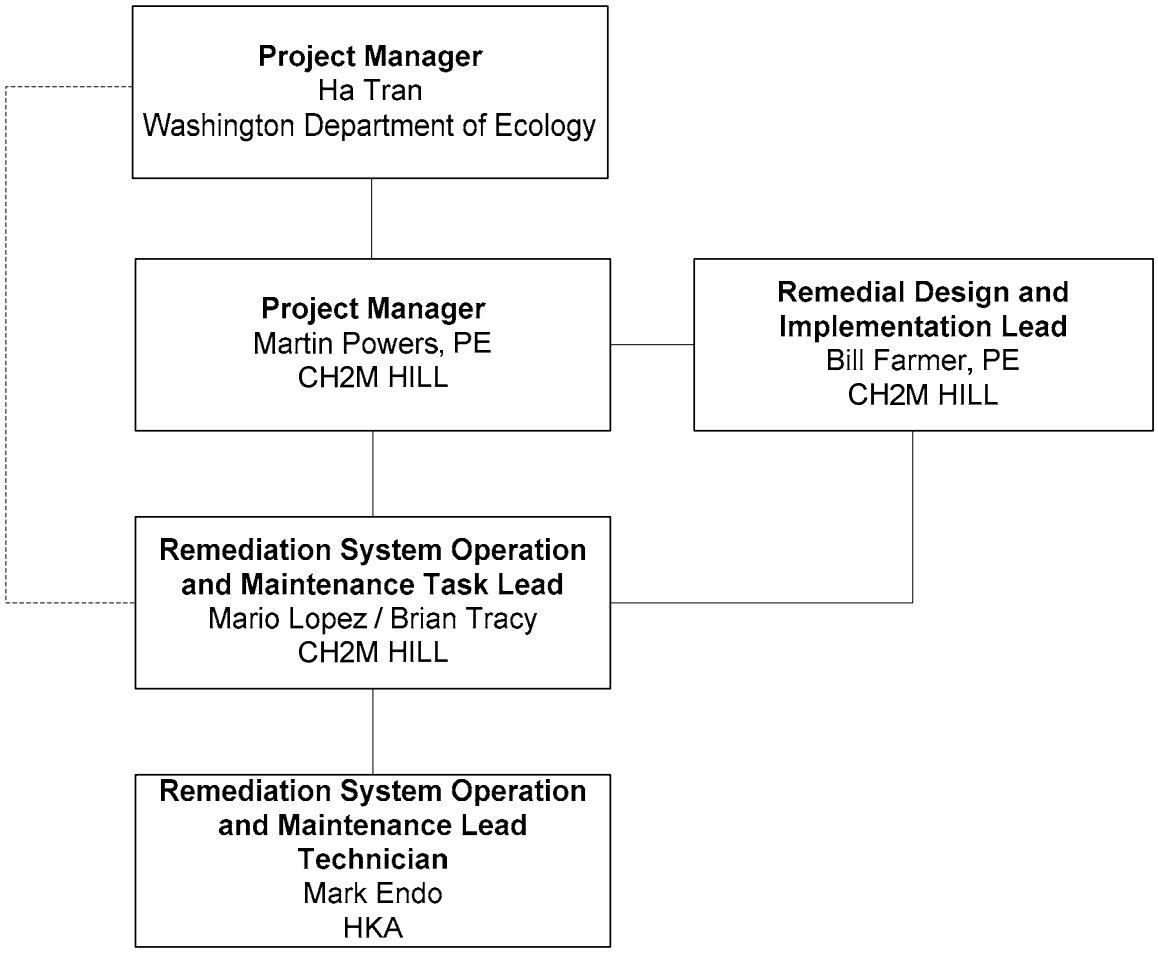


Table 1 lists the key personnel responsible for the O&M of the remediation system at the former Lilyblad site.

TABLE 1
Project Contact List

Title	Person	Phone	Email
Project Manager	Martin Powers	425-233-3493 direct 206-940-3535 cell	martin.powers@ch2m.com
Remedial Design and Implementation Lead	Bill Farmer	425-233-3551 direct	bill.farmer@ch2m.com
Operation Task Lead	Mario Lopez	425- 233-3120 direct 425-647-6637 cell	mario.lopez@ch2m.com
Operation Task Lead	Brian Tracy	428-233-3414 direct 425-516-9401 cell	brian.tracy@ch2m. com
Operation and Maintenance Technical Lead	Mark Endo	847-347-6607	mark.endo@ch2m.com

1.3 Site Background Information

The site description and physical site conditions and surrounding areas are documented in detail in the site RAWP submitted prior to the installation of the system. This summary is intended to provide a brief overview of the site.

1.3.1 Physical Description of the Site

The site consists of the former Lilyblad Petroleum property, a portion of the right-of-way adjacent to Port of Tacoma Road, and adjacent portions of the PW Eagle property, Nelson property, and Saul property (see Appendix C).

1.3.2 Site Operational History

Lilyblad Petroleum Inc. (Lilyblad) began operation at the site in 1972 as a distributor of gasoline, diesel, solvents, and packaged petroleum products. Lilyblad was involved in various solvent mixing and recycling operations between 1972 and 2003. In 2003, Pacific Functional Fluids (PFF) purchased Lilyblad's assets, and continued operations to store, blend, repackage, and distribute chemical and petroleum products. Lilyblad Petroleum Inc. is no longer in business. M&G Holdings currently owns the property that was previously owned by Lilyblad.

1.3.3 Constituents of Concern

As described in the Corrective Action Plan (CAP) (Washington State Department of Ecology, 2008), the preferred cleanup action at the site is intended to protect human health and the environment. The proposed cleanup methods are intended to comply with state and

federal laws and cleanup standards for the constituents of concern (CoC). The CAP defines the cleanup levels (CULs) for the site as presented in Table 2 below:

TABLE 2
Soil and Groundwater Cleanup Levels

Constituent of Concern	Soil CUL (μg/kg)	Groundwater CUL (μg/L)
1,1,1-trichloroethane	1,144	227
1,1,2-tricholoroethane	54.1	16
1,1-dichloroethane	164,000	52,000
1,1-dichloroethene (DCE)	7.9	1.93
1,2,4-trimethylbenzene	10,350,000	26,000
1,2-dichloroethane	100.6	37
1,4-dichlorobenzene	64.6	4.86
Benzene	75	22.7
Bis(2-ethylhexyl)phthalate	4,400	2.2
Cis-1,2-dichloroethene[a] (DCE)	14,880	5,200
Ethylbenzene	41,130	6,910
m,p-xylene	58,400	26,000
Methylene chloride	1,332	590
Tetrachloroethene (PCE)	24.5	3.3
Toluene	71,340	15,000
Trichloroethene (TCE)	121.7	30
Vinyl chloride	7.91	2.4
Naphthalene	115,900	4,940
Pentachlorophenol	37.97	3
2-methylnaphthalene	–	22.5
Diesel range hydrocarbons	2,000,000	1,000
Gasoline range hydrocarbons	100,000	1,000
Motor oil	2,000,000	1,000

NOTES:
μg/kg = micrograms per kilogram
μg/L = micrograms per liter

[a] Erroneously listed as cis-1,2-dichlorobenzene in the CAP.
Ecology derived soil CULs for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) using the three-phase partitioning model and groundwater cleanup numbers.
Ecology used Method A soil and groundwater CULs for total petroleum hydrocarbon (TPH) compounds.
Ecology derived groundwater CULs for protection of surface water and for VOCs and SVOCs applied the more restrictive of two standards: the ambient water quality toxics criteria and the Method B surface water cleanup standards.

1.4 General Remedial Process Description

New and existing DPE wells are used to de-water the subsurface soil down to the aquitard layer exposing a smear zone and saturated zone soil to allow for the extraction of contaminated vapors. In total, the DPE system consists of 71 extraction wells, which are separated into nine distinct DPE fields. As-built drawings of the remediation system are provided in Appendix C. To date, the 14 wells for DPE Fields A and B, associated with the JM Eagle property, are not yet connected to the system, but are planned to be combined in a subsurface vault near the southern corner of the Lilyblad Property and one manifold line will be routed from that vault back to the remedial equipment compound. The DPE fields and the number of extraction wells in each field are listed in Table 3.

TABLE 3

DPE Fields and Respective Extraction Wells

DPE Field	Number of Extraction Wells	Name of Recovery Wells per DPE Field
A[a]	8	RW-59, RW-60, RW-61, RW-62, RW-63, RW-64, RW-65, RW-66
B[a]	6	RW-67, RW-68, RW-69, RW-70, RW-71, RW-72
C	10	RW-22, RW-36, RW-43, RW-44, RW-50, RW-53, RW-55, RW-56, RW-57, RW-58
D	10	RW-23, RW-34- RW-35, RW-45, RW-46, RW-47, RW-48, RW-49, RW-51, RW-52
E	9	RW-20, RW-21, RW-24, RW-31, RW-32, RW-33, RW-38, RW-39, RW-40
F	7	RW-04, RW-05, RW-06, RW-07, RW-08, RW-09, RW-10
G	8	RW-11, RW-12, RW-13, RW-18, RW-19, RW-25, RW-26, RW-27
H	7	RW-14, RW-17, RW-28, RW-30, RW-41, RW-42, RW-54
I	6	RW-01, RW-02, RW-03, RW-15, RW-16, RW-29
Total	**71**	

Note:

[a] Wells in these fields were not active when this version of the O&M Manual was prepared. Installation of these wells is pending resolution of site access issues.

The DPE fields are connected by manifold piping to the remedial equipment compound where the extracted fluids will be separated into air and water treatment trains. A total of eight manifold pipes are routed from the DPE fields to the remedial equipment compound (Note: DPE fields A and B, associated with the JM Eagle property, will be combined in a subsurface vault near the southern corner of the Lilyblad Property and one manifold line will be routed from that vault back to the remedial equipment compound). The grouping of wells into DPE fields allows flexibility in the extraction of fluids from the subsurface as vacuum can be regulated on individual DPE fields. This allows the remedial system to focus on areas of the site that may have higher levels of contamination or which have the greatest impact in controlling groundwater plume migration. An additional level of flexibility in

controlling the extraction of fluids is provided by valves installed at each recovery wellhead that allows for control of the application of vacuum at specific extraction points.

The DPE system is capable of achieving a maximum vapor extraction rate of approximately 600 scfm (standard cubic feet per minute) at 15 inches of Mercury (Hg) on a total of 71 extraction wells. However, the system is designed to apply the vacuum on two DPE field manifolds at any given time (one field manifold per DPE blower), with the result being that the fluid extraction may be focused on two DPE fields (or three DPE fields when the manifold for DPE Fields A and B is under vacuum) on a rotating basis. The rate of groundwater extraction of the DPE system will be a function of the volume of water available in the surficial aquifer and the hydraulic conductivity of the surficial aquifer.

Extracted vapors and groundwater are treated at the remedial equipment compound, with vapor phase CoCs at high concentrations being destroyed in an electric catalytic oxidizer (CatOx). The CatOx has a treatment capacity of approximately 300 scfm and 99 percent destruction removal efficiency (DRE). At lower concentrations, CoCs are captured within vapor-phase GAC adsorbers since vapor phase carbon is typically more cost effective than catalytic oxidation even when factoring in regeneration and/or carbon replacement costs. The vapor-phase adsorbers contain 1,000 lbs of GAC each, with a maximum flowrate capacity of approximately 500 cubic feet per minute (cfm). The remediation system is exempt from compliance with air permitting requirements enforced by PSCAA; however the system is subject to annual registration as a potential emission source. It is our intent to operate the system within the guidelines previously established in PSCAA NoC No. 9367 (see Appendix B—Vapor Discharge Guidelines).

Contaminants in the extracted groundwater are treated and separated in an air stripper with vapor-phase effluent being combined with the DPE vapor stream for treatment on the GAC adsorbers. The air stripper has an air flow rate of approximately 280 cfm and can treat a maximum liquid flow rate of 40 gallons per minute (gpm). Liquid effluent from the air stripper is passed through a 50-micron filter and then treated in liquid-phase GAC adsorbers prior to discharge in conformance with permitted City of Tacoma industrial wastewater discharge requirements. The water discharge from the remediation system must meet the requirements of City of Tacoma Industrial Wastewater Discharge Permit No. TAC-039-2009 (Appendix A).

At a time when the benefit of continuing to operate the DPE system alone appears to be diminishing, based on groundwater, vapor, and soil data collected from the site, *in situ* treatment methods will be implemented. The *in situ* methods planned for the site consist of biostimulation and/or *in situ* chemical oxidation to further reduce CoCs to achieve CULs. Current plans are to inject nutrients (for example, a mixture of nitrogen, phosphate, and potassium) in areas with elevated organic compound concentrations and inject oxidants (such as potassium permanganate or a form of hydrogen peroxide) in areas with elevated halogenated organic compound concentrations.

2.0 Process Components

The major remediation system process components are described in the following sections. As-built drawings of the remediation system are provided in Appendix C. A list of the primary system equipment and associated parts is provided in Appendix D. Engineering specifications and cut sheets for primary system components are provided in Appendix E. Pictures of major system components are provided in Appendix F.

2.1 DPE Wells

The DPE system includes 71 extraction wells located throughout the site. The DPE system can extract soil vapor and groundwater through the 4-inch diameter extraction wells. These wells are either finished above ground or below ground depending on their location in the facility. The casing for each well is SCH-40 PVC, and the slot size is 0.020 inch. The wells are plumbed to the DPE system through a system of nine fields (pipe manifolds), which are then combined into two manifolds in the remediation compound prior to entering moisture separators. Instrumentation for measuring vacuum is located at each wellhead and for each field on the manifold piping within the remediation system building. At each wellhead, a system of valves allow for the application of vacuum on the entire well casing or on a drop tube utilized for groundwater recovery.

2.2 Moisture Knock Out Tanks

Two moisture knock out (KO) tanks are located within the remediation equipment building. The purpose of the moisture KO tanks is to separate the recovered vapors and liquids within the DPE influent. Each KO tank has a 120-gallon reservoir capacity for temporarily storing accumulated liquids. Appropriate fittings, sight glass indicators, and level switches allow for liquid-level indication, water removal, sampling, and automatic shutdown when necessary. Each KO tank is equipped with high level alarms that will shut off the blowers if triggered.

2.3 DPE Blowers

Two DPE blowers are located inside the remediation equipment building. The two DPE blowers are Busch, 15-horsepower (HP), rotary-claw vacuum pumps, each capable of generating flow rates of up to 300 atmospheric cubic feet per minute (acfm) at 15 inches of Hg of vacuum. Two blowers are located downstream of the KO tanks, which are connected to the extraction fields through two manifolds that are designated as low and high contaminant concentration manifolds. The blowers are equipped with motor overload switches that will automatically shut the blowers off if triggered.

2.4 Electric Catalytic Oxidizer

An electric CatOx is located outside of the remediation equipment building and within the remediation equipment compound. The CatOx is connected downstream of one of the DPE

blowers. Vapors with high concentration of contaminants are processed through the CatOx before being discharged to the atmosphere. The unit is a skid-mounted Intellishare, flameless, 300-scfm electric catalytic oxidizer. The CatOx has sensors, a control panel and a programmable logic controller (PLC) to monitor temperature and air flow rate. The CatOx will automatically shut down if the temperature reaches a set point of 900 degrees Fahrenheit or if the inlet air flow reaches 25 percent of the lower explosive limit (LEL). It is expected that the catalytic oxidizer will be removed and all vapor-phase treatment will be achieved with vapor-phase GAC vessels after consistent operation of the DPE system and a decrease in the vapor phase concentrations.

2.5 Heat Exchanger

A heat exchanger is located outside of the remediation equipment building and within the remediation equipment compound. An American Industrial, ACA series, air-cooled Heat Exchanger is connected to the effluent side of the low contaminant concentrations DPE blower to reduce the vapor temperature before entering the vapor-phase GAC vessels. The heat exchanger can function at temperatures up to 400 degree Fahrenheit. The typical temperature of air from a rotary screw blower is 180 to 225 degrees Fahrenheit. At this temperature the heat exchanger can operate at a pressure up to 100 psig (pounds per square inch gauge), and will reduce the temperature of the air to approximately 10 degrees Fahrenheit above ambient temperature.

2.6 Vapor Phase Granular Activated Carbon

Two vapor-phase GAC vessels are located outside of the remediation equipment building and within the remediation equipment compound. The vapors with low concentration contaminants are processed through the 1,000-pound vapor-phase GAC vessels set in series before discharging to the atmosphere. These vessels are Tetrasolv VF-1000 filtration vessels. The maximum operating pressure and temperature for these vessels is 75 psig and 250 degrees Fahrenheit, respectfully.

2.7 Transfer Pumps

Two Continental, 1.5 HP progressive cavity pumps are connected to the moisture knock out tanks to transfer the liquids from these vessels to an equalization tank. Two additional Myers 1.5-horsepower pumps transfer the liquids from the equalization tank to the air stripper and to the liquid phase carbon vessels. These pumps have motor overload switches that will stop the pumps if triggered. In addition, pressure differential switches on the equalization and the discharge pumps will automatically turn them off if a pre-set back pressure (48psi) is reached.

2.8 Air Stripper

An air stripper is located inside the remediation equipment building. Liquids removed from the knock out tanks are transferred to an equalization tank. The liquids are subsequently transferred to an air stripper in batches for treatment. The air stripper is a QED Model EZ4.4 cylindrical, low profile air stripper. The unit comes with a system of trays, sump, and cover made of HDPE material. It is also equipped with a system of low and high level switches

which assist in vacating the process liquids with a 1.5 HP transfer pump. A three-phase, 230V, 6.3 KW, 300 ACFM at 42 IWCV, 2.5 I/O blower is attached to the air stripper that assists in removing volatiles from the water that it processes. The resulting vapor is routed to the vapor-phase GAC vessels. The air stripper has a high-high water level switch that will temporarily prevent any water addition from the equalization tank. If the high-high level does not reset, the DPE blower system will ultimately shut down as the EQ tank will reach high limit.

2.9 Liquid Phase Granular Activated Carbon

Two liquid-phase GAC vessels are located inside the remediation equipment building. Liquids processed through the air stripper are routed through a liquid phase GAC before final discharge to the sanitary sewer. The two liquid-phase GAC units are Tetrasolv AF-500 filter vessels set in series. A pressure sensor switch is located within the inlet line of the lead liquid-phase GAC vessel. If the pressure reaches a set value (50 pounds per square inch [psi]), the effluent transfer pump will be tripped and the water system will ultimately shut down. The liquid-phase GAC vessels have a maximum operating pressure rating of 75 psi.

2.10 Motor Control Center

The power source (480 VAC, 3 phase, 3 wire), main disconnect, and main circuit breaker panel are located on the south end of the enclosed fence just outside the equipment control room. The motor control center (MCC), located inside the equipment control room, houses the power distribution for the remediation system. Through the MCC, the operator can activate/deactivate any motor within the remediation system. The MCC is also equipped with a PLC system that displays system status, process flow, and instrumentation diagram and system shutdowns. A backup battery is installed in the control room to temporarily power the PLC system in the event of a power outage. A separate circuit breaker panel controls the heat tracing and lighting at the remediation system. This panel is located next to the MCC. The CatOx unit has its own control panel, but it is connected to the MCC since it works in conjunction with the high-concentrations DPE blower.

2.11 Nutrient and Chemical Oxidant Injection System

The nutrient and chemical oxidant injection system consists of a piping system connected to each DPE well, a pump, a mixing tank, and a flow meter. The pump is a Grundfos Redi-Flo 3, 0.5-HP pump capable of discharging 10 gpm with at 100 feet of head. The injection piping system is made of 1-inch diameter SDR 11 HDPE piping runs which are manifolded together in the remediation compound. At each wellhead, a system of valves and camlock fittings allow for conversion of the DPE wells into injection wells. An Istec 1700 series water meter is installed in the piping to help control the amount of solution injected per field. The mixing tank is a 1,000-gallon double-walled container which can also serve as a temporary containment for purge water generated during groundwater monitoring well sampling. The injection pump is stored inside the remedial equipment building when not in use. The mixing tank is located outside of the remediation equipment building and within the remediation equipment compound.

3.0 System Operation

This section presents the specific sequence of steps to be followed to bring the remediation system to normal operation. Some components of the system are not required to be active during the normal operation of the system, but the operator must be familiar with their operation. Any person operating the system must be experienced in operating this type of equipment and must receive specific training. Operators must read this section and thoroughly understand it before starting the system. Pictures of the major system components are located in Appendix F.

The following steps are required to start and run the system.

3.1 Pre-Startup Inspection

Note: The Pre-Startup Inspection is meant for cases when the system has been turned off for more than 2 weeks.

1. Conduct a general visual inspection of all equipment in the remediation equipment compound. This includes ensuring all pipes and camlock connections are made and secured.
2. Replace filter bags in each water filter housing.
3. Verify that there is power at the MCC by confirming that the "Control Power" light on front of the MCC is lit.
4. Check if there are any high-level alarms on any of the tanks (knock-out tanks, equalization tank, or air stripper sump). Process water if necessary using instructions in Section 3.5 below.
5. If ambient temperatures are at or below freezing point, ensure the heat tracing system is on and that liquids are not frozen in pipelines prior to starting the remediation system.

3.2 High Concentration DPE System

1. Verify that all valves at selected wellheads, manifolds, and throughout the remediation system are in the correct configuration. Turn appropriate well field automated valves to ON or OFF position on the MCC. The ON setting opens the field's valve, the OFF setting closes the field's valve, and the AUTO setting allows the PLC to control the field's valve (this setting will be discussed in Section 3.4). Each field's setting (ON/OFF/AUTO) will be determined by the Operation Task Lead and is dependent on the current objective of the system (e.g., dewatering, vapor extraction, etc.).
2. In the MCC, make sure the "Oxidizer Bypass "switch is set to the OFF position. (Leave it in this position only when processing vapors through the CatOx. If this DPE system is

connected to the vapor phase carbon, then turn the switch to the ON position and skip steps 4, 6, and 7 below).

3. Verify that the water treatment system switches are on the AUTO position (please see water treatment system, Section 3.5, for instructions).

4. Verify that the manual process inlet valve at the CatOx skid connecting the high concentration DPE blower to the CatOx is in the CLOSED position.

5. On the MCC, turn the DPE Blower #1 (high concentration DPE system) switch to the AUTO position.

6. Open the CatOx control panel and follow the instructions in the PLC screen to start the oxidizer. When the oxidizer is purging, ensure that the air dilution valve located next to the manual process inlet valve fully opens. The valve should open automatically and air should be coming in from the air filter.

7. Once the CatOx has reached operating temperature (550 degrees Fahrenheit to 600 degrees Fahrenheit), the PLC screen at the CatOx control panel will indicate that the operator should turn the manual process inlet valve to the OPEN position. The DPE Blower #1 will start automatically.

8. Manually adjust the vacuum on the air dilution valve at the KO tank to reach the desired position (check with system Operation Task Lead for the desired vacuum pressure). Ensure that the air dilution valve is not in a position that creates a loud, high-pitched whistling sound at the fresh air filter (outside the remediation equipment building).

9. Verify vacuum on each leg of the remediation system and adjust the vacuum at the manifold as necessary by opening/closing the manual gate valves designated for each well field at the manifold.

3.3 Low Concentration DPE System

1. Verify that all valves at selected wellheads, manifolds, and processing system are in the correct configuration. Turn appropriate well field automated valves to ON or OFF position on the MCC. The ON setting opens the field's valve, the OFF setting closes the field's valve, and the AUTO setting allows the PLC to control the field's valve (this setting will be discussed in Section 3.4). Each field's setting (ON/OFF/AUTO) will be determined by the Operation Task Lead and is dependent on the current objective of the system (for example, dewatering, vapor extraction, etc.).

2. Verify that the water treatment system switches are on the AUTO position (see Section 3.5).

3. On the main panel, turn the Heat Exchanger switch to the AUTO position.

4. On the main panel, turn the DPE Blower #2 (low concentration DPE system) switch to the AUTO position.

5. Adjust the vacuum on the air dilution valve at the KO tank to reach the desired position (check with system Operation Task Lead for the desired vacuum pressure). Ensure that

the air dilution valve is not in a position that creates a loud, high-pitched whistling sound at the fresh air filter (outside the remediation equipment building).

6. Verify vacuum on each leg of the remediation system and adjust the vacuum at the manifold as necessary by opening/closing the manual gate valves designated for each well field at the manifold.

3.4 Running System on Alternating Field Mode

1. To run the DPE blowers on alternating field mode, follow the procedures in sections 3.2 and 3.3, but make sure the switches on the MCC to the automated valves on the manifolds are placed in the AUTO position. Running the system in alternative field mode will be determined by the Operation Task Lead and is dependent on the current objective of the system (i.e., dewatering, vapor extraction, etc.).

2. Prior to running the DPE blowers on alternating field mode, set up the timers for each field in the PLC screen located in the MCC. Each timer will have to be set up manually on the PLC screen.

3. Enough time should be put on the timer of each automated valve to allow the opening of the next valve before that valve closes. This will prevent system shut downs due to vacuum dead-heading and blower overloads.

4. Follow steps 2 through 9 on section 3.2 to run the high concentration DPE system.

5. Follow steps 2through 6 on section 3.3 to run the low concentration DPE system.

3.5 Water Treatment System

The water treatment system must be turned to the AUTO position for the system to be able to process any fluids extracted by the DPE system. To prepare the water treatment system, do the following:

1. Verify that all processing pumps are primed by physically filling the discharge housing of the pump with the liquid to be handled (i.e., water).

2. On the main panel, turn the following switches to the AUTO position:

    a. KO Tank #1 Transfer Pump
    b. KO Tank #2 Transfer Pump
    c. Equalization Tank Transfer Pump
    d. Discharge Transfer Pump
    e. Air Stripper Blower

3. Adjust the flow rates on each pump by closing or opening the associated gate valves to prevent potential shutdowns due to high water levels on each of the processing tanks to which these pumps are connected.

3.6 Nutrient/Chemical Oxidant Injection System

1. Connect the Grundfos pump (stored in the main control room) discharge hose to the camlock connection of the injection manifold located on the side of the building.

2. Connect the power cord of the pump into the ground fault circuit interrupter outlet located next to the door of the control room. Note: Power to the outlet is controlled by a HAND/OFF/AUTO switch in the MCC. Verify that the switch is set to the OFF position.
3. Lower the Grundfos pump into the nutrient mixing tank by using a rope attached to the discharge chamber of the pump.
4. Adjust the valves on the injection manifold for the desired DPE field injection setting.
5. Connect the injection lines from the manifold to the desired DPE field extraction wells at each wellhead.
6. In the control panel, turn the Nutrient Pump switch to the AUTO position.
7. To stop power to the nutrient pump, either disconnect the pump at the outlet, or turn the switch to the OFF position on the MCC.

3.7 Shutdown Procedures

1. To shut down the CatOx, follow the instructions in the PLC screen within the oxidizer's control panel. If the PLC screen is not functioning, push the control power button to the OFF position. This will only shut down Blower 1 or the remediation system. An alternative emergency stop push button is located to the left of the control panel of the CatOx. (Please note that this will only shut down DPE Blower #1 of the remediation system).
2. In the MCC, turn all the DPE system switches to the OFF position.
3. Close the manual process inlet valve connecting the High Concentration DPE system to the CatOx.
4. If the shutdown is not being conducted in response to a permit limit upset, process any remaining standing water on all vessels (KO tanks, EQ tank, and air stripper sump) using the 'Hand' setting on the pump switches in the MCC. Please note that the switches for the transfer pumps require that the operator keep his hand on the switch to run the equipment. The operator must go back and forth between the MCC and the equipment room checking water levels on each vessel so as to not run the pumps dry. It is advisable to process water through the system when two system operators are present on site. Processing of liquids should be done so that the water is treated starting with the KO tanks and finishing at the air stripper sump. The discharge pump and air stripper must be run on the Auto position while water is processed from the KO and EQ tanks.
5. If the shutdown is being conducted in response to a permit upset condition, check with Project Manager to determine if remaining water within the system can be processed as a part of the shutdown operation.
6. Turn all the water treatment system switches to the OFF position.
7. Leave the main power on to maintain lighting, exhaust fan, and heater in operable conditions unless directed otherwise by the Project Manager.

8. If ambient temperatures are at or below freezing point, ensure the heat tracing system is on prior to shutting down the remediation system.

3.8 Emergency Shutdown

1. There are three emergency shutdown stop buttons within the remedial compound. By pressing these buttons, energy will automatically be cut off to all electrical components in the system. The locations for these buttons are as follows:
    - On the MCC in the control room (see pictures in Appendix F)
    - On the west wall next to the light switch as one enters the equipment room through the personnel door (see pictures in Appendix F)
    - On the east wall next to the light switch as one enters the equipment room through the double doors (see pictures in Appendix F)
2. If access to either control room or equipment room is restricted, an emergency shutdown can be completed by switching the main power disconnect to the OFF position (see pictures in Appendix F). The main power disconnect is located on the southern exterior of the control room. Please note that turning the main power disconnect to the OFF position should only be done in extreme emergency situations as this type of rapid powering down can damage the remediation equipment.

4.0 System Inspection and Maintenance

This section of the O&M manual provides guidance on maintaining the remedial equipment to optimize the system and minimize downtime from equipment malfunctions. The maintenance requirements for the treatment system are based on equipment manufacturers' recommendations (included in Appendix E).

During normal operation, the system should be maintained and inspected on weekly basis, at a minimum. Routine maintenance activities include checking for any deterioration of the equipment, lubricating motor bearings, replacing bag filters, checking for malfunctions, and any leaks in the system (see Table 4). Preventative maintenance activities should be performed on the system equipment to keep equipment operating efficiently, reduce unscheduled and non-routine downtime, extend equipment life, and promote a safe working environment. Operators must be able to complete preventive maintenance of the remediation equipment (see Table 4). For major maintenance activities, a qualified subcontractor will be hired. The following table summarizes some of the routine maintenance items to be addressed by the system operator.

TABLE 4
Preventive Maintenance Tasks and Frequencies

Equipment	Maintenance Action Requirement	Maintenance Frequency
Moisture KO Tanks	Check for cracks, leaks on fittings, level and high limit switches	Monthly
	Sediment accumulation clean out	Quarterly
Wells/Piping	Inspection	Quarterly
Equalization Tank	Clean out accumulated solids	Quarterly
Flowmeter	Calibrating flow meter	Annually
DPE Blowers	Check inlet filter, housing, and ventilation grills for any debris and dust	Monthly
	Oil level, grease bearings	As needed, but quarterly at a minimum
	Change gear box oil	Every 2.5 years
Catalytic Oxidizer	Replace temperature recording chart sheets	Monthly
	Grease bearings, replace gaskets	As needed
Vapor Phase GAC	Check for breakthrough[a] (PID readings, vapor sampling)	Each visit
	Replace GAC (through subcontractor)	Upon breakthrough
Liquid Phase GAC	Check for breakthrough[a] (system water sampling)	Monthly

TABLE 4
Preventive Maintenance Tasks and Frequencies

Equipment	Maintenance Action Requirement	Maintenance Frequency
	Replace GAC (through subcontractor)	Upon breakthrough
Transfer Pumps	Check for leaks, pump bearings, rotary seals, cleanout strainers	Quarterly
Air Stripper	Check for increase pressure, loose fittings, and cracks	Each visit
	Clean sump and trays	As needed, but semi-annual at a minimum
Air Stripper Blower	Check for loose bolts that may cause vibration on the blowers	Each visit
	Bearings and gasket seals	As needed
Nutrient Pump	Check seals, cable, and electrical cord connections	As needed
Inlet Vacuum Filters	Visually check filters for dirt and moisture accumulation	Each visit
	Replace filters when the pressure differential is in the range of 10 to 15 inches of water column	As needed
Liquid Phase Filters (Bag Filters)	Check differential pressure on gauges	Each visit
	Replace filters when the pressure differential increases by approximately 15 – 25 psi	As needed

[a] When the effluent is greater than 90 percent of the influent concentration, the GAC will be changed. After the GAC is replaced, the lead and lag vessel order will be switched.

Non-routine maintenance activities are not part of the preventive maintenance program. Non-routine maintenance includes responding to system alarms and equipment repair after failure. The need to conduct these activities would typically result from the findings obtained when troubleshooting a system failure or problem. Before conducting any non-routine maintenance activity, the O&M lead technician is required to troubleshoot the problem, proposed corrective measures, associated costs, and impacts to the system's operation and schedule, and present it to the O&M Task Lead for discussion and approval prior to implementation. All non-routine maintenance activities will be recorded on the O&M Log sheet (Appendix G). The cause, implemented corrective measure, and plans for future preventive maintenance shall be recorded on the log sheet and included within an updated version of the O&M Manual as needed to ensure procedures are appropriately modified to prevent future occurrences of the same non-routine downtime. Appendix D provides an equipment and parts list (inventory) for all the system components including their manufacturer and contact information. This list gives the remediation team easy access to items for repair or replacement. Additional specifications and equipment cut sheets for the DPE system equipment can be found in Appendix E.

4.1 Remediation System Sampling

The frequency of sampling and the methods used to analyze the media will be in accordance with the established City of Tacoma permit requirements and the vapor treatment guidelines (see Appendices A and B for guidance, and Appendix F for location of these sample ports). Locations for sampling each media are as follows:

4.1.1 Vapor Sampling

- Influent ports for fields A/B, C, D, E, F, G, H, and I – Sample located on DPE manifold and upstream of the moisture KO tanks in the remediation equipment building.
- DPE Influent Blower #1—Sample port located on the downstream side of the blower in the remediation equipment building.
- DPE Influent Blower #2—Sample port located on the downstream side of the blower in the remediation equipment building.
- Post Vapor Phase GAC #1—Sample port located on piping connecting GAC 1 and GAC 2 carbon vessels outside the remediation equipment building.
- Vapor Phase GAC #2 Effluent—Sample port located on side of the effluent stack connected to GAC 2 outside the remediation equipment building.
- Air Stripper Effluent—Sample port located on piping connecting the air stripper blower to the vapor phase GAC outside the remediation equipment building.
- CatOx Effluent—Sample port located on the side of the effluent stack just above the oxidizer's control panel outside the remediation equipment building.

4.1.2 Water Sampling

- Total Influent Post KO Tank—Sample port located on the effluent side of the EQ tank transfer pump in the remediation equipment building.
- Post Air Stripper—Sample port located on effluent side of the discharge pump bag filter in the remediation equipment building.
- Post Liquid Phase GAC #1—Sample port located on piping connecting the liquid phase GAC 1 and GAC 2 in the remediation equipment building.
- Post Liquid Phase GAC #2 Effluent—Sample port located on discharge pipe located downstream of the water flow meter sensor in the remediation equipment building.

4.2 Operation and Maintenance Documents

A notebook containing the O&M log sheets recording operating parameters, equipment inspections, and basic maintenance should be kept on site to track maintenance tasks and operational parameters. The O&M Lead Technician is responsible for documenting system operation parameters, any maintenance activities completed, and observations in a field logbook. This log will enable operators to refer to past activities and events to improve system performance, provide troubleshooting ideas, and assist in report writing.

An O&M log sheet should be completed on every site visit. A hardcopy of each O&M log sheet will be filed in the project folder at CH2M HILL's Bellevue, Washington office, and the original will be stored in the logbook onsite for documenting purposes. In addition the system operator should complete the O&M log sheet in an electronic file located on the project electronic database folder. A copy of a blank O&M log sheet can be found in Appendix G.

A full list of the equipment and parts are included in Appendix D. The parts list table includes part numbers and vendors for routine replacement parts including bag filters and GAC replacement.

4.3 Waste Generation

It is anticipated that wastes will be generated during the operation and maintenance of the remediation system. This waste will be managed in accordance with the procedures stated in the Waste Management Plan of the RAWP (CH2M Hill, 2009). Solid waste (bag filters, dry sediment, and spent carbon) will be temporarily stored outside the remediation system trailer, containerized in 55–gallon drums, labeled, and properly disposed of from the site within 90 days of generation. Wastewater (purge groundwater, equipment cleaning wastewater) will be treated through the system and disposed to the sanitary sewer. The Liquid Spill Prevention Plan in Appendix I presents scenarios for temporarily storing liquids outside of the remediation system trailer, and the procedures for processing these liquids through the remediation system. Any used oil generated during replacement of DPE blower gear oil (scheduled for every 2.5 years) will be transported to a local oil recycler.

4.4 Operator Training

Training is necessary to ensure that the system operators possess the proper skills and knowledge to safely operate the remediation system. All employees involved with system testing, operation, and maintenance should receive thorough safety training. Safety training focuses on ordinary and emergency situations. Health and safety procedures and issues are to be discussed at safety meetings held at the site on each visit if more than one person is performing operation and maintenance activities. If operation and maintenance is being performed by one system operator, that person should mentally review the tasks to be performed and consider the safety precautions to be taken in accordance with the Site Health and Safety Plan (HSP).

The items below list the minimum health and safety training requirements that all system operators must complete to safely conduct activities at the site:

- First Aid Training
- HAZWOPER Training
- Use and Care of Personal Protection Equipment (PPE)
- Fire extinguisher Training
- Lock Out Tag Out Training
- Electrical Safety Awareness

In addition to the general health and safety training, system operators must be trained in testing, operating, and maintaining the remediation equipment. The training should cover equipment startup and shutdown procedures, process parameter monitoring, sampling media, equipment maintenance, and troubleshooting. An operator's training log will be maintained with this O&M Manual where one can track who has received this training (see Appendix H).

Site specific training may also be required by both JM Eagle and PFF facilities. O&M personnel must inquire with each facility to keep up to date with such training. Records of the training for each system operator should be kept up to date in Appendix H of the O&M Manual maintained at the site.

5.0 Health and Safety

This section presents the general guidelines for personnel safety and information on specific hazards associated with the site. The most recent HSP, located in the electrical control room in the remediation system trailer, shall be used for detailed guidance on health and safety procedures.

O&M personnel at the site are responsible for updating and following the site-specific HSP. The HSP shall be kept onsite within the remediation building, available to anyone who visits the site. The plan includes general health and safety practices, as well as information on hazards specific to the site and the O&M activities. Examples of specific items that are included in the HSP are levels of PPE, air monitoring details, and materials handling.

Any maintenance activity performed at the site, the hazards posed and control measures required to perform that activity can be found on the site's HSP. If new activities are proposed in the operation of the system, an Activity Hazard Analysis (AHA) will be written and included in the HSP located onsite.

Pre-Task Safety Plans (PTSPs) will be generated by the system O&M lead technician at the start of each day's activities to ensure that any hazards associated with those activities pose no harm to the operator or others. Additionally, safe behavior observations (SBOs) will be conducted on the system operation and maintenance lead technician on a regular basis (at minimum once per month) to compare the actual work process against established safe work procedures identified in the project HSP.

6.0 References

CH2M HILL. 2009. *Lilyblad Site Remedial Action Work Plan.* January.

Washington State Department of Ecology. 2008. *Corrective Action Plan, Lilyblad Site, Tacoma, WA.*

APPENDIX A

City of Tacoma Industrial Wastewater Permit

Tacoma City of Tacoma
Public Works Department

August 12, 2009

Hand Delivered:

Ha Tran
WA State Dept. of Ecology
Industrial Section
PO Box 47600
Olympia WA 98504-7600

Received by **Date**

Subject: Industrial Wastewater Permit – Lilyblad Petroleum Site Remediation

Dear Ms Tran:

Enclosed are the Industrial Wastewater Discharge Permit and Permit Fact Sheet for the Lilyblad Petroleum Site Remediation project, located at 2244 Port of Tacoma Road, Tacoma WA. Please read and become familiar with it.

Your first report is due 45 days from start up
Sampling analysis for pollutants listed in Section T1.A must be done within 30 days after the system starts up, and the results submitted to Environmental Compliance Support (ESC) within 45 days after start up.

Quarterly reports are required
Quarterly sample analysis for pollutants listed in Section T1.A shall be submitted to ESC by the 15th day of each month following a calendar quarter. (i.e: January 15th for Oct – Dec; April 15th for January – March; etc.) The report that is due 45 days after start up will satisfy the third quarter reporting requirement. Therefore, the first quarterly report will be due January 15, 2010 for the 4th quarter of 2009.

Each required report must include the certification statement found in Section T3.F of the Permit. Reports must be signed by you or Martin Powers of CH2M Hill, unless another Authorized Representative as described in Section T1.C.1 is appointed in writing.

Please do not hesitate to contact your Source Control Representative, Linda Reiter, at (253) 502-2159 if you have questions or concerns regarding your permit requirements.

Sincerely,

Michael L. Kennedy
Assistant Division Manager
Environmental Compliance Support

mlk:lr:cfp

Enclosure: Industrial Wastewater Permit

cc: Martin Powers, CH2M Hill

File: G/EnviroCompliance/PERMITS/Lilyblad/Permits/2009 DOE Lilyblad Permit cvr.doc

Lilyblad Petroleum Remediation Site
Permit No. TAC – 039-2009
August 2009

INDUSTRY FACT SHEET

1. APPLICANT INFORMATION

A. Applicant: Washington State Dept. of Ecology and CH2M Hill, Inc

Facility (Site) Name Lilyblad Petroleum Remediation Site

B. Mailing Address 1100 112th Ave. S. Suite 400 Bellevue, WA 98004

C. Facility Address 2244 Port of Tacoma Road Tacoma WA 98421

D. Permit Contact with signatory authority Martin Powers
Title CH2M Hill Project Manager
Phone 425.233.3496
2nd Permit Contact: Brian Tracy Title CH2M Hill
Phone 425.233.3414

E. Federal Category N/A NAICS: 562910 – Groundwater Remediation

F. Wastewater Treatment Plant Receiving Wastewater CTP 1

G. Stormwater Basin Lincoln Ave Ditch, Blair Waterway

2. SITE HISTORY

This project is located at the former site of Lilyblad Petroleum, Inc. where Washington State Dept. of Ecology (DOE) has determined that soil and groundwater are contaminated with 23 constituents of concern, consisting mainly of petroleum hydrocarbons and toxic organic compounds from past industrial activity on the site. Lilyblad Petroleum is no longer in business, and the property is owned by M & G Holdings.

Facilities that occupy part of the site include JM Eagle (PW Pipe) and Pacific Functional Fluids, LLC. In 2000, Lilyblad was ordered by DOE to keep the plume of contamination from flowing off the property. Trenches and extraction wells were installed to help contain the plume. In 2003, DOE approved a pilot test to treat some areas. The pilot project was shut down in 2006.

Now, under an Enforcement Order, DOE has assumed responsibility for soil and groundwater remediation and issued an intent to incur a lien to secure their interest in the property. CH2M Hill has been contracted by DOE to operate a dual phase (vacuum) extraction soil and groundwater remediation system. Treatment equipment owned by DOE will be located next to Port of Tacoma Road on property now occupied by Pacific Functional Fluids, LLC (PFF). However, PFF is not responsible for the equipment or any part of the groundwater treatment system. Treated groundwater will discharge

below grade, into the existing side sewer serving the Pacific Functional Fluids office building, that connects to the municipal sanitary main in Port of Tacoma Road.

PFF has no responsibility for the remediation system. They are have been issued a separate NPDES permit to discharge treated boiler blowdown and contact storm water from their facility (including the tank farm) to the storm drain. The adjacent contaminated property, now occupied by PW Eagle, is covered by buildings and impervious pavement. Untreated stormwater runoff from that property is conveyed through the municipal storm sewer.

3. DESCRIPTION OF OPERATION

Dual phase extraction (DPE) will be used to remove volatile and semi-volatile organic compounds in both soil and groundwater at a site now occupied by Pacific Functional Fluids and PW Eagle (PW Pipe). Air stripping, bag filtration, and carbon adsorption will be used to remove contaminants from the extracted groundwater before it is discharged to the sanitary sewer. As groundwater treatment operations continue, it is expected that pollutant concentrations will decline to levels where air stripping will no longer be needed, and water will be treated with particulate filters and granulated activated carbon. It is estimated that it will take between 8 and 24 months to pump the groundwater down to a level below the area of contamination. After groundwater is pumped down, soils will be treated by vapor extraction.

4. DESCRIPTION OF DISCHARGE

A. Groundwater Pretreatment Process and Equipment

Groundwater will be extracted from a total of 72 wells located throughout the site. The extraction wells are organized into nine separate manifold systems that employ (2) 300 cubic feet per minute (cfm) vacuum blowers to extract subsurface vapors and enhance groundwater recovery, a 650 cfm air/water separator, and a 40 gallon per minute (gpm) groundwater transfer pump.

The treatment system is designed to treat up to 40 gallons per minute (gpm). It consists of:

- 300 gallon polyethylene holding tank with high level switch;
- Air Stripper, Model QED 40 gpm – Induced Draft, to remove volatile organic compounds from the liquid waste stream;
- (2) 100 gpm capacity bag filters for solids removal; and
- Liquid Phase Carbon Treatment consisting of (2), 500 lb carbon vessels arranged in series with 40 gpm capacity in each vessel.

The estimated groundwater flow from each well is 0.1 gallons per minute (gpm). Two manifold systems (approximately 24 wells) will be under vacuum for extraction at any given time, on a rotating basis.

INDUSTRY FACT SHEET

The system is expected to generate an average volume of approximately 2 gpm, with a maximum potential flow of 35 gpm. Flow is anticipated to be in the higher range during the initial weeks of operation while groundwater levels are lowered.

B. Waste Treatment Data

Efficiency data for the QED Air Stripper Model ver.cl.10 was submitted, indicating removal efficiency for the organic pollutants is high for all tested constituents except pentachlorophenol, bi(2-chloroethyl) ether, and MEK. The air stripper effluent will be further treated by a granulated activated carbon filter that is expected to remove remaining pollutants. Sampling data from a similar system used to treat groundwater from this site between 2003 and 2006 show that pollutants were effectively removed by air stripping followed by carbon filtration (see attached spreadsheet).

4. RATIONALE FOR WASTEWATER DISCHARGE LIMITATIONS

A. Categorical Standards – Not applicable

B. Combined Waste Steam Formula – Not applicable

C. Local Limits
Discharge limits for this permit will be those listed in Tacoma Municipal Code Chapter 12.08.

D. Categorical Standard/Local Limit Comparison – Not applicable

E. Best Professional Judgment
Although the City of Tacoma has not codified a TTO limit, Best Professional Judgement leads us to employ the TTO limit of 2.13 mg/l (calculated by adding the concentrations of all pollutants present at, or with a PQL of 10 ug/l or greater) imposed for industries subject to federal categorical regulations.

Wastewater Discharge Limitations

Parameters	Units	Daily Maximum
Arsenic	mg/L	0.1
BETX	mg/L	10 [1]
Cadmium	mg/L	0.25
Chromium, Total	mg/L	1.0
Chromium^{+6}	mg/L	0.25 [2]
Copper	mg/L	1.0
Lead	mg/L	0.4
Mercury	mg/L	0.05
Nickel	mg/L	1.0
pH within the range of	units	5.5-11.0

INDUSTRY FACT SHEET

Total Petroleum [3]Hydrocarbons	mg/L	50 [4]
Volatile and Semi-Volatile Organics	mg/L	2.13 [5]
Zinc	mg/L	2.0
Flow	gpd	40

[1] Benzene may not exceed 0.5 ppm.
[2] Analysis for Chromium $^{+6}$ is only required if Total Chromium exceeds 0.25 mg/l
[3] As Silica Gel Treated Hexane Extractable Material (SGT-HEM).
[4] No free floating oil or visible sheen is allowed.
[5] Total of all concentrations(or method reporting limits if not detected) equal to or greater than 10 ug/l)) (except benzene, ethylbenzene, toluene, and xylene-(See BETX)

No discharge of flammable solvents or pollutants which may create a fire or explosion hazard in the municipal sewer system shall be allowed including, but not limited to, wastewater with a closed cup flashpoint of less than 140 °F or 60 °C using test methods prescribed in 40 CFR 261.21.

No discharge of potentially toxic or harmful materials, other than those listed above, is permitted unless specifically approved by TACOMA. Specific limitations may be placed on other parameters, if determined appropriate by TACOMA.

5. MONITORING REQUIREMENTS

Parameter	Sampling Frequency	Type of Sample	EPA Analysis Method
pH	Quarterly	Grab	1 50.1
Total Petroleum Hydrocarbons (SGT-HEM)	Quarterly	Grab	1664
Metals, Total	100 ml/15 min Quarterly	Composite	200.7
Semi-Volatile Organic Constituents	100 ml/15 min Quarterly	Composite	625
Volatile Organic Constituents including xylenes	Quarterly	Grab	624
Flow	Continuously	Metered	

A. Frequency and Type

The discharge from the treatment system will be sampled for all parameters listed above within 30 days of startup to confirm that the discharge is in compliance with discharge limits. Additional sampling and analysis shall be done quarterly, with analysis results submitted to Environmental Services on or

before the 15th day of the month following the end of each calendar quarter (i.e., the 15th day of January, April, July, and October.)

1. Composite Samples

For metals and semi-volatile organics, flow proportional samples should be composited for a period of 24 hours. If flow proportional sampling is not practical, equal aliquots of no less than 100 ml should be taken at evenly spaced time intervals of no more than 15 minutes, over one 24 hour period each quarter.

2. Grab Samples

One grab sample shall be taken each quarter during normal operation for pH, petroleum hydrocarbons (as silica gel treated-hexane extractable materials), and volatile organics.

6. MONITORING LOCATIONS

All parameters shall be sampled at the end of the treatment system, before the water enters the sanitary sewer.

7. REPORTING REQUIREMENTS

A. Routine Reporting

Sampling and analysis shall be done for all parameters listed in Section T1.A of the permit within 30 days of the treatment system startup; the analysis report shall be submitted to ESCS within 15 days after it is received by DOE. Daily average flow measurement shall also be provided for the first 30 days of operation. Subsequent reports containing sampling analysis data and flow volume shall be submitted quarterly.

B. Signatory Requirements

DOE will delegate CH2M Hill Project Manager, Martin Powers, to have signatory authority for all permit related reports and documents.

6. SPECIAL REQUIREMENTS

A. Side sewer must be properly abandoned

The wastewater pipe installed for this project must be removed and the connection to the existing side sewer that serves the building at 2244 Port of Tacoma Road must be properly abandoned when the groundwater treatment system is taken out of service.

INDUSTRY FACT SHEET

B. Slug Discharge and Accidental Spill Prevention Plan

There is believed to be no risk of slug discharge or accidental spill at this site. Therefore, an Accidental Spill Prevention Plan will not be required.

C. Contact Stormwater – Not applicable

D. Compliance Schedule – Not applicable

E. Waste Charaterization

A similar treatment system was used to treat contaminated groundwater at this site in 2006. Analysis results were submitted with the permit application, showing that contaminates were almost entirely removed by the proposed technology.

WA Dept of Ecology – Lilyblad Site
2244 Port of Tacoma Road
Permit No. TAC-039-2009
Eff: August 17, 2009 - Exp: August 17, 2014

Permit Submittal Schedule

Action/Submittal	Permit Section	Due	Submitted
2009			
Start up compliance report	T3.A	45 days after startup	
Quarterly reports	T3.B	October 15th	
• Sampling analysis results for parameters listed in Permit Section T1.3			
2010			
Quarterly reports	T3.B	January 15, 2010	
• Sampling analysis results for parameters listed in Permit Section T1.3.		April 15, 2010 July 15, 2010 October 15, 2010	
2011			
Quarterly reports	T3.B	January 15, 2011	
• Sampling analysis results for parameters listed in Permit Section T1.3.		April 15, 2011 July 15, 2011 October 15, 2011	
2012			
Quarterly reports	T3.B	January 15, 2012	
• Sampling analysis results for parameters listed in Permit Section T1.3.		April 15, 2012 July 15, 2012 October 15, 2012	
2013			
Quarterly reports	T3.B	January 15, 2013	
• Sampling analysis results for parameters listed in Permit Section T1.3.		April 15, 2013 July 15, 2013 October 15, 2013	
SUBMIT APPLICATION TO RENEW PERMIT		**February 18, 2013**	
2014			
Quarterly reports	T3.B	January 15, 2014	
• Sampling analysis results for parameters listed in Permit Section T1.3.		April 15, 2014 July 15, 2014	
PERMIT EXPIRES		**August 17, 2014**	

ADDITIONAL REQUIREMENTS:

Test Flow Meter	T2.B*	Annually, with January 15th report

*See Flow Meter Installation and Testing Guidelines

NOTE: While we endeavor to list all ordinary reporting requirements in this schedule, it is the Permittee's responsibility to maintain compliance will all Permit conditions. Please become familiar with your permit to assure that all Permit conditions are met.

Washington State DOE/ CH2M Hill
Lilyblad Site Remediation Project
INDUSTRIAL WASTEWATER DISCHARGE PERMIT No. TAC – 039-2009
TABLE OF CONTENTS

SECTION **PAGE**

INDUSTRIAL WASTEWATER DISCHARGE PERMIT

Permit Holder:	Washington State Dept. of Ecology
Contact (phone):	Ha Tran (360.407.6064)
Mailing Address:	PO Box 47706, Olympia, WA 98504-7600
Authorized Representative:	CH2M Hill, Inc.
Address:	1100 112th Ave. S. Suite 400 Bellevue, WA 98004
Contact (phone): With Signatory Authority	Martin Powers (425.233.3493)

Discharge Location:	2244 Port of Tacoma Road
Industry Type:	Groundwater Remediation
SIC: 3463	NAICS: 541380

The above Industrial User **(Permittee)** is authorized by the Director of the Department of Public Works (**Director**), City of Tacoma (**City**) to discharge industrial and domestic wastewater into the City's municipal sanitary sewer system. The Permittee shall discharge in compliance with City Municipal Code Chapter 12.08 and any or all applicable provisions of federal and state laws or regulations, as amended, and in accordance with specific provisions of this permit.

This permit is granted based upon the information filed on **October 30, 2003, September 28, 2006** and **October 28, 2008** with the **Environmental Services Compliance Support (ESCS) Division**, and in conformance with plans, specifications, and/or other data submitted to the City in support of the above application.

Dan C. Thompson, Ph.D.
Acting Asst. P.W. Director/Environmental Services

The 24-hour emergency telephone number to report spills, etc. is (253) 591-5595. During regular business hours (8:00 A.M. to 4:30 P.M.) contact ESCS at **(253) 591-5588**.

T1. WASTEWATER DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

Beginning on the effective date of the permit, and remaining in effect until the expiration date, the Permittee is hereby authorized to discharge industrial wastewater into the City's municipal sanitary sewer system subject to the following limitations.

The wastewater discharge authorized under this permit is contaminated groundwater extracted and pretreated under a Washington State Department of Ecolcgy Cleanup Action Plan and Enforcement Order.

A. WASTEWATER DISCHARGE LIMITATIONS

Definitions and special requirements associated with statements contained in this section are noted in Section T1.C.

Wastewater Discharge Limitations

Parameters	Units	Daily Maximum
Arsenic, total	mg/L	0.1
BETX	mg/L	10 [1]
Cadmium, total	mg/L	0.25
Chromium, total	mg/L	1.0
Chromium $^{+6}$	mg/L	0.25 [2]
Copper, total	mg/L	1.0
Lead, total	mg/L	0.4
Mercury, total	mg/L	0.05
Nickel, total	mg/L	1.0
pH within the range of	units	5.5-11.0
Total Petroleum [3]Hydrocarbons	mg/L	50 [4]
Volatile and Semi-Volatile Organics	mg/L	2.13 [5]
Zinc, total	mg/L	2.0
Flow	Gal/Min	40

[1] Benzene may not exceed 0.5 ppm.
[2] Analysis for Chromium $^{+6}$ is only required if Total Chromium exceeds 0.25 mg/l
[3] As Silica Gel Treated Hexane Extractable Material (SGT-HEM).
[4] No free floating oil or visible sheen is allowed.
[5] Total of all concentrations (or method reporting limits if not detected) equal to or greater than 10 ug/l (except benzene, ethylbenzene, toluene, and xylene - see BETX)

1. No discharge of flammable solvents or pollutants which may create a fire or explosion hazard in the municipal sewer system shall be allowed including, but not limited to, wastewater with a closed cup flashpoint of less than 140 °F or 60 °C using test methods prescribed in 40 CFR 261.21.

2. No discharge of potentially toxic or harmful materials, other than those listed above, is permitted unless specifically approved by ESCS. Specific limitations may be placed on other parameters, if determined appropriate by ESCS.

B. WASTEWATER MONITORING REQUIREMENTS

The sample location for all parameters listed below shall be at the discharge from the treatment system before entering the sanitary sewer.

Parameter	Sampling Frequency	Type of Sample	EPA Analysis Method
pH	Quarterly	Grab	1 50.1
Total Petroleum Hydrocarbons	Quarterly	Grab	1664
Metals, Total	Quarterly	Time Composite 100 ml/15 min	200.7
Semi-Volatile Organic Constituents	Quarterly	Time Composite 100 ml/15 min	625
Volatile Organic Constituents including xylenes	Quarterly	Grab	624
Flow	Continuously	Metered	

1. The Permittee shall analyze samples for all listed parameters and is responsible for continuous compliance with all of the above limitations.

2. If sampling and analyses of the authorized discharge are performed over and above the requirements of this Permit, they shall be done in accordance with the methods described in this Permit. The results of those analyses shall be submitted to ESCS within the time frames specified for required reports.

3. All samples taken for parameters listed in T1.A from the sample location described in Section T2.A., shall be collected and analyzed in accordance with 40 CFR Part 136. Results of those analyses shall be submitted to ESCS within the time frame specified for required reports.

C. DEFINITIONS AND SPECIAL REQUIREMENTS

1. AUTHORIZED REPRESENTATIVE

The Permittee's Authorized Representative must sign the certification statement that must accompany all reports required by this permit. (See Section T3.F). The Authorized Representative must be:

a. a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or

b. the manager of one or more manufacturing, production, or operation facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second quarter 1980 dollars), provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty to make major capital investment recommendations, and initiate and direct other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations; can ensure that the necessary systems are established or actions taken to gather complete and accurate information for control mechanism requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures. Or,

c. a general partner or proprietor of the Industrial User submitting the reports; or

d. a duly authorized representative of the individual designated in paragraphs a - c of this section **if** the authorization is made in writing and submitted to ESCS by that individual; and

e. the authorization specifies either an individual or a position having responsibility for the overall operation of the facility from which the Industrial Discharge originates, such as the position of plant manager, operator of a well, or well field superintendent, or a position of equivalent responsibility, or having overall responsibility for environmental matters for the company.

2. COMPOSITE SAMPLE

A composite sample is collected over time, formed either by continuous sampling or by mixing discrete sample`s. The sample may be either of the following types:

a. A "time-composite" sample, which is composed of discrete sample aliquots collected in one container at constant time intervals, irrespective of stream flow; or

b. A "flow-proportional" sample, which is collected either at constant sample volume at time intervals proportional to stream flow, or by sample volumes proportional to flow while maintaining a constant time interval between aliquots.

In either case, the Permittee shall demonstrate that the type of sample collected is representative of the wastewater being discharged. Representative samples shall be taken during a normal workday when typical operations are in progress and the usual process wastewaters are generated. The sample shall be taken at mid-point in the wastewater flow and stirring up bottom sediments within the channel shall be avoided.

3. DAILY MAXIMUM

Daily Maximum is the highest allowable value for any calendar day.

4. DAILY MAXIMUM FLOW

Daily maximum flow is defined as the highest flow during any day of the reporting period.

5. GRAB SAMPLE

A grab sample shall consist of an individual sample, which is representative of the wastewater flowing through the sample point and collected in less than 15 minutes without regard to flow or time. Representative samples shall be taken during a normal workday when typical operations are in progress and when the usual process wastewaters are generated. The sample shall be taken at mid-point in the wastewater flow and stirring bottom sediments within the channel shall be avoided.

D. SAMPLING and REPORTING REQUIREMENTS

1. REPRESENTATIVE SAMPLING

Samples and measurements taken to meet the requirements of this permit shall be representative of the volume and nature of the monitored discharge and shall be collected, preserved and analyzed in accordance with 40 CFR Part 136, **Guidelines Establishing Test Procedures For The Analysis of Pollutants**, as amended. Samples shall be taken at a time that is representative of a normal workday when typical operations are in progress and the usual process wastewaters are generated.

2. SAMPLE FREQUENCY

Sampling shall be performed once each calendar quarter (January – March; April – June; July – September and October – December), during any 24-hour period of normal operations.

3. RECORDING OF RESULTS

For each measurement or sample taken pursuant to the requirements of this permit, the Permittee shall record the following information:

a. Place, date and time of sampling;

b. Dates the analyses were performed;

c. Person(s) performing the sampling and analyses;

d. Analytical techniques or methods used; and

e. Results of all analyses.

4. TEST PROCEDURES

Sampling and analytical methods used to meet the requirements specified in this permit, or for other monitoring activities associated with the Permittee's wastewater discharge, shall be performed by a laboratory accredited by the Department of Ecology for such analyses. Unless approved otherwise in writing by the City, sampling protocols and analytical methods shall conform to 40 CFR Part 136, as amended, **Guidelines Establishing Test Procedures for the Analysis of Pollutants**. Samples for TPH shall be analyzed using EPA Method 1664, *Silica Gel Treated, n-Hexane Extractable Material.*

Specific analytical techniques shall be selected to insure that method detection limits are equal to or less than the discharge limitations of this permit.

T2. SPECIAL CONDITIONS

A. SAMPLE LOCATION

The Permittee shall maintain an approved sampling point after treatment and before discharge to the sanitary sewer, to allow inspection, sampling and flow measurement of the wastewater stream discharged. The sample point shall be in accordance with the requirements specified by ESCS.

B. FLOW METER

A flow meter, approved by ESCS, shall be used to measure discharge flow volume. The flow meter shall read in cubic feet and will be used to determine the volume of water discharged to the sanitary sewer in order to calculate appropriate fees for service.

The Permittee shall operate, calibrate, and maintain the flow meter in accordance with the manufacturer's recommendations and The City of Tacoma's "Submeter Installation and Testing Guidelines." All maintenance and calibrations shall be recorded in a maintenance log and be available for inspection.

C. WASTEWATER DISCHARGE LINE REMOVAL

When the site remediation project is complete, the wastewater pipe installed for this discharge shall be removed. and the connection to the private sanitary sewer that serves 2244 Port of Tacoma Road must be properly abandoned.

T3. REPORTING REQUIREMENTS

A. START UP

To confirm compliance, samples shall be analyzed within 30 days after start up for the parameters specified in section T1.A and B. Results of the analysis shall be submitted to ESCS within 45 days after start up, along with the average daily flow volumes for the first 30 days of operation.

B. ROUTINE REPORTING

Quarterly reports shall be submitted to ESCS, listing the sampling results for the parameters specified in section T1.A. Results obtained during the previous reporting period shall be submitted no later than the **15th** calendar day of the month after the completed reporting period. The first quarterly report shall be submitted October 15, 2009. Future reports shall be due **January 15th, April 15th, July 15th and, October 15th.** Any reason(s) for not complying with this requirement and any steps taken by to comply shall be part of the report. All required reports shall be signed by an Authorized Representative and include the certification statement detailed in Section T3.F.

C. ACCIDENTAL, SLUG, AND EXCESSIVE DISCHARGE

The Permittee shall immediately notify ESCS on becoming aware of any accidental, excessive or slug discharge to the sanitary sewer as outlined in Tacoma Municipal Code Chapter 12.08. Written notification discussing the circumstances of the discharge or spill and the disposition of the spilled materials shall be submitted to ESCS within five (5) calendar days of the occurrence.

D. NON-COMPLIANCE REPORTING

1. Any event or circumstance that places the Permittee in a temporary state of non-compliance with wastewater discharge limitation(s) contained in this Permit or other limitations specified in the City's Municipal Code shall be reported to ESCS within **24 hours** of discovery. A written report explaining the circumstances surrounding the event and any corrective action(s) taken shall be submitted to ESCS within **5 calendar days.**

2. Any failure to meet the limits or sampling frequencies specified in Section T1.B shall be reported to ESCS within **24 hours** of discovery of the violation. The Permittee shall repeat the analysis of each parameter that exceeded its discharge limitation and submit the results to ESCS within **30 calendar days** after discovery of the violation.

E. REPORTING ADDRESS

All reports shall be submitted to the following address:

Pretreatment Coordinator
Environmental Services Compliance Support
City of Tacoma
2201 Portland Avenue
Tacoma, WA 98421

The business hour telephone number is (253) 591-5588.
The after hours telephone number is (253) 591-5595.

F. SIGNATORY REQUIREMENTS

1. All reports and documents required by this permit and any industrial wastewater discharge permit applications shall be signed by an executive officer of the Permittee or their designee.

2. Plans for modifications of existing pretreatment equipment or for installation of additional equipment shall also be signed by a professional engineer registered in the State of Washington, unless waived by the Director.

3. Any person signing a document required by this permit shall make the following certification statement:

   "I certify, under penalty of law that this document and all attachments to it were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. Further, I certify that this facility is implementing the Accidental Spill Prevention Plan most recently approved by ESCS. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

T4. GENERAL CONDITIONS

A. PROHIBITED MATERIALS

The Permittee shall comply with all the general prohibited discharge standards in Tacoma Municipal Code Chapter 12.08.020 **Prohibitions on Discharges** and 12.08.030 **Prohibitions on Storm drainage, Ground Water and Unpolluted Water**.

B. RIGHT OF ENTRY

The Permittee shall, at all reasonable times, allow authorized representatives of the City bearing proper credentials and identification to:

1. Enter upon the Permittee's premises to inspect and investigate conditions relating to compliance with any of the terms of this permit;

2. Access and copy any records required under the terms and conditions of this permit;

3. Inspect any pretreatment or monitoring equipment or analytical method required by this permit; and

4. Sample any wastewater discharge.

C. RECORDS RETENTION

The Permittee shall retain and preserve for no less than **three (3) years** any records, log books, documents, memoranda, reports, correspondence and any and all summaries thereof, relating to monitoring, sampling and chemical analyses made by or on behalf of the Permittee in connection with its wastewater discharge or off-site transportation and/or disposal of its wastewaters and sludges.

All records pertaining to matters subject to administrative relief or any other enforcement or litigation activities brought by the City shall be retained and preserved by the Permittee until all enforcement activities have concluded and all periods of limitation with respect to any and all appeals have expired. All records required by the permit shall be available for review at reasonable times by authorized representatives of the City.

D. CONFIDENTIAL INFORMATION

In accordance with City Municipal Code Section 12.08.170 **Confidential Information**, information and data furnished to the Director with respect to the nature and frequency of discharge shall be available to the public or other governmental agency without restriction, in accordance with Washington State Public Disclosure laws.

E. DILUTION

To achieve compliance with the limitations contained in this permit the Permittee shall not increase the use of potable or process water, or in any way attempt to dilute a discharge as a partial or complete substitute for adequate treatment.

F. HAZARDOUS WASTE NOTIFICATION

Federal regulation 40 CFR Part 403.12(p) **Industrial User Hazardous Waste Notification Requirements**, requires the Permittee to notify ESCS, the EPA Regional Waste Management Division Director, and the Department of Ecology in writing if the Permittee discharges into the City's municipal sanitary sewer system any substance which, if otherwise disposed of, would be a hazardous waste under 40 CFR Part 261.

G. DISCHARGE TO STORM SEWERS OR PUBLIC WATERS

Only unpolluted stormwater may be discharged to the storm drainage system. The Permittee is hereby notified that discharges to public waters and City storm sewer systems are regulated by the Federal Clean Water Act, as amended, Washington State RCW 90-48, as amended, and the Tacoma Municipal Code, Chapter 12.08.

H. PROPER DISPOSAL OF PRETREATMENT SLUDGES AND SPENT CHEMICALS

Sludges, solid waste, and spent chemicals shall not be discharged to the sanitary sewer. The Permittee is hereby advised that other State and Federal regulations govern the disposition of these materials, namely Section 405 of the Clean Water Act, as amended, subtitles C and D of the Resource Conservation and Recovery Act, as amended, and Chapter 173-303 WAC, Dangerous Waste Regulations.

I. EMERGENCY SUSPENSION OF SERVICE AND REVOCATION OF PERMIT

The Director may without advance notice, order the suspension of wastewater treatment service and may revoke this Wastewater Discharge Permit when it appears to the Director that an actual or threatened discharge:

1. Threatens or presents an imminent or substantial danger to the health or welfare of personnel or to the environment;

2. Threatens to interfere with the operation of the Municipal Sanitary Sewer System or causes the City to violate its NPDES permit; or

3. Causes the Permittee to violate any pretreatment limitation imposed by this permit or other regulation contained in Tacoma Municipal Code Chapter 12.08.

The Permittee shall immediately cease all discharges to the sanitary sewer when notified of the Director's suspension order. If the Permittee fails to comply with the suspension order, the Director may utilize any judicial remedies to compel the Permittee

to specifically comply with such an order. The Director may reinstate the Wastewater Discharge Permit, wastewater treatment service, or both, upon proof by the Permittee that the non-complying discharge or conditions creating the threat, as set forth above, have been eliminated.

J. LIMITATION ON PERMIT TRANSFER

Wastewater discharge permits are issued to a particular user for a specific operation and are not assignable to another entity, or transferable to any other location without the prior written approval of ESCS. The sale of a business shall obligate the purchaser to obtain prior written approval from ESCS to continue discharging into the sanitary sewer system.

K. MODIFICATION OR REVISION OF THE PERMIT

Terms and conditions of the Permittee's Industrial Wastewater Discharge permit may be subject to modification or revision by ESCS:

1. Whenever limitations or requirements identified in the Tacoma Municipal Code are changed, modified, or revised, or any other just cause exists;

2. To incorporate special conditions resulting from a compliance order;

3. As a result of the EPA or the State promulgating new or revising existing pretreatment regulations;

4. When there has been a change in the condition of the receiving waters or any other condition that requires either a temporary or permanent reduction or elimination of the permitted discharge;

5. Upon request by the Permittee, provided such request does not create a violation of any existing applicable requirements, standards, laws, rules or regulations;

6. Upon violation of any terms or conditions of this permit;

7. Upon misrepresentation or failure to disclose fully all relevant facts in the permit application or in any required report;

8. To reflect a transfer of the facility's ownership, operation, or both, to a new owner or operator.

Substantial permit modifications shall be processed with public notice for review and comments, including an opportunity for public hearing in accordance with requirements of 40 CFR 403.18. All other permit modifications consistent with Tacoma's approved pretreatment program may be implemented after the Permittee has had the opportunity to comment on the proposed modification.

Any permit modification which results in a revision of the existing permit limitations or requirements shall include a reasonable compliance schedule.

L. NEW OR INCREASED DISCHARGE

A new application and the appropriate engineering plans must be submitted to ESCS for approval at least **90 calendar days** prior to the introduction of the following changes, unless this requirement is waived by ESCS.

1. A new process wastewater discharge;
2. An increase in a process wastewater discharge's volume or frequency; or
3. A change in the process wastewater discharge's pollutant concentration

No modifications or alterations to pretreatment equipment shall be made until plans have been approved and a new or modified permit has been issued.

M. MODIFICATION OF PRETREATMENT EQUIPMENT

Prior to installing, modifying or expanding pretreatment equipment, or changing wastewater treatment chemicals, the Permittee shall submit to ESCS for approval, the appropriate plans, specifications, engineering reports, Material Safety Data Sheets, or other pertinent information. Pretreatment equipment construction or installation is prohibited until the Permittee has obtained written approval from ESCS.

No person, by virtue of such approval, shall be relieved from compliance with other local, state, or federal laws relating to the construction and approval of such facilities or equipment.

Each pretreatment facility shall be constructed, installed, and maintained at the expense of the Permittee.

N. UNABLE TO COMPLY

In the event the Permittee is unable to comply with any of the conditions of this permit due to any cause, the Permittee shall:

1. **Immediately** take action to stop, contain, and clean up any unauthorized discharge(s) and correct the problem;
2. **Within 24 hours** notify ESCS of the Permittee's failure to comply; and
3. **Within five (5) calendar days** of the violation, submit a detailed written report describing the nature of the violation, any corrective action taken or planned to prevent a recurrence, and any other pertinent information.

Following these requirements does not relieve the Permittee from its responsibility to continuously maintain compliance with the conditions of this permit or the resulting liability for failure to comply.

O. UPSETS

If the Permittee experiences an upset as defined in Chapter 12.08.010, upon its discovery the Permittee shall **immediately** inform ESCS and within **five (5) calendar days** submit a report specifying the following information.

1. Description of the upset, its cause, and the upset impact on the Permittee's compliance status.

2. Duration, dates, and times of non-compliance. If non-compliance is expected to continue, the Permittee shall state when it expects to return to compliance status.

3. Steps taken to reduce, eliminate and prevent recurrence of the upset or other non-compliance condition. The steps should include, but not be limited to, reducing or controlling production, providing alternate treatment or power supply, and providing temporary storage, off-site wastewater disposal, or both.

Responses by the Permittee to the above reporting requirements will be used to determine what enforcement action, if any, will be taken by ESCS in accordance with Section T.4 X of this Permit.

P. BYPASSES

1. A **"bypass"** is the intentional diversion of wastestreams from any portion of a Permittee's pretreatment facility.

2. **Severe property damage** is substantial physical damage to property or pretreatment facilities, which could cause them to become inoperable, or a substantial and permanent loss of natural resources which one may reasonably expect to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

3. If the Permittee knows in advance that a bypass is necessary, it shall request and receive permission in writing from ESCS prior to implementing the bypass. At a minimum, the written request shall contain the information specified below.
   After considering the information provided and the effects of the proposed bypass, ESCS may approve or deny the request for a bypass. An approved bypass may require the Permittee to conduct special monitoring.

4. If the Permittee experiences an unanticipated bypass, the Permittee shall:

   a. Submit verbal notice **immediately** upon becoming aware of the bypass;

   b. Provide a report within **five (5) calendar days** from becoming aware of the bypass. The report shall contain a description of the bypass, its cause; duration, including dates and times, and the steps taken to reduce, eliminate, and prevent a reoccurrence. On a case-by-case basis ESCS may waive the report if verbal notification was received **immediately** and the incident was minor.

5. Any bypass is prohibited unless:

   a. The Permittee submitted notices as required above;

   b. The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage; or

   c. There were no feasible alternatives to the bypass, such as use of auxiliary treatment facilities, retention of untreated wastewater, or planned maintenance. This condition is not satisfied if:

   d. Adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass during normal periods of equipment downtime or preventative maintenance; or

   e. Back-up equipment failed to operate during primary/lead equipment failure.

Q. PROPER OPERATION

At all times, the Permittee shall maintain in good working order and efficiently operate:

1. Any monitoring equipment required by this permit; and

2. Any pretreatment or control facilities or systems installed or used by the Permittee to achieve compliance with the terms and conditions of this permit.

In order to maintain compliance when a reduction, loss, failure, or bypass of the pretreatment facility has occurred, the Permittee shall control production or its wastewater discharge until the facility is restored or an alternative method of pretreatment is provided. This requirement applies even when the primary source of power for the pretreatment facility is reduced, lost, or fails.

R. DUTY TO REAPPLY

The Permittee shall reapply for permit renewal at least **180 calendar days** prior to the permit's expiration. At the Director's discretion, an expired permit may be administratively extended until a new permit is issued.

S. SEVERABILITY

The provisions of this permit are severable and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision or other circumstance and the remainder of this permit shall not be affected thereby.

T. PROPERTY RIGHTS

The issuance of this permit does not convey any property rights, either real or personal property, or any exclusive privileges, nor does it authorize any invasion of personal rights.

U. COMPLIANCE WITH OTHER REGULATIONS

Nothing in this permit shall be construed to excuse the Permittee from complying with any applicable federal, state, or local statutes, ordinances, or regulations.

V. VIOLATION OF TERMS AND CONDITIONS

All discharges and activities authorized by this permit shall be consistent with the terms and conditions of this permit. The discharge of any pollutant at a rate more frequent or at a concentration in excess of that authorized by this permit shall constitute a violation of the terms and conditions of this permit.

W. ENFORCEMENT PROVISION

In response to the following violations by the Permittee, as provided by Tacoma Municipal Code Chapter 12.08, the City may seek any or all remedies and penalties, both civil and criminal, and recover all costs incurred:

1. Any violation of the provisions of this permit.

2. Any violation of the provisions of Tacoma Municipal Code Chapter 12.08; or

3. Any violation of any Order from the City with respect to provisions set forth in this permit or in Tacoma Municipal Code Chapter 12.08.

The range and severity of any remedy or penalty taken by the City against the Permittee will be determined by, but not limited to, the nature, duration, frequency, and consequences of the violation and any economic benefit gained from non-compliance.

APPENDIX B

Vapor Discharge Guidelines

Puget Sound Clean Air Agency

Notice of Construction No. **9367**

Registration No. **25006**

Date **2/13/2007**

HEREBY ISSUES AN ORDER OF APPROVAL TO CONSTRUCT, INSTALL, OR ESTABLISH

In-situ Soil & Groundwater Remediation by various technologies in series with all emissions routed through catalytic oxidizers or carbon adsorbers to a stack.

APPLICANT

Glen Tegen
Lilyblad Petroleum Inc
PO Box 817
Tacoma, WA 98401

OWNER

Lilyblad Petroleum Inc
PO Box 817
Tacoma, WA 98401

INSTALLATION ADDRESS

Lilyblad Petroleum Inc, 2232 & 2244 Port of Tacoma Road, Tacoma, WA, 98421

THIS ORDER IS ISSUED SUBJECT TO THE FOLLOWING RESTRICTIONS AND CONDITIONS

1. Approval is hereby granted as provided in Article 6 of Regulation I of the Puget Sound Clean Air Agency to the applicant to install or establish the equipment, device or process described hereon at the INSTALLATION ADDRESS in accordance with the plans and specifications on file in the Engineering Division of the Puget Sound Clean Air Agency.

2. This approval does not relieve the applicant or owner of any requirement of any other governmental agency.

3. Lilyblad Petroleum Inc. (Lilyblad) shall route all air emissions from the in-situ soil and groundwater Dual Vacuum Extraction (DVE) system and associated wells through thermal catalytic oxidizers (Oxidizers) or two-stage carbon adsorber (Adsorbers) before venting through a stack to the atmosphere. The total vapor flow rate from the DVE and wells entering the control equipment (Oxidizers or Adsorbers) should not exceed 1200 scfm.

4. If Lilyblad routes the emissions through Oxidizer(s), Lilyblad shall monitor monthly the concentrations of pollutants of concern at the inlet and outlet of the Oxidizer(s) by collecting samples and performing lab analysis, the temperature of the vapor at the inlet and outlet of the combustion chamber of the Oxidizer(s), the flow rate of vapor exiting the Oxidizer(s), and the Destructive Efficiencies (DEs) of the Oxidizer(s) for Volatile Organic Compounds (VOCs).

The concentration of a pollutant of concern in the vapor leaving the Oxidizer shall not exceed the concentrations indicated below:

Pollutant of Concern	Concentration (ug/m3) in vapor leaving Oxidizer(s)
Vinyl Chloride	200
Methylene Chloride	1,000
Benzene	500
Trichloroethene (TCE)	1,000

Tetrachloroethene (PCE)	10,000
1,4-Dichlorobenzene	10,000
Volatile Organic Compounds (VOCs)	26,000

FEB 13 2007

The temperature of the vapor at the inlet of the combustion chambers of the Oxidizer(s) shall be at least 550 deg F, and the temperature of the vapor at the outlet of the combustion chamber of the Oxidizer(s) shall not exceed 900 deg F. The DEs of the Oxidizer(s) shall be at least 96% unless the concentration of VOCs in the vapor exiting the Oxidizer(s) does not exceed 26,000 ug/m3. The total flow rate of vapor exiting the Oxidizer(s) shall not exceed 600 scfm. Lilyblad shall estimate the DE of the Oxidizer(s) with the quantity of VOC flowing into and out of the Oxidizer(s). Lilyblad shall record the concentrations, DEs, flow rates of vapor exiting the Oxidizer(s) and temperatures.

5. If Lilyblad routes the emissions through Oxidizer(s), Lilyblad shall route the effluent from the Oxidizer(s) through a caustic scrubber to remove Hydrogen Chloride (HCl) that might form in the Oxidizer(s) if the concentration of HCl in the vapor exiting the Oxidizer(s) is not below 6 ppmv. Lilyblad shall monitor monthly the concentration of HCl in the vapor leaving the Oxidizer and caustic scrubber. The concentration of HCl in the vapor leaving the caustic scrubber shall be less than 6 ppmv. The combined flow rate of vapor leaving the caustic scrubber shall not exceed 600 scfm. Lilyblad shall record the concentration of HCl in the vapor leaving the caustic scrubber and the flow rate of the vapor leaving the scrubber.

6. If Lilyblad routes the emissions through an Adsorber, Lilyblad shall monitor monthly the concentrations of pollutants of concern at the inlet and outlet of the first carbon drum of the Adsorber by collecting samples and performing lab analysis. The concentration of a pollutant of concern in the vapor leaving the first carbon drum of the Adsorber shall be less than the concentrations indicated below:

Pollutant of Concern	Conc. (ug/m3) in vapor leaving 1st Carbon Drum
Vinyl Chloride	200
Methylene Chloride	1,000
Benzene	500
Trichloroethene (TCE)	1,000
Tetrachloroethene (PCE)	10,000
1,4-Dichlorobenzene	10,000
Volatile Organic Compounds (VOCs)	26,000

7. Lilyblad may remove the control equipment (Oxidizers or Adsorbers) and vent directly through stacks if three consecutive monthly monitoring indicate the concentration of each of the pollutants of concern in the vapor entering the control equipment is less than the concentrations shown below, provided Lilyblad continues to monitor the concentration of each of the pollutants of concern in the uncontrolled vapor entering the stacks.

Pollutant of Concern	Concentration (ug/m3) in vapor entering the stacks

Vinyl Chloride	200
Methylene Chloride	1,000
Benzene	500
Trichloroethene (TCE)	1,000
Tetrachloroethene (PCE)	10,000
1,4-Dichlorobenzene	10,000
Volatile Organic Compounds (VOCs)	26,000

FEB 13 2007

If one monitoring indicates that the concentration of one of the pollutants of concern in the uncontrolled vapor entering a stack is not below the concentration allowed in Condition 7, Lilyblad shall re-install the control equipment. The total flow rate through all the stacks shall not exceed 1200 scfm.

8. Lilyblad shall make all monitoring records available to personnel of Puget Sound Clean Air Agency. The records shall include the temperature of the vapor at the inlet and outlet of the combustion chamber of Oxidizers, lab analysis of the concentration of pollutants of concerns in the vapors, DEs of the Oxidizers, concentration of HCl in the vapor exiting the caustic scrubber, flow rate of vapor through the Oxidizers, Adsorbers, scrubber, and stacks, and the calibration records of the meters used to measure the flow rates.

9. The duration of the project shall not exceed nine years from the date of this Order.

APPEAL RIGHTS

Pursuant to Puget Sound Clean Air Agency's Regulation I, Section 3.17 and RCW 43.21B.310, this Order may be appealed to the Pollution Control Hearings Board (PCHB). To appeal to the PCHB, a written notice of appeal must be filed with the PCHB and a copy served upon Puget Sound Clean Air Agency within 30 days of the date the applicant receives this Order.

Kwame Agyei
Reviewing Engineer
ns

Steven Van Slyke
Supervising Engineer

Lopez, Mario/SEA

From: Steve Van Slyke [SteveV@pscleanair.org]
Sent: Tuesday, June 02, 2009 7:56 AM
To: Powers, Martin/SEA
Cc: Lopez, Mario/SEA; Kim Cole
Subject: RE: PSCAA application
Attachments: 50-131-RegistrationGeneralforPublic.pdf

Martin,

When I look at the two statutes that address the question you and I discussed (see excerpts below), I think it supports the conclusion that the proposal is exempt from the Notice of Construction (NOC) application review process which would conclude with an Order of Approval (and special permit conditions). That would be the procedural requirement referenced, being an authorization or approval. I don't think this would apply to our Registration program, since there is no procedural decision to register a source. Registration would also be consistent with provisions for fees discussed in the MTCA statute and would eventually offset some of the costs related to continued discussions related the need for a wet scrubber. I am attaching a Registration Questionnaire that is normally used to initiate the data entry. Our registration regulation identifies any emission generating activity which has a gaseous emission control device (e.g. oxidizer, carbon adsorber, or wet scrubber for absorption) that is rated at 200 cfm or higher would be subject to registration. If the operation were registered, the current program fee structure would produce an annual invoice of $1000 and you would receive your first invoice in November 2009 for the calendar year 2010.

<<50-131-RegistrationGeneralforPublic.pdf>>
We should probably talk a little more about your questions regarding the wet scrubber requirement. My quick read of the conditions for the equipment that has been removed would suggest that you would not need the scrubber if the oxidizer HCl concentration was <6 ppm. I hope this helps for answer the questions for now. I don't see a problem for your startup plans based on the NOC exemption and the registration process can be completed in a very short period of time.

Thanks,
Steve

Steve Van Slyke
Supervisory Engineer
Puget Sound Clean Air Agency
1904 3rd Ave., Suite 105
Seattle, WA 98101-3317

(206) 689-4052
(206) 343-7522 (fax)

SteveV@pscleanair.org

70.94.335

Hazardous substance remedial actions — Procedural requirements not applicable.

The procedural requirements of this chapter shall not apply to any person conducting a remedial action at a facility pursuant to a consent decree, order, or agreed order issued pursuant to chapter 70.105D RCW, or to the department of ecology when it conducts a remedial action under chapter 70.105D RCW.

The department of ecology shall ensure compliance with the substantive requirements of this chapter through the consent decree, order, or agreed order issued pursuant to chapter 70.105D RCW, or during the department-conducted remedial action, through the procedures developed by the department pursuant to RCW 70.105D.090.

[1994 c 257 § 15.]
Notes:
Severability -- 1994 c 257: See note following RCW 36.70A.270.

70.105D.090
Remedial actions — Exemption from procedural requirements.

(1) A person conducting a remedial action at a facility under a consent decree, order, or agreed order, and the department when it conducts a remedial action, are exempt from the procedural requirements of chapters 70.94, 70.95, 70.105, 77.55, 90.48, and 90.58 RCW, and the procedural requirements of any laws requiring or authorizing local government permits or approvals for the remedial action. The department shall ensure compliance with the substantive provisions of chapters 70.94, 70.95, 70.105, 77.55, 90.48, and 90.58 RCW, and the substantive provisions of any laws requiring or authorizing local government permits of approvals. The department shall establish procedures for ensuring that such remedial actions comply with the substantive requirements adopted pursuant to such laws, and shall consult with the state agencies and local governments charged with implementing these laws. The procedures shall provide an opportunity for comment by the public and by the state agencies and local governments that would otherwise implement the laws referenced in this section. Nothing in this section is intended to prohibit implementing agencies from charging a fee to the person conducting the remedial action to defray the costs of services rendered relating to the substantive requirements for the remedial action.

(2) An exemption in this section or in RCW 70.94.335, 70.95.270, 70.105.116, *77.55.030, 90.48.039, and 90.58.355 shall not apply if the department determines that the exemption would result in loss of approval from a federal agency necessary for the state to administer any federal law, including the federal resource conservation and recovery act, the federal clean water act, the federal clean air act, and the federal coastal zone management act. Such a determination by the department shall not affect the applicability of the exemptions to other statutes specified in this section.

[2003 c 39 § 30; 1994 c 257 § 14.]
Notes:
***Reviser's note:** RCW 77.55.030 was recodified as RCW 77.55.061 pursuant to 2005 c 146 § 1001.
Severability -- 1994 c 257: See note following RCW 36.70A.270.

From: Martin.Powers@CH2M.com [mailto:Martin.Powers@CH2M.com]
Sent: Tuesday, May 12, 2009 4:07 PM
To: Steve Van Slyke
Cc: Mario.Lopez@CH2M.com
Subject: FW: PSCAA application

Steve,
Based on information provided to Mario Lopez by Kim Cole, we are under the impression that our previous agreement on "renewing" the prior NoC is no longer on the table for the Lilyblad site in Tacoma. Is this the case?

Can't we maintain that agreement and provide the data showing compliance with limits without the scrubber during the first few weeks of operation of the system? Are you and Kim available to discuss?

Thanks,
Martin

From: Lopez, Mario/SEA
Sent: Thursday, February 05, 2009 6:26 PM
To: Powers, Martin/SEA; Tracy, Brian/SEA
Cc: Farmer, Bill/SEA
Subject: FW: PSCAA application

Hey guys,

I am coming home tonight and will be at the office sometime tomorrow for just a couple of hours. Just wanted to forward this message from Steve Van Slyke in regards to our Air Permit. Just need to stay within required criteria and we should be fine.

Mario López

P Please consider the environment before printing this e-mail.

From: Steve Van Slyke [mailto:SteveV@pscleanair.org]
Sent: Thursday, February 05, 2009 2:55 PM
To: Lopez, Mario/SEA
Subject: RE: PSCAA application

Mario,

It appears that you do not need to do anything with the air permit for this project. The NOC Order of Approval (copy attached) has language that allows operation without the scrubber provided you meet an alternative emission limit. If you know you'll meet the 6 ppm criteria and have the required monitoring data to back that up, you would be complying with this Order. I'm attaching the original NOC review worksheet prepared by Kwame for this approval for your files and reference. I would say you should just comply with this permit and let me know if you have any questions regarding project changes or options which were not anticipated as a part of the original review.

Let me know if you have more questions.

Thanks,

Steve

Steve Van Slyke
Supervisory Engineer
Puget Sound Clean Air Agency
1904 3rd Ave., Suite 105
Seattle, WA 98101-3317

(206) 689-4052
(206) 343-7522 (fax)

SteveV@pscleanair.org

From: Mario.Lopez@CH2M.com [mailto:Mario.Lopez@CH2M.com]
Sent: Wednesday, January 14, 2009 11:35 AM
To: Steve Van Slyke
Subject: RE: PSCAA application

Steve,

The permit issued in 2007 is for the same site. The system treatment pathway is the same. In our design, we do not have a caustic scrubber to treat the HCl because we think that we can meet the 6ppm criteria stated in the permit. If you need to revise our flow diagrams or RAWP, just let me know so I can provide you with copies.

Thanks,

Mario López

P Please consider the environment before printing this e-mail.

From: Steve Van Slyke [mailto:SteveV@pscleanair.org]
Sent: Tuesday, January 13, 2009 6:08 PM
To: Lopez, Mario/SEA
Subject: RE: PSCAA application

Mario,

Before I answer the procedural questions you are asking, could you check to see if the permit we issued in 2007 to Lilyblad is for the site you are working on? If it is the same site, can you tell me if that permit is consistent with the treatment pathway you are presently on or is there something different being contemplated?

Let me know.

Thanks,

Steve

Steve Van Slyke
Supervisory Engineer
Puget Sound Clean Air Agency
1904 3rd Ave., Suite 105
Seattle, WA 98101-3317

(206) 689-4052
(206) 343-7522 (fax)

SteveV@pscleanair.org

From: Mario.Lopez@CH2M.com [mailto:Mario.Lopez@CH2M.com]
Sent: Friday, January 09, 2009 6:53 PM
To: Steve Van Slyke
Subject: PSCAA application

Steve,

Here is an excerpt from the regulatory history at the site which goes over the application and modifications to the consent decree for the site and mentions that Ecology has now taken the lead on the cleanup. We might be exempt from filing a NOC for an air permit, but want to see if we can get a written statement from PSCAA. We also want to know what the requirements are to meet the substantive conditions of the Washington State Clean Air Act. We are in the process of writing the Operation and Maintenance Plan for the site and would like to know what our monitoring and reporting requirements will be so we can add this information to the plan.

Lilyblad formerly operated the facility as an interim status dangerous waste treatment, storage, and disposal (TSD) facility regulated under Subtitle C of Public Law 94-580, the Resource

Conservation and Recovery Act (RCRA). Ecology is authorized to enforce RCRA through Chapter 70.105 RCW, the Hazardous Waste Management Act (HWMA) of 1976. Ecology implements the HWMA through the Dangerous Waste Regulations in Chapter 173-303 WAC. Corrective action requirements for releases of dangerous waste and dangerous constituents at facilities seeking or required to have a permit to treat, store, recycle, or dispose of dangerous wastes are described in Chapter 173-303-646 WAC. To fulfill corrective actions requirements, Ecology issued enforcement actions pursuant to the Model Toxics Control Act (Chapters 70.105 RCW and 173-340 WAC). Ecology named Lilyblad and Sol Pro potentially liable persons (PLPs) in accordance with Chapter 173-340-500 WAC.

On October 30, 1995, the PLPs and Ecology entered into the Agreed Order DE 95HS-S292 requiring the PLPs to prepare the remedial investigation/feasibility study (RI/FS) and CAP.

Ecology issued an amendment to the Order on October 10, 2000. Under the amendment, Lilyblad developed and implemented an interim action work plan to remediate contaminated groundwater and soil at the site. Ecology amended the Order on August 15, 2006 and took over the preparation of the FS and CAP.

Mario López | Staff Engineer 2

CH2MHILL <http://ch2mhill.com> | Environmental Services

1100 112th Avenue NE, Suite 400 Bellevue, WA 98004
425.453.5000 ext. 25120 | 425.647.6637 cell

P Please consider the environment before printing this e-mail.

DRAFT

pscleanair.org
Puget Sound Clean Air Agency

PUGET SOUND CLEAN AIR AGENCY

1904 3rd Ave, Ste 105 Seattle WA 98101-3317
Telephone: (206) 689-4052 or 1-800-552-3565 Fax: (206) 343-7522
www.pscleanair.orgp

QUESTIONNAIRE FOR REGISTRATION

Facility Name: Former Lilyblad Petroleum Site	
Mailing Address: Washington State DoE - Attn: Ha Tran 300 Desmond Drive SE	City, Zip: Lacey, 98503
Facility Address: 2244 Port of Tacoma Road	City, Zip: Tacoma, 98421
Phone Number: (360) 407-6064	Email: HTRA461@ECY.WA.GOV

Please describe your process. What do you make or do?

Remediation system is subject of this registration. Remediation system removes VOCs from subsurface.

How much do you produce annually? How many hours of operation is this based on?

Not Applicable

PRODUCTION EQUIPMENT (include combustion equipment like boilers, but do not include office equipment like computers)

Type of Equipment *	Equipment Maximum Production Capacity	Type of Air Pollution Control Device (if applicable) *	Control Device Air Flow Rate (cfm) & Diameter of Duct (in)*	Year Equipment & Control Installed
Air Stripper	300 cfm	Activated Carbon Adsorption	500 - 1500 cfm 4 in	2009
Dual - Phase Extraction Blower No. 1	300 cfm	Catalytic Oxidizer Activated Carbon Adsorption	300 cfm / 6 in. 500 - 1500 cfm / 4 in.	2009
Dual - Phase Extraction Blower No. 2	300 cfm	Activated Carbon Adsorption	500 - 1500 cfm / 4 in.	2009

* On the back of this form you will find a sample list of the types of equipment and air pollution controls that should be listed

CERTIFICATION

I, the undersigned, do hereby certify, that the information contained in this questionnaire is, to the best of my knowledge, accurate and complete.

Signature — 7/1/09 Date

Ha Tran, Environmental Engineer — Type or Print Name & Title

360-407-6064, ha.tran@ecy.wa.gov — Phone & Email

Puget Sound Clean Air Agency personnel will review the information you submitted and will contact you regarding whether registration and/or permits for your equipment are needed.

PROCESS EQUIPMENT (such as, but not necessarily limited to)	
Abrasive Blasting	
Air Strippers (Soil & Groundwater Remediation)	
Anodizing	
Asphalt Batch Plant	
Baking Oven	
Boiler	
Burn-off Oven	
Coffee Roaster	
Cold Solvent Cleaner	
Composting	
Concrete Batch Plant	
Crematory	
Crusher - Portable	
Curing Oven	
Diesel Engine Generator	
Dry Cleaner (Unvented w/ Refrigerated Condenser)	
Drying Oven	
Dryer - Rotary	
Electroplating	
Ethylene Oxide Sterilizer	
Evaporators	
Fiberglassing	
Foundry Operations	
Furnace	
Galvanizing Line	
Gasoline Pump	
Gas Turbine (Stationary)	
Heater	
Incinerator	
Kiln	
Microchip & circuit board mfg.	
Miscellaneous Equipment	
Printing Press	
Pumping Station	
Rendering Equipment	
Sanding	
Sewage Treatment Facility	
Smokehouse	
Spray coating	
Storage Bin/Silo	
Storage Tank (including VOC storage)	
Vapor Degreaser	
Wood Preserving Line	
Woodworking System	

AIR POLLUTION CONTROLS (such as, but not necessarily limited to)	
Activated carbon adsorption	
Afterburner	
Baghouse	
Barometric condenser	
Biofilter	
Catalytic oxidizer	
Chemical oxidation	
Condenser	
Cyclone - single	
Cyclones - multiple	
Demister	
Dry sorbent injection	
Electrostatic precipitator (ESP)	
Flaring	
Freeboard refrigeration device	
HEPA (High-efficiency particulate air filter)	
HVAF (High Velocity Air Filter)	
Mat or panel filter	
Miscellaneous control devices	
Mist eliminator - high efficiency	
NSCR (non-selective catalytic reduction)	
Refrigerated condenser	
Rotoclone	
SCR (selective catalytic reduction)	
Screen	
Steam or water injection	
Sulfur plant	
Vapor recovery unit	
Venturi scrubber	
Water curtain	
Water sprays	
Wet electrostatic precipitator	
Wet scrubber	

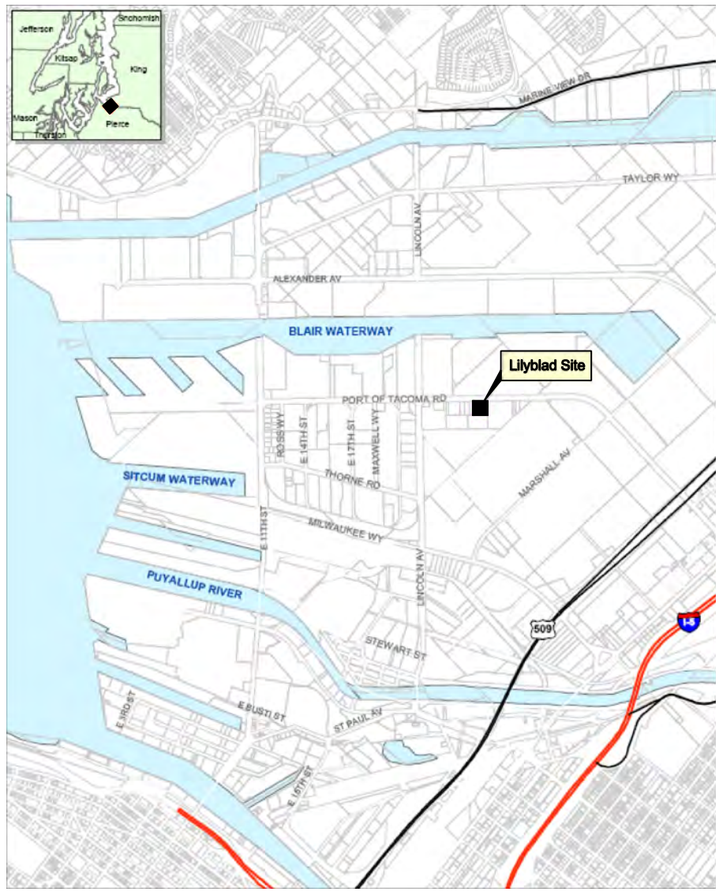
*

APPENDIX C

As-built Drawings

ECOLOGY LILYBLAD SITE REMEDIATION

2244 PORT OF TACOMA ROAD
TACOMA, WASHINGTON



SITE LOCATION MAP

INDEX TO DRAWINGS

SHEET NUMBER	DRAWING NUMBER	DRAWING TITLE
1	G-01	COVER SHEET AND DRAWING INDEX
2	C-01	SITE PLAN
3	C-02	DPE WELL AND PIPING LAYOUT
4	C-03	REMEDIAL COMPOUND - PLAN VIEW
5	M-01	DPE WELL DETAILS
6	M-02	DPE WELL AND TRENCH CROSS SECTION DETAILS
7	M-03	PIPING CONNECTION DETAILS
8	M-04	PIPING MANIFOLD DETAILS
9	M-05	PIPE ATTACHMENT DETAILS
10	I-01	PROCESS & INSTRUMENTATION DIAGRAM - CONVEYANCE PIPING
11	I-02	PROCESS & INSTRUMENTATION DIAGRAM - REMEDIATION SYSTEM
12	E-01	ELECTRICAL DIAGRAM

RECORD DRAWINGS

Revisions Drawn By K. WEIGUM Date OCT. 26, 2009

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NO.	DSGN	DR	CHK	APVD
	BT / ML	AH	ML / BF	MP

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LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

CH2MHILL

GENERAL

COVER SHEET AND DRAWING INDEX

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

RECORD DRAWINGS
AUGUST 3, 2009

DATE	OCTOBER 2008
PROJ	380987
DWG	G-01
SHEET	1

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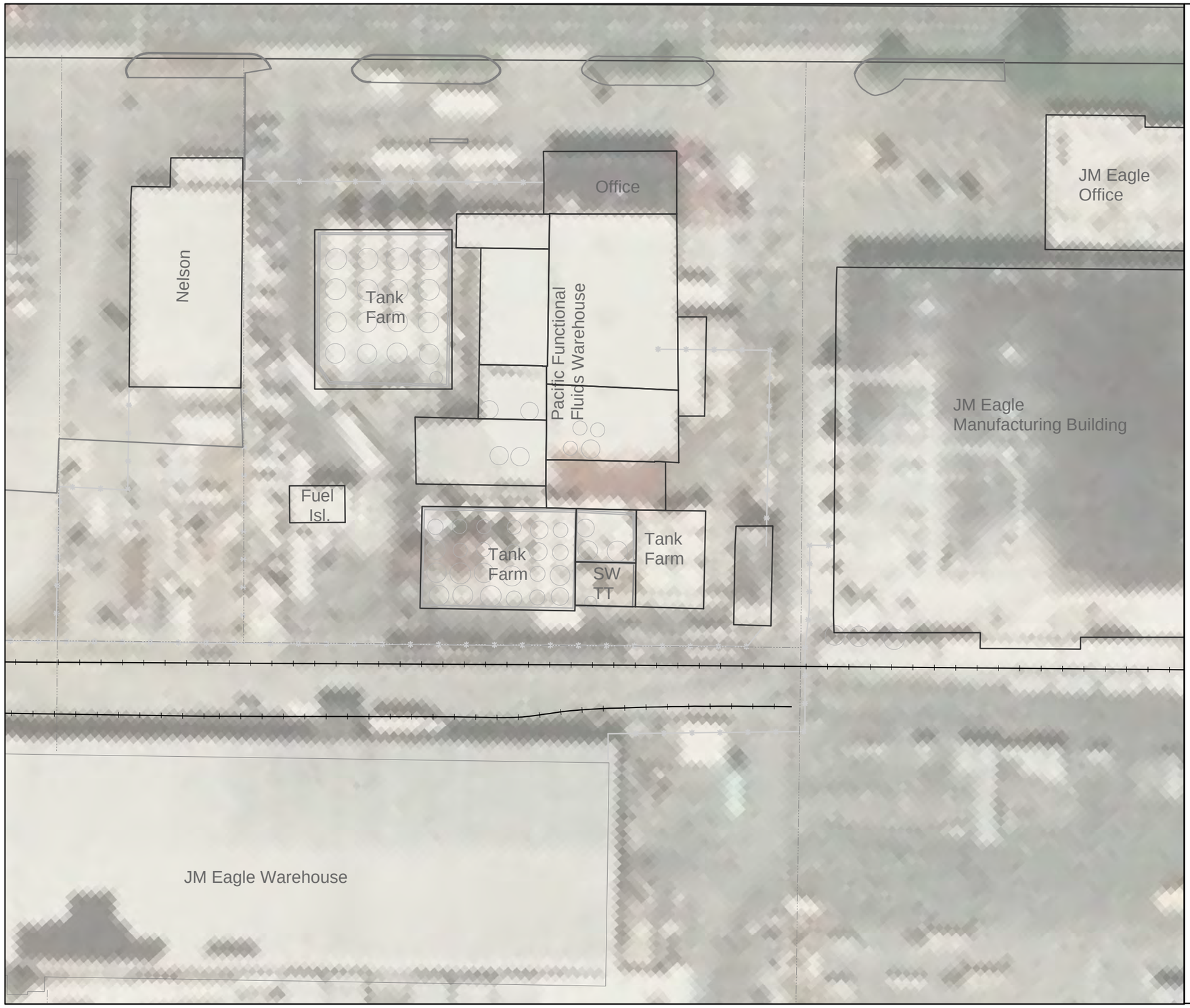
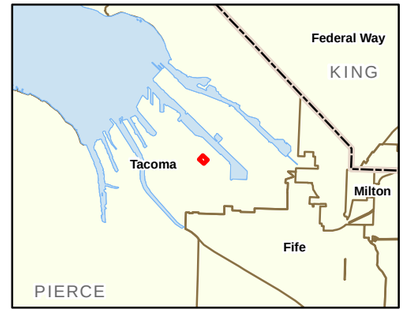




LEGEND

- Property Line
- Railroad
- Fence
- Edge of Pavement
- Road
- Tank
- Building

0 25 50 100
Feet

1 INCH = 55 FEET

NOTE: This figure was created using ArcGIS.

NO	DSGN	DATE	DR
	BT/ML		
	BH	CHK	
	BF/MP/ML	APVD	
	BY	APVD	
		APVD	MP

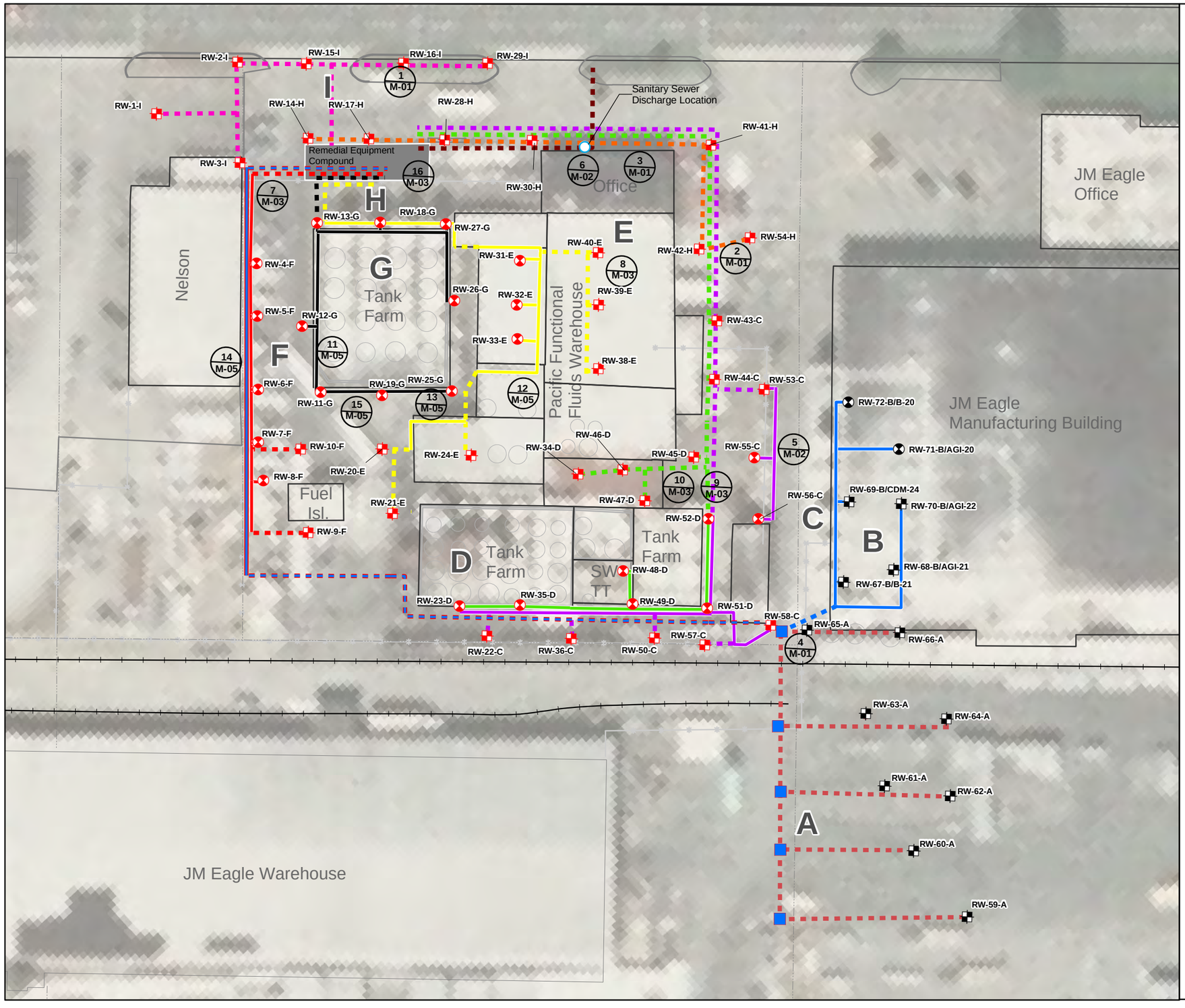
REVISION

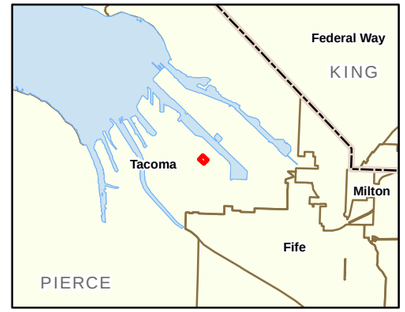
CH2MHILL

LIL'YBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

SITE PLAN

DATE	OCTOBER 2009
PROJ	380987
DWG	C-01
SHEET	2 of 12





LEGEND

- Proposed Above Grade Recovery Well
- Existing Well to be Completed as Below Grade Recovery Well
- Above Grade Recovery Well
- Below Grade Recovery Well
- Vault
- Sanitary Sewer Clean Out
- Remediation Compound

Piping Routes

- Field A - Below Grade (Existing)
- Field A/B - Above Grade
- Field A/B - Below Grade (Existing)
- Field B - Below Grade (Proposed)
- Field B- Above Grade (Proposed)
- Field C- Below Grade
- Field C - Above Grade
- Field D - Below Grade
- Field D - Above Grade
- Field E - Below Grade
- Field E - Above Grade
- Field F - Below Grade
- Field F - Above Grade
- Field G - Below Grade
- Field G - Above Grade
- Field H - Below Grade
- Field I - Below Grade
- Sanitary Sewer Discharge- Below Grade

0 25 50 100
Feet

1 INCH = 55 FEET

NOTE: Extraction wells are to be completed with a 4-inch diameter well casing unless noted otherwise

NOTE: This figure was created using ArcGIS.

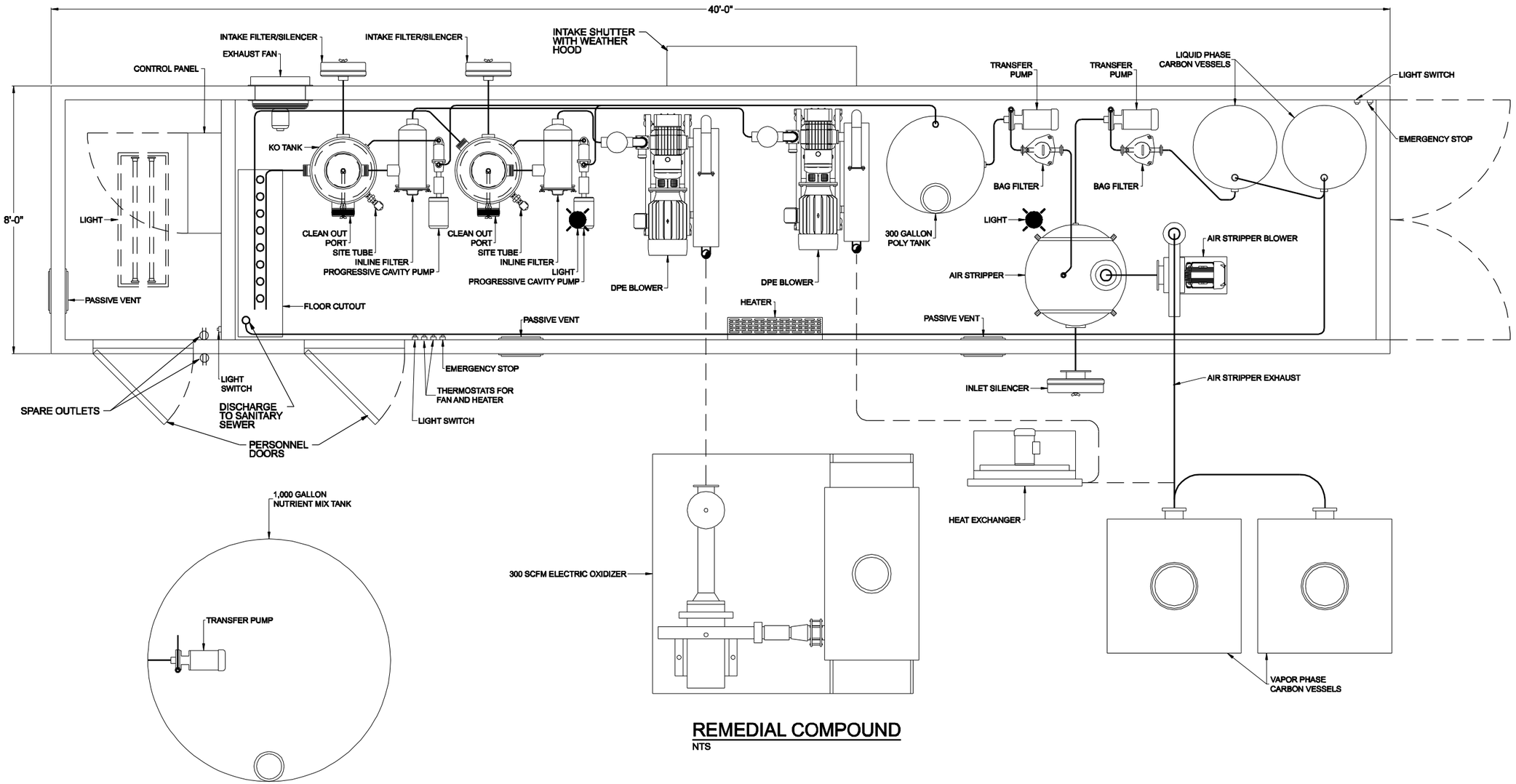
NO	DATE	DSGN
		DR
		ML/BT
REVISION	CHK	BH
	BY	APVD
		APVD
		BF/MP/ML
		MP

CH2MHILL

LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

DPE WELL AND PIPING LAYOUT

DATE	OCTOBER 2009
PROJ	380987.
DWG	C-02
SHEET	3 of 12



REMEDIAL COMPOUND
NTS

RECORD DRAWINGS

Revisions Drawn By: K. WEIGUM Date: OCT. 26, 2009

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NO.		CHK	APVD
DSGN	BT / ML	AH	ML / BF
DR			MP

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LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

CH2MHILL

REMEDIAL COMPOUND PLAN VIEW

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2008
PROJ	380987
DWG	C-03
SHEET	4

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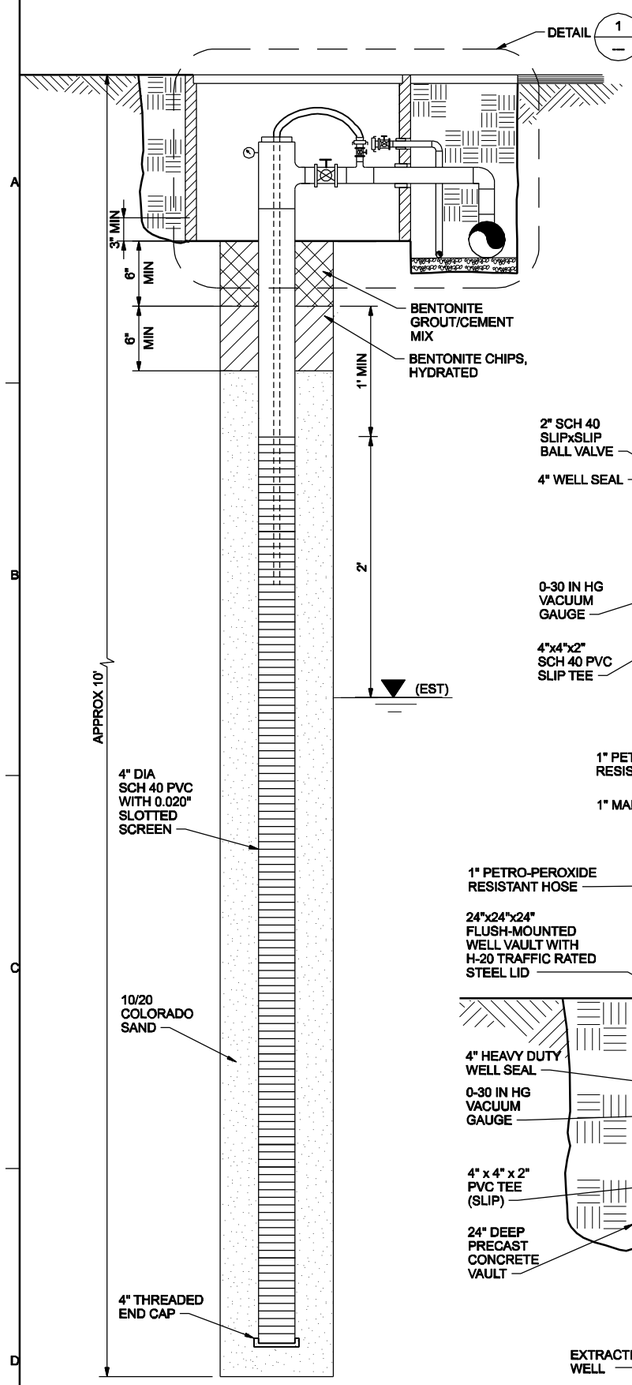
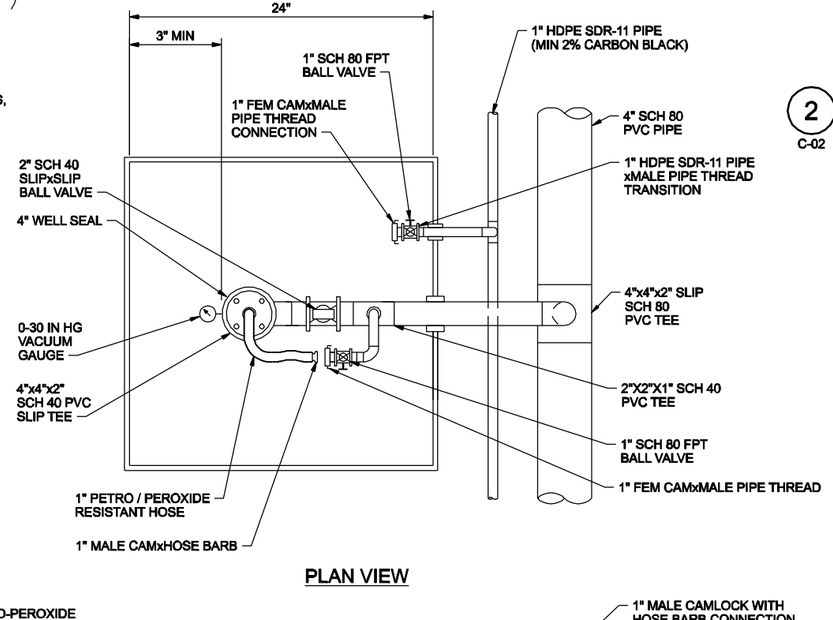
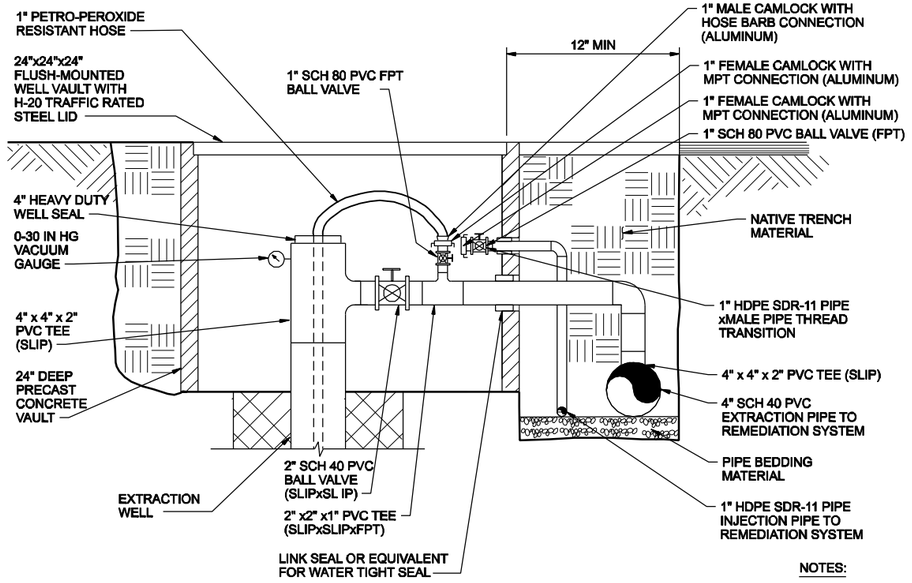


DPE BELOW GRADE EXTRACTION WELL CONSTRUCTION, TYP

NOT TO SCALE



PLAN VIEW



SECTION VIEW

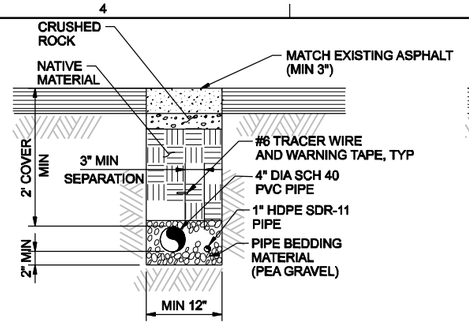
1 BELOW GRADE WELLHEAD, TYP 1 OF 33

NOT TO SCALE

C-02

NOTES:

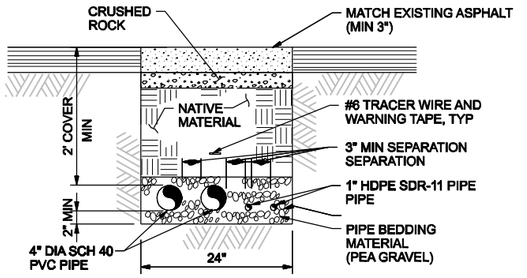
1. ALL ABOVE GROUND PIPING TO BE INSULATED & HEAT TRACED.
2. ALL BELOW GROUND PIPING TO BE WIRE TRACED AND LABELED WITH WARNING TAPE.



2 TRENCH DETAILS

NOT TO SCALE

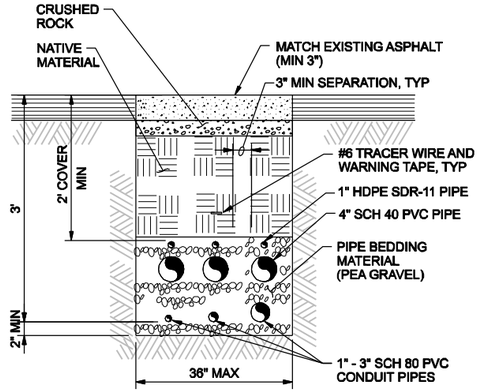
C-02



7 TRENCH DETAILS

NOT TO SCALE

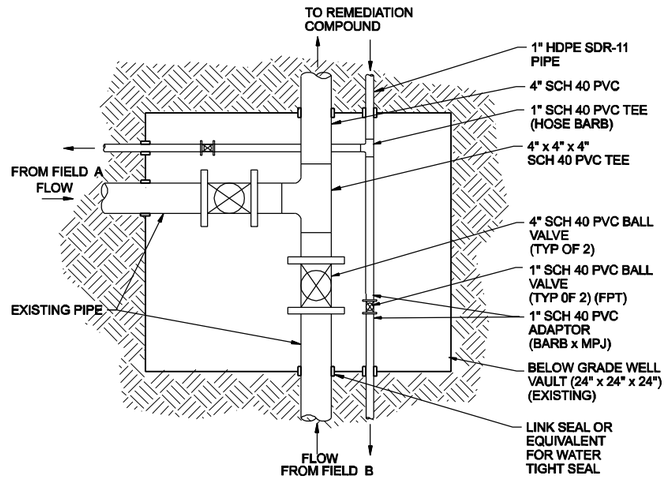
C-02



3 TRENCH DETAILS

NTS

C-02



4 PROPOSED FIELD A/B WELL VAULT DETAIL

NOT TO SCALE

C-02

RECORD DRAWINGS

Revisions Drawn By: K. WEIGUM Date: OCT. 26, 2009

NO.	DSGN	DR	CHK	APVD
	BT / ML	BT / ML	AH	ML / BF	MP

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LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

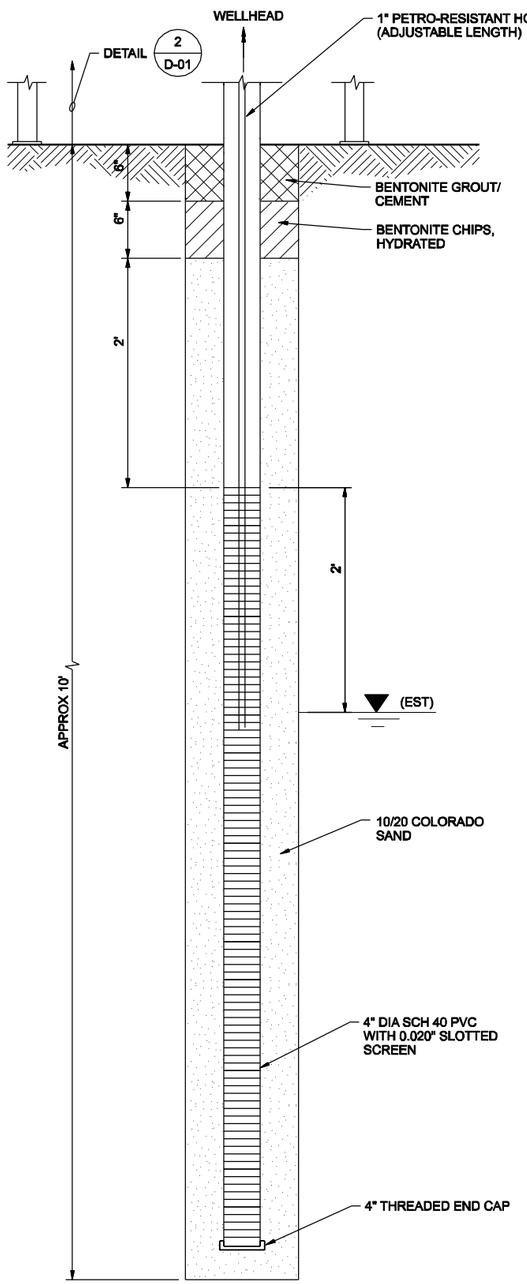
CH2MHILL

DPE WELL DETAILS

VERIFY SCALE

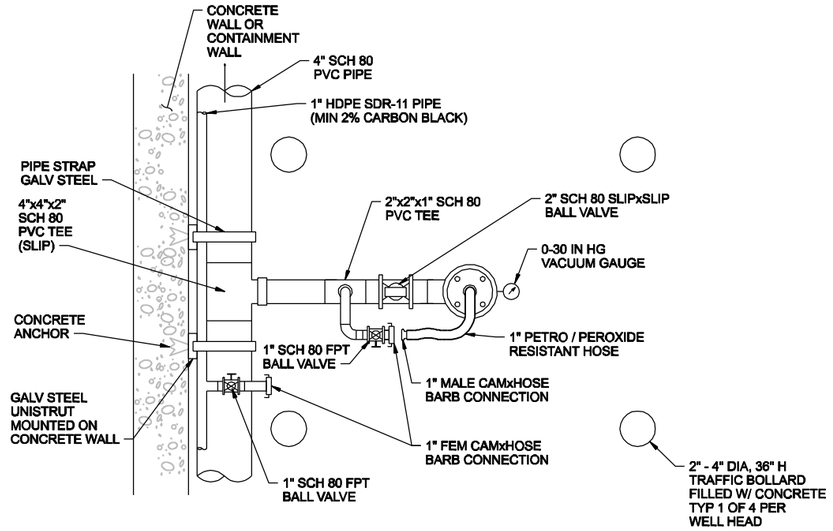
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	OCTOBER 2008
PROJ	380987
DWG	M-01
SHEET	5

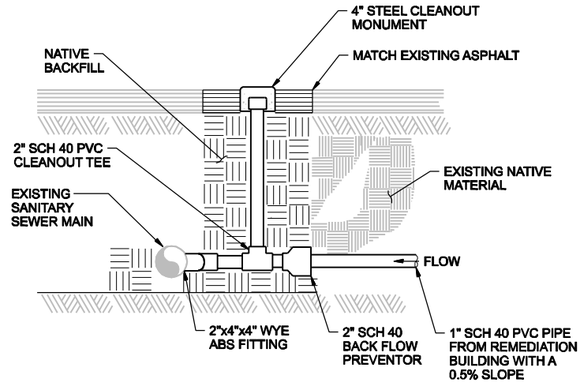


DPE ABOVE GRADE EXTRACTION WELL CONSTRUCTION, TYP

NOT TO SCALE

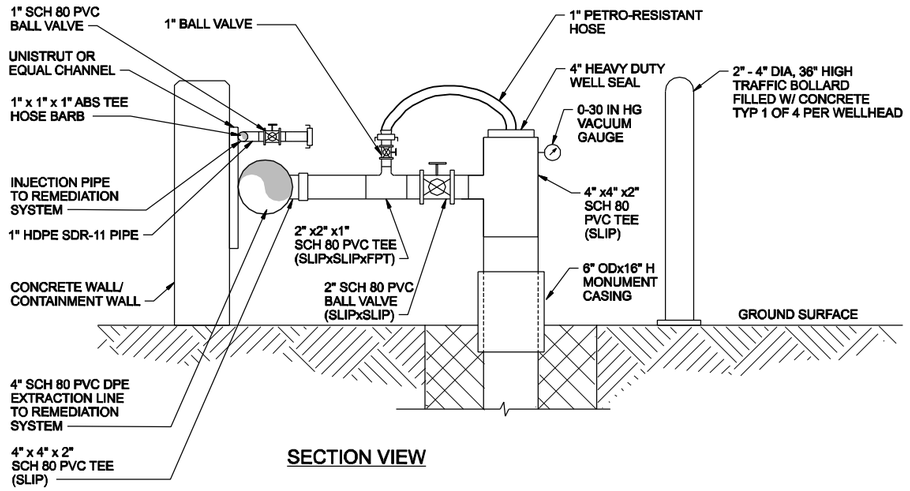


PLAN VIEW



CONNECTION TO SANITARY SEWER DISCHARGE

6 C-02



SECTION VIEW

ABOVE GRADE WELLHEAD, TYP 1 OF 24

5 C-02

NOT TO SCALE

NOTES:

1. ALL ABOVE GROUND PIPING TO BE INSULATED & HEAT TRACED.
2. ALL BELOW GROUND PIPING TO BE WIRE TRACED AND LABELED WITH WARNING TAPE.

RECORD DRAWINGS

Revisions Drawn By K. WEIGUM Date OCT. 26, 2009

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NO.	DSGN	DR	CHK	APVD
	BT / ML	AH	ML / BF	MP

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CH2MHILL

LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

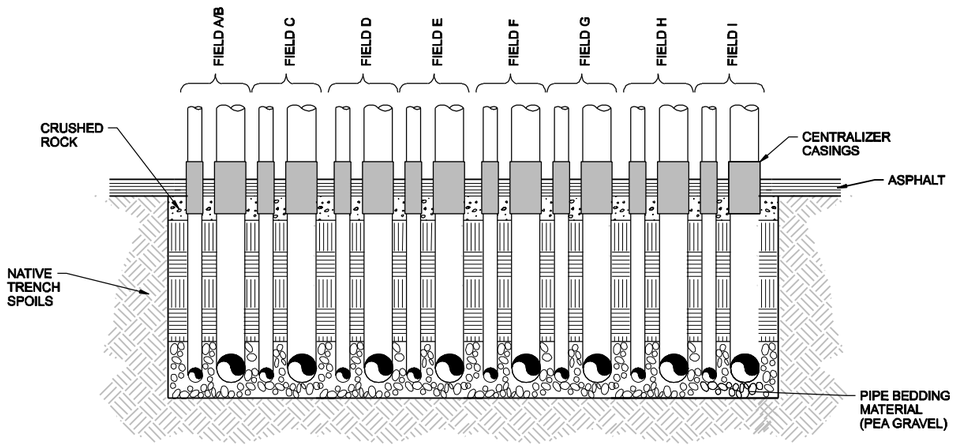
DPE WELL AND TRENCH CROSS SECTION DETAILS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	OCTOBER 2008
PROJ	380987
DWG	M-02
SHEET	6

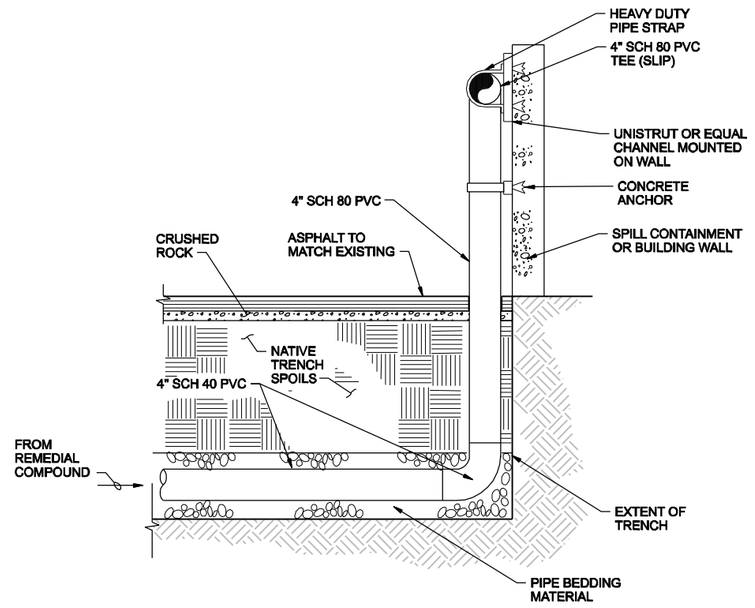
FILENAME: 01sd002d_380987.dgn PLOT DATE: 10/27/2009 PLOT TIME: 1:30:28 PM



BELOW GRADE TO REMEDIAL COMPOUND TRANSITION

16 C-02

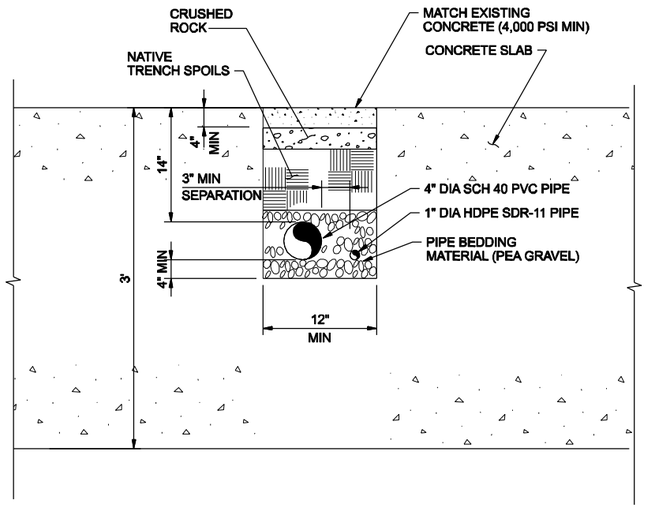
NOT TO SCALE



BELOW GRADE TO ABOVE GRADE DPE EXTRACTION TRANSITION

9 C-02

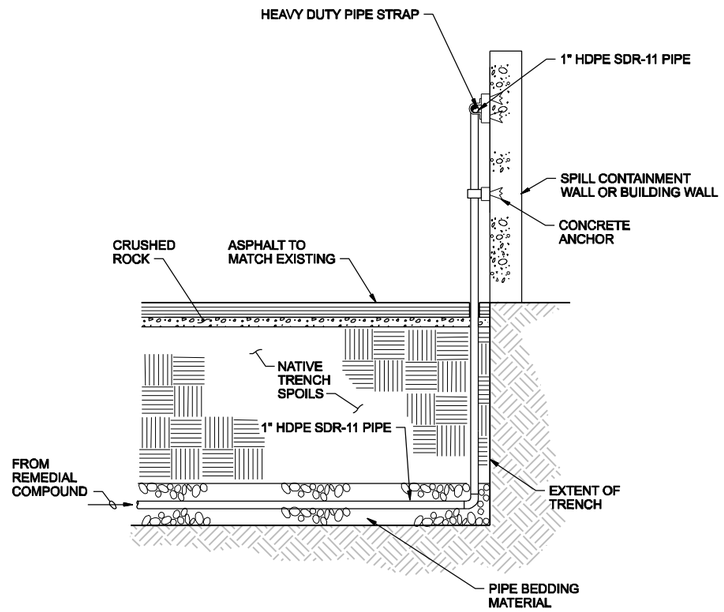
NOT TO SCALE



WAREHOUSE/INTERIOR TRENCH DETAIL

8 C-02

NOT TO SCALE



BELOW GRADE TO ABOVE GRADE INJECTION PIPE TRANSITION

10 C-02

NOT TO SCALE

NOTES:

1. ALL ABOVE GROUND PIPING TO BE INSULATED & HEAT TRACED.
2. ALL BELOW GROUND PIPING TO BE WIRE TRACED AND LABELED WITH WARNING TAPE.

RECORD DRAWINGS

Revisions Drawn By K. WEIGUM Date OCT. 26, 2009

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NO.	DSGN	DR	CHK	APVD
	BT / ML	BT / ML	AH	ML / BF

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LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

CH2MHILL

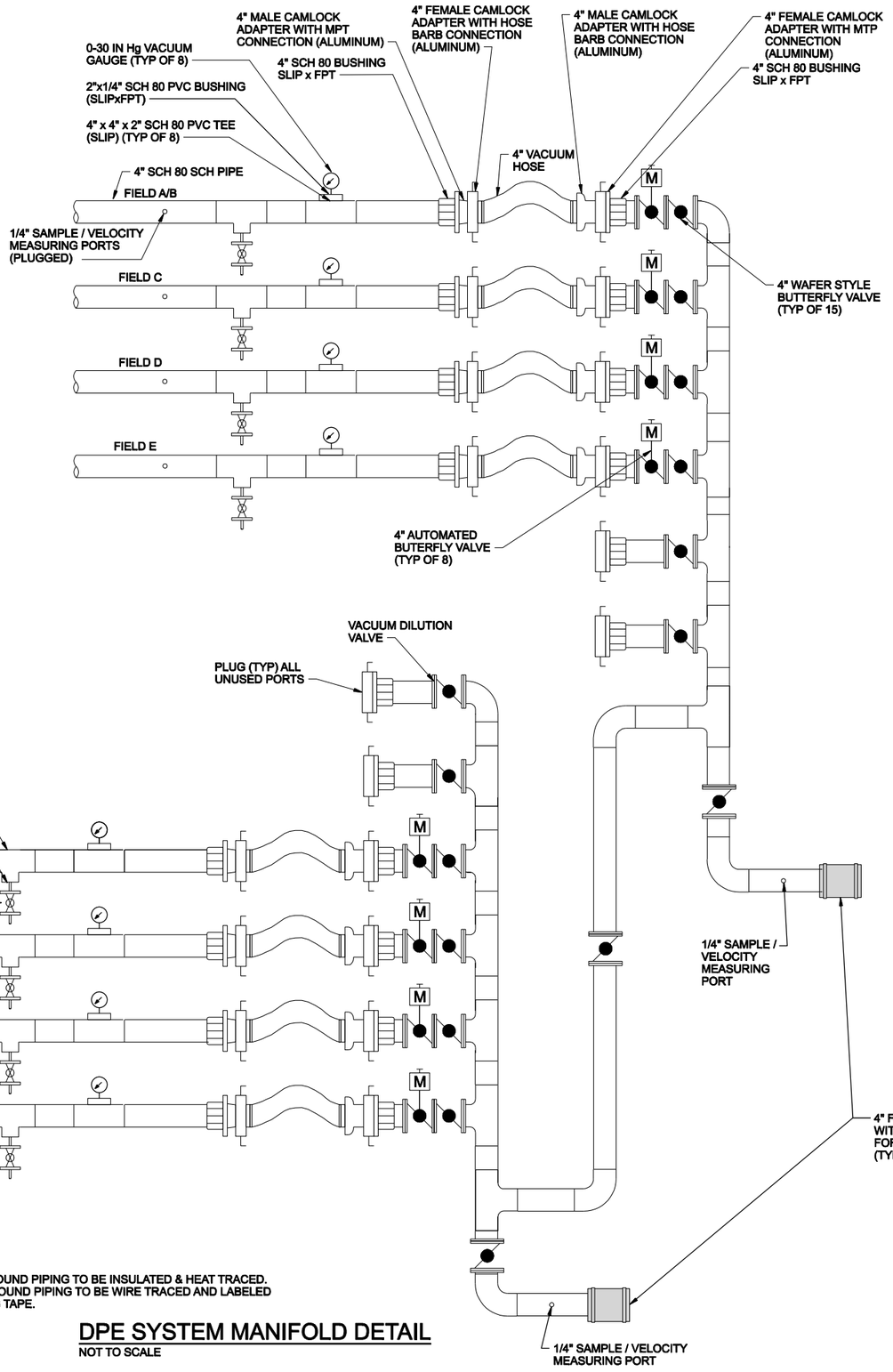
PIPING CONNECTION DETAILS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

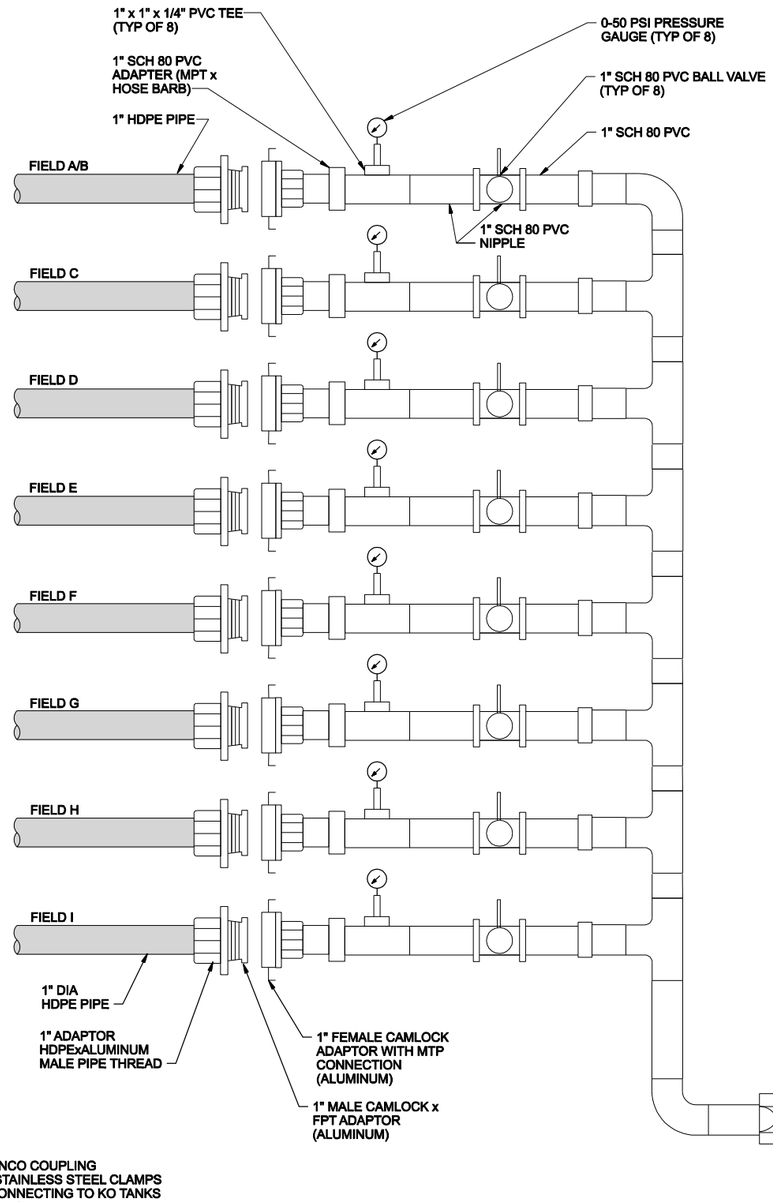
DATE	OCTOBER 2008
PROJ	380987
DWG	M-03
SHEET	7

FILENAME: 01sd004d_380987.dgn PLOT DATE: 10/27/2009 PLOT TIME: 12:34:21 PM



NOTES:
1. ALL ABOVE GROUND PIPING TO BE INSULATED & HEAT TRACED.
2. ALL BELOW GROUND PIPING TO BE WIRE TRACED AND LABELED WITH WARNING TAPE.

DPE SYSTEM MANIFOLD DETAIL
NOT TO SCALE



INJECTION SYSTEM MANIFOLD DETAIL
NOT TO SCALE

RECORD DRAWINGS

Revisions Drawn By: K. WEIGUM Date: OCT. 26, 2009

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NO.	DSGN	DR	CHK	APVD
	BT / ML		AH	ML / BF

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LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

CH2MHILL

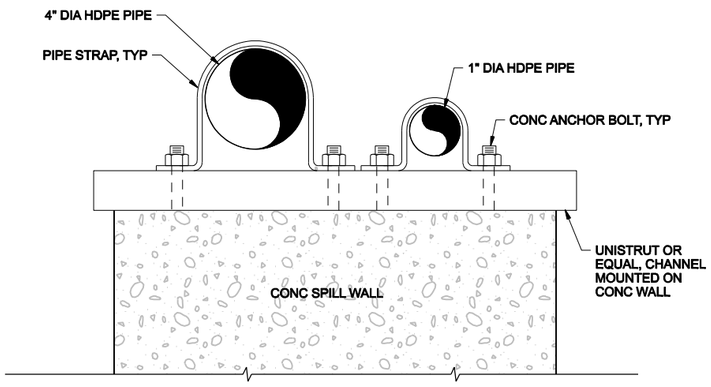
DESIGN DETAILS

PIPING MANIFOLD DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2008
PROJ	380987
DWG	M-04
SHEET	8

FILENAME: 01sd003d_380987.dgn PLOT DATE: 10/24/2009 PLOT TIME: 11:08:59 AM

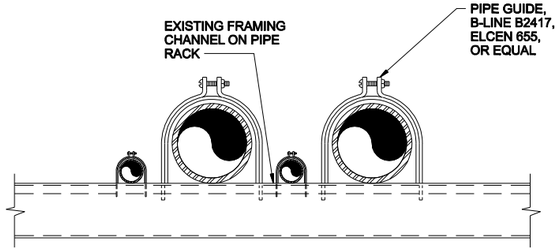


NOTE:
PIPES TO BE ANCHORED EVERY 10 LINEAR FEET.

PIPE ATTACHMENT TO TOP OF SPILL WALL, TYP

11 NOT TO SCALE

C-02

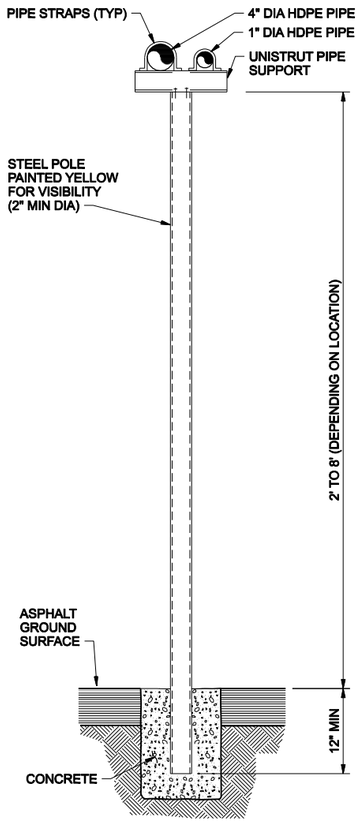


NOTES:
1. THIS GUIDE NOT BE USED FOR INSULATED PIPE.
2. PIPES TO BE ANCHORED W/ PIPE STRAP EVERY 10 LINEAR FEET.

PIPE ATTACHMENT TO PIPE RACK, TYP

13 NOT TO SCALE

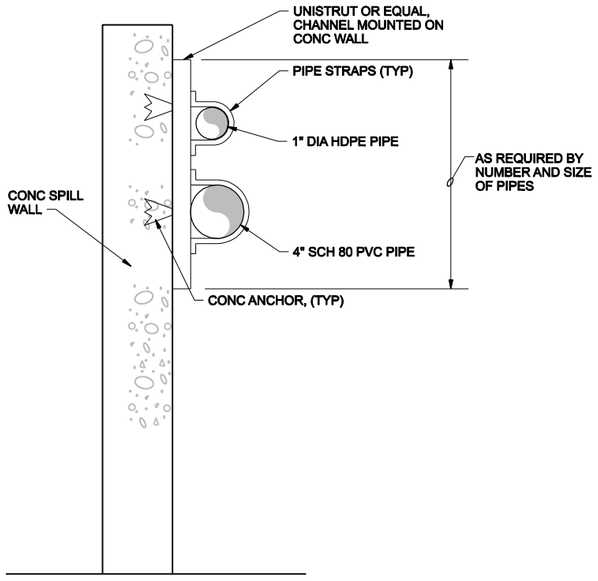
C-02



VERTICAL PIPE SUPPORT

15 NOT TO SCALE

C-02

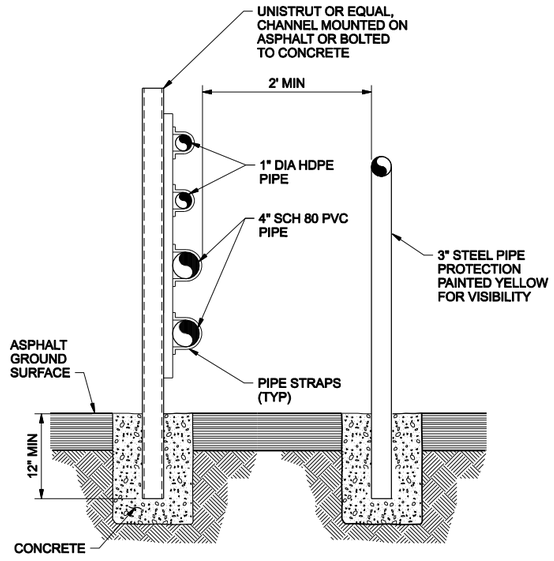


NOTE:
PIPES TO BE ANCHORED TO UNISTRUT EVERY 10 LINEAR FEET.

PIPE ATTACHMENT TO SIDE SPILL WALL, TYP

12 NOT TO SCALE

C-02



NOTE:
PIPES TO BE ANCHORED TO UNISTRUT EVERY 10 LINEAR FEET..

PIPE ATTACHMENT TO VERTICAL SUPPORT, TYP

14 NOT TO SCALE

C-02

RECORD DRAWINGS

Revisions Drawn By K. WEIGUM Date OCT. 26, 2009

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NO.	DSGN	DR	CHK	APVD
	BT / ML	BT / ML	AH	MP

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CH2MHILL

LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

DESIGN DETAILS

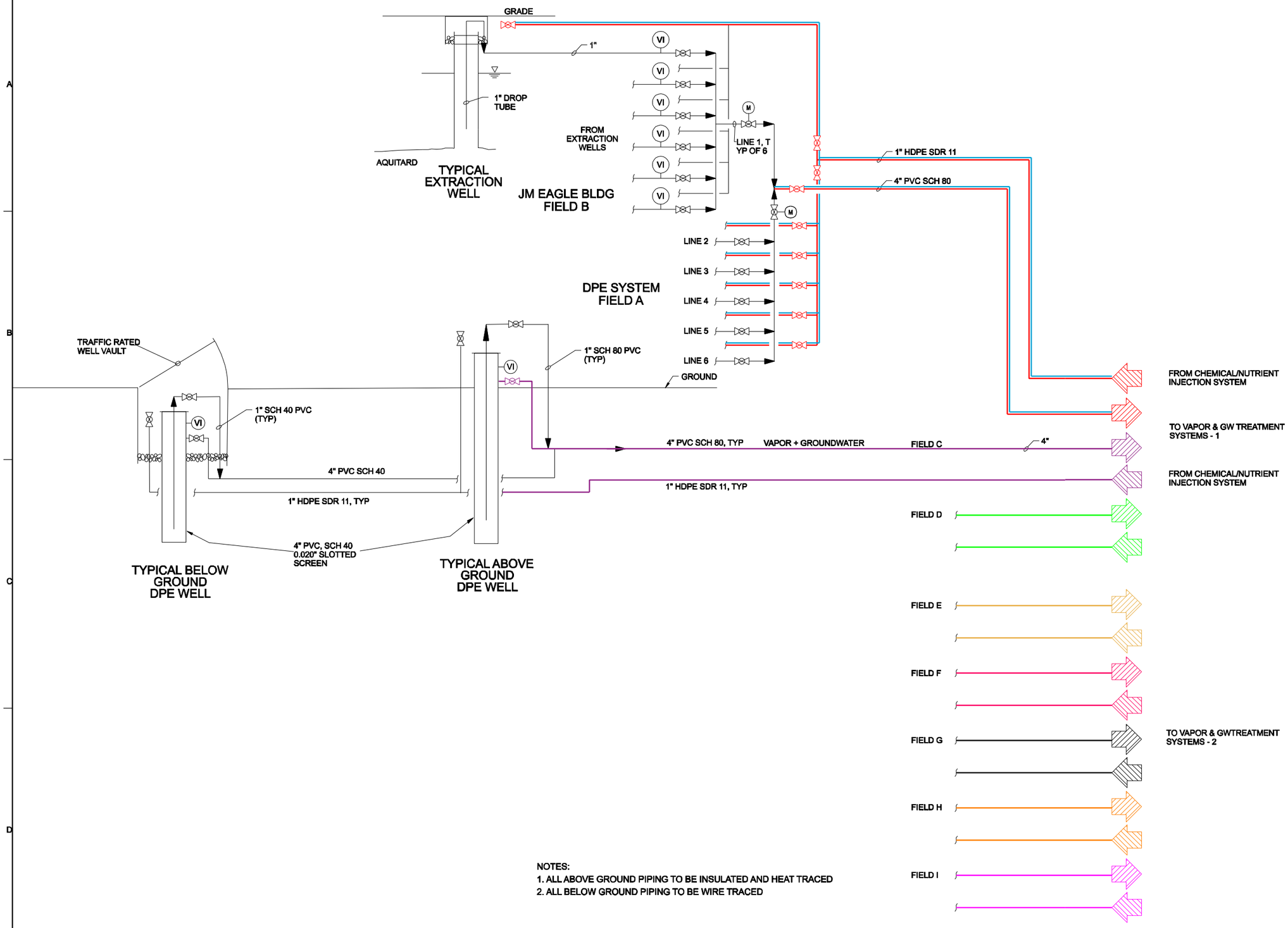
APIPE ATTACHMENT DETAILS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2008
PROJ	380987
DWG	M-05
SHEET	9

FILENAME: 01sd005d_380987.dgn PLOT DATE: 10/24/2009 PLOT TIME: 11:58:54 AM



NOTES:
1. ALL ABOVE GROUND PIPING TO BE INSULATED AND HEAT TRACED
2. ALL BELOW GROUND PIPING TO BE WIRE TRACED

RECORD DRAWINGS

Revisions Drawn By: K. WEIGUM Date: OCT. 26, 2009

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NO.	DSGN	DR	CHK	APVD
	BT / ML	ML / BF	AH	MP

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CH2MHILL

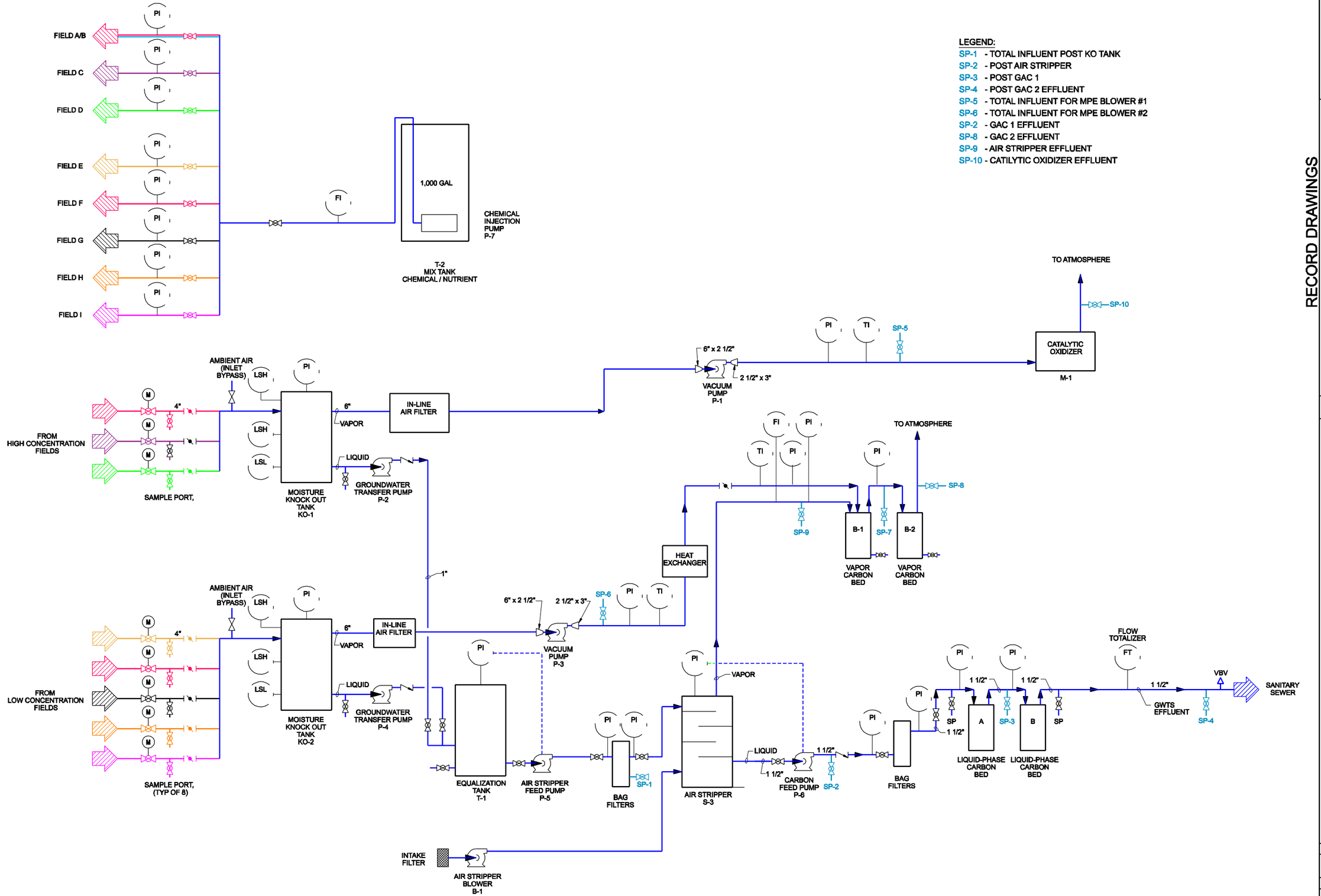
LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

PROCESS AND INSTRUMENTATION DIAGRAM CONVEYANCE PIPING

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2008
PROJ	380987
DWG	I-01
SHEET	10

FILENAME: 01pid002_380987.dgn PLOT DATE: 10/27/2009 PLOT TIME: 1:18:57 PM



RECORD DRAWINGS

Revisions Drawn By: K. WEIGUM Date: OCT. 26, 2009

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NO.	DSGN	DR	CHK	APVD
	BT / ML	AH	ML / BF	MP

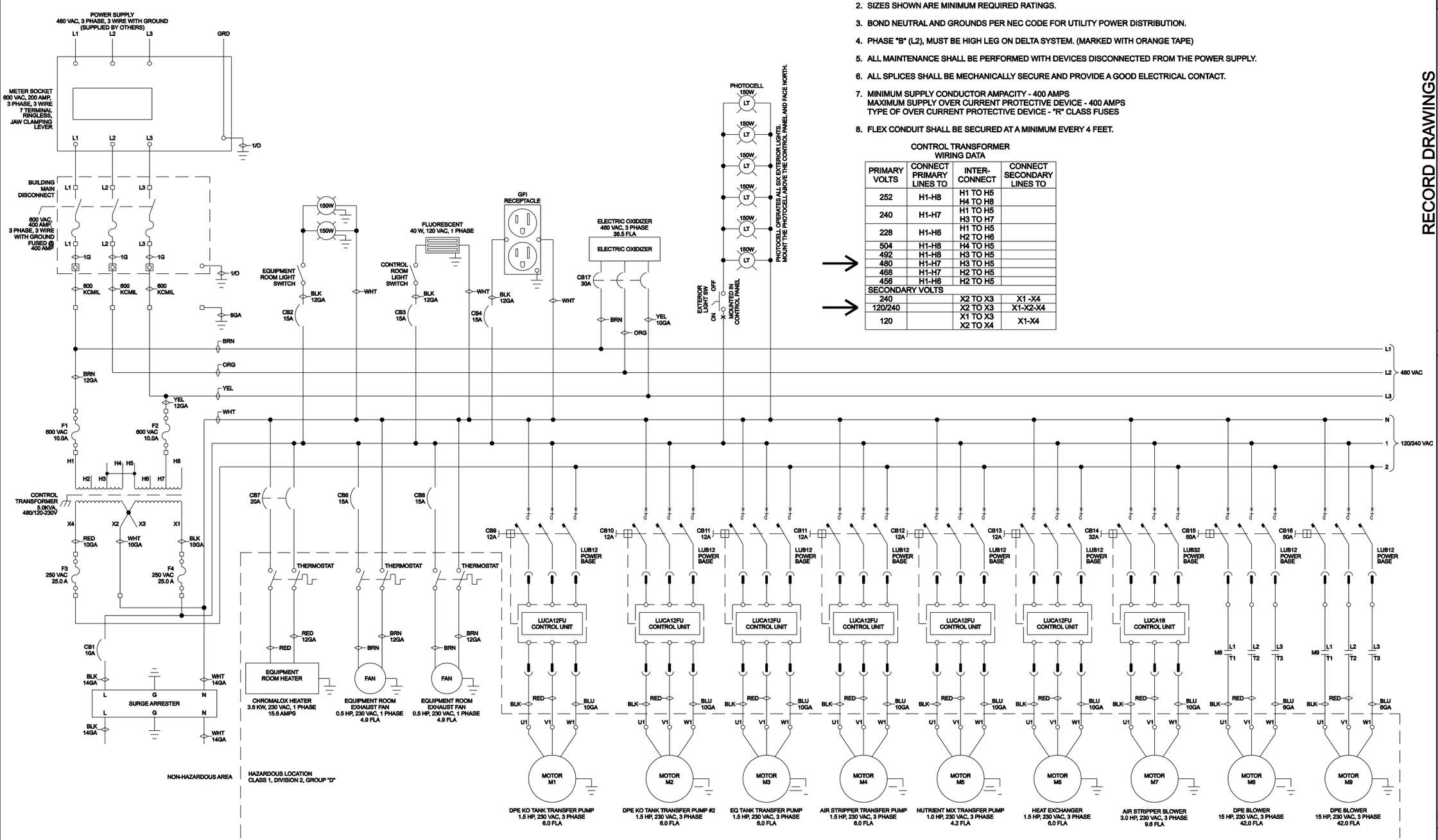
LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

CH2MHILL

PROCESS AND INSTRUMENTATION DIAGRAM
REMEDIATION SYSTEM

DATE	OCTOBER 2008
PROJ	380987
DWG	I-02
SHEET	11

FILENAME: 01pid001_380987.dgn PLOT DATE: 11/11/2009 PLOT TIME: 3:26:49 PM



NOTES:

1. CABLE SIZED PER LOCAL CODE AND UTILITY REQUIREMENTS.
2. SIZES SHOWN ARE MINIMUM REQUIRED RATINGS.
3. BOND NEUTRAL AND GROUNDS PER NEC CODE FOR UTILITY POWER DISTRIBUTION.
4. PHASE "B" (L2), MUST BE HIGH LEG ON DELTA SYSTEM. (MARKED WITH ORANGE TAPE)
5. ALL MAINTENANCE SHALL BE PERFORMED WITH DEVICES DISCONNECTED FROM THE POWER SUPPLY.
6. ALL SPLICES SHALL BE MECHANICALLY SECURE AND PROVIDE A GOOD ELECTRICAL CONTACT.
7. MINIMUM SUPPLY CONDUCTOR AMPACITY - 400 AMPS
   MAXIMUM SUPPLY OVER CURRENT PROTECTIVE DEVICE - 400 AMPS
   TYPE OF OVER CURRENT PROTECTIVE DEVICE - "R" CLASS FUSES
8. FLEX CONDUIT SHALL BE SECURED AT A MINIMUM EVERY 4 FEET.

CONTROL TRANSFORMER
WIRING DATA

PRIMARY VOLTS	CONNECT PRIMARY LINES TO	INTER-CONNECT	CONNECT SECONDARY LINES TO
252	H1-H8	H1 TO H5 H4 TO H8	
240	H1-H7	H1 TO H5 H3 TO H7	
228	H1-H6	H1 TO H5 H2 TO H6	
504	H1-H8	H4 TO H5	
492	H1-H8	H3 TO H5	
480	H1-H7	H3 TO H5	
468	H1-H7	H2 TO H5	
456	H1-H6	H2 TO H5	
SECONDARY VOLTS			
240		X2 TO X3	X1 -X4
120/240		X2 TO X3	X1-X2-X4
120		X1 TO X3 X2 TO X4	X1-X4

RECORD DRAWINGS

Revisions Drawn By K. WEIGUM Date OCT. 26, 2009

NO.		CHK	APVD
DSGN	BT / ML	DR	AH ML / BF MP

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LILYBLAD SITE REMEDIATION
WASHINGTON STATE DEPARTMENT
OF ECOLOGY

CH2MHILL

ELECTRICAL DIAGRAM

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2008
PROJ	380987
DWG	E-01
SHEET	12

APPENDIX D

Equipment and Parts List

Description	QTY	Part Number	Manufacturer	Telephone	Parts Supplier
ROTARY CLAW VACUUM BLOWER 300 ACFM @ 20" HG VACUUM, 3-INCH I/O	2	MI 1502 BV	BUSCH	(408) 782-0800	BUSCH
MOTOR, 15 HP, 230V, 3PH, TEFC	2	15 HP	BUSCH	(408) 782-0800	BUSCH
VACUUM RELIEF VALVE	2	INCLUDED	BUSCH	(408) 782-0800	BUSCH
DISCHARGE SILENCER	2	INCLUDED	BUSCH	(408) 782-0800	BUSCH
AIR STRIPPER BLOWER, 230V, 3PH, 6.3 KW, 300 ACFM @ 42 IWCV, 2.5-INCH I/O	1	SB0530.D0H0.UJ11	BUSCH	(408) 782-0800	BUSCH
AIR STRIPPER RING, TOP SUPPORT	1	CP4TR	QED	(360) 297-5409	Olympic Environmental Equipment
TOP COVER ASSEM	1	CP4TP	QED	(360) 297-5409	Olympic Environmental Equipment
TRAYS	4	CP4T	QED	(360) 297-5409	Olympic Environmental Equipment
SUMP	1	CP4S	QED	(360) 297-5409	Olympic Environmental Equipment
TENSION ROD KIT	1	CP4TN-4	QED	(360) 297-5409	Olympic Environmental Equipment
RING, BOTTOM SUPPORT	1	CP4BR	QED	(360) 297-5409	Olympic Environmental Equipment
LIQUID PHASE CARBON	2	HPAF-500	TETRASOLV	(713) 703-6516	TETRASOLV
VAPOR PHASE CARBON	2	VF-1000	TETRASOLV	(713) 703-6516	TETRASOLV
CLEAR TRAP FILTER	2	ST-235P-300CN W/ 1/2"	SOLBERG	(630) 773-0727	SOLBERG
INLINE FILTER	2	CSL-234P-400	SOLBERG	(630) 773-0727	SOLBERG
TRANSFER PUMP - TEFC, 1.5HP, 230/460V, 1.25"I/1"O	2	CT15FAB 1.5 HP	MYERS	(419) 289-1144	MYERS
PROGRESSIVE CAVITY PUMP, 1.5 HP, 230/460V, 3PH, TEFC, 1.5"I/1.25"O	2	CP56C-1.5M W/ STATOR	CONTINENTAL	(206) 762-0500	Cascade Machinery & Electric
300 GALLON POLY EQUALIZATION TANK	1	NOR300VERT	NORWESCO	(800) 328-3420	NORWESCO
FILTER HOUSINGS, 2-INCH I/O	2	007A1304L020N2VC	CUSTOM SERVICE & DESIGN	(248) 340-9005	CUSTOM SERVICE & DESIGN
FILTER BAGS #2	50	PEG50P2SH	CUSTOM SERVICE & DESIGN	(253) 922-2268	Grainger
1000 GALLON DOUBLE WALL TANK/DUAL CONTAINMENT TANK	1	TC7485DC	CHEM-TAINER INDUSTRIES, IN	(800) 275-2436	CHEM-TAINER INDUSTRIES, INC
INLET FILTER/SILENCER	2	F64-4"	STODDARD	(425) 822-3335	APSCO, Inc.
INLET FILTER/SILENCER	1	F64-6 FLG	STODDARD	(425) 822-3335	APSCO, Inc.
VACUUM GAGE, 0-30"HG, FLUTTER GUARD GAGE WITH BACK CONNECTION	14	63-W3005H-02B-XSF-G/# C	ASHCROFT	(800) 576-6308	ASHCROFT
VACUUM TRANSDUCER 4-20MA	2	K1-7M02-42-C1-VAC TO 0-G	ASHCROFT	(800) 576-6308	ASHCROFT
PRESSURE TRANSDUCER, 4-20 MA, 0-60PSI	3	K1-7M02-42-C1-0-60PSI	ASHCROFT	(800) 576-6308	ASHCROFT
TEMPERATURE GAGE, 50-400 DEG F	4	30EI-60R-040-50/400F	ASHCROFT	(800) 576-6308	ASHCROFT
PRESSURE GAGE, 0-60 PSI, FLUTTER GUARD GAGE WITH BACK CONNECTION	8	63-W3005H-02B-XSF-60#	ASHCROFT	(800) 576-6308	ASHCROFT
PRESSURE GAGE, 0-30 PSI, FLUTTER GUARD GAGE WITH BACK CONNECTION	2	63-W3005H-02B-XSF-30#	ASHCROFT	(800) 576-6308	ASHCROFT
FLOW SENSOR	1	P51530-P0	SIGNET	(916) 817-2279	SIGNET
FLOW TRANSMITTER	1	3-8550-1P	SIGNET	(916) 817-2279	SIGNET
MOUNTING DISPLAY	1	PV8T010F	SIGNET	(916) 817-2279	SIGNET
PANEL MOUNT DISPLAY	1	INCLUDED	SIGNET	(916) 817-2279	SIGNET
PITOT TUBE, 6-INCH	1	DS-300-6"	DWYER	(219) 879-8000	DWYER
MAGNEHELIC GAGE, SQUARE ROOT SCALE, 0-400 CFM, 0-0.61"WC	1	2SQRT	DWYER	(219) 879-8000	DWYER
LOW PSI SWITCH - EXP	1	1950-5-2F	DWYER	(219) 879-8000	DWYER
MAGNEHELIC GAGE	1	2030	DWYER	(219) 879-8000	DWYER
4-INCH WAFER STYLE BUTTERFLY VALVE	18	BFV204WFB311HL0	DWYER	(219) 879-8000	DWYER
2-WAY, 4-INCH WAFER STYLE AUTOMATED BUTTERFLY VALVE, EXPLOSION-PROOF	8	ABFV204WFB331U14C-EX	DWYER	(219) 879-8000	DWYER
18" EXHAUST FAN, 3860 CFM, 0.5HP, 1-60-115/230V, XP	1	EN182-H, XP	NEW YORK BLOWER	(800) 208-7918	NEW YORK BLOWER
HEATER 3.6 KW,EXP,480VAC, 1PH	1	CVEP-3.6 087097	CHROMALOX	(425) 885-0372	Technical Controls Inc.
HEAT EXCHANGER, 1HP, 208/230/460V, 3 PH, TEFC, 2.5"I/O, APPROXIMATELY 43" WIDE X C S OO	1	ACA4362-1 3PH TEFC	AMERICAN INDUSTRIAL	(434) 757-1800	AMERICAN INDUSTRIAL
230V/3PH/75FLA, 6' X 6', 2500 LBS	3	300 SCFM	INTELLISHARE	(715) 233-6115	INTELLISHARE
FAN SHUTTER, 36 INCH	1	4YN18	DAYTON	(253) 922-2268	Grainger
SPRAY ON BED LINER ON EQUIPMENT ROOM FLOOR AND 6-INCHES UP WALLS - Q OO	1	CUSTOM	LINE-X	(877) 330-1331	LINE-X
ELECTRIC WELL PUMP	1	10-REDI-FLO3-100	GRUNDFOS	(913) 227-3400	GRUNDFOS
WELL PUMP MOTOR	1	1/2HP, 115V, 1PH	FRANKLIN	(260) 824-2900	FRANKLIN
25' MOTOR LEAD	1	25' MOTOR LEAD	FRANKLIN	(260) 824-2900	FRANKLIN
COOLING SHROUD	1	COOLING SHROUD	GRUNDFOS	(913) 227-3400	GRUNDFOS
PRESSURE GAGE, 0-60 PSI, FLUTTER GUARD GAGE WITH BACK CONNECTION	8	63-W3005H-02B-XSF-60#	ASHCROFT	(800) 576-6308	ASHCROFT
WATER FLOWMETER, 3/4"	1	1710	ISTEC	(973) 383-9888	ISTEC
VITON O-RINGS	1	INCLUDED	ISTEC	(973) 383-9888	ISTEC
AIR/WATER SEPARATOR, RATED FOR 350 CFM	2	120 GALLON	SILVAN	(800) 247-8265	SILVAN
DEMISTER ELEMENT SS MESH	2	8-INCH	ACS	(800) 231-0077	ACS
LEVEL SWITCHES FOR AIR/WATER SEPARATOR	2	STAINLESS STEEL	FLO PLUS	(253) 922-2268	Grainger
LEVEL SWITCHES FOR AIR STRIPPER	3	1002080	SUPERSINGLE	(253) 922-2268	Grainger
LEVEL SWITCHES FOR POLY TANK	3	1002080	SUPERSINGLE	(253) 922-2268	Grainger

APPENDIX E

Remedial Equipment Cut Sheets

Seneca Companies

HEADQUARTERS
Des Moines, Iowa
4140 E. 14th St.
Des Moines, IA 50313
P.O. Box 3360
Des Moines, IA 50313-0360
515.262.5000
800.369.5500 (Toll Free)
515.262.4951 (Fax)

March 12, 2009

Brian Tracey
CH2M Hill
1100 112th Ave. NE, Suite 400
Bellevue, WA 98004

Subject: Shop Drawing Submittal, Remediation System for CH2M Hill – Ecology Lilyblad

Dear Brian:

Enclosed please find the Shop Drawing Submittal and catalog cut sheets for the remediation system for CH2M Hill – Ecology Lilyblad. Your comments and written shop drawing approval are requested prior to beginning construction.

Seneca appreciates the opportunity to construct this remediation system and looks forward to working with CH2M Hill.

If you have any questions, please contact me at (515) 261-7715 or at jramm@senecaco.com.

Sincerely,
Seneca Environmental Services

James M. Ramm, PE
Project Engineer

Sincerely,
Seneca Environmental Services

Dan Nolan
Sales Representative

Enc. Shop Drawings
Manufacturer's Data

cc: Project 6351005
Martin Powers, CH2M Hill
Mario Lopez, CH2M Hill

MANUFACTURER'S DATA

Busch Rotary Claw Vacuum Pumps

American Industrial Heat Exchangers

Solberg Inlet Vacuum Air Filters

Stoddard Intake Filter Silencers

QED Air Strippers

Busch Samos Regenerative Blower for Air Stripper

Continental Progressive Cavity Pumps

Myers Centrifugal Pumps

Tetrasolv Liquid Phase Carbon

Tetrasolv Vapor Phase Carbon

Norwesco Tank

Chem-Tainer Double Wall Tank

WE Anderson Butterfly Valves and Motor Actuated Butterfly Valves

CSD Bag Filters

Dwyer Pitot Tubes

Dwyer Magnehelic Gages

Signet 4-20 mA Flowmeter

Chromalox Convection Heater

New York Blower Exhaust Fan

Dry Rotary Claw Pressure or Vacuum Pumps

Mink MI 1124 – 2122 BV
Mink MI 1124 – 1502 BP

MI 1502 BV

Description

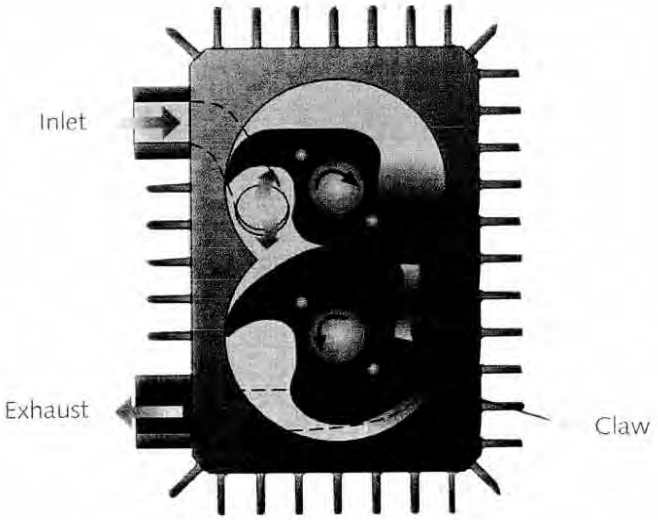
The Busch Mink is a rotary claw-type, positive displacement, dry pump designed for either pressure or vacuum applications. The Mink is available as a single-stage or two-stage vacuum pump.
Vacuum or pressure is produced by two non-contacting rotors in an oil-free pumping chamber. The dry, non-contacting design makes the Mink ideal for pneumatic conveying, printing, soil remediation, and any application where dust particles may be present. Wearing parts are separated from the pumping chamber which leads to a longer pump life with low maintenance.

Features

- Non-contacting design
- Dry (oil-free) pumping chamber
- Air-cooled
- Low maintenance – no wear in pumping chamber
- Simple, modular construction
- Suitable for variable speed applications
- Discharge silencers on vacuum models; inlet silencers on pressure models
- Frame rails on models MI 1354-1502
- Suitable for dusty environments
- Integral relief valve (where necessary)
- Inlet filters on pressure models

Dry Rotary Claw Pressure or Vacuum Pumps

Operating Principle



Operating Principle

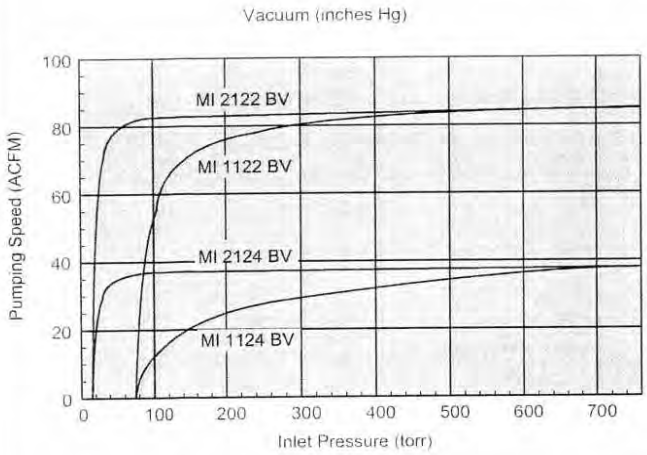
Inside the pump housing, two claw shaped rotors take in air as they rotate in opposite directions. The air is compressed by the rotors, then discharged through a silencer to atmosphere. The non-return valve incorporated into the inlet flange prevents air from back flowing into the pumping chamber when the pump is turned off. Mink MI dry rotary claw direct drive pumps are driven by a C-face motor, and the two rotors are synchronized by gears. A wide range of accessories allows optimum adaptation to many applications.

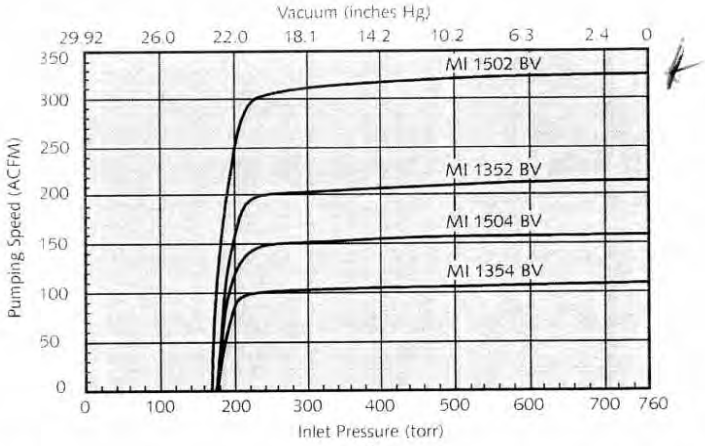
Applications

- Wood Industry
- Pneumatic conveying
- Transport and lifting systems
- Medical technology
- Central vacuum systems
- Packaging industry
- Plastics industry
- Food industry
- Printing industry
- Ceramics and brick industry
- Environmental technology
- Vacuum sewage
- Textile industry
- Paper industry
- Beverage industry

Technical Data

Pumping Speed vs. Inlet Pressure

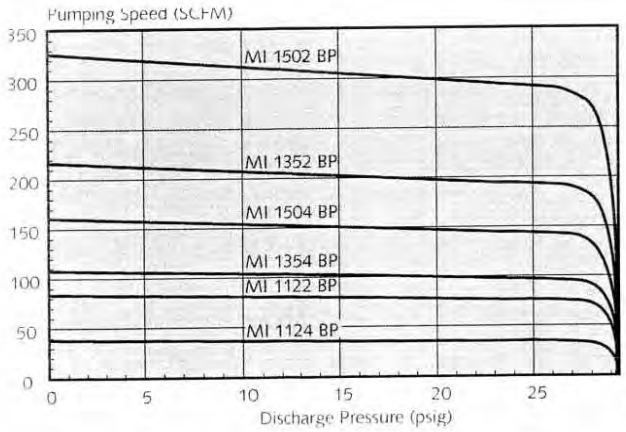




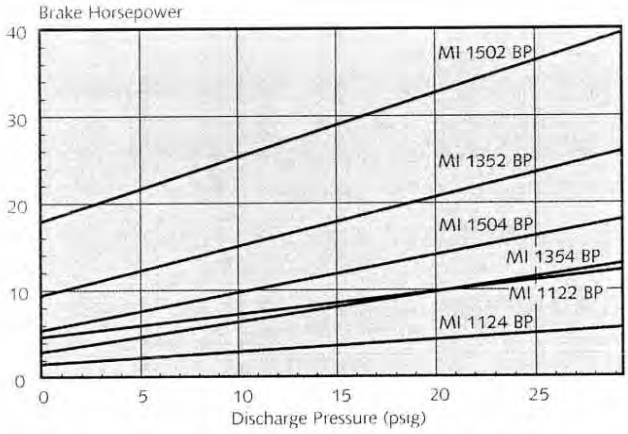
Model MI (Vacuum)		1124 BV	1122 BV	1354 BV	1504 BV	1352 BV	1502 BV	2124 BV*	2122 BV*
Nominal pumping speed	ACFM	38	85	108	160	216	325	38	85
Free air displacement	CFM	50	100	125	188	250	376	50	100
End vacuum	"Hg	26.9	26.9	23.1	23.1	23.1	23.4	29.3	29.3
End vacuum	torr	75	75	173	173	173	165	15	15
Motor rating	HP	3.0	5.0	5.0	7.5	10	15	3	7.5
Motor speed	RPM	1800	3600	1800	1800	3600	3600	1800	3600
Approx. weight	Lbs	231	253	680	760	775	950	325	352
Inlet pipe connection	Inches	1 1/4	1 1/4	2	2	2	3	1 1/4	1 1/4
Discharge pipe connection	Inches	1 1/2	1 1/2	2	2	2	3	1 1/2	1 1/2
Sound rating	dBA	78	84	81	81	85	85	77	84

*Two stage models

Pumping Speed vs. Discharge Pressure

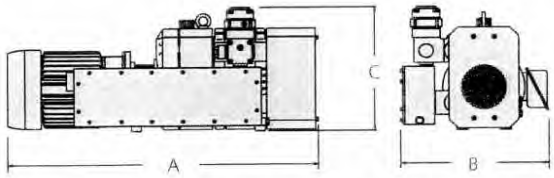


Brake Horsepower vs. Discharge Pressure

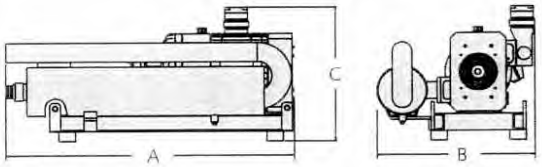


Model MI (Pressure)		1124 BP	1122 BP	1354 BP	1504 BP	1352 BP	1502 BP
Nominal pumping speed	SCFM	38	85	108	160	216	325
Free air displacement	CFM	50	100	125	188	250	376
Maximum pressure	psig	29.4	29.4	29.4	29.4	29.4	29.4
Motor rating	HP	7.5	15	15	20	30	40
Motor speed	RPM	1800	3600	1800	1800	3600	3600
Approx. weight	Lbs	243	297	1025	1075	1195	1350
Discharge pipe connection	Inches	1 1/4	1 1/4	2	2	2	3
Sound rating	dBA	76	84	85	85	86	87

Dimensions



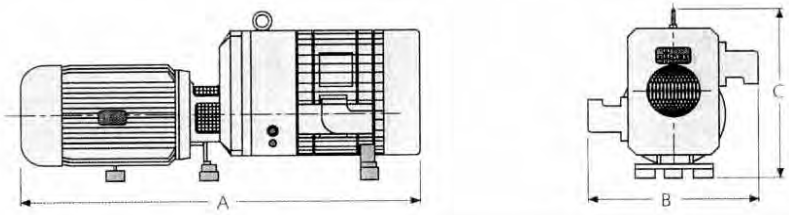
Models 1124 BV, 1122 BV, 2122 BV, 2124 BV



Models 1354 BV, 1504 BV, 1352 BV, 1502 BV

Model MI	1124 BV	1122 BV	1354 BV	1504 BV	1352 BV	1502 BV	2124 BV*	2122 BV*
A length	35 3/8	35 3/8	51	52 1/8	51	52 1/8	39 1/4	42 5/16
B width	16 5/8	16 5/8	28 1/8	29 1/4	29 1/8	31 5/16	17 1/4	20 7/8
C height	14 3/8	14 3/8	25 7/8	24 3/4	25 7/8	28 5/8	15 11/16	15 11/16

All dimensions in inches unless otherwise noted. *Two stage models

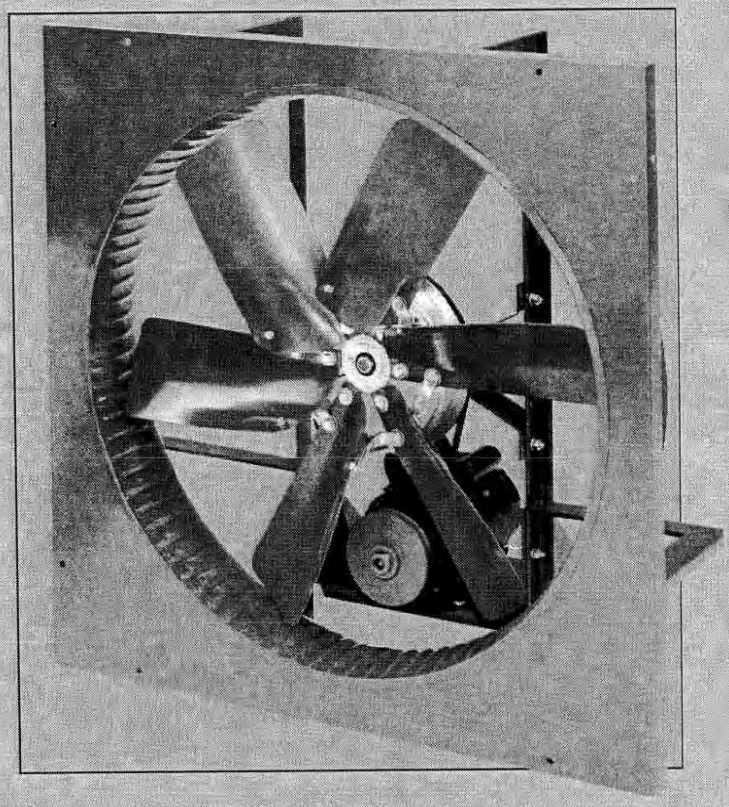


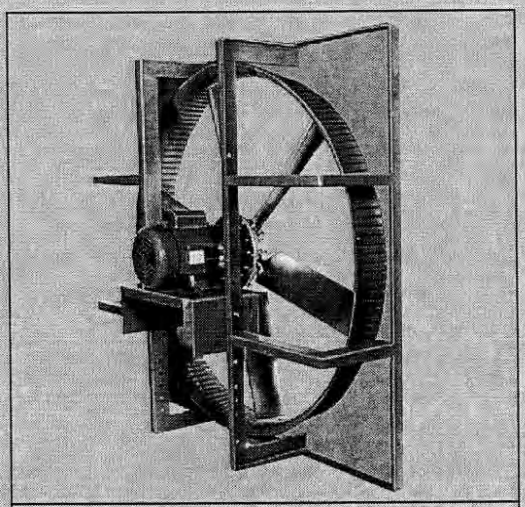
Model MI	1124 BP	1122 BP	1354 BP	1504 BP	1352 BP	1502 BP
A length	39 1/8	39 1/8	44 11/16	43 5/16	48 5/16	49 15/16
B width	22 1/2	22 1/2	19 1/16	19 1/2	19 1/16	25 15/16
C height	16 3/4	16 3/4	17 3/4	16 3/4	20 15/16	20 3/4

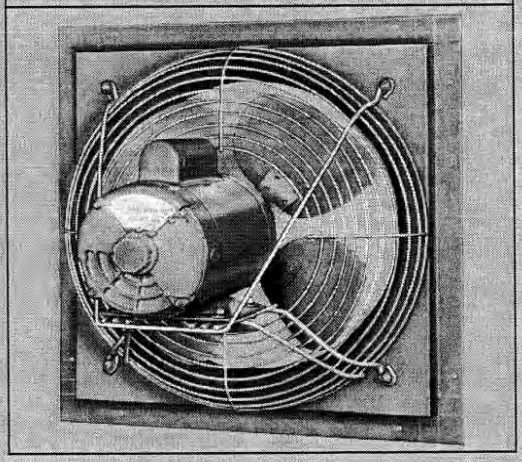
All dimensions in inches unless otherwise noted

BULLETIN 731
FEBRUARY, 2002

BELT-DRIVE AND DIRECT-DRIVE
PROPELLER FANS







BELT-DRIVE

- Exhaust or supply
- Capacities to 117,800 CFM
- Static pressures to 3/4"WG

DIRECT-DRIVE

- Exhaust or supply
- Capacities to 61,400 CFM
- Static pressures to 3/4"WG

nyb | The New York Blower Company®

7660 QUINCY STREET–WILLOWBROOK, ILLINOIS 60527-5530
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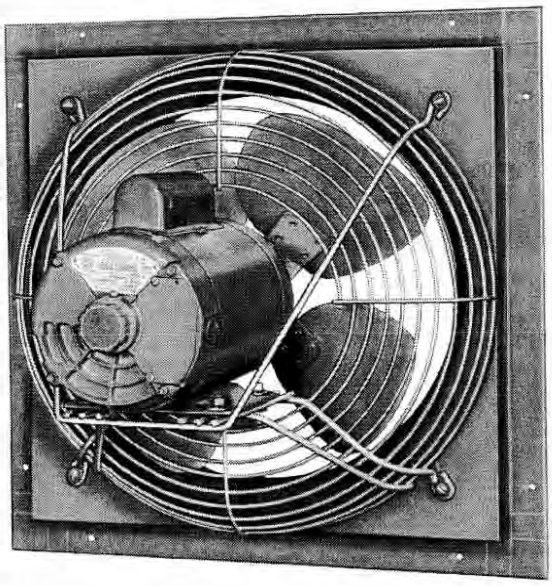
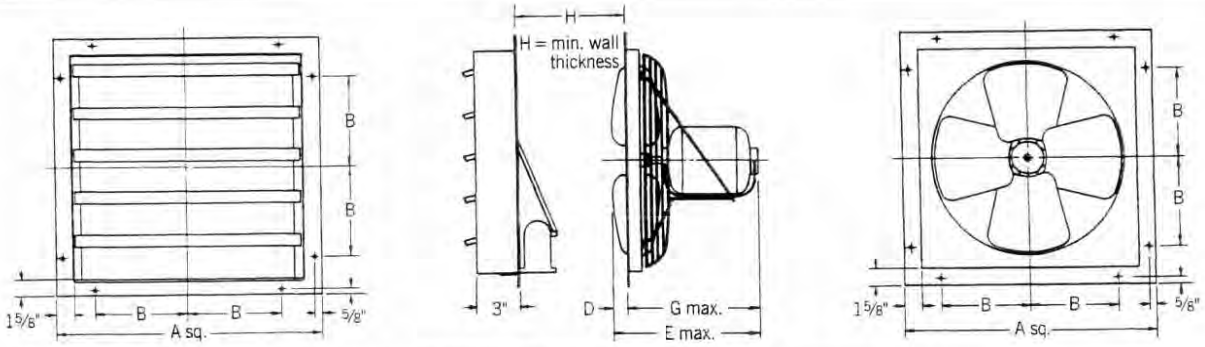
DIRECT-DRIVE PROPELLER FANS



MODEL N

EXHAUST or SUPPLY

- **Eight wheel diameters**—8" through 24".
- **250 to 6400 CFM**—up to 1/2" static pressure.
- **Panels**—square steel construction with streamlined venturi inlet...venturi is reversed in supply-fan panels...baked-green enamel finish.
- **Wheels**—aluminum blades with steel hubs.
- **Motor mounts**—wire-guard-type motor mount [see photo at left] is standard on all Model N units...guard is zinc-plated steel.
- **Motors**—standard motors are totally enclosed air over with pre-lubricated ball bearings except 1/12 and 1/20 HP motors, which are shaded-pole totally enclosed permanently lubricated sleeve-bearing type. Motors 1/4 HP and larger are suitable for either horizontal or vertical service...specify "for vertical mounting" to have wheel locked to motor shaft...1/20 and 1/12 HP motors are not suitable for vertical service.



SPECIFICATIONS DIMENSIONS IN INCHES.

Application	Model	Wheel diameter	A	B	D	E†	G†	H minimum		Mounting hole no. and diameter		Weight* [lbs.]
								Auto-matic	Motor-operated	Fan	Shutter	
EXHAUST	EN82-	8	13 1/4	3	1/4	10 1/4	10 1/4	1 5/8	4 1/2	8 - 5/16	8 - 9/32	25
	EN102-	10	15 1/4	4		10 3/8	10 1/8	1 5/8	4 3/4	8 - 5/16	8 - 9/32	29
	EN122-	12	17 1/4	5	7/8	11 1/2	10 3/4	2	5 3/8	8 - 5/16	8 - 9/32	35
	EN142-	14	20 1/4	6 1/2	5/8	11 1/4	10 5/8	2	5 1/8	8 - 5/16	8 - 9/32	40
	EN162-	16	23 1/4	8	1	12	11	2	5 1/2	8 - 5/16	8 - 9/32	50
	EN182-	18	24 1/4	8 1/2	5/8	11 1/2	10 7/8	2	5 1/8	8 - 5/16	8 - 9/32	65
	EN202-	20	27 1/4	10	7/8	12 7/8	12	2	5 3/8	8 - 5/16	8 - 9/32	80
	EN242-	24	30 1/4	11 1/2	1	13 3/8	12 3/8	2	5 1/2	8 - 5/16	8 - 9/32	95
SUPPLY	SN82-	8	13 1/4	3	1/8	10 1/4	10 1/4	Auto-matic shutter not available	9 1/2	8 - 5/16	8 - 9/32	25
	SN102-	10	15 1/4	4		10 1/4	10 1/4		9 1/2	8 - 5/16	8 - 9/32	29
	SN122-	12	17 1/4	5		11	11		9 1/2	8 - 5/16	8 - 9/32	35
	SN142-	14	20 1/4	6 1/2		11 5/8	11 5/8		9 1/2	8 - 5/16	8 - 9/32	40
	SN162-	16	23 1/4	8		11 1/4	11 1/8		9 1/2	8 - 5/16	8 - 9/32	50
	SN182-	18	24 1/4	8 1/2		12	12		9 1/2	8 - 5/16	8 - 9/32	65
	SN202-	20	27 1/4	10		12 1/2	12 1/2		9 1/2	8 - 5/16	8 - 9/32	80
	SN242-	24	30 1/4	11 1/2	1/4	12 1/2	12 1/4		9 1/2	8 - 5/16	8 - 9/32	95

† E and G based on longest motor used for each size fan. * Shipping weights shown are maximum and include totally enclosed motors and weight of packaging.
NOTE: Exhaust units are available with either automatic or motorized shutters. Supply units require motorized supply shutter.
When ordering, specify complete model number as shown on page 3. Dimensions not to be used for construction unless certified. Tolerance: ± 1/8"

MODEL EN DIRECT-DRIVE EXHAUST performance ratings

Model	HP	RPM	CFM						Max. BHP*
			0"SP	1/10"SP	1/8"SP	1/4"SP	3/8"SP	1/2"SP	
EN82-H	1/20	1550	418	258	243				
EN82-H-3	†1/20	1550/1300/1100	418/350/297	258/216/183	243/204/172				
EN102-H	1/20	1550	900	735	680				
EN102-H-3	†1/20	1550/1300/1100	900/755/639	735/616/511	680/570/483				
EN122-M	1/12	1075	1200	965	790				
EN122-H	1/4	1725	1900	1790	1750	1500			
EN122-MH	1/4	1725/1140	1900/1257	1790/1182	1750/1158	1500/992			
EN142-M	1/12	1050	1340	1150	1095				
EN142-H	1/4	1725	2150	2020	1980	1820	1660		
EN142-MH	1/4	1725/1140	2150/1420	2020/1335	1980/1310	1820/1202	1660/1098		
EN162-M	1/4	1140	2070	1880	1820	1600			
EN162-H	1/2	1750	3050	2910	2880	2720	2560		.45
EN162-MH	1/3	1725/1140	3010/1990	2880/1902	2840/1878	2680/1770	2510/1660		.45
EN182-M	1/4	1140	2620	2400	2330	2050			
EN182-H	1/2	1725	3860	3720	3690	3500	3290	3050	.54
EN182-MH	1/2	1725/1140	3860/2560	3720/2460	3690/2440	3500/2310	3290/2180	3050/2020	.54
EN202-M	1/4	1140	3360	3110	3050	2670			
EN202-H	3/4	1725	5000	4850	4800	4600	4400	4180	.82
EN242-L	1/4	1140	4250	4000	3930	3500			
EN242-M	1/2	1140	5380	5100	5020	4620	4200		.53
EN242-H	★3/4	1140	6420	6150	6070	5650	5210	4650	.84

MODEL SN DIRECT-DRIVE SUPPLY performance ratings

[If shutters are required, use motorized supply type]

Model	HP	RPM	CFM						Max. BHP*
			0"SP	1/10"SP	1/8"SP	1/4"SP	3/8"SP	1/2"SP	
SN82-H	1/20	1550	442	316	270				
SN82-H-3	†1/20	1550/1300/1100	442/371/314	316/265/224	270/226/192				
SN102-H	1/20	1550	870	755	720				
SN102-H-3	†1/20	1550/1300/1100	870/730/617	755/633/536	720/604/511				
SN122-M	1/12	1075	1150	920	850				
SN122-H	1/4	1725	1815	1675	1650	1475			
SN122-MH	1/4	1725/1140	1815/1200	1675/1106	1650/1090	1475/975			
SN142-M	1/12	1050	1350	1160	1100				
SN142-H	1/4	1725	2100	1990	1960	1840	1680		
SN142-MH	1/4	1725/1140	2100/1390	1990/1315	1960/1295	1840/1216	1680/1110		
SN162-M	1/4	1140	2000	1800	1750	1450			
SN162-H	1/2	1750	2950	2830	2800	2650	2500		.45
SN162-MH	1/3	1725/1140	2900/1915	2790/1840	2760/1756	2600/1718	2440/1610		.45
SN182-M	1/4	1140	2610	2400	2340	1960			
SN182-H	1/2	1725	3920	3750	3700	3490	3280	3000	.57
SN182-MH	1/2	1725/1140	3920/2590	3750/2480	3700/2440	3490/2305	3280/2165	3000/1980	.57
SN202-M	1/4	1140	3570	3260	3200	2810			
SN202-H	3/4	1725	5300	5100	5000	4820	4600	4350	.92
SN242-L	1/4	1140	4400	4150	4080	3700			
SN242-M	1/2	1140	5380	5100	5030	4650	4200		.52
SN242-H	★3/4	1140	6400	6100	6020	5600	5120	4480	.79

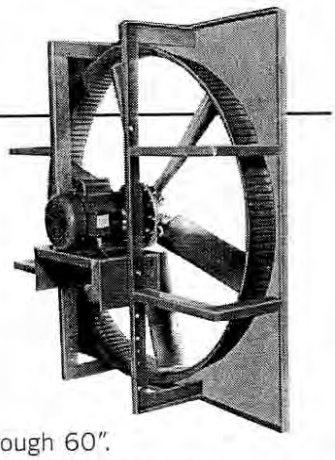
NOTE Static pressure rating on multispeed fans is at the higher speed. Low-speed performance ratings are shown for the identical system.

* Maximum BHP over cataloged range. Motors are rated on internal temperature rise rather than nameplate HP.

† Shaded-pole motor. Three-speed capacities shown are obtainable with 3-speed switch furnished with unit.

★ Available in 3-phase only.

DIRECT-DRIVE PROPELLER FANS



MODEL NYCDC

EXHAUST or SUPPLY

AMCA SEAL

The New York Blower Company certifies that the Model NYCDC fans shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publications 211 and 311 and comply with the requirements of the AMCA Certified Ratings Program.

7-PART SIZING NOMENCLATURE

EXAMPLE

NY	C	D	C	18	F	11
New York Blower	Model	Direct-drive	Style	Fan size	Motor horse-power	Fan RPM

DESIGN FEATURES

- **Eight wheel diameters**—18" through 60".
- **1600 to 61,400 CFM**—up to 3/4" static pressure.
- **Wheels**—cast-aluminum adjustable-pitch airfoil blades. Number of blades and blade pitch set for catalog performance.
- **Panels**—heavy-gauge steel construction with streamlined inlet.
- **Finish**—epoxy-powder coating, average 3 mil thickness, baked at 400°F. Impact and chemical-resistant.
- **Horizontal or vertical operation**—for wall or roof mounting.
- **Motors**—wide selection available.
- **Dimensions and accessories**—dimensions are shown on page 10. Optional accessories are shown on page 11.

MODEL NYCDC performance ratings

Fan		CFM							Motor HP	Max. BHP	Sones at 0"SP	Fan RPM	Wheel		Apprx. shpg. wt. #	Shutter model
Size	Model	0"SP	1/8"SP	1/4"SP	3/8"SP	1/2"SP	5/8"SP	3/4"SP					No. blades	Pitch		
18	NYCDC18F11	2890	2526	2032					1/6	0.18	9.5	1160	4	23.5	60	SU18
	NYCDC18G11	3328	3035	2632					1/4	0.29	11.5	1160	6	28	62	SU18
	NYCDC18H11	3856	3543	3059					1/3	0.38	12.4	1160	6	33.5	58	SU18
	NYCDC18F17	2642	2299	1967	1595				1/6	0.19	15.4	1750	3	10.5	51	SU18
	NYCDC18H17	3659	3373	3068	2706	2235			1/3	0.38	16.8	1750	3	19	55	SU18
	NYCDC18J17	4050	3820	3587	3320	2993	2610	2194	1/2	0.57	18.7	1750	4	21	63	SU18
	NYCDC18K17	5065	4851	4569	4272	3942	3456	2894	3/4	0.85	23	1750	4	29.5	70	SU18
	NYCDC18L17	5435	5214	4980	4770	4546	4258	3909	1	1.20	22	1750	6	31	74	SU18
24	NYCDC24G8	5890	4869	3546					1/4	0.29	12.1	870	3	28	95	S24
	NYCDC24J8	6923	6304	5478	3998				1/2	0.57	15.4	870	6	30.5	119	S24
	NYCDC24H11	5659	4996	4300	3262				1/3	0.37	17.7	1160	3	15.5	100	S24
	NYCDC24J11	7197	6519	5714	4812				1/2	0.59	19.1	1160	3	23.5	95	S24
	NYCDC24K11	8567	7747	6728	5837	4308			3/4	0.85	22	1160	3	33	104	S24
	NYCDC24L11	9318	8574	7813	6957	5707			1	1.14	25	1160	4	33.5	122	SR24
	NYCDC24L17	8229	7753	7358	6983	6460	5854	5210	1	1.18	34	1750	3	14.5	100	S24
	NYCDC24M17	9810	9382	8942	8470	7916	7374	6807	1 1/2	1.70	36	1750	3	19.5	122	SR24
	NYCDC24N17	11646	11235	10739	10221	9651	9052	8445	2	2.31	39	1750	3	27	117	SR24
	NYCDC24P17	13449	12948	12461	12005	11563	11089	10517	3	3.47	56	1750	4	31	143	SR24
30	NYCDC30G8	6959	5680	3716					1/4	0.29	15.3	870	3	12.5	108	S30
	NYCDC30J8	9727	8287	6678					1/2	0.58	16.5	870	3	22.5	116	S30
	NYCDC30K8	11088	9857	8475	6852				3/4	0.85	21	870	4	25	121	S30
	NYCDC30K11	10211	9439	8380	7253	5364			3/4	0.87	26	1160	3	15	131	S30
	NYCDC30L11	11971	11026	9884	8785	7265			1	1.14	27	1160	3	19.5	136	S30
	NYCDC30M11	13453	12657	11661	10742	9675	8208		1 1/2	1.70	31	1160	4	22	162	S30
	NYCDC30N11	15421	14507	13519	12375	11277	10049		2	2.27	34	1160	4	27	175	SR30
	NYCDC30N17	13716	13156	12517	11835	11161	10457	9695	2	2.24	47	1750	3	12	131	SR30
	NYCDC30P17	16883	16339	15746	14907	14287	13592	12818	3	3.46	52	1750	3	17.5	157	SR30
	NYCDC30Q17	20296	19791	19262	18500	17905	17332	16731	5	5.73	65	1750	4	22	175	SR30

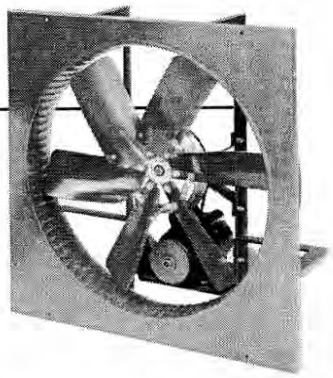
See page 5 for performance-table notes.

MODEL NYCDC performance ratings [continued]

Fan		CFM							Motor HP	Max. BHP	Sones at 0"SP	Fan RPM	Wheel		Apprx. shpg. wt. #	Shutter model
Size	Model	0"SP	1/8"SP	1/4"SP	3/8"SP	1/2"SP	5/8"SP	3/4"SP					No. blades	Pitch		
36	NYCDC36L6	15166	13428	11504	8275				1	1.13	24	680	6	23.5	195	S36
	NYCDC36M6	17616	16111	13671	10232				1½	1.67	26	680	6	30	261	S36
	NYCDC36L8	15110	13215	10748	8133				1	1.14	27	870	3	20	178	S36
	NYCDC36M8	17697	15810	13253	10129				1½	1.72	28	870	3	27.5	185	S36
	NYCDC36N8	19152	17634	15906	13468				2	2.30	33	870	4	28.5	239	SR36
	NYCDC36P8	22314	21202	19777	17836	15385	12578		3	3.41	39	870	6	29.5	270	SR36
	NYCDC36M11	15810	14417	12949	11604	10038			1½	1.70	40	1160	3	12.5	185	S36
	NYCDC36N11	18781	17324	15688	13922	12336	10551		2	2.31	42	1160	3	17.5	194	SR36
	NYCDC36P11	22145	20931	19114	17409	15401	13202		3	3.44	44	1160	3	24	240	SR36
	NYCDC36Q11	25938	24835	23680	22432	20951	19063	16909	5	5.71	54	1160	4	29.5	289	
	NYCDC36Q17	22279	21361	20488	19630	18799	17981	17159	5	5.73	79	1750	3	11	196	
	NYCDC36R17	27585	26651	25669	24602	23646	22722	21819	7½	8.47	83	1750	3	16.5	240	
	NYCDC36S17	31604	30726	29804	28832	27791	26684	25542	10	11.19	78	1750	3	20.5	267	
42	NYCDC42M6	20660	17624	14584	11783				1½	1.71	31	680	4	21.5	293	S42
	NYCDC42N6	22048	19876	17980	16050				2	2.31	36	680	6	22	319	S42
	NYCDC42L8	16053	13871	11574	8770				1	1.14	33	870	3	8	229	S42
	NYCDC42M8	19684	17398	14856	12241				1½	1.70	37	870	3	13	238	S42
	NYCDC42N8	22803	20405	17788	14905				2	2.27	41	870	3	17.5	286	S42
	NYCDC42P8	23247	21939	20679	19429	18052	16304	13495	3	3.31	49	870	6	15	351	S42
	NYCDC42N11	19570	17975	16339	14624	12881	10654		2	2.29	51	1160	3	6	189	S42
	NYCDC42P11	23738	21937	20306	18759	17055	14854	12235	3	3.31	58	1160	3	10.5	225	SR42
	NYCDC42Q11	31267	29640	27673	25656	23586	21408	19055	5	5.78	70	1160	3	18.5	240	SR42
	NYCDC42R17	30907	29798	28711	27672	26655	25554	24398	7½	8.45	114	1750	3	7	225	
	NYCDC42S17	35812	34607	33414	32280	31206	30175	29155	10	11.27	128	1750	3	10.5	245	
48	NYCDC48L6	19158	15792	12004					1	1.16	29	680	3	9	270	S48
	NYCDC48M6	23063	19348	15364					1½	1.70	31	680	3	14	308	S48
	NYCDC48N6	24888	21994	18685	15530				2	2.33	37	680	4	15.5	331	S48
	NYCDC48N8	23584	21044	18143	15270	11815			2	2.26	41	870	3	8	302	S48
	NYCDC48P8	28999	26364	23143	20083	16624			3	3.45	47	870	3	13.5	319	S48
	NYCDC48Q8	35919	32759	29209	25467	20568			5	5.64	49	870	3	21.5	378	SR48
	NYCDC48R8	39162	37352	35207	32664	30448			7½	8.50	68	870	6	20	428	SR48
	NYCDC48Q11	32064	30247	28224	26105	23829	21625	19483	5	5.60	70	1160	3	8.5	319	SR48
	NYCDC48R11	39344	37422	35328	32792	30462	28136	25773	7½	8.47	80	1160	3	14	359	SR48
	NYCDC48S11	44737	42565	40131	37704	35346	32752	29347	10	11.33	81	1160	3	18.5	395	
	NYCDC48T17	45574	44428	43220	41852	40456	39127	37690	15	16.76	142	1750	3	7	359	
	NYCDC48U17	49629	48619	47609	46599	45581	44500	43422	20	22.17	161	1750	4	7.5	395	
54	NYCDC54M6	26200	22089	17992					1½	1.73	37	680	3	8.5	375	S54
	NYCDC54N6	29639	25602	20796	14890				2	2.27	39	680	3	12	397	S54
	NYCDC54P8	32293	29264	26144	22614	18652			3	3.33	54	870	3	7.5	393	S54
	NYCDC54Q8	41756	37845	35237	30261	26722	23053		5	5.82	61	870	3	15	443	SR54
	NYCDC54R8	48304	45458	42027	35213	30889	26860		7½	8.61	67	870	3	22	473	SR54
	NYCDC54R11	43875	41864	39351	36781	34602	32118	29100	7½	8.28	94	1160	3	8	439	SR54
	NYCDC54S11	50560	48007	45916	43404	39866	37179	35111	10	11.36	103	1160	3	12	473	SR54
	NYCDC54T11	58018	56403	54597	52499	49742	47262	45173	15	17.41	128	1160	4	14.5	500	
60	NYCDC60N6	31795	26932	21425	16194				2	2.29	40	680	3	6	412	S60
	NYCDC60P6	37877	32608	27882	21251				3	3.44	48	680	3	11	492	S60
	NYCDC60Q8	43820	39639	36142	32648	27552	23321		5	5.78	66	870	3	8	452	S60
	NYCDC60R8	52955	49203	44663	40761	35890	28254		7½	8.71	80	870	3	14	484	SR60
	NYCDC60S11	54238	51001	48093	45745	43499	40386	35960	10	11.38	104	1160	3	6	480	SR60
	NYCDC60T11	61427	59014	56886	55040	52871	49802	46550	15	16.81	123	1160	4	7.5	510	

- Performance shown is for installation Type A: Free Inlet, Free Outlet. Performance ratings do not include the effects of appurtenances in the airstream.
- The sound ratings shown are loudness values in fan sones at 5 ft. [1.5m] in a hemispherical free field calculated per AMCA Standard 301. Values shown are for installation Type A: Free Inlet fan-sone levels. The sound ratings shown are at 0" static pressure.
- BHP at most static pressures listed is less than that shown. Motor loading beyond the nominal nameplate rating does not overheat the motor and is within NEMA-recommended limits and motor service factor due to the moving airstream.
- Shutter models shown are automatic [gravity] type. Add suffix M for manual operation [except Model SU18]. Add suffix E for motor operation.

BELT-DRIVE PROPELLER FANS



AMCA SEAL

The New York Blower Company certifies that the Models NYCBL-NYCBH, NYCABL-NYCABH, and NYCBHX fans shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publications 211 and 311 and comply with the requirements of the AMCA Certified Ratings Program.

6-PART SIZING NOMENCLATURE

EXAMPLE

NY	C	B	L	24	K
New York Blower	Model	Belt-drive	Style	Fan size	Motor horse-power

MODELS NYCBL-NYCBH/NYCABL-NYCABH/NYCBHX

EXHAUST or SUPPLY*

DESIGN FEATURES

- **Seven wheel diameters**—24" through 60".
- **2800 to 59,500 CFM**—up to 3/4" static pressure.
- **Frame and panel**—welded steel construction...streamlined venturi inlet.
- **Wheels**—six die-formed steel blades for maximum airflow, efficient operation.
- **Bearings and shaft**—fixed shaft design with integral drive sheave/wheel hub assembly...eliminates overhung bearing load. Permanently lubricated/sealed bearings with L-10 life of 300,000 hours.
- **Finish**—epoxy-powder coating, average 3 mil thickness, baked at 400°F. Impact and chemical-resistant.
- **Motors**—wide selection available.
- **Dimensions and accessories**—dimensions are shown on pages 9 and 10. Optional accessories are shown on page 11.

* Supply applications require the use of a wall housing.

MODEL NYCBL-NYCBH performance ratings

USE THESE PERFORMANCE TABLES TO MAKE SELECTIONS REQUIRING PRESSURES ABOVE 1/4"SP.

Fan		CFM							Motor HP	Max. BHP	Sones at 0"SP	Fan RPM	Apprx. shpg. wt. #	Shutter model
Size	Model	0"SP	1/8"SP	1/4"SP	3/8"SP	1/2"SP	5/8"SP	3/4"SP						
24	NYCBL24K	7813	7286	6630	5873	4378			3/4	0.91	26	907	93	S24
	NYCBH24L*	8907	8441	7927	7314	6598			1	1.25	32	1034	98	S24
	NYCBH24M*	9260	8806	8304	7739	7141	6093	4644	1 1/2	1.56	34	1075	128	S24
30	NYCBL30K	10787	9857	8557	6741				3/4	0.92	20	688	106	S30
	NYCBH30L	11760	10915	9881	8353	5684			1	1.26	23	750	111	S30
	NYCBH30M	13186	12440	11609	10444	9043	6656		1 1/2	1.77	27	841	140	S30
	NYCBH30N	14801	14139	13438	12605	11440	10202		2	2.31	33	944	143	S30
	NYCBH30P*	16965	16390	15797	15154	14397	13398	12311	3	3.41	41	1082	168	S30
36	NYCBL36L	14934	13552	11542	8606				1	1.26	23	590	119	S36
	NYCBH36M	16402	15160	13573	11268	7781			1 1/2	1.77	27	648	156	S36
	NYCBH36N	18604	17519	16305	14585	12457			2	2.28	32	735	159	S36
	NYCBH36P	20604	19629	18591	17296	15572	13595	10997	3	3.41	39	814	186	S36
42	NYCBH42M	19709	17928	15453	12269	7910			1 1/2	1.76	25	513	166	S42
	NYCBH42N	21899	20365	18551	16101	11725			2	2.30	30	570	169	S42
	NYCBH42P	24627	23311	21737	19575	17719	13446	10530	3	3.39	37	641	199	S42
48	NYCBH48N	27638	25360	22180	17121				2	2.30	27	474	214	S48
	NYCBH48P	31428	29519	26939	23213	18874			3	3.39	33	539	259	S48

* These models have fixed-pitch motor pulley.

- Performance shown is for installation Type A: Free Inlet, Free Outlet. Performance ratings do not include the effects of appurtenances in the airstream. Power rating [BHP] does not include drive losses.
- The sound ratings shown are loudness values in fan sones at 5 ft. [1.5m] in a hemispherical free field calculated per AMCA Standard 301. Values shown are for installation Type A: Free Inlet fan-sone levels. The sound ratings shown are at 0" static pressure.
- BHP at most static pressures listed is less than that shown. Motor loading beyond the nominal nameplate rating does not overheat the motor and is within NEMA-recommended limits and motor service factor due to the moving airstream.
- Shutter models shown are automatic [gravity] type. Add suffix M for manual operation. Add suffix E for motor operation.

MODEL NYCABL-NYCABH performance ratings

USE THESE PERFORMANCE TABLES TO MAKE SELECTIONS REQUIRING PRESSURES FROM 0" to 1/4"SP.

Fan		CFM			Motor HP	Max. BHP	Sones at 0"SP	Fan RPM	Apprx. shpg. wt. #	Shutter model
Size	Model	0"SP	1/8"SP	1/4"SP						
24	NYCABL24G	5384	4513	2766	1/4	0.30	13.5	625	70	S24
	NYCABL24H	6133	5425	4386	1/3	0.41	17.3	712	73	S24
	NYCABL24J	7020	6375	5668	1/2	0.60	22	815	79	S24
	NYCABL24K	8192	7695	7108	3/4	0.91	28	951	93	S24
	NYCABH24L*	9174	8717	8213	1	1.25	34	1065	98	S24
30	NYCABL30G	7652	6085		1/4	0.30	11.4	488	77	S30
	NYCABL30H	8530	7257		1/3	0.41	13.7	544	80	S30
	NYCABL30J	9423	8324	6549	1/2	0.59	16.3	601	86	S30
	NYCABL30K	11054	10149	8937	3/4	0.91	21	705	106	S30
	NYCABH30L	12355	11555	10623	1	1.25	25	788	111	S30
	NYCABH30M	13939	13235	12472	1 1/2	1.77	30	889	140	S30
	NYCABH30N	15288	14647	13975	2	2.30	35	975	143	S30
	NYCABH30P*	17514	16957	16385	3	3.41	44	1117	168	SR30
36	NYCABL36K	13744	12213	9762	3/4	0.90	20	543	114	S36
	NYCABL36L	15465	14138	12297	1	1.25	25	611	119	S36
	NYCABH36M	17414	16251	14869	1 1/2	1.76	29	688	156	S36
	NYCABH36N	19085	18029	16866	2	2.30	34	754	159	S36
	NYCABH36P	21869	20953	19992	3	3.42	43	864	186	SR36
42	NYCABL42H	12602	9242		1/3	0.41	11.3	328	104	S42
	NYCABL42J	14292	11404		1/2	0.59	14.3	372	110	S42
	NYCABL42K	16213	13934	10363	3/4	0.91	17.8	422	124	S42
	NYCABL42L	18249	16307	13615	1	1.25	22	475	129	S42
	NYCABH42M	20593	18915	16688	1 1/2	1.76	27	536	166	S42
	NYCABH42N	22668	21204	19412	2	2.30	32	590	169	S42
	NYCABH42P	26049	24817	23327	3	3.41	42	678	199	S42
48	NYCABL48J	17667	12635		1/2	0.59	12.9	303	144	S48
	NYCABL48K	20408	16877		3/4	0.91	16.8	350	149	S48
	NYCABL48L	22565	19445	13978	1	1.25	19.9	387	154	S48
	NYCABH48M	25422	22798	18566	1 1/2	1.76	24	436	211	S48
	NYCABH48N	27638	25360	22180	2	2.27	27	474	214	S48
	NYCABH48P	31428	29519	26939	3	3.32	33	539	259	S48
54	NYCABH54J	19825	13417		1/2	0.59	13.8	283	197	S54
	NYCABH54K	23117	18385		3/4	0.92	17.9	330	204	S54
	NYCABH54L	25008	20892	11236	1	1.25	20	357	211	S54
	NYCABH54M	28511	25180	19719	1 1/2	1.76	25	407	212	S54

* These models have fixed-pitch motor pulley.

See page 6 for performance-table notes.

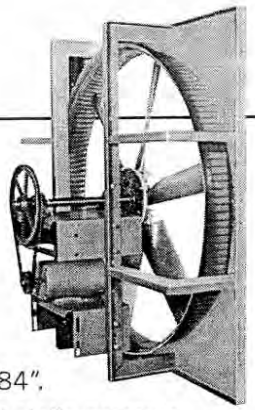
MODEL NYCBHX performance ratings

USE THESE PERFORMANCE TABLES TO MAKE SELECTIONS REQUIRING HIGHER VOLUMES.

Fan		CFM							Motor HP	Max. BHP	Sones at 0"SP	Fan RPM	Apprx. shpg. wt. #	Shutter model
Size	Model	0"SP	1/8"SP	1/4"SP	3/8"SP	1/2"SP	5/8"SP	3/4"SP						
48	NYCBHX48Q	35476	33929	31997	29409	26066	21074		5	5.91	52	628	388	SR48
	NYCBHX48R	40560	39240	37684	35858	33386	30488	26976	7 1/2	8.62	68	718	445	SR48
	NYCBHX48S	45644	44490	43184	41679	40014	37747	35159	10	12.45	85	808	479	
54	NYCBHX54N	30043	26247	18351					2	2.16	26	377	352	S54
	NYCBHX54P	33629	30378	25249					3	2.99	31	422	374	S54
	NYCBHX54Q	40801	38160	35196	30243	22086			5	5.44	43	512	402	SR54
	NYCBHX54R	42873	40359	37566	33782	26777			7 1/2	6.28	47	538	459	SR54
	NYCBHX54S	50045	47891	45715	43190	39874	34191	27230	10	10.03	62	628	491	
60	NYCBHX60N	34058	29872	22388					2	2.36	26	359	360	S60
	NYCBHX60P	38327	34846	29270					3	3.37	32	404	382	S60
	NYCBHX60Q	44304	41304	37689	31802				5	5.19	42	467	409	S60
	NYCBHX60R	51039	48404	45665	42231	36537	29266		7 1/2	8.01	54	538	467	SR60
	NYCBHX60S	59578	57296	55131	52438	49576	44667	39858	10	12.65	70	628	500	SR60

See page 6 for performance-table notes.

BELT-DRIVE PROPELLER FANS



AMCA SEAL

The New York Blower Company certifies that the Model NYCBC fans shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publications 211 and 311 and comply with the requirements of the AMCA Certified Ratings Program.

6-PART SIZING NOMENCLATURE

EXAMPLE

NY	C	B	C	48	N
New York Blower	Model	Belt-drive	Style	Fan size	Motor horse-power

MODEL NYCBC

EXHAUST or SUPPLY

DESIGN FEATURES

- **Five wheel diameters**—48" through 84".
- **14,000 to 117,800 CFM**—up to 3/4" static pressure.
- **Frame and panel**—welded steel construction...streamlined venturi inlet.
- **Wheels**—cast-aluminum adjustable-pitch airfoil blades are securely attached to a heavy cast-aluminum hub.
- **Bearings and shaft**—steel fan shaft supported by two heavy-duty pillow-block ball bearings.
- **Finish**—epoxy-powder coating, average 3 mil thickness, baked at 400°F. Impact and chemical-resistant.
- **Dimensions and accessories**—dimensions are shown on page 9. Optional accessories are shown on page 11.

MODEL NYCBC performance ratings

USE THESE PERFORMANCE TABLES TO MAKE SELECTIONS REQUIRING MAXIMUM VOLUMES AND PRESSURES.

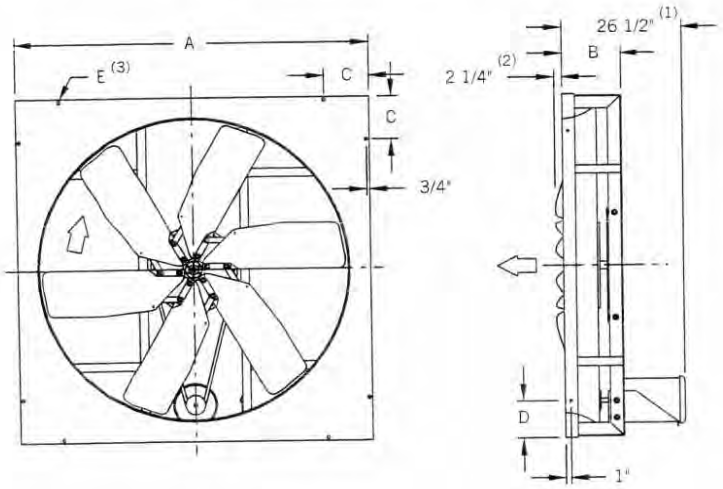
Fan		CFM							Motor HP	Max. BHP	Sones at 0"SP	Fan RPM	Apprx. shpg. wt. #	Shutter model
Size	Model	0"SP	1/8"SP	1/4"SP	3/8"SP	1/2"SP	5/8"SP	3/4"SP						
48	NYCBC48N	27131	24062	20721	15365				2	2.26	33	700	359	S48
	NYCBC48P	30968	28293	25550	21826	16995			3	3.39	41	799	383	S48
	NYCBC48Q	36626	34374	32071	29736	26650	22702	17266	5	5.61	54	945	398	S48
	NYCBC48R	41820	39851	37852	35819	33764	31175	27612	7½	8.32	69	1079	455	SR48
	NYCBC48S	46044	44258	42452	40615	38768	36875	34504	10	11.09	83	1188	489	SR48
54	NYCBC54L	23897	17331						1	1.12	22	467	367	S54
	NYCBC54M	27274	22248	13981					1½	1.66	27	533	379	S54
	NYCBC54N	30242	25651	19237					2	2.26	32	591	380	S54
	NYCBC54P	34489	30670	25683	19426				3	3.36	40	674	402	S54
	NYCBC54Q	40988	38123	34250	29377	24447			5	5.64	55	801	430	S54
	NYCBC54R	46770	44345	40954	37973	33060	28834	22856	7½	8.40	70	914	487	SR54
	NYCBC54S	51427	49252	46535	43341	40552	35673	31882	10	11.16	85	1005	519	SR54
60	NYCBC60L	27428	19065						1	1.11	25	437	381	S60
	NYCBC60M	31382	24760	15368					1½	1.66	31	500	393	S60
	NYCBC60N	34771	29285	20768					2	2.26	37	554	393	S60
	NYCBC60P	39667	35018	28189	21036				3	3.35	46	632	415	S60
	NYCBC60Q	47135	43239	38812	32500	26273			5	5.63	63	751	442	S60
	NYCBC60R	53788	50368	46894	42068	36622	30983	24968	7½	8.36	81	857	500	SR60
	NYCBC60S	59123	56008	52907	49337	44191	39475	34242	10	11.10	97	942	533	SR60
72	NYCBC72N	44303	35814	22467					2	2.19	24	281	732	S72
	NYCBC72P	51083	44599	35032					3	3.35	31	324	754	S72
	NYCBC72Q	60700	55262	47784	40066				5	5.62	41	385	768	S72
	NYCBC72R	69371	64532	59668	51733	45056	32768		7½	8.40	52	440	826	S72
	NYCBC72S	76466	72029	67882	61637	55122	48437	38049	10	11.24	63	485	857	S72
	NYCBC72T*	87187	83258	79601	75745	69544	63744	58787	15	16.67	80	553	928	SR72
	NYCBC72U*	96332	92758	89377	86112	82174	76074	70901	20	22.48	98	611	962	SR72
84	NYCBC84Q	74528	66415	54355	39643				5	5.65	36	299	1092	S84
	NYCBC84R	84997	77824	68687	58350	43030			7½	8.38	45	341	1149	S84
	NYCBC84S	93721	87139	80433	69678	60413			10	11.24	54	376	1180	SR84
	NYCBC84T	106931	101088	95624	88192	78813	71136	59347	15	16.69	69	429	1253	SR84
	NYCBC84U*	117899	112565	107578	102269	93763	86019	79119	20	22.38	83	473	1287	SR84

* These models have fixed-pitch motor pulley.

See page 9 for performance-table notes.

DIMENSIONS Not to be used for construction unless certified.

MODEL NYCBHX BELT-DRIVE

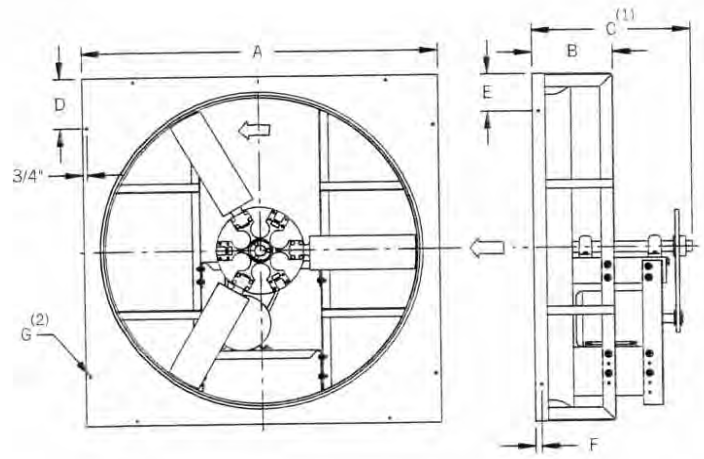


Size	DIMENSIONS [Inches]					Gauges	
	A	B	C	D	E[3]	Panel	Blade
48	56	12 3/4	8	6	3/8	12	10
54	62	12 11/16	8	6	3/8	12	10
60	68	12 9/16	11	9	1/2	12	10

Tolerance: ± 1/8"

1. Dimension is maximum with constant speed, 3-phase TEFC motor of maximum horsepower for fan size and style indicated. This dimension will vary with the type and HP of the motor actually selected.
2. Maximum blade protrusion beyond panel.
3. Mounting-panel hole diameters.

MODEL NYCBC BELT-DRIVE



Size	DIMENSIONS [Inches]							Gauge panel
	A	B	C[1]	D	E	F	G[2]	
48	56	12 3/4	27	8	6	1	3/8	12
54	62	12 11/16	27	8	6	1	3/8	12
60	68	12 9/16	27	11	9	1	1/2	12
72	80	17 7/8	34	13	11	1	1/2	10
84	92	17 7/8	34	15	13	1 5/8	1/2	10

Tolerance: ± 1/8"

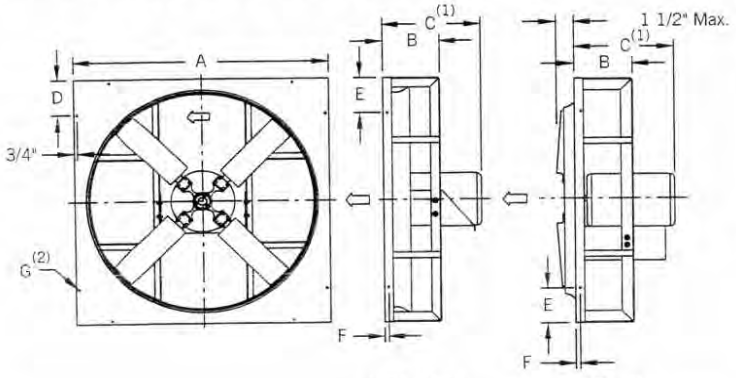
1. Dimension is maximum with constant speed, 3-phase TEFC motor of maximum horsepower for fan size and style indicated. This dimension will vary with the type and HP of the motor actually selected. Drawings of belt, drive, and blade assembly are schematic. Multiple belts are used on certain sizes and HPs. Blade assembly is 3-blade for 48" to 60" and 8-blade for 72" to 84".
2. Mounting-panel hole diameters.

MODEL NYCBC performance-table notes

- Performance shown is for installation Type A: Free Inlet, Free Outlet. Performance ratings do not include the effects of appurtenances in the airstream. Power rating [BHP] does not include drive losses.
- The sound ratings shown are loudness values in fan sones at 5 ft. [1.5m] in a hemispherical free field calculated per AMCA Standard 301. Values shown are for installation Type A: Free Inlet fan-sone levels. The sound ratings shown are at 0" static pressure.
- BHP at most static pressures listed is less than that shown. Motor loading beyond the nominal nameplate rating does not overheat the motor and is within NEMA-recommended limits and motor service factor due to the moving airstream.
- Shutter models shown are automatic [gravity] type. Add suffix M for manual operation. Add suffix E for motor operation.

DIMENSIONS Not to be used for construction unless certified.

MODEL NYCDC DIRECT-DRIVE

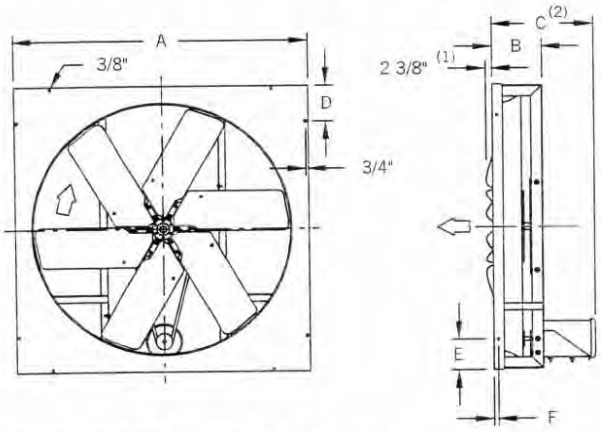


Size	DIMENSIONS [Inches]							Gauge panel
	A	B	C[1]	D	E	F	G[2]	
18	26	6 3/4	13 3/8	11/16	11/16	9/16	5/16	18
24	32	10 5/16	17 5/8	6	6	7/8	3/8	18
30	38	10 5/16	19	6	6	7/8	3/8	18
36	44	10 1/16	20 1/4	7	6	7/8	3/8	16
42	50	9 7/16	20 1/4	7	5	7/8	3/8	16
48	56	12 3/4	23 1/2	8	6	1	3/8	12
54	62	12 11/16	24	8	6	1	3/8	12
60	68	12 9/16	24	11	9	1	1/2	12

Tolerance: ± 1/8"

1. Dimension is maximum with constant speed, 3-phase TEFC motor of maximum horsepower for fan size and style indicated. This dimension will vary with the type and HP of the motor actually selected.
2. Mounting-panel hole diameters.

MODELS NYCBL-NYCBH/NYCABL-NYCABH BELT-DRIVE



1. Maximum blade protrusion beyond panel.
2. Dimension is maximum with constant speed, 3-phase TEFC motor of maximum horsepower for fan size and style indicated. This dimension will vary with the type and HP of the motor actually selected.

MODELS NYCBL/NYCABL

Size	DIMENSIONS [Inches]						Gauges	
	A	B	C[2]	D	E	F	Panel	Blade
24	32	10 5/16	17 7/8	6	6	7/8	18	14
30	38	10 5/16	17 7/8	6	6	7/8	18	14
36	44	10 1/16	17 3/4	7	6	7/8	16	14
42	50	9 7/16	17 1/8	7	5	7/8	16	14
48	56	10 1/4	17 7/8	8	6	1	16	14

Tolerance: ± 1/8"

MODELS NYCBH/NYCABH

Size	DIMENSIONS [Inches]						Gauges	
	A	B	C[2]	D	E	F	Panel	Blade
24	32	10 5/16	18 1/4	6	6	7/8	18	14
30	38	10 5/16	20 1/8	6	6	7/8	18	14
36	44	10 1/16	22	7	6	7/8	16	14
42	50	9 7/16	21 3/8	7	5	7/8	16	14
48	56	10 1/4	22 1/4	8	6	1	14	14
54	62	8 7/8	20 7/8	8	6	7/8	16	14

Tolerance: ± 1/8"

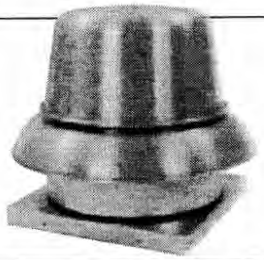
CENTRIFUGAL ROOF EXHAUSTERS

BELT-DRIVE

12 sizes: 6" to 48" diameter
CFM range: 160 to 35,000 CFM
Aluminum BI wheel
Upblast

DIRECT-DRIVE

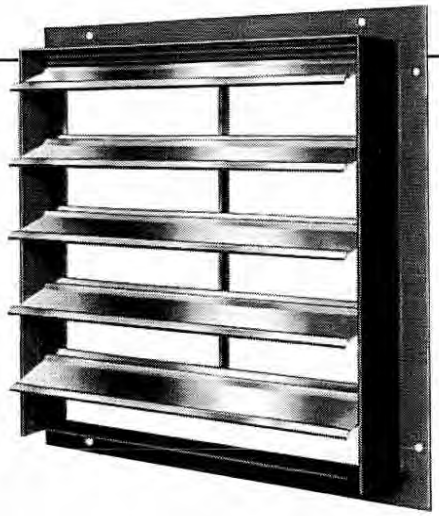
6 sizes: 6" to 15" diameter
CFM range: 25 to 3250 CFM
Aluminum BI wheel
Upblast and Downblast



Contact your New York Blower representative for additional information.

Accessories

Model N



Shutters

Construction—pressed-steel frames with felt-edged aluminum blades. All-welded frame. Blades use die-formed edges that overlap when closed. Blades are positively held open by internal tie rod. See page 2 for dimensions.

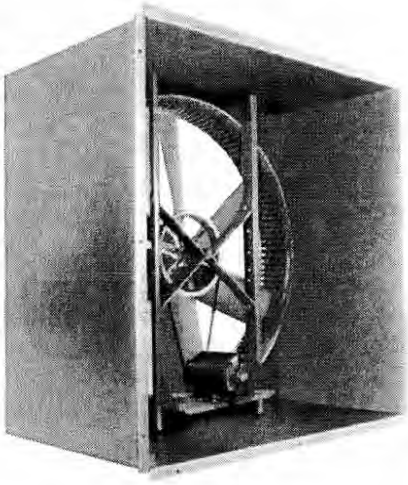
Automatic—open when fan is activated, gravity close. Suitable for wall-mounting only with exhaust fans. For vertical fan applications, use motorized shutter.

Motorized—open and closed with shutter actuator in response to fan operation. Available with reversed blades for use with supply fans.

Model NYC

Shutters

Type S and SR—sturdy, all-aluminum shutters correspond with the dimensions of the Model NYC fans and may be mounted to a common frame member for fans through 60". Shutters for 72" and 84" fans are larger than the fan panel. All sizes are available for automatic, manual, or motorized use. For improved fan performance and longer fan and shutter life, a space between fan and shutter equal to ½ the diameter of the propeller is recommended. If job conditions will not permit this, a minimum space of 5" to 7" depending on fan size is required. Shutter bird guard available...mounts to front of shutter. Shutter bird guard not available on Size 18 Model NYCDC fan.



Wall Housing

Heavy-gauge, galvanized steel wall housings. This combination allows mounting on interior or exterior walls. The wall housing allows for uninterrupted interior space, is used for supply applications on Models NYCBL, NYCBH, NYCABL, NYCABH, and NYCBHX fans, and provides for necessary depth between fan blades and shutters.

Guards

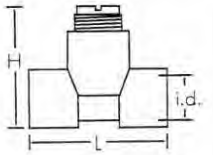
Basket-style safety guard for both front [SGF] and motor side [SGM] for Model NYC fans. They are constructed of 16-gauge PVC-coated steel wire with 1½" x 1" spacing and shipped separately. They comply with OSHA regulations for fan-blade guarding and are required for fans installed within 8 feet of floor or work area.

Spark-Resistant Construction

For hazardous locations, any Model NYC fan, with the exception of Model NYCBHX, can be ordered with a nonferrous blade assembly [where not normally supplied] and explosion-proof motors. **Motors only**—qualify for Class I, Group D, and Class II, Groups F and G, hazards.

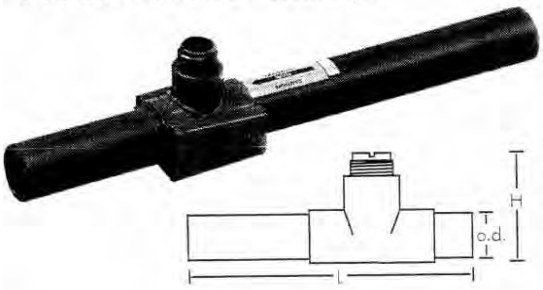
+GF+ SIGNET Installation Fittings

PVC TEES SCH 80 - Fitting only



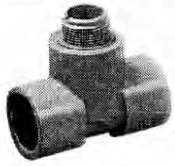
Part no.	Code	Size	L	H	i.d.
PV8T005F	159 000 527	0.50 in.	3.75	3.6	0.85
PV8T007F	159 000 529	0.75 in.	3.75	3.8	1.06
PV8T010F	159 000 531	1.00 in.	4.26	4.0	1.33
PV8T012F	159 000 533	1.25 in.	4.36	4.4	1.67
PV8T015F	159 000 535	1.50 in.	4.90	4.6	1.91

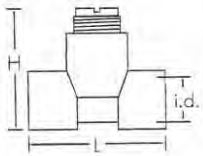
PVC TEES SCH 80 - With Pipe*



Part no.	Code	Size	L	H	o.d.
PV8T005	159 000 526	0.50 in.	14	3.6	0.84
PV8T007	159 000 528	0.75 in.	14	3.8	1.05
PV8T010	159 000 530	1.00 in.	17	4.0	1.32
PV8T012	159 000 532	1.25 in.	20	4.4	1.66
PV8T015	159 000 534	1.50 in.	24	4.6	1.90
PV8T020	198 801 415	2.00 in.	24	5.0	2.38
PV8T025	198 801 573	2.50 in.	24	5.4	2.88
PV8T030	198 801 416	3.00 in.	24	6.0	3.50
PV8T040	198 801 436	4.00 in.	24	7.0	4.50

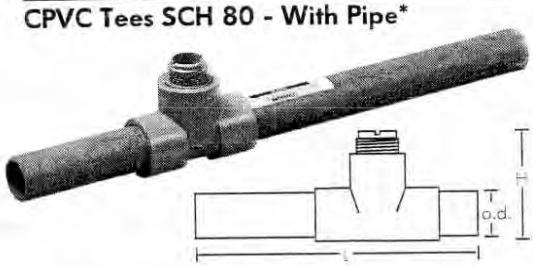
CPVC Tees SCH 80 - Fitting only





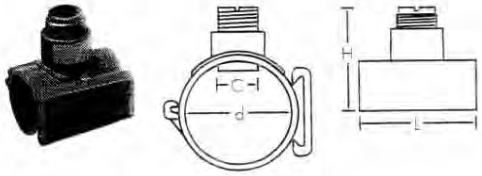
Part no.	Code	Size	L	H	i.d.
CPV8T005F	159 000 409	0.50 in.	3.75	3.6	.85
CPV8T007F	159 000 411	0.75 in.	3.75	3.8	1.06
CPV8T010F	159 000 413	1.00 in.	4.26	4.0	1.33
CPV8T012F	159 000 415	1.25 in.	4.36	4.4	1.67
CPV8T015F	159 000 417	1.50 in.	4.90	4.6	1.91

CPVC Tees SCH 80 - With Pipe*



Part no.	Code	Size	L	H	o.d.
CPV8T005	159 000 408	0.50 in.	14	3.6	0.84
CPV8T007	159 000 410	0.75 in.	14	3.8	1.05
CPV8T010	159 000 412	1.00 in.	17	4.0	1.32
CPV8T012	159 000 414	1.25 in.	20	4.4	1.66
CPV8T015	159 000 416	1.50 in.	24	4.6	1.90

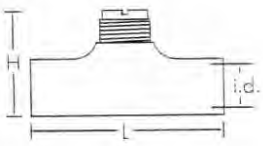
PVC Clamp-on Saddles



Part no.	Code	Size	L	H	d	C
PV8S020	159 000 637	2.00 in.	4.00	5.0	2.375	1.43
PV8S025	159 000 638	2.50 in.	4.75	5.4	2.875	1.43
PV8S030	198 150 577	3.00 in.	5.00	6.0	3.500	1.43
PV8S040	198 150 578	4.00 in.	5.00	7.0	4.500	1.43
PV8S060	198 150 579	6.00 in.	5.00	10.0	6.625	2.25
PV8S080	159 000 639	8.00 in.	5.00	11.5	8.625	2.25

- Mounts on PVC pipe
- C - Clearance dimension

Fiberglass Glue-on Tees



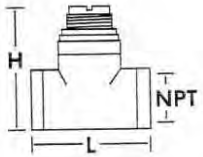
Part no.	Code	Size	L	H	i.d.
FPT015	159 000 446	1.50 in.	5.5	4.7	1.92
FPT020	159 000 447	2.00 in.	7.7	8.0	2.38

- PVDF insert - all sizes

*Pipe lengths included with these fittings do not satisfy straight-run requirements for all installation configurations.

+GF+ SIGNET Installation Fittings

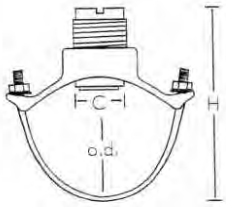
Galvanized Iron/Brass Threaded Tee with NPT Threads



Part no.	Code	Size	NPT	L	H
IR4T010	198 001 421	1.00 in.	1.0	3.4	4.1
IR4T012	198 801 422	1.25 in.	1.25	3.56	4.34
IR4T015	198 801 423	1.50 in.	1.50	3.75	4.67
IR4T020	198 801 424	2.00 in.	2.0	3.90	5.05
BR4T010	198 801 770	1.00 in.	1.0	3.36	2.40
BR4T012	198 801 771	1.25 in.	1.25	3.42	2.67
BR4T015	198 801 772	1.50 in.	1.50	3.46	2.97
BR4T020	198 801 773	2.00 in.	2.0	3.68	3.53

- PVDF insert - all sizes
- For use with SCH 40 metal pipe

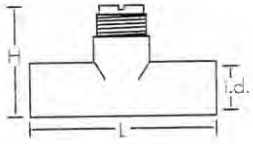
Iron Strap-on Saddle



Part no.	Code	Size	H	o.d min	o.d. max	C
IR8S020	198 801 425	2.00 in.	5.5	2.35	2.56	1.44
IR8S025	198 901 426	2.50 in.	5.5	2.44	2.91	1.44
IR8S030	198 801 427	3.00 in.	6.5	2.97	3.54	1.44
IR8S040	198 801 420	4.00 in.	7.5	3.74	4.55	1.44
IR8S050	198 801 429	5.00 in.	9.0	4.74	5.63	2.25
IR8S060	198 801 430	6.00 in.	10.5	5.94	6.70	2.25
IR8S080	198 801 431	8.00 in.	12.0	7.69	8.72	2.25
IR8S100	198 801 432	10.0 in.	18.0	10.64	12.12	2.25
IR8S120	198 810 433	12.0 in.	20.0	12.62	14.32	2.25

- C - Clearance dimension
- Up to 8 in.- PVDF insert, over 8 in. - PVC insert

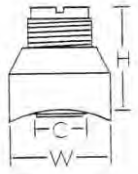
Copper/Bronze Sweat-on Tee



Part no.	Code	Size	L	H	i.d.
CUKT005	198 801 687	0.50 in.	3.15	3.57	0.62
CUKT007	198 801 688	0.75 in.	2.96	3.52	0.87
CUKT010	198 801 689	1.00 in.	3.23	3.80	1.12
CUKT012	198 801 690	1.25 in.	4.16	4.12	1.38
CUKT015	198 801 691	1.50 in.	4.43	4.34	1.63
CUKT020	198 801 418	2.00 in.	5.31	4.86	2.11

- No insert up to 1 in., over 1 in. - PVDF insert
- For use with copper pipe

Copper/Bronze Braze-on Brazolet

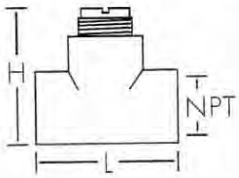


Part no.	Code	Size	W	H	C
BR4B025	198 801 794	2.5 in.	2.50	2.96	1.438
BR4B030	198 801 795	3.0 in.	2.55	2.90	1.438
BR4B040	198 801 796	4.0 in.	2.50	2.75	1.438
BR4B050	198 801 797	5.0 in.	3.50	3.98	2.25
BR4B060	198 801 798	6.0 in.	3.50	4.00	2.25
BR4B080	198 801 799	8.0 in.	3.50	4.00	2.25
BR4B100	198 801 800	10.0 in.	3.50	4.00	2.25
BR4B120	198 801 801	12.0 in.	3.50	7.00	2.25

- C - Clearance dimension
- Up to 8 in. - PVDF insert, over 8 in. - PVC insert
- For use with copper pipe

+GF+ SIGNET Installation Fittings

Carbon Steel Threaded Tees with NPT Threads



Part no.	Code	Size (NPT)	L	H
CS4T005	198 801 459	0.50 in.	3.6	4.0
CS4T007	198 801 460	0.75 in.	3.6	4.2
CS4T010	198 801 461	1.00 in.	3.6	4.2
CS4T012	198 801 462	1.25 in.	3.8	4.5
CS4T015	198 801 419	1.50 in.	4.1	4.8
CS4T020	198 801 463	2.00 in.	4.9	5.3

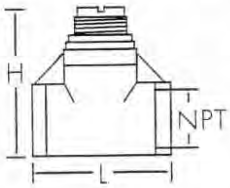
- PVDF insert - all sizes
- For use with SCH 40 metal pipe

Carbon Steel Weld-on Weldolets

Part no.	Code	Size	H	W	C
CS4W025	198 801 464	2.50 in.	2.96	2.50	1.44
CS4W030	198 801 557	3.00 in.	2.90	2.55	1.44
CS4W040	198 801 552	4.00 in.	2.75	2.50	1.44
CS4W050	198 801 465	5.00 in.	3.98	3.50	2.25
CS4W060	198 801 553	6.00 in	4.00.	3.50	2.25
CS4W080	198 801 574	8.00 in.	4.00	3.50	2.25
CS4W100	198 801 575	10.0 in.	4.00	3.50	2.25
CS4W120	198 801 576	12.0 in.	7.00	3.50	2.25

- Up to 8 in.- PVDF insert, over 8 in. - PVC insert
- For use with SCH 40 metal pipe (Special order over 12 in.)
- C - Clearance dimension

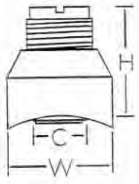
316 SS Threaded Tees with NPT Threads



Part no.	Code	Size (NPT)	L	H
CR4T005	198 801 554	0.50 in.	3.6	4.0
CR4T007	198 801 555	0.75 in.	3.6	4.2
CR4T010	198 801 556	1.00 in.	3.6	4.2
CR4T012	198 801 783	1.25 in.	3.8	4.5
CR4T015	198 801 784	1.50 in.	4.1	4.8
CR4T020	198 801 785	2.00 in.	4.9	5.3

- PVDF insert - all sizes
- For use with SCH 40 metal pipe

316 SS Weld-on Weldolets

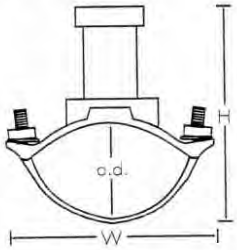


Part no.	Code	Size	H	W	C
CR4W025	198 801 786	2.50 in.	2.96	2.50	1.44
CR4W030	198 801 787	3.00 in.	2.90	2.55	1.44
CR4W040	198 801 788	4.00 in.	2.50	2.75	1.44
CR4W050	198 801 789	5.00 in.	3.98	3.50	2.25
CR4W060	198 801 790	6.00 in.	4.00	3.50	2.25
CR4W080	198 801 791	8.00 in.	4.00	3.50	2.25
CR4W100	198 901 792	10.0 in.	4.00	3.50	2.25
CR4W120	198 801 793	12.0 in.	7.00	3.50	2.25

- Up to 8 in. - PVDF insert, over 8 in. - PVC insert
- For use with SCH 40 metal pipe
- C - Clearance dimension

+GF+ SIGNET Installation Fittings

Metalex Strap-On Saddle



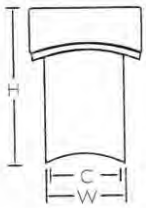
Part no.	Code	Size	H	W	o.d. min	o.d. max
P526-1020	159 000 484	2.00 in.	7.0	5.5	2.35	2.56
P526-1025	159 000 485	2.50 in.	7.0	5.5	2.44	2.91
P526-1030	159 000 486	3.00 in.	7.5	6.0	2.97	3.54
P526-1040	159 000 487	4.00 in.	8.0	7.0	3.74	4.55
P526-1050	159 000 488	5.00 in.	10.0	8.0	4.74	5.63
P526-1060	159 000 489	6.00 in.	10.5	9.5	5.94	6.70
P526-1080	159 000 490	8.00 in.	12.75	12.0	7.69	8.72
P526-1100	159 000 491	10.0 in.	14.5	15.0	10.64	12.12
P526-1120	159 000 492	12.0 in.	17.0	17.0	12.62	14.32

Metalex Socket Weld Mini-Tap

Part no.	Code	Size	L	H	W	i.d.
P526-2005	198 840 501	0.50 in.	2.0	3.0	2.4	0.850
P526-2007	198 840 502	0.75 in.	2.0	3.0	2.4	1.060
P526-2010	198 840 503	1.00 in.	2.0	3.0	2.4	1.325

•For use with SS pipe

Metalex Weld-On Mini-Tap

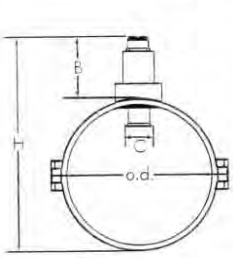


Part no.	Code	Size	H	W	C
P526-2012	159 000 494	1.25 in.	2.25	1.66	1.062
P526-2015	198 840 506	1.50 in.	2.20	1.66	1.062
P526-2020	159 000 495	2.00 in.	2.17	1.66	1.062
P526-2025	159 000 496	2.50 in.	2.10	1.66	1.062
P526-2030	159 000 497	3.00 in.	2.0	1.66	1.062
P526-2040	159 000 498	4.00 in.	1.95	1.66	1.062
P526-2050	159 000 499	5.00 in.	1.83	1.66	1.062
P526-2060	159 000 500	6.00 in.	1.75	1.66	1.062
P526-2080	159 000 501	8.00 in.	1.56	1.66	1.062
P526-2100	159 000 502	10.0 in.	1.35	1.66	1.062
P526-2120	159 000 503	12.0 in.	1.15	1.66	1.062

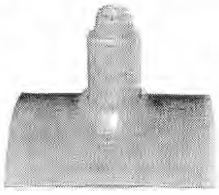
•For use with SS pipe

PP Clamp-On Saddle Fittings

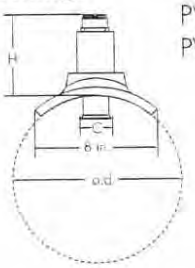
Part no.	Code	Size	H	W	C	o.d.
PPS100	159 000 693	10 in.	16.75	7.04	2.25	10.75
PPS120	159 000 694	12 in.	18.18	9.68	2.25	12.75



PVC Glue-On Saddle Fittings



Part no.	Code	Size	H	W	C	o.d.
PV8S100	159 000 695	10 in.	5.43	9.0	2.25	10.75
PV8S120	159 000 696	12 in.	5.15	9.0	2.25	12.75



+GF+ SIGNET Fitting Insert Reference

Fitting Accessories	Insert part no.	Code	Description
	P31515-0V200	159 000 459	Pipe Adapter Insert, PVDF
	P31515-0C200	159 000 631	Pipe Adapter Insert, CPVC
	P31515-0P200	159 000 630	Pipe Adapter Insert, PVC
	P31520-1V	159 000 460	Pipe Adapter Insert
	P31520-2P	159 000 461	Pipe Adapter Insert
	P31536	198 840 201	Sensor Plug, Polypro
	P31536-2	159 000 649	Sensor Plug, PVDF
	P31671-1	159 000 465	Insert, PVDF 1.5 in.

	Fitting insert no.	Description	Insert Part No.
Brazolet Fittings	BR4B025	Brazolet, Brass	P31515-0V200
	BR4B030	Brazolet, Brass	P31515-0V200
	BR4B040	Brazolet, Brass	P31515-0V200
	BR4B050	Brazolet, Brass	P31520-1V
	BR4B060	Brazolet, Brass	P31520-1V
	BR4B080	Brazolet, Brass	P31520-1V
	BR4B100	Brazolet, Brass	P31520-2P
	BR4B120	Brazolet, Brass	P31520-2P
Tee Fittings	BR4T010	Tee, Brass	P31515-0V200
	BR4T012	Tee, Brass	P31515-0V200
	BR4T015	Tee, Brass	P31515-0V200
	BR4T020	Tee, Brass	P31515-0V200
	CUKT005	Tee, Copper	Not applicable
	CUKT007	Tee, Copper	Not applicable
	CUKT010	Tee, Copper	Not applicable
	CUKT012	Tee, Copper	P31515-0V200
	CUKT015	Tee, Copper	P31671-1
	CUKT020	Tee, Copper	P31520-1V
	CR4T005	Tee, SS	P31515-0V200
	CR4T007	Tee, SS	P31515-0V200
	CR4T010	Tee, SS	P31515-0V200
	CR4T012	Tee, SS	P31515-0V200
	CR4T015	Tee, SS	P31671-1
	CR4T020	Tee, SS	P31520-1V
	CS4T005	Tee, Carbon Steel	P31515-0V200
	CS4T007	Tee, Carbon Steel	P31515-0V200
	CS4T010	Tee, Carbon Steel	P31515-0V200
	CS4T012	Tee, Carbon Steel	P31515-0V200
	CS4T015	Tee, Carbon Steel	P31515-0V200
	CS4T020	Tee, Carbon Steel	P31515-0V200

WARNING!

FOR YOUR SAFETY: Always confirm the chemical compatibility and the maximum pressure/temperature specifications for fitting and sensor selection prior to purchase. Failure to do so may result in property damage and/or serious personal injury.

+GF+ SIGNET Fitting Insert Reference

	Fitting insert no.	Description	Insert Part No.
Tee Fittings	FPT015	Tee, Fiberglass	P31515-0V200
	FPT020	Tee, Fiberglass	P31515-0V200
	IR4T010	Tee, Iron	P31515-0V200
	IR4T012	Tee, Iron	P31515-0V200
	IR4T015	Tee, Iron	P31515-0V200
	IR4T020	Tee, Iron	P31515-0V200
Weldolet Fittings	CR4W025	Weldolet, SS	P31515-0V200
	CR4W030	Weldolet, SS	P31515-0V200
	CR4W040	Weldolet, SS	P31515-0V200
	CR4W050	Weldolet, SS	P31520-1V
	CR4W060	Weldolet, SS	P31520-1V
	CR4W080	Weldolet, SS	P31520-1V
	CR4W100	Weldolet, SS	P31520-2P
	CR4W120	Weldolet, SS	P31520-2P
	CS4W025	Weldolet, Carbon Steel	P31515-0V200
	CS4W030	Weldolet, Carbon Steel	P31515-0V200
	CS4W040	Weldolet, Carbon Steel	P31515-0V200
	CS4W050	Weldolet, Carbon Steel	P31520-1V
	CS4W060	Weldolet, Carbon Steel	P31520-1V
	CS4W080	Weldolet, Carbon Steel	P31520-1V
	CS4W100	Weldolet, Carbon Steel	P31520-2P
	CS4W120	Weldolet, Carbon Steel	P31520-2P
Saddle Fittings	FPS030	Saddle, Fiberglass	P31515-0V200
	FPS040	Saddle, Fiberglass	P31520-1V
	FPS060	Saddle, Fiberglass	P31520-1V
	FPS080	Saddle, Fiberglass	P31520-1V
	FPS100	Saddle, Fiberglass	P31520-2P
	FPS120	Saddle, Fiberglass	P31520-2P
	IR8S020	Saddle, Iron	P31515-0V200
	IR8S025	Saddle, Iron	P31515-0V200
	IR8S030	Saddle, Iron	P31515-0V200
	IR8S040	Saddle, Iron	P31515-0V200
	IR8S050	Saddle, Iron	P31520-1V
	IR8S060	Saddle, Iron	P31520-1V
	IR8S080	Saddle, Iron	P31520-1V
	IR8S100	Saddle, Iron	P31520-2P
	IR8S120	Saddle, Iron	P31520-2P

+GF+ SIGNET Fitting Insert Reference

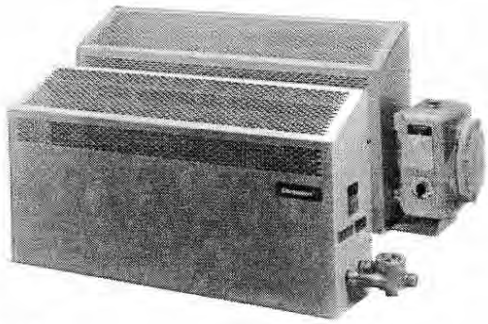
Saddle Fittings

Fitting insert no.	Description	Insert Part No.
PPS100	10" Clamp-on Fitting, PP	P31520-2P
PPS120	12" Clamp-on Fitting, PP	P31520-2P
PV8S020	Saddle, PVC	Not applicable
PV8S025	Saddle, PVC	Not applicable
PV8S030	Saddle, PVC	Not applicable
PV8S040	Saddle, PVC	Not applicable
PV8S060	Saddle, PVC	Not applicable
PV8S080	Saddle, PVC	Not applicable
PV8S100	10" Glue-on Saddle, PVC	Not applicable
PV8S120	12" Glue-on Saddle, PVC	Not applicable

CVEP

Explosion Proof Convection Heater

- 1.6 - 9 kW
- 5,459 - 30,708 Btuh
- 120, 208, 240, 277, 480 and 575 Volt
- 1 & 3 Phase
- Built-in & Prewired Control Options
- UL Listed and CSA Certified for Class 1, Division 1 or 2, Group B, C & D Environments
- CE Approved Models Available



Description

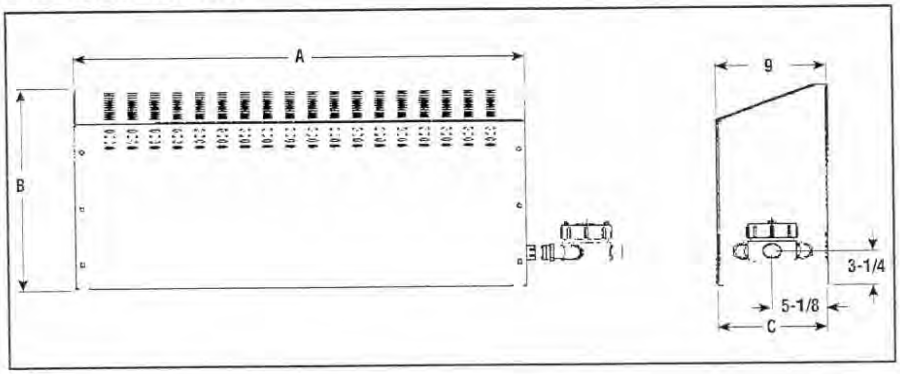
Type CVEP explosion proof convection heater is designed to provide a rugged, corrosion-resistant heat source for areas where volatile flammable liquids, gases or vapors are present. All basic models without controls are UL listed and CSA certified for use in areas designated as Class 1, Division 1 or 2 Group B, C or D locations.

Applications

- Petroleum Refineries, Gasoline Storage and Dispensing Areas
- Industrial Areas Using Flammable Liquids in Dip Tanks
- Petroleum Refineries
- Dry Cleaning Plants
- Utility and Natural Gas Plants
- Aircraft Hangers/Fueling Areas
- Solvent Extraction Plants
- Storage Areas for Flammable Products or Batteries
- Sewage Treatment Plants
- Hydrogen Atmospheres

Refer to WR-80EP in the Controls section.

Dimensions (Inches)



Dimensions (Inches)

kW	A	B	C
1.6, 1.8 and 3.6	34	20	9
3.2 and 7.6	58	20	9
4.0, 4.5 and 9.0	70	20	9

Construction

Cabinet — Sloped top, constructed of heavy 16 gauge steel, polyester powder coated for maximum corrosion resistance.

Explosion Proof Junction Box — For conduit entry and ease of power wiring.

Heating Elements — Sealed, metal sheath, heavy-duty, low watt density, enclosed high grade resistance wire embedded in MgO refractory core. Elements are inserted in a copper tube with aluminum fins.

Features

Integral Mounting Brackets allow for easy wall installation.

Sloped Top Cabinet ensures maximum ventilation by preventing objects from being placed on the top which would restrict air flow.

Designed for Areas Classified

- Class I, Division 1 or 2, Groups B, C, D
- Temperature Code T3A 180°C (356°F) or T2A 280°C (536°F)

Optional Features (Factory Installed)

- Thermostat
- Magnetic Contactor
- Control Voltage Transformer

Advantages

- Easy Installation
- Clean, Safer Heat Source
- Pre-Wired Control Options
- Long Life

CVEP

Convection Heater For Hazardous Locations

Specifications and Ordering Information

Electrical					Model	Stock	PCN	Wt. (Lbs.)
kW	Volts	Phase	Amps	Btuh				
Temperature Code T3A (356°F, 180°C) Group B, C, and D								
1.6	208	1	7.7	5,500	CVEP-16-81-00-00	NS	088336	58
1.6	208	3	4.5	5,500	CVEP-16-83-00-00	NS	086844	58
1.6	240	1	6.7	5,500	CVEP-16-21-00-00	NS	086852	58
1.6	240	3	3.8	5,500	CVEP-16-23-00-00	NS	086860	58
1.6	277	1	5.8	5,500	CVEP-16-71-00-00	NS	086879	58
1.6	480	1	3.3	5,500	CVEP-16-41-00-00	NS	086887	58
1.6	480	3	1.9	5,500	CVEP-16-43-00-00	NS	086895	58
1.6	575	1	2.8	5,500	CVEP-16-61-00-00	NS	086908	58
3.2	208	1	15.4	11,000	CVEP-32-81-00-00	NS	086916	94
3.2	208	3	9.0	11,000	CVEP-32-83-00-00	NS	086924	94
3.2	240	1	13.3	11,000	CVEP-32-21-00-00	NS	086932	94
3.2	240	3	7.7	11,000	CVEP-32-23-00-00	NS	086940	94
3.2	277	1	11.6	11,000	CVEP-32-71-00-00	NS	086959	94
3.2	480	1	6.7	11,000	CVEP-32-41-00-00	NS	086967	94
3.2	480	3	3.8	11,000	CVEP-32-43-00-00	NS	086975	94
3.2	575	1	5.6	11,000	CVEP-32-61-00-00	NS	086983	94
4	208	1	19.2	13,600	CVEP-40-81-00-00	NS	086991	112
4	208	3	11.1	13,600	CVEP-40-83-00-00	NS	087003	112
4	240	1	16.7	13,600	CVEP-40-21-00-00	NS	087011	112
4	240	3	9.6	13,600	CVEP-40-23-00-00	NS	087020	112
4	277	1	14.4	13,600	CVEP-40-71-00-00	NS	087038	112
4	480	1	8.3	13,600	CVEP-40-41-00-00	NS	087046	112
4	480	3	4.8	13,600	CVEP-40-43-00-00	NS	087054	112
4	575	1	7	13,600	CVEP-40-61-00-00	NS	087062	112
Temperature Code T2A (536°F, 280°C) Group B, C, and D								
1.8	120	1	15	6,140	**CVEP-18-11-00-00**	**S**	**028759**	46
1.8	208	1	8.7	6,140	**CVEP-18-81-00-00**	**S**	**028767**	46
1.8	208	3	5	6,140	CVEP-18-83-00-00	NS	028775	46
1.8	240	1	7.5	6,140	**CVEP-18-21-00-00**	**S**	**028783**	46
1.8	240	3	4.4	6,140	CVEP-18-23-00-00	NS	028791	46
1.8	277	1	6.5	6,140	CVEP-18-71-00-00	NS	028804	46
1.8	480	1	3.7	6,140	CVEP-18-41-00-00	NS	028812	46
1.8	480	3	2.2	6,140	CVEP-18-43-00-00	NS	028820	46
3.6	208	1	17.3	12,300	**CVEP-36-81-00-00**	**S**	**087070**	58
3.6	208	3	10	12,300	CVEP-36-83-00-00	NS	087089	58
3.6	240	1	15	12,300	**CVEP-36-21-00-00**	**S**	**087097**	58
3.6	240	3	8.7	12,300	CVEP-36-23-00-00	NS	087100	58
3.6	277	1	13	12,300	**CVEP-36-71-00-00**	**S**	**087118**	58
3.6	480	1	7.5	12,300	**CVEP-36-41-00-00**	**S**	**087126**	58
3.6	480	3	4.3	12,300	CVEP-36-43-00-00	NS	087134	58
3.6	575	1	6.3	12,300	CVEP-36-61-00-00	NS	087142	58
7.6	208	1	36.5	24,000	CVEP-76-81-00-00	NS	085913	94
7.6	208	3	21.1	24,000	CVEP-76-83-00-00	NS	085921	94
7.6	240	1	31.7	24,000	CVEP-76-21-00-00	NS	085930	94
7.6	240	3	18.3	24,000	CVEP-76-23-00-00	NS	085948	94
7.6	277	1	27.4	24,000	CVEP-76-71-00-00	NS	085956	94
7.6	480	1	15.8	24,000	CVEP-76-41-00-00	NS	085964	94
7.6	480	3	9.2	24,000	CVEP-76-43-00-00	NS	085972	94
7.6	575	1	13.2	24,000	CVEP-76-61-00-00	NS	085980	94
9	208	1	43.3	30,700	CVEP-90-81-00-00	NS	087230	112
9	208	3	25	30,700	CVEP-90-83-00-00	NS	087249	112
9	240	1	37.5	30,700	CVEP-90-21-00-00	NS	087257	112
9	240	3	21.7	30,700	CVEP-90-23-00-00	NS	087265	112
9	277	1	32.5	30,700	CVEP-90-71-00-00	NS	087273	112
9	480	1	18.8	30,700	CVEP-90-41-00-00	NS	087281	112
9	480	3	10.8	30,700	CVEP-90-43-00-00	NS	087290	112
9	575	1	15.7	30,700	CVEP-90-61-00-00	NS	087302	112
Stock CVEP with Built-in Thermostat								
1.8	120	1	15	6,140	**CVEP-18-11-00-42**	**S**	**028839**	59
1.8	208	1	8.7	6,140	**CVEP-18-81-00-42**	**S**	**028847**	59
1.8	240	1	7.5	6,140	CVEP-18-21-00-42	NS	028855	59
1.8	277	1	6.5	6,140	CVEP-18-71-00-42	NS	028863	59
1.8	480	1	3.7	6,140	CVEP-18-41-32-42[1]	NS	028871	69
3.6	208	1	17.3	12,300	**CVEP-36-81-00-42**	**S**	**028644**	60
3.6	240	1	15	12,300	**CVEP-36-21-00-42**	**S**	**028660**	60
3.6	480	1	7.5	12,300	CVEP-36-41-32-42[1]	NS	028652	70

Stock Status: S = stock AS = assembly stock NS = non-stock
To Order—Specify model, PCN, kW, volts, phase and quantity.
CE approved models available. Contact your Chromalox representative.

Note —
1. Includes control transformer and contactor
2. Other sizes and configurations available, contact your Local Chromalox Sales office.

CVEP

Explosion Proof Convection Heater *(cont'd.)*

Ordering Information

To Order — Complete the Model Number using the Matrix provided.

Power & Temp. Control Options

Power Control Combination	Thermostat Option	Figure Number
00	00	1
00	40[1]	5
00	42[2]	2
30 - 35	00	4
30 - 35	40	5
30 - 35	42	3

[1] Thermostat option: 40
Temperature range: 40˚ - 90˚F
Electrical Rating: 25 Amp 24V, 120V, 240V AC 22 Amp 277 VAC Higher Voltage or 3 phase requires magnetic contactor option and transformer

[2] Thermostat option: 42
Temperature range: 50˚ - 90˚F
Electrical Rating: 22 Amps 125/277 VAC Higher Voltage or 3 phase requires magnetic contactor option and transformer

Model	Explosion Proof Convection Heater					
CVEP						
	Code Watts					
	16 = 1600 **40** = 4000					
	18 = 1800 **45** = 4500					
	32 = 3200 **76** = 7600					
	36 = 3600 **90** = 9000					
		Code Voltage				
		1 = 120 **6** = 575				
		2 = 240 **7** = 277				
		3 = 380 **8** = 208				
		4 = 480 **9** = 600				
		5 = 415				
			Code Phase			
			1 = Single			
			3 = Three			
				Code Power Control Options (See Options Table)		
				00 = no transformer no contactor		
				30 = (24V) transformer and contactor		
				31 = no transformer with contactor(24V)		
				32 = (120V) transformer and contactor		
				33 = no transformer with contactor(120V)		
				34 = no transformer with contactor(208/240V)		
				35 = no transformer with contactor(277V)		
					Code Thermo/Class Options (See Options Table)	
					00 = no thermo B, C & D	
					40 = thermo in box B, C & D	
					42 = thermo C & D	
CVEP	**16**	**1**	**1**	**30**	**42**	**Typical Model Number**

CE approved models available. Contact your Chromalox representative.

Dimensions (Inches)

Figure 1

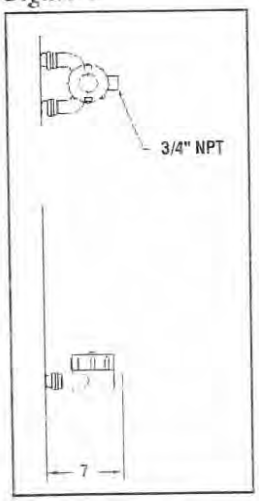


Figure 2

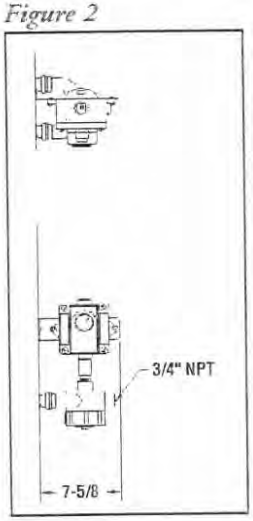


Figure 3

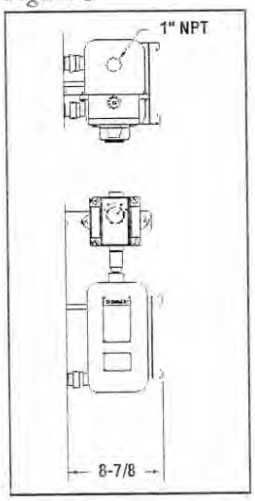


Figure 4

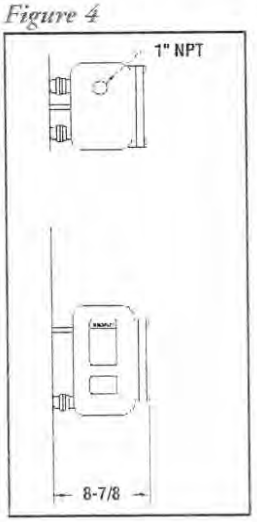
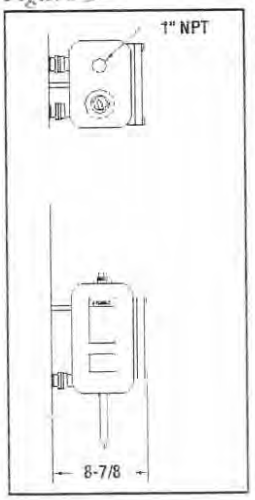


Figure 5



CVEP
Convection Heater For Hazardous Locations

Sample Specifications – U.S. approved models

1. General

1.1 The Explosion-Proof Convection Air Heater Catalog Number _____ Rated _____ Volts, _____ Phase, _____ Watts, shall be designed and constructed for use in hazardous locations.

1.2 ☐ For Groups B, C and D Check This Block
The Heater shall be Underwriters Laboratories Inc. Listed and Canadian Standards Association Certified for constant use in Class I, Groups B, C and D Division 1 or 2 hazardous locations, and National Electric Code minimum gas ignition temperature identification number ☐ T2A, 280°C (536° F) or ☐ T3A, 180°C (356°F).

1.3 ☐ For Groups C and D Check This Block
The Heater shall be Underwriters Laboratories Inc. Listed and Canadian Standards Association Certified for constant use in Class I, Groups C and D Division 1 or 2 hazardous locations, and National Electric Code minimum gas ignition temperature identification number ☐ T2A, 280°C (536°F) or ☐ T3A, 180°C (356°F).

1.4 ☐ For Group D Check This Block
The heater shall be Underwriters Laboratories Inc. Listed and Canadian Standards Association Certified for constant use in Class 1, Group D Division 1 or 2 hazardous locations, and National Electric Code minimum gas ignition temperature identification number ☐ T2A, 280°C (536°F) or ☐T3A, 180°C (356°F).

1.5 The Heater shall be the natural convection type intended for wall mounting.

2. Construction

2.1 The back panel shall be designed to be easily mounted to the wall using keyhole slots.

2.2 The back panel shall be fabricated for 16 gauge steel, 9" deep by 20" high, finished with corrosion resistant polyester powder coating.

2.3 The back panel shall include perforations and a baffle to direct outside air between the panel and the mounting surface.

2.4 The front cabinet shall be easily removable by unthreading 4 bolts from threaded inserts.

2.5 The front cabinet shall be fabricated from 16 gauge steel, 9" deep by 20" high, and coated with corrosion resistant polyester powder coating.

2.6 The front cabinet shall be sloped to prevent objects from being placed on top causing restricted air flow.

3. Elements

3.1 The elements shall be constructed of heavy duty resistance wire insulated by magnesium oxide refractory, which has been highly compacted to transmit heat and act as an electrical insulator.

3.2 The elements are to be contained in a tube assembly, which is then swaged to an O.D. of 1.25".

3.3 The element assembly is inserted into a copper tube with 3" x 3.25" aluminum fins spaced at 48 fins per linear foot.

3.4 The finned assembly is to be mounted to the rear panel by polyester powder-coated brackets.

4. Controls (Optional)

4.1 The CVEP shall include the following built in control features:
☐ operating temperature control
☐ magnetic contactor
☐ control transformer with ☐ 120V ☐ 24V secondary

4.2 The control components shall be factory installed, wired and tested.

5. Terminal Box (For units without transformer or contactor options)

The terminal box shall be constructed of copper free aluminum, to include a grounding lug and to be U.L. listed for Class I hazardous locations (as indicated in 1. General Specifications above.)

Calculating air velocity from velocity pressure

Manometers for use with a Pitot tube are offered in a choice of two scale types. Some are made specifically for air velocity measurement and are calibrated directly in feet per minute. They are correct for standard air conditions: i.e. air density of .075 lbs. per cubic foot which corresponds to dry air at 70°F, barometric pressure of 29.92 inches Hg. To correct the velocity reading for other than standard air conditions, the actual air density must be known. It may be calculated if relative humidity, temperature and barometric pressure are known.

Most manometer scales are calibrated in inches of water. Using readings from such an instrument, the air velocity may be calculated using the basic formula:

$$V=1096.7\sqrt{\frac{h_v}{d}} \left\{ \begin{array}{l} =4004.4\ \sqrt{h_v} \text{ for .075 lb/ft}^3 \text{ dry air} \\ \text{@ 70°F, 29.92 in. Hg Baro.} \end{array} \right\}$$

Where: V = Velocity in *feet per minute.*
h_v = Velocity pressure in *inches of water.*
d = Density of air in *pounds per cubic foot.*

To determine dry air density, use the formula:

$$d=1.325\frac{P_B}{T}$$

Where: d = Air density in *pounds per cubic foot.*
P_B = Barometric (or absolute) static pressure in *inches of mercury.*
T = Absolute temperature (indicated temperature in °F plus 460°).

With dry air at 29.9 inches mercury, air velocity can be read directly from curves on the following page. For partially or fully saturated air a further correction is required. To save time when converting velocity pressure into air velocity, the Dwyer Air Velocity Calculator may be used. A simple slide rule, it provides for all the factors needed to calculate air velocity quickly and accurately. It is included as an accessory with each Dwyer Pitot tube.

To use the Dwyer Calculator:

1. Set relative humidity on scale provided. On scale opposite known dry bulb temperature, read correction factor.
2. Set temperature under barometric pressure scale. Read density of air over correction factor established in 1 (above).
3. On the other side of calculator, set air density reading just obtained on the scale provided.
4. Under Pitot tube reading (velocity pressure, inches of water) read air velocity, feet per minute.

Determining Volume Flow

Once the average air velocity is known, the air flow rate in cubic feet per minute is easily computed using the formula:

$Q=AV$

Where: Q= Quantity of flow in *cubic feet per minute.*
A=Cross sectional area of duct in *square feet.*
V=Average velocity in *feet per minute.*

Determining Air Volume by Calibrated Resistance

Manufacturers of air filters, cooling and condenser coils and similar equipment often publish data from which approximate air flow can be determined. It is characteristic of such equipment to cause a pressure drop which varies proportionately to the square of the flow rate. Figure 5 shows a typical filter and a curve for air flow versus resistance. Since it is plotted on logarithmic paper, it appears as a straight line. On this curve, a clean filter which causes a pressure drop of .50 inches w.c. would indicate a flow of 2,000 c.f.m.

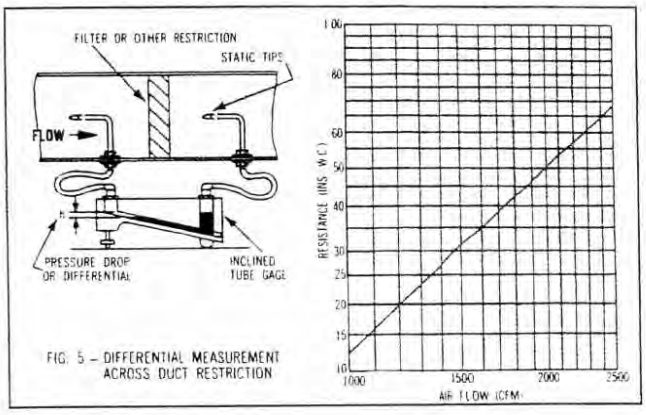


FIG. 5 – DIFFERENTIAL MEASUREMENT ACROSS DUCT RESTRICTION

For example, assuming a manufacturer's specification for a filter, coil, etc:

Given Flow Q (ft^3/min.) = at differential "h" (inches w.c.)

To determine flow at other differentials the formula is:

$$Q_n \text{ (other flows)} = Q\sqrt{\frac{h_n}{h}}$$

Where: Q = Quantity of flow in *cubic feet per minute*
h = differential in *inches water column*
h_n = differential (other flow conditions)

Other Devices for Measuring Air Velocity

A wide variety of devices are commercially available for measuring air velocities. These include hot wire anemometers for low air velocities, rotating and swinging vane anemometers and variable area flowmeters.

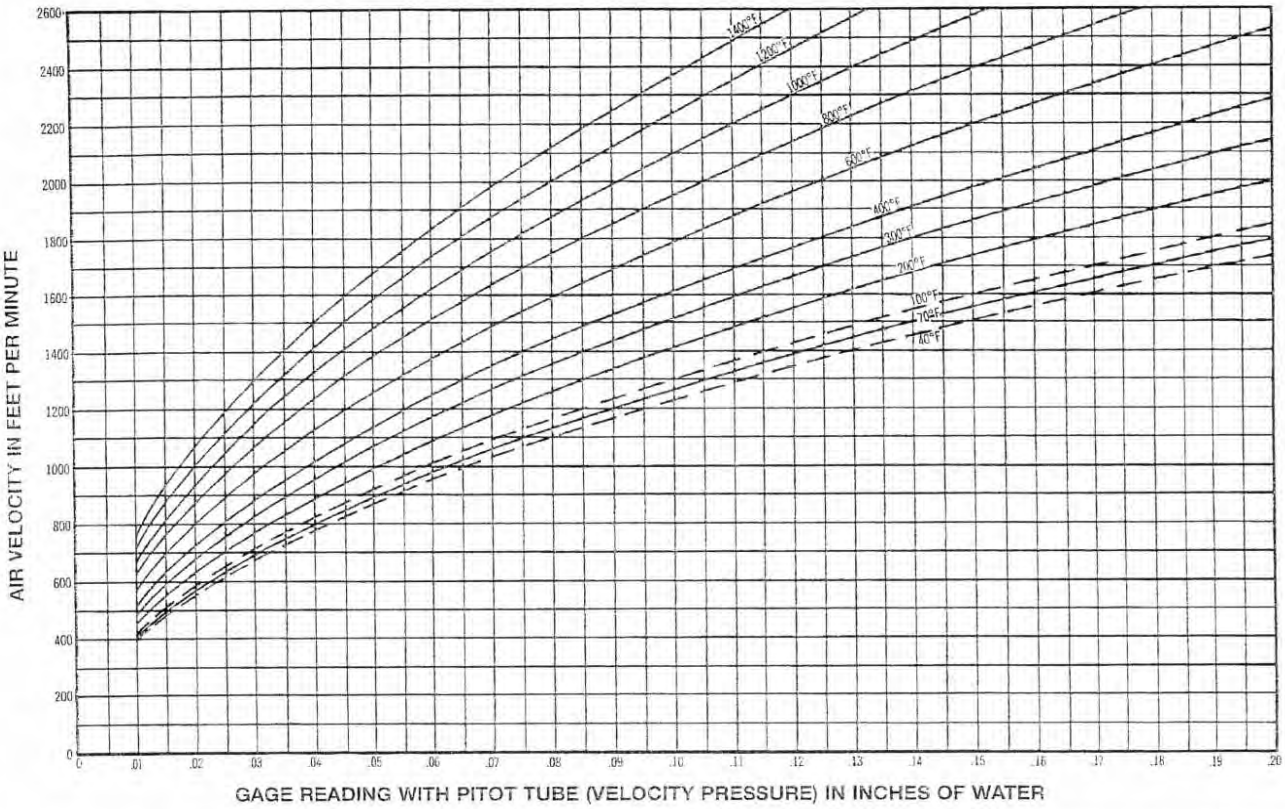
The Dwyer No. 460 Air Meter is one of the most popular and economical variable area flowmeter type anemometers. Quick and easy to use, it is a portable instrument calibrated to provide a direct reading of air velocity.

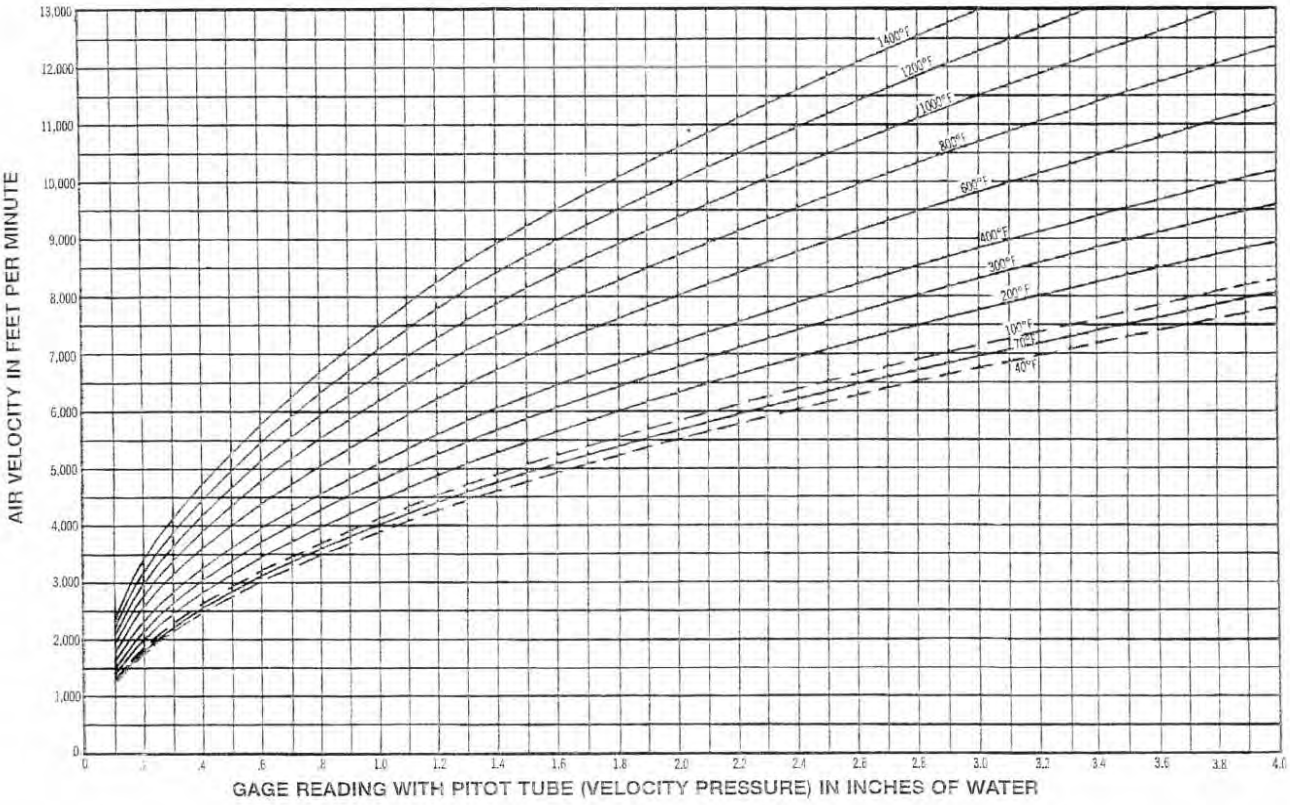
A second scale is provided on the other side of the meter to read static pressure in inches w.c. The 460 Air Meter is widely used to determine air velocity and flow in ducts, and from supply and return grilles and diffusers. Two scale ranges are provided (high and low) with calibrations in both f.p.m. and inches w.c.

To Check Accuracy

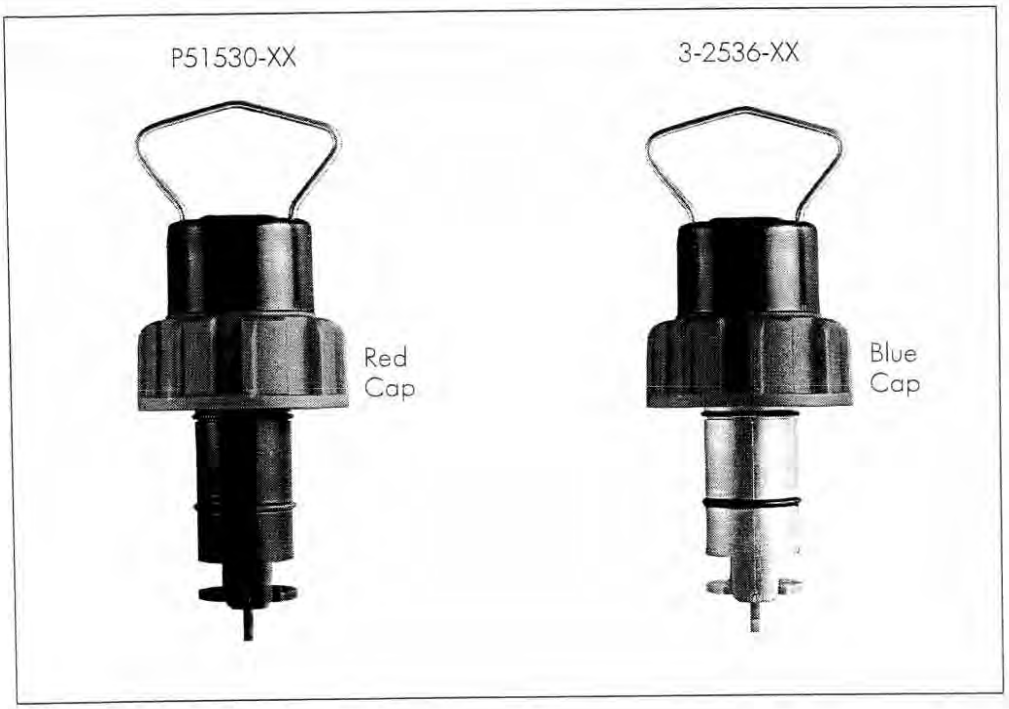
Use only devices of certified accuracy. All anemometers and to a lesser extent portable manometers should be checked regularly against a primary standard such as a hook gage or high quality micromanometer. If in doubt return your Dwyer instrument to the factory for a complete calibration check at no charge.

AIR VELOCITY FLOW CHARTS





+GF+ SIGNET 515/2536 Rotor-X Flow Sensors



Features

- **PVDF or Polypropylene molded sensor body**
- **Simple insertion design**
- **Separate versions for remote and integral installations**
- **Wide Turndown Ratio of 66:1 for 2536, 20:1 for 515**
- **Use with comprehensive line of fittings from DN15 to DN1000 (0.5 to 36 in.)**
- **Process Ready Signal (3-2536-XX)**
- **Extended length for wet-tap installations available**

Application

- **Pure Water Production**
- **Filtration Systems**
- **Chemical Production**
- **Liquid Delivery Systems**
- **Pump Protection**
- **Scrubbers**

Description

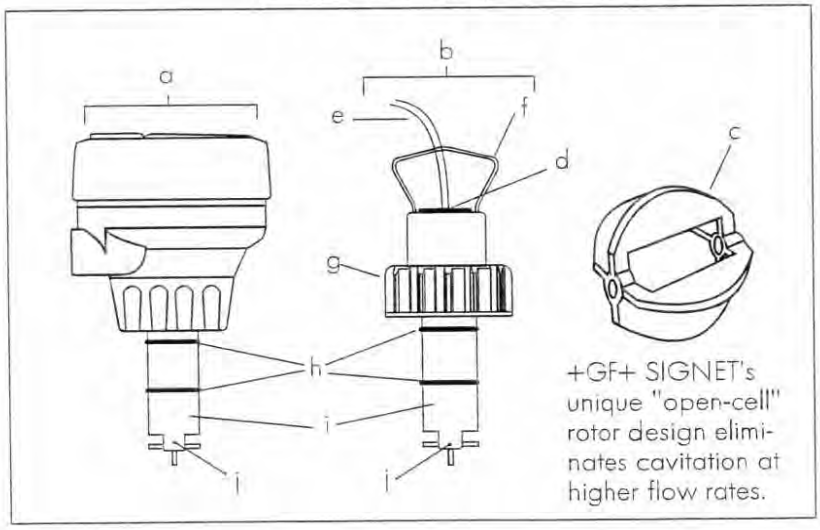
Simple and reliable, Rotor-X paddlewheel flow sensors deliver time-honored performance. These highly repeatable, rugged sensors offer exceptional value with little or no maintenance required. Installation is simple with +GF+ SIGNET's comprehensive line of fittings for all pipe materials in sizes from DN15 to DN1000 (0.5 to 36 in.). Output signal of the 515 is a sinusoidal frequency capable of driving a self-powered flowmeter (3-5090). The 3-2536 has a process-ready open-collector signal and can operate to flows as low as 0.1 m/s (0.3 ft/s).

Options

Rotor-X Sensors	Instrument Options									
	8550-1	8550-2	8550-3	8550-XP	5090	5075	5100	5500	5600	9010
515	●	●	●	●	●	●	●	●	●	●
8510	●	●	●							
2536	●	●	●	●		●		●	●	●
8512	●	●	●							

Technical Features

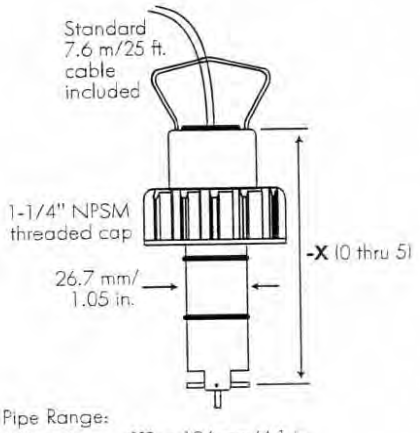
a) Integral mount sensor (8510/8512) shown with field-mount transmitter (sold separately)
b) Remote mount sensor (515/2536)
c) Open cell rotor and rotor pins available in variety of material options (sleeved rotor available for abrasive solutions)
d) 1/2 in. NPT conduit connection
e) 7.6m/25 ft. cable standard, extendable up to 60m/200 ft. (515) or 305m/1,000 ft. (2536)
f) Large bail for sensor removal
g) Glass-filled PP ring nut with provision for lead seal installation
h) Dual O-ring seal (FPM standard, EPR and Kalrez® available)
i) One-piece injection molded (black glass-filled PP or natural PVDF) sensor body
j) Rotor pin



+GF+ SIGNET's unique "open-cell" rotor design eliminates cavitation at higher flow rates.

Dimensions

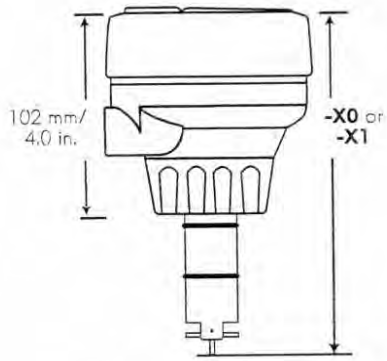
515/2536 Sensor



Pipe Range:

1/2 to 4 in.	**-X**0 = 104 mm/4.1 in.	
5 to 8 in.	**-X**1 = 137 mm/5.4 in.	
10" and up	**-X**2 = 213 mm/8.4 in.	
1/2 to 4 in.	**-X**3 = 297 mm/11.7 in.	Wet-tap Lengths
5 to 8 in.	**-X**4 = 333 mm/13.1 in.	
10" and up	**-X**5 = 409 mm/16.1 in.	

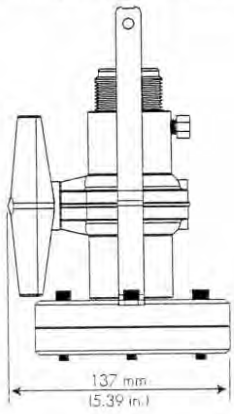
8512 Integral Sensor with Transmitter (sold separately)

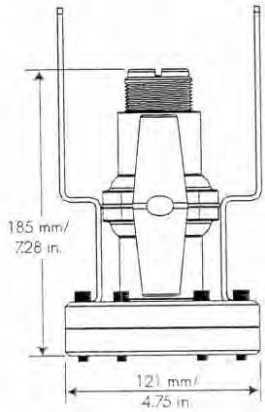


-X0 = 152 mm/6.0 in.
-X1 = 185 mm/7.3 in.

3519 Wet Tap Assembly

(see catalog page for details)





Fitting Types

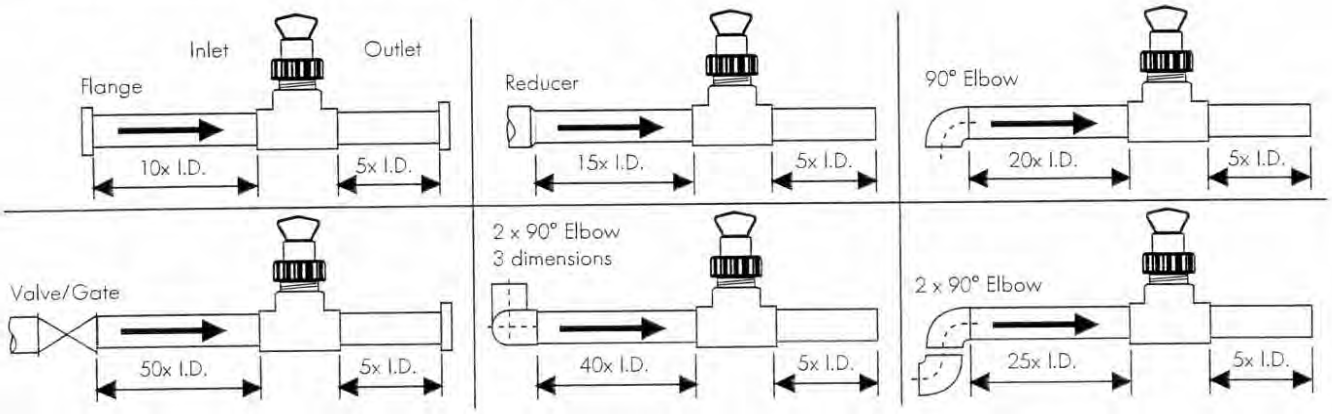
Refer to Fittings section of +GF+ SIGNET catalog for a complete listing of part numbers

Type	Description
Plastic tees	• 0.5 to 4 inch versions • PVC or CPVC
PVC Glue-on Saddles	• Available in 10 and 12 inch sizes only • Cut 2-1/2 inch hole in pipe • Weld in place using solvent cement
PVC Saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • 6 to 8 inch, cut 2-1/4 inch hole in pipe
PP Clamp-on Saddles	• Available in 10 and 12 inch sizes only • Cut 2-1/4 inch hole in pipe
Iron Strap-on saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/4 inch hole in pipe • Special order 12 in. to 36 in.

Type	Description
Iron, Carbon Steel, 316 SS Threaded tees	• 0.5 to 2 in. versions • Mounts on threaded pipe ends
Carbon steel & stainless steel Weld-on Weldolets	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/4 inch hole in pipe
Fiberglass tees & saddles: FPT FPS	• 1.5 in. to 8 in. PVDF insert • > 8 in. PVC insert • Special order 12 in. to 36 in.
Metric Wafer Fitting	• For pipes DN 65 to 200 mm • PP or PVDF
Metric Union Fitting	• For pipes from DN 15 to 50 mm • PP or PVDF

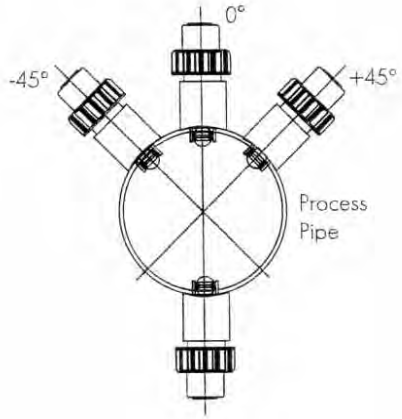
Installation

- Six common installation configurations are shown here as guidelines to help you select the best location in your piping system for a paddlewheel flow sensor.
- Always maximize distance between sensors and pump sources.



Sensor Mounting Position

- Horizontal pipe runs: Mount sensor in a vertical position for best performance, or at a maximum 45° angle to avoid air bubbles (pipe must be full). Do not mount the sensor on the bottom of the pipe if sedimentation is likely.
- Vertical pipe runs: Mount sensor in any orientation. Upward flow is preferred to ensure full pipe.



Maximum Operating Pressure/Temperature

515 Sensor:

Glass-filled Polypropylene Body:

12.5 bar (180 psi) max. @ 20°C (68°F)

1.7 bar (25 psi) max. @ 90°C (194°F)

PVDF Body:

14 bar (200 psi) max. @ 20°C (68°F)

1.7 bar (25 psi) max. @ 100°C (212°F)

2536 Sensor:

Polypropylene Body:

12.5 bar (180 psi) max. @ 20°C (68°F)

1.7 bar (25 psi) max. @ 85°C (185°F)

PVDF Body:

14 bar (200 psi) max. @ 20°C (68°F)

1.7 bar (25 psi) max. @ 85°C (185°F)

3519 Wet-Tap:

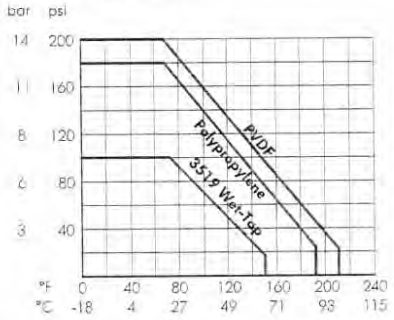
7 bar (100psi) max. @ -18° to 20°C (0° to 68°F)

1.4 bar (20 psi) max. @ 66°C (150°F)

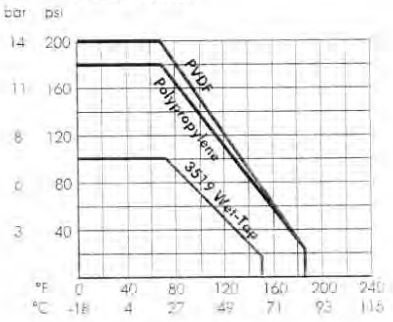
Note: Wet-tap max. installation/removal pressure:

1.7 bar (25 psi) @ 22°C (72°F).

515 Sensor

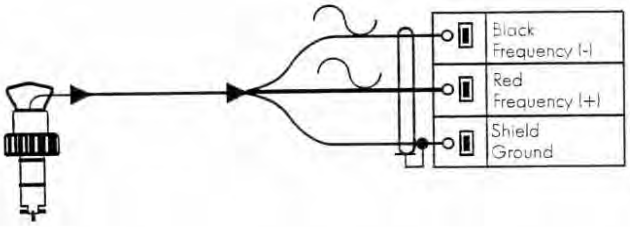


2536 Sensor

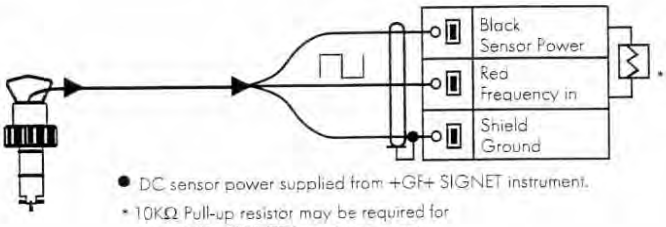


Wiring

515 Sensor Connection to +GF+ SIGNET Instruments



2536 Sensor Connection to +GF+ SIGNET Instruments



● DC sensor power supplied from +GF+ SIGNET instrument.

* 10KΩ Pull-up resistor may be required for non +GF+ SIGNET brand instrument

Technical Data

General (for both 515 & 2536)

Pipe Size Range: 15 to 1000 mm (0.5 to 36 in.)
Linearity: ±1% of full range
Repeatability: ±0.5% of full range
Minimum Reynolds Number Required: 4500
Wetted Materials:

Sensor Body:	Glass-filled Polypropylene (black) or PVDF (natural)
O-rings:	FPM-Viton® (std) or EPDM or FPM-Kalrez®
Pin:	Titanium or Hastelloy-C or PVDF; other material options available
Rotor:	Black PVDF or Natural PVDF; optional Tefzel with or w/o Fluoraloy B® sleeve

Cable Type: 2-conductor twisted pair with shield (22 AWG)
Shipping Weight:

-X0	0.454 kg	1 lb.
-X1	0.476 kg	1.04 lbs.
-X2	0.680 kg	1.50 lbs.
-X3	0.794 kg	1.75 lbs.
-X4	0.850 kg	1.87 lbs.
-X5	1 kg	2.20 lbs.
3519	1.3 kg	2.86 lbs.

Standards and Approvals (for both 515 & 2536):

- Manufactured under ISO 9001 and ISO 14001
- CE

General (515 Only)

Flow Rate Range: 0.3 to 6 m/s (1 to 20 ft./s)
Pipe Size Range: DN15 to DN1000 (0.5 to 36 in.)
Cable Length: 7.6 m (25 ft.) standard/60 m (200 ft.) maximum
Signal:
Frequency: 19.7 Hz per m/s nominal (6 Hz per ft/s)
Amplitude: 3.3 V p/p per m/s nominal (1 V p/p per ft/s)
Source Impedance: 8 Ω

Standards and Approvals (515 only):

- FM Class I, II, II/Div./groups A-G

General (2536 Only)

Flow Rate Range: 0.1 to 6 m/s (0.3 to 20 ft./s)
Pipe Size Range: DN15 to DN1000 (0.5 to 36 in.)
Cable Length: 7.6 m (25 ft.) standard/305 m (1,000 ft.) maximum
Signal:
Frequency: 49Hz per m/s nominal (15 Hz per ft/s nominal)
Supply voltage: 3.5 to 24 VDC regulated
Supply current: <1.5 mA @ 3.3 to 6 VDC
<20 mA @ 6 to 24 VDC
Output Type: Open collector transistor, sinking
Output Current: 10 mA max.

Ordering Information

515/8510-XX (Sinusoidal)

Mfr. Part No.	Code	Pipe Sizes	Body	Rotor/Pin
Remote				
P51530-H0	198 801 659	0.5 to 4 in.	Polypro	Blk PVDF/Hastelloy-C
P51530-P0	198 801 620	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
P51530-P1	198 801 621	5 to 8 in.	Polypro	Blk PVDF/Titanium
P51530-P2	198 801 622	10 to 36 in.	Polypro	Blk PVDF/Titanium
Remote Wet-Tap				
P51530-P3	198 840 310	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
P51530-P4	198 840 311	5 to 8 in.	Polypro	Blk PVDF/Titanium
P51530-P5	198 840 312	10 to 36 in.	Polypro	Blk PVDF/Titanium
Remote				
P51530-S0	198 801 661	0.5 to 4 in.	Polypro	Blk PVDF/Natural PVDF
P51530-T0	198 801 663	0.5 to 4 in.	Natural PVDF	Natural PVDF
P51530-T1	198 801 664	5 to 8 in.	Natural PVDF	Natural PVDF
P51530-V0	198 801 623	0.5 to 4 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
P51530-V1	198 801 624	5 to 8 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
P51530-V2	198 801 625	10 to 36 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
Integral				
3-8510-P0	198 864 504	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3-8510-P1	198 864 505	5 to 8 in.	Polypro	Blk PVDF/Titanium
3-8510-T0	159 000 622	0.5 to 4 in.	Natural PVDF	Natural PVDF
3-8510-V0	198 864 506	0.5 to 4 in.	Natural PVDF	Nat. PVDF/Hastelloy-C

2536/8512-XX (Open-Collector)

Remote				
3-2536-P0	198 840 143	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3-2536-P1	198 840 144	5 to 8 in.	Polypro	Blk PVDF/Titanium
3-2536-P2	198 840 145	10 to 36 in.	Polypro	Blk PVDF/Titanium
3-2536-T0	198 840 149	0.5 to 4 in.	Natural PVDF	Natural PVDF
3-2536-V0	198 840 146	0.5 to 4 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
3-2536-V1	198 840 147	5 to 8 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
Remote Wet-Tap				
3-2536-P3	159 000 758	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3-2536-P4	159 000 759	5 to 8 in.	Polypro	Blk PVDF/Titanium
3-2536-P5	159 000 760	10 to 36 in.	Polypro	Blk PVDF/Titanium
Integral				
3-8512-P0	198 864 513	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3-8512-P1	198 864 514	5 to 8 in.	Polypro	Blk PVDF/Titanium
3-8512-T0	198 864 518	0.5 to 4 in.	Natural PVDF	Natural PVDF
3-8512-V0	198 864 516	0.5 to 4 in.	Natural PVDF	Nat. PVDF/Hastelloy-C

Wet-Tap Sensor and Valve Assembly (Fitting Separate)

Remote Wet-Tap				
3519/515-P3	159 000 819	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3519/515-P4	159 000 820	5 to 8 in.	Polypro	Blk PVDF/Titanium
3519/515-P5	159 000 821	10 to 36 in.	Polypro	Blk PVDF/Titanium
3519/2536-P3	159 000 822	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3519/2536-P4	159 000 823	5 to 8 in.	Polypro	Blk PVDF/Titanium
3519/2536-P5	159 000 824	10 to 36 in.	Polypro	Blk PVDF/Titanium

Accessories

Mfr. Part. No.	Code	Description
Rotors 515/8510-XX		
M1538-2	198 801 181	Rotor, PVDF Black
P51547-3	159 000 474	Rotor, PVDF Natural
M1538-4	198 820 018	Rotor, Tefzel®
P51550-3	198 820 043	Rotor and Pin, PVDF Natural
3-0515.322-1	198 820 059	Sleeved Rotor, PVDF Black
3-0515.322-2	198 820 060	Sleeved Rotor, PVDF Natural
3-0515.322-3	198 820 017	Sleeved Rotor, Tefzel®

Accessories (continued)

Mfr. Part No.	Code	Description
Rotors 2536/8512-XX		
3-2536.320-1	198 820 052	Rotor, PVDF Black
3-2536.320-2	159 000 272	Rotor, PVDF Natural
3-2536.320-3	159 000 273	Rotor, Tefzel®
3-2536.321	198 820 054	Rotor and Pin, PVDF Natural
3-2536.322-1	198 820 056	Sleeved Rotor, PVDF Black
3-2536.322-2	198 820 057	Sleeved Rotor, PVDF Natural
3-2536.322-3	198 820 058	Sleeved Rotor, Tefzel®
Rotor Pins		
M1546-1	198 801 182	Pin, Titanium
M1546-2	198 801 183	Pin, Hastelloy-C
M1546-3	198 820 014	Pin, Tantalum
M1546-4	198 820 015	Pin, Stainless Steel
P51545	198 820 016	Pin, Ceramic
O-Rings		
1220-0021	198 801 186	O-Ring, FPM-Viton®
1224-0021	198 820 006	O-Ring, EPDM
1228-0021	198 820 007	O-Ring, FPM-Kalrez®
Miscellaneous		
P31536	198 840 201	Sensor Plug, Polypro
P31536-1	198 840 202	Sensor Plug, PVDF Metric
P31536-2	159 000 649	Sensor Plug, PVDF
P31542	198 801 630	Sensor Cap, Red (for use w/515)
P31542-3	159 000 464	Sensor Cap, Blue (for use w/2536)
P31934	159 000 466	Conduit Cap
P51589	159 000 476	Conduit Adapter Kit
5523-0222	159 000 392	Cable (per foot), 2 cond. w/shield, 22 AWG
3-8051	159 000 187	Transmitter Integral Adapter

Engineering Specifications for both 515 and 2536 Flow Sensors

- The flow sensor shall use a four-blade, open-cell rotor design using insertion paddlewheel technology.
- Linearity of the output signal with respect to flow rate shall be ±1 % of full range.
- Measurement repeatability of the output signal with respect to flow rate shall be ±0.5 % of full range.
- The sensor body shall be made of injection-molded polypropylene (PP) that shall accommodate up to 12.5 bar @ 20°C (180 psi @ 68°F) and 1.7 bar @ 90°C (25 psi @ 194°F). As an alternative, the sensor shall be made of injection-molded polyvinylidene fluoride (PVDF) that shall accommodate up to 14 bar @ 20°C (200 psi @ 68°F) and 1.7 bar @ 100°C (25 psi @ 212°F).
- The sensor shall attach to a pipe via a variety of insertion-style installation fittings supplied by the flow sensor manufacturer. Attachment shall use a 1-1/4 X 11-1/2 NPSM threaded cap. Sealing shall be accomplished with a double O-ring seal. O-rings shall be made of FPM-Viton®, FPM-Kalrez® or EPDM.
- The sensor shall be equipped with 0.5 in. female conduit connection.

Engineering Specifications for +GF+ SIGNET 515 Rotor-X Flow Sensor

- The sensor shall require no electrical power.
- The sensor shall provide an output signal of 3.3 V p-p per m/s nominal (1 V p-p per ft/s) at a frequency of 19.7 Hz per m/s nominal (6 Hz per ft/s) from 0.3 to 6 m/s (1 to 20 ft/s).
- Output shall be via a twisted pair, foil-shielded cable with drain wire. Supplied cable shall be at least 7.6 m (25 ft) long, with a maximum allowable length of 60 m (200 ft).
- The operating range of the sensor shall accommodate nominal flow rates from 0.3 to 6 m/s (1 to 20 ft/s).
- The sensor shall meet appropriate CE standards and FM standards for Classes 1, 11 and 111, Division I/Groups A-G.

Engineering Specifications for +GF+ SIGNET 2536 Low Flow Sensor

- The sensor shall operate with a power input of 3.3 to 6VDC @ <1.5 mA or from 6 to 24 VDC @ <20 mA.
- The sensor output shall provide an open-collector pulse at a frequency of 49.2 Hz per m/s nominal (15 Hz per ft/s).
- Output shall be via a twisted pair, foil-shielded cable with drain wire. Supplied cable shall be at least 7.6 m (25 ft) long, with a maximum allowable length of 305 m (1000 ft).
- The operating range of the sensor shall accommodate nominal flow rates from 0.1 to 6 m/s (0.3 to 20 ft/s).
- The sensor shall meet appropriate CE standards.

+GF+ SIGNET 8550 Flow Transmitters

3-8550-X (Field)

3-8550-XP (Panel)

Features

- **Permanent & resettable totalizers**
- **Scaleable outputs**
- **Relay options**
- **Mounting versatility**
- **2 x 16 character dot matrix LCD**
- **NEMA 4X enclosure with self-healing window**
- **Large pushbuttons**
- **Numbered terminals**
- **Output simulation for complete system testing**

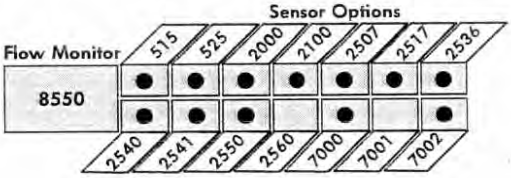
Application

- **Flow control and monitoring**
- **Filtration or softener regeneration**
- **Effluent totalization**
- **Pump protection**
- **Feed pump pulsing**
- **Ratio control**
- **Water distribution**
- **Leak detection**

Description

+GF+ SIGNET 8550 Flow Transmitters are advanced instruments that convert the signal from all +GF+ SIGNET flow sensors into a 4 to 20 mA signal for long distance transmission. Configuration flexibility is maximized with single or dual input/output, two optional relays for process control, two packaging options for integral/pipe mount or panel installation, and scalability for virtually any flow range or engineering unit. State-of-the-art electronic design ensures long-term reliability, signal stability, and simple user setup and operation.

Options

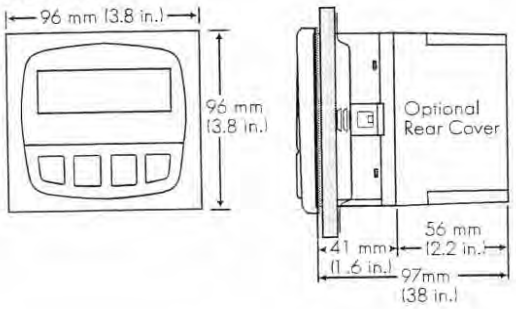


Technical Features

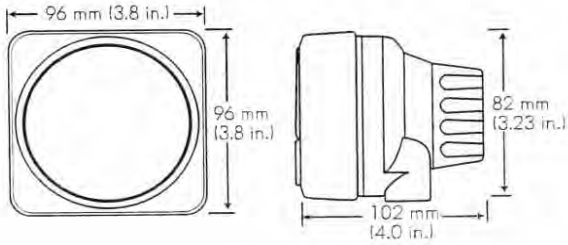
Mounting Version	Part No.	Wire Power	Sensor Input	4 to 20 mA Output	Open Collector/ Relay
Field 	3-8550-1	2/4 non-powered and powered sensors	1	1	1 O.C. Hi, Lo, Pulse Freq or Off
	3-8550-2	4 non-powered and powered sensors	1	1	2 Relays Hi, Lo, Pulse or Off
	3-8550-3	2/4 non-powered and powered sensors	2	2 Sensor 1, Sensor 2 or delta Flow	2 O.C.'s Hi, Lo, Pulse Freq or Off
Panel 	3-8550-1P	2/4 non-powered and powered sensors	1	1	1 O.C. Hi, Lo, Pulse Freq or Off
	3-8550-2P	4 non-powered and powered sensors	1	1	2 Relays Hi, Lo, Pulse or Off
	3-8550-3P	2/4 non-powered and powered sensors	2	2 Sensor 1, Sensor 2 or delta Flow	2 O.C.'s Hi, Lo, Pulse Freq or Off

Dimensions

Panel Mount



Integral/Universal Mount



Installation

The transmitter is available in a panel mount or a field version. The field version is mounted to the sensor using the integral mount kit (3-8051) or you may select the universal mount kit (3-8050) to mount the transmitter on a surface near the sensor.

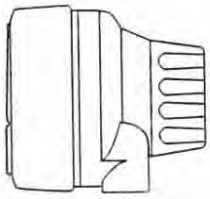
1. Panel Mount

3-8550-XP

All panel mount transmitters (3-8550-XP) include a mounting bracket and gasket for a NEMA 4X watertight panel installation. Panel mount transmitters fit into a standard 1/4 DIN panel cutout.

2. Integral Mount

3-8051Kit

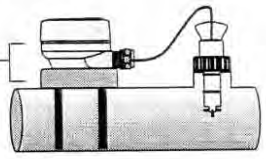


The Integral Mount Kit (3-8051) can be ordered separately and includes a conduit base, locking ring, and integral adapter for mounting the transmitter directly onto a sensor.

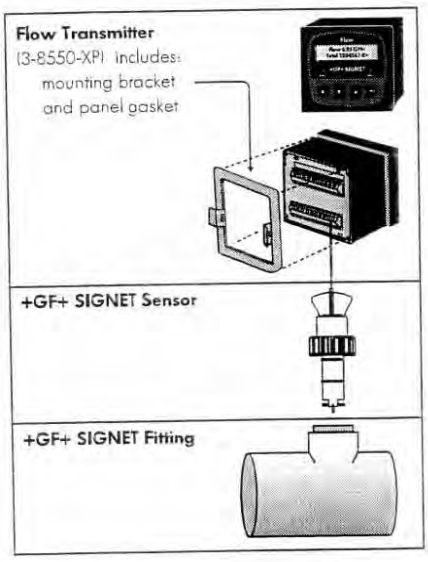
3. Universal Mount

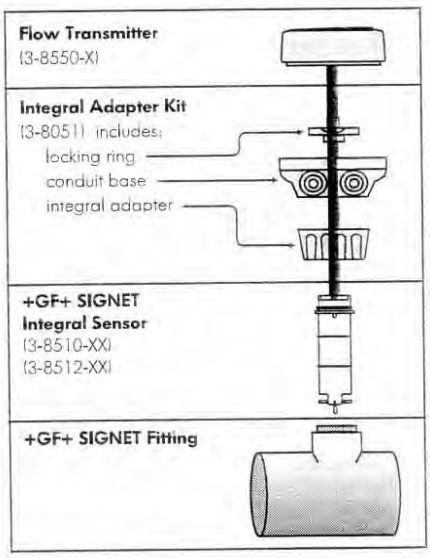
3-8550-X Transmitter

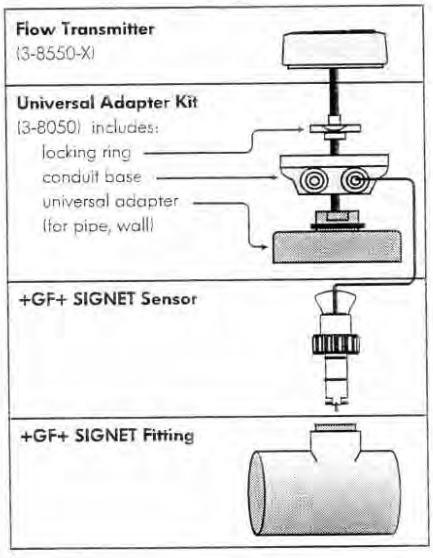
3-8050 Kit



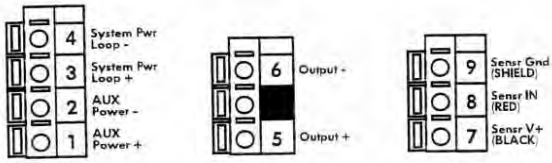
The Universal Mount Kit (3-8050) can be ordered separately and includes a conduit base, locking ring, and universal adapter for mounting the transmitter on a pipe, wall, or other stationary surface.



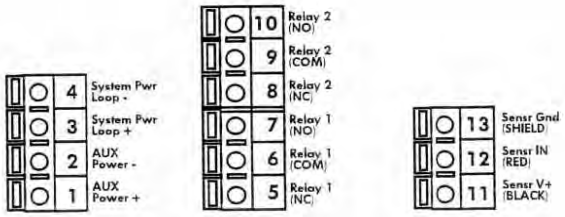




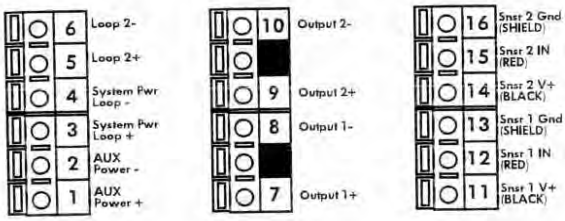
Rear Terminal View



Terminal 8550-1



Terminal 8550-2



Terminal 8550-3

Note: The terminal blocks are not labeled on the back of the unit. An adhesive label is supplied with terminal descriptions to serve as a remote terminal display.

Technical Data

General

Compatibility:
+GF+ SIGNET Flow Sensors with frequency outputs (all except 2560 and 7001)
Accuracy: ± 0.5% of reading @ 25°C
Enclosure:
- Rating: NEMA 4X/IP65 front
- Case: PBT
- Panel Case Gasket: Neoprene
- Window: Polyurethane coated polycarbonate
- Keypad: Sealed 4-key silicone rubber
- Shipping Weight: 0.325kg (0.8 lbs.)

Display:
- Alphanumeric 2 x 16 LCD
- Update rate: 1 second
- Contrast: User selectable, 5 levels

Environmental

Operating temperature:
-10 to 70°C (14 to 158°F)
Storage temperature:
-15 to 80°C (5 to 176°F)
Relative humidity:
0 to 95%, non-condensing

Standards and Approvals

- CE, UL listed
- Manufactured under ISO 9001 and ISO 14001
- NEMA 4X and IP65

Electrical

Power:
- 12 to 24 VDC ±10%, regulated
(-1) 61 mA max.; (-2) 200 mA max.; (-3) 122 mA max.

Sensor Input:
- Range: 0.5 to 1500 Hz
- Sensor power:
2-wire: 1.5 mA @ 5 VDC ± 1%
3 or 4 wire: 20 mA @ 5 VDC ± 1%
- Optically isolated from current loop
- Short circuit protected

Current output:
- 4 to 20 mA, isolated, fully adjustable and reversible
- Max loop impedance:
50Ω max. @ 12 V,
325Ω max. @ 18 V,
600Ω max. @ 24 V
- Update rate: 100 ms
- Accuracy: ±0.03 mA

Relay output:
- Mechanical SPDT contacts: Hi, Lo, Pulse, Off
- Maximum voltage rating: 5 A @ 30 VDC, 5 A @ 250 VAC resistive load
- Hysteresis: User selectable
- Max 300 pulses/min.

Open-collector output: Hi, Lo, Pulse, Off
- Open-collector, optically isolated, 50 mA max. sink, 30 VDC max. pull-up voltage.
- Max 300 pulses/min.
- Hysteresis: User selectable

Ordering Information

Mfr. Part No.	Code	Description
3-8550-1	159 000 047	Flow transmitter, Field mount
3-8550-1P	159 000 048	Flow transmitter, Panel mount
3-8550-2	159 000 049	Flow transmitter, Field mount with relays
3-8550-2P	159 000 050	Flow transmitter, Panel mount with relays
3-8550-3	159 000 051	Flow transmitter, Field mount with dual input/output
3-8550-3P	159 000 052	Flow transmitter, Panel mount with dual input/output

Accessories

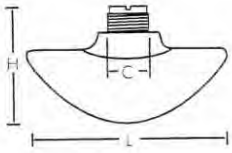
Mfr. Part No.	Code	Description
3-8050	159 000 184	Universal mounting kit
3-8050.395	159 000 186	Transmitter NEMA 4X cover
3-8051	159 000 187	Flow Integral Mnt NPT
3-8052	159 000 188	3/4 in. Integral Mounting Kit
3-8050.396	159 000 617	RC Filter kit (for relay use)
3-8050.392	159 000 640	Model 200 retro-fit adapter
3-0000.596	159 000 641	Heavy duty wall mount bracket
3-5000.598	198 840 225	Surface Mount Bracket
3-9000.392	159 000 368	Liquid tight connector kit for rear cover (includes 3 connectors)
3-9000.392-1	159 000 839	Liquid tight connector kit, NPT (1 piece)
3-9000.392-2	159 000 841	Liquid tight connector kit, PG13.5 (1 piece)

Engineering Specifications

- The transmitter shall meet appropriate CE, & UL standards.
- The transmitter shall be manufactured under ISO 9001 and ISO 14001 certified processes.
- The transmitter shall be field or panel mountable.
- The transmitter shall have flow rate and dual totalization capability.
- The display units shall be fully scaleable.
- The device shall meet NEMA 4X and IP65 standards.
- The operating voltage shall be 12 to 24 VDC.
- The transmitter shall have a 4 to 20 mA output with an open collector output, 5 to 30 VDC or a 4 to 20 mA output with 2 relays, or dual 4 to 20 mA output with dual open collector with delta capability.
- The transmitter shall have simulate capability.
- The transmitter shall be +GF+ SIGNET 8550 Flow Transmitter.

+GF+ SIGNET Installation Fittings

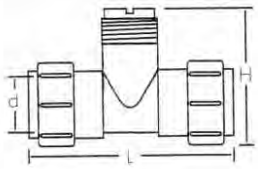
Fiberglass Glue-on Saddles



Part no.	Code	Size	L	H	o.d.	C
FPS030	159 000 441	3.00 in.	5.9	4.5	3.50	1.44
FPS040	159 000 442	4.00 in.	8.0	4.5	4.50	1.44
FPS060	159 000 443	6.00 in.	8.0	6.5	6.62	2.25
FPS080	198 801 417	8.00 in.	10.0	8.0	8.62	2.25
FPS100	159 000 444	10.0 in.	12.0	8.5	10.75	2.25
FPS120	159 000 445	12.0 in.	12.0	8.5	12.75	2.25

- C - Clearance dimension
- Up to 8 in. - PVDF insert, over 8 in. - PVC
- Mounts on fiberglass pipe

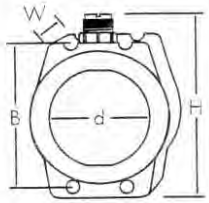
Metric PP Union Tee Fittings



Part no.	Code	DN	L	H	d
PPMT005	198 150 522	15 mm	128	97	20
PPMT007	198 150 523	20 mm	142	105	25
PPMT010	198 150 524	25 mm	156	110	32
PPMT012	198 150 525	32 mm	160	120	40
PPMT015	198 150 526	40 mm	176	130	50
PPMT020	198 150 527	50 mm	194	146	63

•Socket fusion equipment is required to install PVDF and PP union tees.

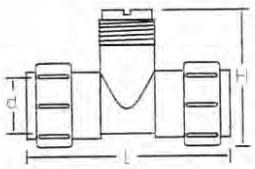
Metric PP Wafer Fittings



Part no.	Code	DN	W	H	d	B
PPMT025	198 150 560	65 mm	46	175	75	142
PPMT030	198 150 696	80 mm	49	194	90	160
PPMT040	198 150 562	100 mm	56	220	110	186
PPMT050	198 150 563	125 mm	64	265	140	215
PPMT060	198 150 564	150 mm	70	297	160	240
PPMT080	198 150 565	200 mm	71	352	225	297

• Not compatible with integral mount transmitters due to limited clearance between flange rings

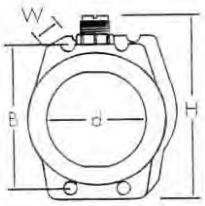
Metric PVDF Union Tee Fittings



Part no.	Code	DN	L	H	d
SFMT005	198 150 529	15 mm	128	97	20
SFMT007	198 150 530	20 mm	142	105	25
SFMT010	198 150 531	25 mm	156	110	32
SFMT012	198 150 532	32 mm	160	120	40
SFMT015	198 150 533	40 mm	176	130	50
SFMT020	198 150 534	50 mm	194	146	63

•Socket fusion equipment is required to install PVDF and PP union tees.

Metric PVDF Wafer Fittings



Part no.	Code	DN	W	H	d	B
SFMT025	198 150 571	65 mm	46	175	75	142
SFMT030	198 150 697	80 mm	49	194	90	160
SFMT040	198 150 573	100 mm	56	220	110	186
SFMT050	198 150 574	125 mm	64	265	140	215
SFMT060	198 150 575	150 mm	70	297	160	240
SFMT080	198 150 576	200 mm	71	352	225	297

• Not compatible with integral mount transmitters due to limited clearance between flange rings

Series ABFV Automated Butterfly Valve

For your convenience, sample model configurations are listed with the proper sized actuators. Models listed have cast iron body, 316 SS disc, and EPDM liner and o-rings. The 2-way models have a valve arrangement shown of normally closed, while the 3-way models have no valve arrangement code shown, please specify when ordering. All electric actuators shown are 115 VAC and NEMA 4. All pneumatic actuators are sized with an air supply pressure of 80 psi. Consult the factory for model number changes for electric actuator options of explosion-proof and other supply voltages.

2-Way, Lug Style, EPDM Liner

Size	Double Acting Pneumatic		Spring Return Pneumatic		Two Position Electric		Modulating Electric	
	Model	Price	Model	Price	Model	Price	Model	Price
2"	ABFV202LTB331DA2C	$188.00(B)	ABFV202LTB331SR4C	$262.00(B)	ABFV202LTB331U12C	$575.00(B)	ABFV202LTB331V12C	$1463.00(B)
2-1/2"	ABFV225LTB331DA2C	198.00(B)	ABFV225LTB331SR4C	272.00(B)	ABFV225LTB331U12C	585.00(B)	ABFV225LTB331V12C	1473.00(B)
3"	ABFV203LTB331DA3C	225.00(B)	ABFV203LTB331SR5C	311.00(B)	ABFV203LTB331U13C	679.00(B)	ABFV203LTB331V13C	1657.00(B)
4"	ABFV204LTB331DA3C	260.00(B)	ABFV204LTB331SR6C	420.00(B)	ABFV204LTB331U14C	991.00(B)	ABFV204LTB331V14C	1856.00(B)
5"	ABFV205LTB331DA5C	365.00(B)	ABFV205LTB331SR6C	633.00(B)	ABFV205LTB331U16C	1337.00(B)	ABFV205LTB331V16C	2105.00(B)
6"	ABFV206LTB331DA5C	404.00(B)	ABFV206LTB331SR8C	672.00(B)	ABFV206LTB331U16C	1376.00(B)	ABFV206LTB331V16C	2144.00(B)
8"	ABFV208LTB331DA6C	557.00(B)	ABFV208LTB331SR8C	766.00(B)	ABFV208LTB331U17C	1588.00(B)	ABFV208LTB331V17C	2350.00(B)
10"	ABFV210LTB331DA8C	913.00(B)	ABFV210LTB331SR9C	1434.00(B)	ABFV210LTB331U19C	2700.00(B)	ABFV210LTB331V19C	3578.00(B)
12"	ABFV212LTB331DAAC	1560.00(B)	ABFV212LTB331SRBC	2313.00(B)	ABFV212LTB331U19C	2953.00(B)	ABFV212LTB331V19C	3832.00(B)

Model Numbers shown are normally closed, change the model code at the end from "C" to "A" for normally open.

2-Way, Wafer Style, EPDM Liner

Size	Double Acting Pneumatic		Spring Return Pneumatic		Two Position Electric		Modulating Electric	
	Model	Price	Model	Price	Model	Price	Model	Price
2"	ABFV202WFB331DA2C	$184.00(B)	ABFV202WFB331SR4C	$257.00(B)	ABFV202WFB331U12C	$571.00(B)	ABFV202WFB331V12C	$1459.00(B)
2-1/2"	ABFV225WFB331DA2C	192.00(B)	ABFV225WFB331SR4C	266.00(B)	ABFV225WFB331U12C	579.00(B)	ABFV225WFB331V12C	1467.00(B)
3"	ABFV203WFB331DA3C	218.00(B)	ABFV203WFB331SR5C	304.00(B)	ABFV203WFB331U13C	672.00(B)	ABFV203WFB331V13C	1651.00(B)
4"	ABFV204WFB331DA3C	247.00(B)	ABFV204WFB331SR6C	407.00(B)	ABFV204WFB331U14C	978.00(B)	ABFV204WFB331V14C	1844.00(B)
5"	ABFV205WFB331DA5C	351.00(B)	ABFV205WFB331SR6C	619.00(B)	ABFV205WFB331U16C	1332.00(B)	ABFV205WFB331V16C	2090.00(B)
6"	ABFV206WFB331DA5C	384.00(B)	ABFV206WFB331SR8C	652.00(B)	ABFV206WFB331U16C	1356.00(B)	ABFV206WFB331V16C	2124.00(B)
8"	ABFV208WFB331DA6C	537.00(B)	ABFV208WFB331SR8C	745.00(B)	ABFV208WFB331U17C	1567.00(B)	ABFV208WFB331V17C	2329.00(B)
10"	ABFV210WFB331DA8C	877.00(B)	ABFV210WFB331SR9C	1398.00(B)	ABFV210WFB331U19C	2663.00(B)	ABFV210WFB331V19C	3542.00(B)
12"	ABFV212WFB331DAAC	1509.00(B)	ABFV212WFB331SRBC	2262.00(B)	ABFV212WFB331U19C	2903.00(B)	ABFV212WFB331V19C	3781.00(B)

Model Numbers shown are normally closed, change the model code at the end from "C" to "A" for normally open.

3-Way, Lug Style, EPDM Liner

Size	Double Acting Pneumatic		Spring Return Pneumatic		Two Position Electric		Modulating Electric	
	Model*	Price	Model*	Price	Model*	Price	Model*	Price
2"	ABFV302LTB331DA3_	$749.00(B)	ABFV302LTB331SR5_	$826.00(B)	ABFV302LTB331U13_	$1499.00(B)	ABFV302LTB331V13_	$2357.00(B)
2-1/2"	ABFV325LTB331DA3_	856.00(B)	ABFV325LTB331SR6_	976.00(B)	ABFV325LTB331U14_	1741.00(B)	ABFV325LTB331V14_	2600.00(B)
3"	ABFV303LTB331DA4_	924.00(B)	ABFV303LTB331SR6_	996.00(B)	ABFV303LTB331U15_	1982.00(B)	ABFV303LTB331V15_	2840.00(B)
4"	ABFV304LTB331DA5_	1017.00(B)	ABFV304LTB331SR7_	1275.00(B)	ABFV304LTB331U16_	2207.00(B)	ABFV304LTB331V16_	3065.00(B)
5"	ABFV305LTB331DA6_	1129.00(B)	ABFV305LTB331SR9_	1714.00(B)	ABFV305LTB331U16_	2436.00(B)	ABFV305LTB331V16_	3264.00(B)
6"	ABFV306LTB331DA7_	1499.00(B)	ABFV306LTB331SR9_	1915.00(B)	ABFV306LTB331U17_	2639.00(B)	ABFV306LTB331V17_	3497.00(B)
8"	ABFV308LTB331DA9_	2003.00(B)	ABFV308LTB331SR9_	2165.00(B)	ABFV308LTB331U19_	3726.00(B)	ABFV308LTB331V19_	4585.00(B)
10"	ABFV310LTB331DAA_	2658.00(B)	ABFV310LTB331SRB_	3609.00(B)	ABFV310LTB331U19_	4328.00(B)	ABFV310LTB331V19_	4947.00(B)
12"	ABFV312LTB331DAB_	3766.00(B)	ABFV312LTB331SRC_	5897.00(B)	ABFV312LTB331U1A_	5777.00(B)	ABFV312LTB331V1A_	6650.00(B)

*Complete model includes Valve Arrangement - see Model Chart on previous page.

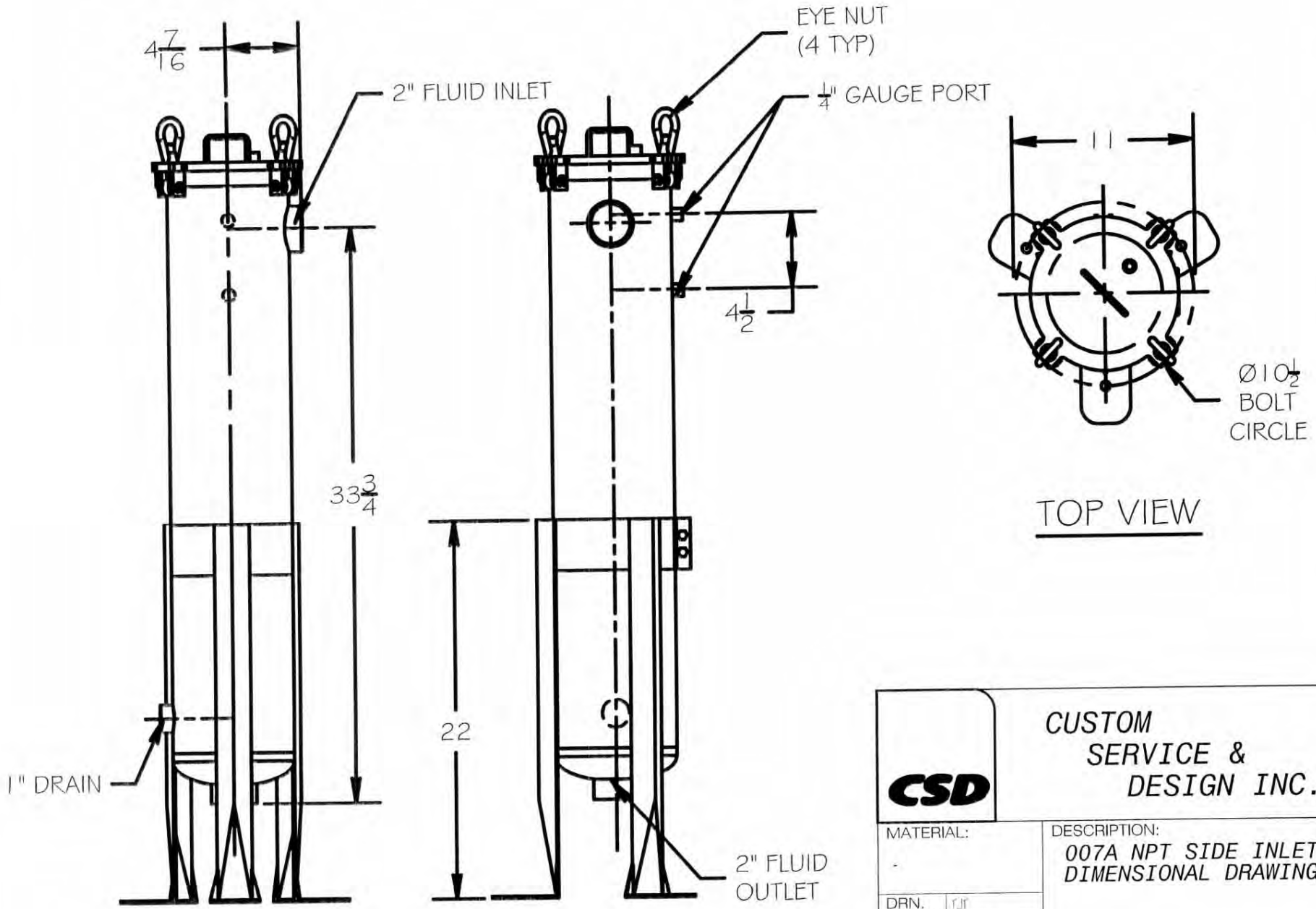
Options:

Explosion-proof Electric Actuator
-Add suffix "EX" to the model number ..... add $232.00(B)

Optional Electric Actuator Supply Voltages
-Contact factory for model number change
Sizes up to U_6, V_6 ..... add $35.25(B)
Sizes U_7, V_7 and up ..... add $124.00(B)

Solenoid Valve - Add suffix -SV ..... add $120.00(B)

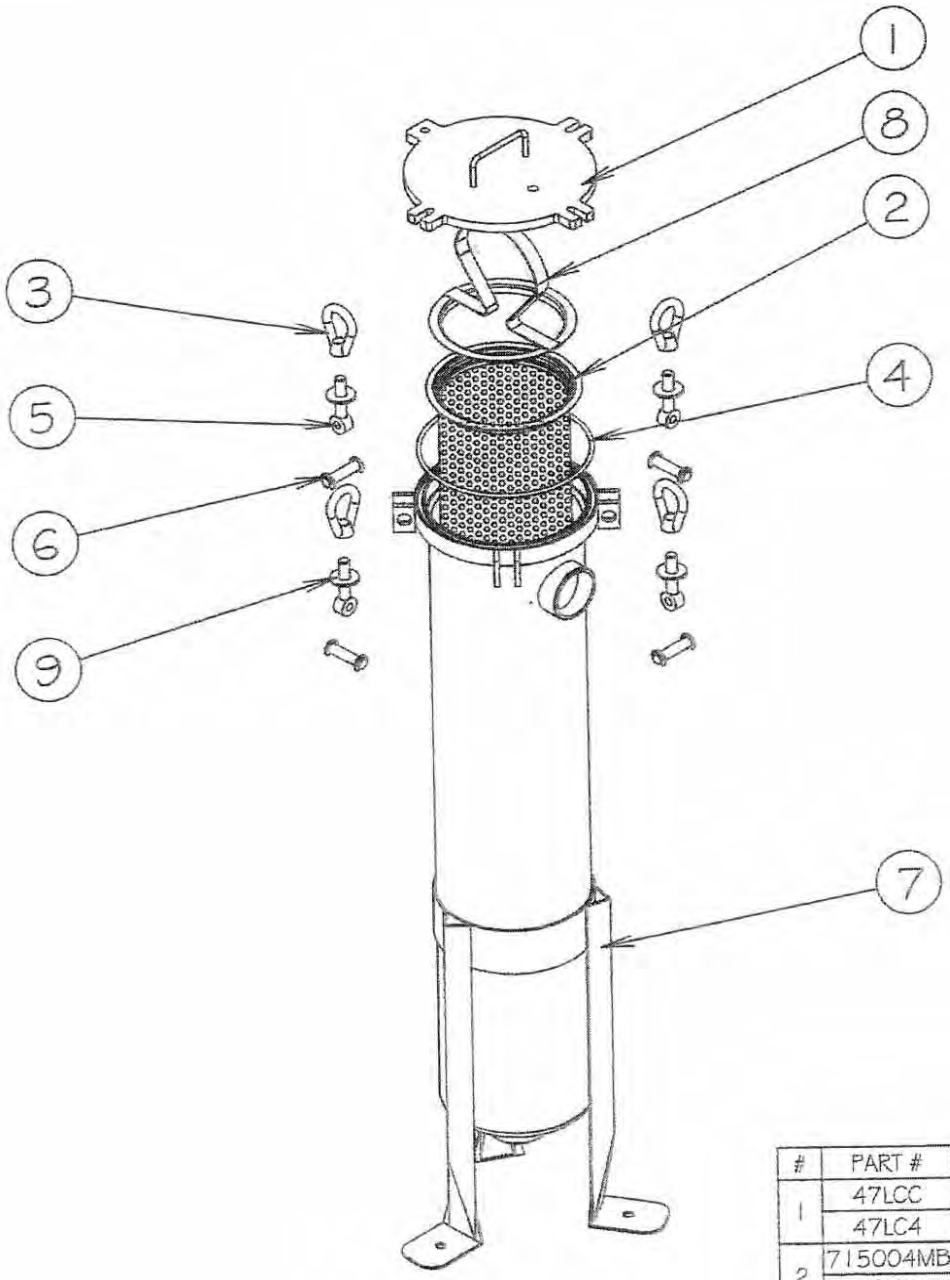
(B)Items subject to schedule B discounts.



CUSTOM SERVICE & DESIGN INC.

MATERIAL: -	DESCRIPTION: 007A NPT SIDE INLET DIMENSIONAL DRAWING
DRN. TJT	
DATE 5/1/06	
CHK'D	PART NO. 007A1304L
DATE	
SCALE EIGHTH	NOTICE: SCALE ON "A" SIZE PLOTS ONLY

TOLERANCE
FRAC ± 1/4
.000 ± .005
.0000 ± .0005



#	PART #	DESCRIPTION
1	47LCC	CARBON STEEL LID
	47LC4	304L STAINLESS STEEL LID
2	715004MB	15" S.S. BASKET
	730004MB	30" S.S. BASKET
3	4EN	EYE NUT
4	890*	GASKET
5	4RE	EYE BOLT
6	3CPA	CLEVIS PIN ASSY.
7	A7LGC	CARBON STEEL LEGS
	A7LG4	STAINLESS STEEL LEGS
8	A7054	OMEGA SPRING *OPTIONAL*
9	1/2 USS	FLAT WASHER

CSD

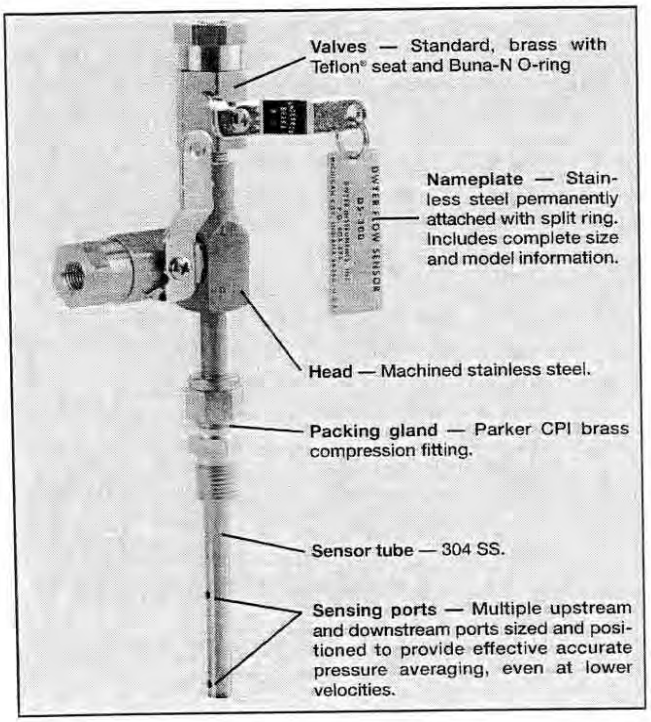
CUSTOM SERVICE & DESIGN INC.

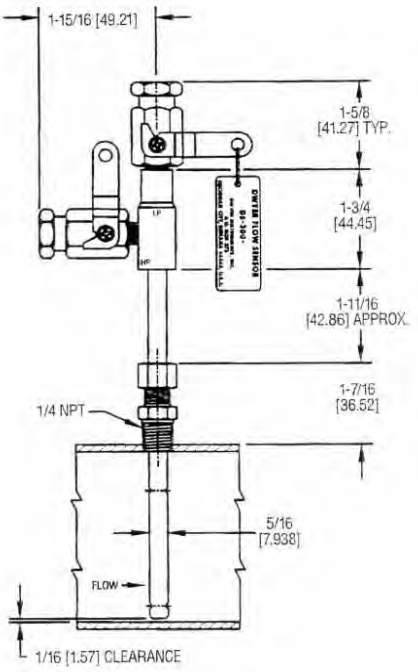
PARTS LIST

CHK'D		PART NO.	MATERIAL:	DESCRIPTION:	TOLERANCE
DATE		007A!**4L		007A SIDE INLET SPARE PARTS LIST	FRAC ± 1/4 .000 ± .005 .0000 ± .0005
SCALE NTS			DRN. TJT		
NOTICE: SCALE ON "A" SIZE PLOTS ONLY			DATE 10/23/05		

Series DS In-Line Flow Sensors

Use with the Dwyer Differential Pressure Gages or Transmitters





Dwyer Flow Sensors are averaging Pitot tubes that provide accurate and convenient flow rate sensing for schedule 40 pipe. When purchased with a Dwyer Capsuhelic® differential pressure gage of appropriate range, the result is a flow indicating system delivered off the shelf at an economical price.

Pitot tubes have been used in flow measurement for years. Conventional pitot tubes sense velocity pressure at only one point in the flowing stream. Therefore, a series of measurements must be taken across the stream to obtain a meaningful average flow rate. The Dwyer flow sensor eliminates the need for "traversing" the flowing stream because of its multiple sensing points and built-in averaging capability.

Dwyer Series DS-300 flow sensors are designed to be inserted in the pipeline through a compression fitting. They are furnished with instrument shut-off valves on both pressure connections. Valves are fitted with ⅛" female NPT connections. Accessories include adapters with ¼" SAE 45° flared ends compatible with hoses supplied with the Model A-471 Portable Capsuhelic® kit. Standard valves are rated at 200 psig (13.7 bar) and 200°F (93.3°C). Where valves are not required, they can be omitted at reduced cost. Series DS-300 flow sensors are available for pipe sizes from 1" to 10".

DS-400 Averaging Flow Sensors are quality constructed from extra strong ¾" dia. stainless steel to resist increased forces encountered at higher flow rates with both air and water. This extra strength also allows them to be made in longer insertion lengths up to 24 inches (61 cm). All models include convenient and quick-acting quarter-turn ball valves to isolate the sensor for zeroing. Process connections to the valve assembly are ⅛" female NPT. A pair of ⅛" NPT × ¼" SAE 45° flared adapters are included, compatible with hoses used in the Model A-471 Portable Capsuhelic® Gage Kit. Supplied solid brass mounting adapter has a ¾" dia. compression fitting to lock in required insertion length and a ¾" male NPT thread for mounting in a thred-o-let (not included).

Select model with suffix which matches pipe size

DS-300-1"
DS-300-1¼"
DS-300-1½"
DS-300-2"
DS-300-2½"
DS-300-3"
DS-300-4"
DS-300-6"
DS-300-8"
DS-300-10"

DS-400-6"
DS-400-8"
DS-400-10"
DS-400-12"
DS-400-14"
DS-400-16"
DS-400-18"
DS-400-20"
DS-400-24"

Options and Accessories

A-160 Thredolet,¾" NPT, forged steel, 3000 psi
A-161 Brass Bushing, ¾" x ⅜"
(DS-300) To order, add suffix -LVdeduct
Ⓑ Items subject to Schedule B discounts

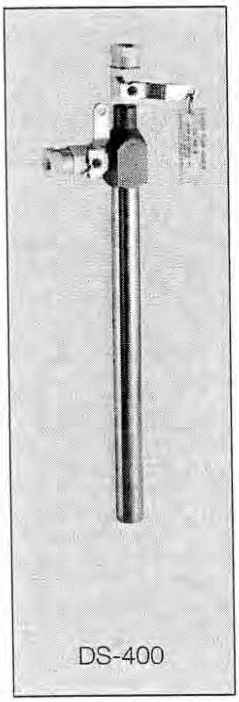
How To Order

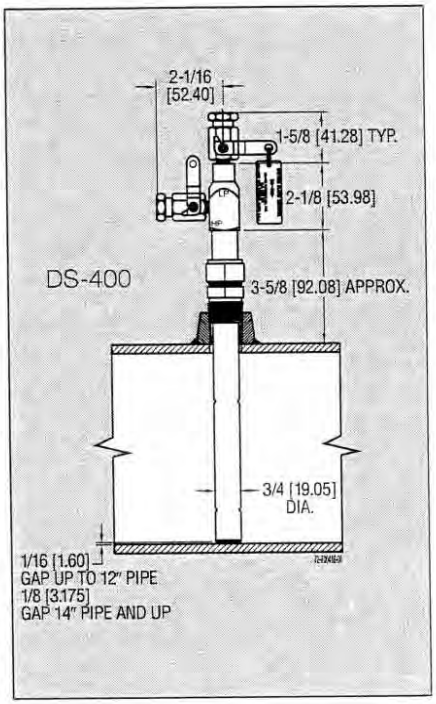
Merely determine the pipe size into which the flow sensor will be mounted and designate the size as a suffix to Model DS-300. For example, a flow sensor to be mounted in a 2" pipe would be a Model No. DS-300-2".

For non-critical water and air flow monitoring applications, the chart below can be utilized for ordering a stock Capsuhelic® differential pressure gage for use with the DS-300 flow sensor. Simply locate the maximum flow rate for the media being measured under the appropriate pipe size and read the Capsuhelic® gage range in inches of water column to the left. The DS-300 sensor is supplied with installation and operating instructions, Bulletin F-50. It also includes complete flow conversion information for the three media conditions shown in the chart below. This information enables the user to create a complete differential pressure to flow rate conversion table for the sensor and differential pressure gage employed. Both the Dwyer Capsuhelic® gage and flow sensor feature excellent repeatability so, once the desired flow rate is determined, deviation from that flow in quantitative measure can be easily determined. You may wish to order the adjustable signal flag option for the Capsuhelic® gage to provide an easily identified reference point for the proper flow.

Capsuhelic® gages with special ranges and/or direct reading scales in appropriate flow units are available on special order for more critical applications. Customer supplied data for the full scale flow (quantity and units) is required along with the differential pressure reading at that full flow figure. Prior to ordering a special Capsuhelic® differential pressure gage for flow read-out, we recommend you request Bulletin F-50 to obtain complete data on converting flow rates of various media to the sensor differential pressure output. With this bulletin and after making a few simple calculations, the exact range gage required can easily be determined.

Large 3/4 Inch Diameter for Extra Strength in Lengths to 24 Inches



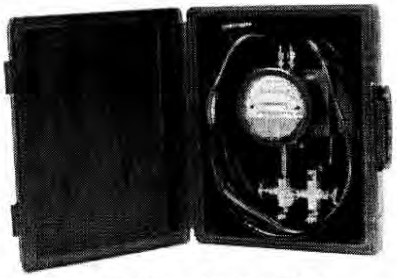


GAGE RANGE (IN. W.C.)	MEDIA @ 70°F	FULL RANGE FLOWS BY PIPE SIZE (APPROXIMATE)									
		1"	1¼"	1½"	2"	2½"	3"	4"	6"	8"	10"
2	Water (GPM)	4.8	8.3	11.5	20.5	30	49	86	205	350	560
	Air @ 14.7 PSIA (SCFM)	19.0	33.0	42.0	65.0	113	183	330	760	1340	2130
	Air @ 100 PSIG (SCFM)	50.0	90.5	120.0	210.0	325	510	920	2050	3600	6000
5	Water (GPM)	7.7	14.0	18.0	34.0	47	78	138	320	560	890
	Air @ 14.7 PSIA (SCFM)	30.0	51.0	66.0	118.0	178	289	510	1200	2150	3400
	Air @ 100 PSIG (SCFM)	83.0	142.0	190.0	340.0	610	820	1600	3300	5700	10000
10	Water (GPM)	11.0	19.0	25.5	45.5	67	110	195	450	800	1260
	Air @ 14.7 PSIA (SCFM)	41.0	72.0	93.0	163.0	250	410	725	1690	3040	4860
	Air @ 100 PSIG (SCFM)	120.0	205.0	275.0	470.0	740	1100	2000	4600	8100	15000
25	Water (GPM)	18.0	32.0	40.5	72.0	108	173	310	720	1250	2000
	Air @ 14.7 PSIA (SCFM)	63.0	112.0	155.0	255.0	390	640	1130	2630	4860	7700
	Air @ 100 PSIG (SCFM)	185.0	325.0	430.0	760.0	1200	1800	3300	7200	13000	22000
50	Water (GPM)	25.0	44.0	57.5	100.0	152	247	435	1000	1800	
	Air @ 14.7 PSIA (SCFM)	90.0	161.0	205.0	360.0	560	900	1600	3700	6400	
	Air @ 100 PSIG (SCFM)	260.0	460.0	620.0	1050.0	1700	2600	4600	10000	18500	
100	Water (GPM)	36.5	62.0	82.0	142.0	220	350	620	1500		
	Air @ 14.7 PSIA (SCFM)	135.0	230.0	300.0	505.0	800	1290	2290	5000		
	Air @ 100 PSIG (SCFM)	370.0	660.0	870.0	1500.0	2300	3600	6500	15000		

Model A-471 Portable Kit

The Dwyer Series 4000 Capsuhelic® differential pressure gage is ideally suited for use as a read-out device with the DS-300 Flow Sensors. The gage may be used on system pressures of up to 500 psig even when the flow sensor differential pressure to be read is less than 0.5" w.c. With accuracy of ±3% of full scale, the Capsuhelic® gage can be used in ambient temperatures from 32 to 200°F (0 to 93.3°C). Zero and range adjustments are made from outside the gage. The standard gage with a die cast aluminum housing can be used with the flow sensor for air or oil applications. For water flow measurements, the optional forged brass housing should be specified. The Capsuhelic® gage may be panel or surface mounted and permanently plumbed to the flow sensor if desired. The optional A-610 pipe mounting bracket allows the gage to be easily attached to any 1¼" - 2" horizontal or vertical pipe.

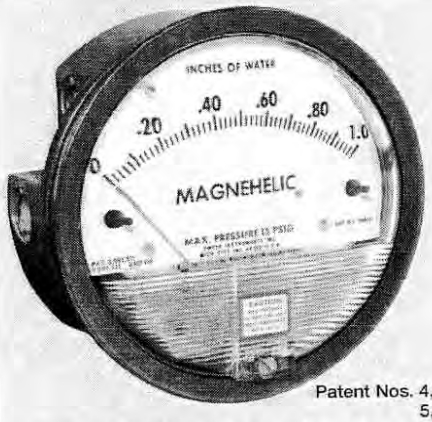
For portable operation, the A-471 Capsuhelic® Portable Gage Kit is available complete with tough polypropylene carrying case, mounting bracket, 3-way manifold valve, two 10' high pressure hoses, and all necessary fittings. See pages 6 and 7 for complete information on the Capsuhelic® gage.



CAPSUHELIC® GAGE SHOWN INSTALLED IN A-471 PORTABLE KIT

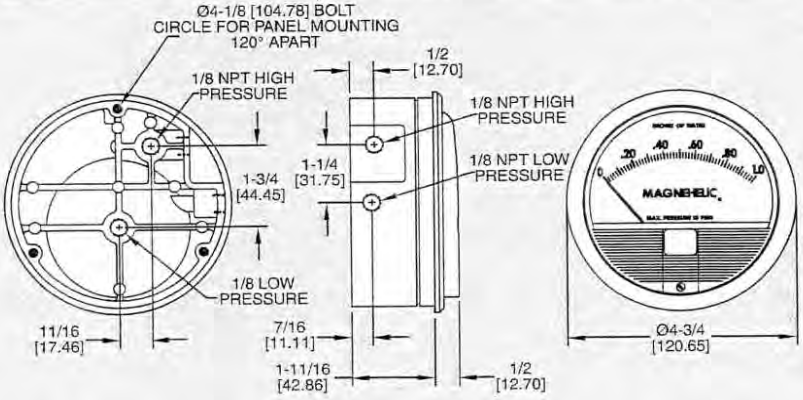
Series 2000 Magnehelic® Differential Pressure Gages

Indicate Positive, Negative or Differential, Accurate within 2%



Patent Nos. 4,030,365
5,012,678

Standard Magnehelic® Pressure Gage has a large, easy-to-read 4" dial.



Dimensions, Standard Series 2000 Magnehelic® Pressure Gages. (Slightly different on medium and high pressure models)

Select the Dwyer Magnehelic® gage for high accuracy – guaranteed within 2% of full scale – and for the wide choice of 81 models available to suit your needs precisely. Using Dwyer's simple, frictionless Magnehelic® movement, it quickly indicates low air or non-corrosive gas pressures – either positive, negative (vacuum) or differential. The design resists shock, vibration and over-pressures. No manometer fluid to evaporate, freeze or cause toxic or leveling problems. It's inexpensive, too.

The Magnehelic® is the industry standard to measure fan and blower pressures, filter resistance, air velocity, furnace draft, pressure drop across orifice plates, liquid levels with bubbler systems and pressures in fluid amplifier or fluidic systems. It also checks gas-air ratio controls and automatic valves, and monitors blood and respiratory pressures in medical care equipment.

Note: May be used with Hydrogen where pressures are less than 35 psi.

MOUNTING. A single case size is used for most models of Magnehelic® gages. They can be flush or surface mounted with standard hardware supplied. With the optional A-610 Pipe Mounting Kit they may be conveniently installed on horizontal or vertical 1¼" - 2" pipe. Although calibrated for vertical position, many ranges above 1" may be used at any angle by simply re-zeroing. However, for maximum accuracy, they must be calibrated in the same position in which they are used. These characteristics make Magnehelic® gages ideal for both stationary and portable applications. A 4⅛" hole is required for flush panel mounting. Complete mounting and connection fittings plus instructions are furnished with each instrument.

Flush ...Surface...or Pipe Mounted

VENT VALVES

In applications where pressure is continuous and the Magnehelic® gage is connected by metal or plastic tubing which cannot be easily removed, we suggest using Dwyer A-310A vent valves to connect gage. Pressure can then be removed to check or re-zero the gage.

HIGH AND MEDIUM PRESSURE MODELS

Installation is similar to standard gages except that a 4⅛" hole is needed for flush mounting. The medium pressure construction is rated for internal pressures up to 35 psig and the high pressure up to 80 psig. Available for all models. Because of larger case, the medium pressure and high pressure models will not fit in a portable case size. Installation of the A-321 safety relief valve on standard Magnehelic® gages often provides adequate protection against infrequent overpressure.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases. (Natural Gas option available.)
Wetted Materials: Consult factory.
Housing: Die cast aluminum case and bezel, with acrylic cover. Exterior finish is coated gray to withstand 168 hour salt spray corrosion test.
Accuracy: ±2% of full scale (±3% on - 0, -100 Pa, -125 Pa, 10MM and ±4% on - 00, -60 Pa, -6MM ranges), throughout range at 70°F (21.1°C).
Pressure Limits: -20" Hg, to 15 psig,† (-0.677 bar to 1.034 bar); MP option: 35 psig (2.41 bar), HP option: 80 psig (5.52 bar).
Overpressure: Relief plug opens at approximately 25 psig (1.72 bar), standard gages only.
Temperature Limits: 20 to 140°F.* (-6.67 to 60°C).
Size: 4" (101.6 mm) Diameter dial face.
Mounting Orientation: Diaphragm in vertical position. Consult factory for other position orientations.
Process Connections: 1/8" female NPT duplicate high and low pressure taps - one pair side and one pair back.
Weight: 1 lb 2 oz (510 g), MP & HP 2 lb 2 oz (963 g).
Standard Accessories: Two 1/8" NPT plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapter and three flush mounting adapters with screws. (Mounting and snap ring retainer substituted for 3 adapters in MP & HP gage accessories.)
*Low temperature models available as special option.
†For applications with high cycle rate within gage total pressure rating, next higher rating is recommended. See Medium and High pressure options at lower left.

OPTIONS AND ACCESSORIES

Transparent Overlays
Furnished in red and green to highlight and emphasize critical pressures.

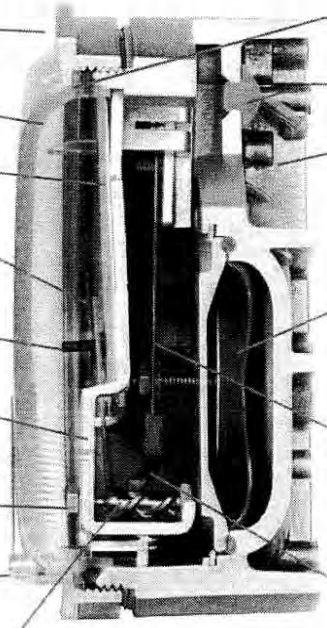
Adjustable Signal Flag
Integral with plastic gage cover. Available for most models except those with medium or high pressure construction. Can be ordered with gage or separate.

LED Setpoint Indicator
Bright red LED on right of scale shows when setpoint is reached. Field adjustable from gage face, unit operates on 12-24 VDC. Requires MP or HP style cover and bezel.

Portable Units
Combine carrying case with any Magnehelic® gage of standard range, except high pressure connection. Includes 9 ft. (2.7 m) of ⅜" I.D. rubber tubing, standhang bracket and terminal tube with holder.

Air Filter Gage Accessory Package
Adapts any standard Magnehelic® for use as an air filter gage. Includes aluminum surface mounting bracket with screws, two 5 ft. (1.5 m) lengths of ¼" aluminum tubing two static pressure tips and two molded plastic vent valves, integral compression fittings on both tips and valves.

Quality design and construction features



Bezel provides flange for flush mounting in panel.

Clear plastic face is highly resistant to breakage. Provides undistorted viewing of pointer and scale.

Precision litho-printed scale is accurate and easy to read.

Red tipped pointer of heat treated aluminum tubing is easy to see. It is rigidly mounted on the helix shaft.

Pointer stops of molded rubber prevent pointer over-travel without damage.

"Wishbone" assembly provides mounting for helix, helix bearings and pointer shaft.

Jeweled bearings are shock-resistant mounted; provide virtually friction-free motion for helix. Motion damped with high viscosity silicone fluid.

Zero adjustment screw is conveniently located in the plastic cover, and is accessible without removing cover. O-ring seal provides pressure tightness.

Helix is precision made from an alloy of high magnetic permeability. Mounted in jeweled bearings, it turns freely, following the magnetic field to move the pointer across the scale.

O-ring seal for cover assures pressure integrity of case.

Blowout plug of silicone rubber protects against overpressure on 15 psig rated models. Opens at approximately 25 psig.

Die cast aluminum case is precision made and iridite-dipped to withstand 168 hour salt spray corrosion test. Exterior finished in baked dark gray hammerloid. One case size is used for all standard pressure options, and for both surface and flush mounting.

Silicone rubber diaphragm with integrally molded O-ring is supported by front and rear plates. It is locked and sealed in position with a sealing plate and retaining ring. Diaphragm motion is restricted to prevent damage due to overpressures.

Calibrated range spring is flat spring steel. Small amplitude of motion assures consistency and long life. It reacts to pressure on diaphragm. Live length adjustable for calibration.

Samarium Cobalt magnet mounted at one end of range spring rotates helix without mechanical linkages.

MODELS

Dual Scale English/Metric Models		
Model Number	**Range, in. W.C.**	**Range, Pa or kPa**
2000-0D	0-0.5	0-125 Pa
2001D	0-1.0	0-250 Pa
2002D	0-2.0	0-500 Pa
2003D	0-3.0	0-750 Pa
2004D	0-4.0	0-1.0 kPa
2006D	0-6.0	0-1.5 kPa
2008D	0-8.0	0-2.0 kPa
2010D	0-10	0-2.5 kPa

SERIES 2000 MAGNEHELIC® — MODELS AND RANGES

The models below will fulfill most requirements. Page 11 also shows examples of special models built for OEM customers. For special scales furnished in ounces per square inch, inches of mercury, metric units, etc., contact the factory.

Model Number	Range Inches of Water
2000-00†••	0-.25
2000-0†•	0-.50
2001	0-1.0
2002	0-2.0
2003	0-3.0
2004	0-4.0
2005	0-5.0
2006	0-6.0
2008	0-8.0
2010	0-10
2015	0-15
2020	0-20
2025	0-25
2030	0-30
2040	0-40
2050	0-50
2060	0-60
2080	0-80
2100	0-100
2150	0-150

Model Number	Range Zero Center Inches of Water
2300-0†•	.25-0-.25
2301	.5-0-.5
2302	1-0-1
2304	2-0-2
2310	5-0-5
2320	10-0-10
2330	15-0-15

Model Number	Range PSI
2201	0-1
2202	0-2
2203	0-3
2204	0-4
2205	0-5
2210*	0-10
2215*	0-15
2220*	0-20
2230**	0-30

*MP option standard
**HP option standard

Dual Scale Air Velocity Units

Model Number	Range in W.C. Velocity, F.P.M.
2000-00AV†••	0-.25/300-2000
2000-0AV†•	0-.50/500-2800
2001AV	0-1.0/500-4000
2002AV	0-2.0/1000-5600
2010AV	0-10/2000-12500

For use with pitot tube.

Model Number	Range MM of Water
2000-6MM†••	0-6
2000-10MM†•	0-10
2000-25MM	0-25
2000-50MM	0-50
2000-80MM	0-80
2000-100MM	0-100
Zero Center Ranges	
2300-20MM†	10-0-10

Model Number	Range, CM of Water
2000-15CM	0-15
2000-20CM	0-20
2000-25CM	0-25
2000-50CM	0-50
2000-80CM	0-80
2000-100CM	0-100
2000-150CM	0-150
2000-200CM	0-200
2000-250CM	0-250
2000-300CM	0-300
Zero Center Ranges	
2300-4CM	2-0-2
2300-10CM	5-0-5
2300-30CM	15-0-15

Model Number	Range, Pascals
2000-60PA†••	0-60
2000-100PA†•	0-100
2000-125PA†•	0-125
2000-250PA	0-250
2000-300PA	0-300
2000-500PA	0-500
2000-750PA	0-750
Zero Center Ranges	
2300-250PA	125-0-125
2300-500PA	250-0-250

Model Number	Range, Kilopascals
2000-1KPA	0-1
2000-1.5KPA	0-1.5
2000-2KPA	0-2
2000-3KPA	0-3
2000-4KPA	0-4
2000-5KPA	0-5
2000-8KPA	0-8
2000-10KPA	0-10
2000-15KPA	0-15
2000-20KPA	0-20
2000-25KPA	0-25
2000-30KPA	0-30
Zero Center Ranges	
2300-1KPA	.5-0-.5
2300-3KPA	1.5-0-1.5

Accessories

A-299, Surface Mounting Bracket
A-300, Flat Flush Mounting Bracket.....
A-310A, 3-Way Vent Valve.....
A-321, Safety Relief Valve.....
A-432, Portable Kit.....
A-605, Air Filter Kit.....
A-610, Pipe Mount Kit.....

Options — To order, add suffix: I.E. 2001-ASF
ASF (Adjustable Signal Flag)
HP (High Pressure Option)
LT (Low Temperatures to -20°F)
MP (Med. Pressure Option)
SP (Setpoint Indicator)

Scale Overlays — Red, Green, Mirrored or Combination. Specify Locations

Special Purpose Ranges

Scale No. 2401 Square Root Specify Range
Scale No. 2402 Blank Scale Specify Range

Model 2000-00N. range -.05 to +.20" W.C. For room pressure monitoring

1011R01-0296P

†These ranges calibrated for vertical scale position.
• Accuracy +/-3%. •• Accuracy +/-4%

Air Velocity Measurement

Introduction

In air conditioning, heating and ventilating work, it is helpful to understand the techniques used to determine air velocity. In this field, *air velocity* (distance traveled per unit of time) is usually expressed in feet per minute (FPM). By multiplying air velocity by the cross section area of a duct, you can determine the air volume flowing past a point in the duct per unit of time. *Volume flow* is usually measured in cubic feet per minute (CFM).

Velocity or volume measurements can often be used with engineering handbook or design information to reveal proper or improper performance of an airflow system. The same principles used to determine velocity are also valuable in working with pneumatic conveying, flue gas flow and process gas systems. However, in these fields the common units of velocity and volume are sometimes different from those used in air conditioning work.

To move air, fans or blowers are usually used. They work by imparting motion and pressure to the air with either a screw propeller or paddle wheel action. When force or pressure from the fan blades causes the air to move, the moving air acquires a force or pressure component in its direction of motion due to its weight and inertia. Because of this, a flag or streamer will stand out in the air stream. This force is called *velocity pressure*. It is measured in inches of water column (w.c.) or water gage (w.g.). In operating duct systems, a second pressure is always present. It is independent of air velocity or movement. Known as *static pressure*, it acts equally in all directions. In air conditioning work, this pressure is also measured in inches w.c.

In pressure or supply systems, static pressure will be positive on the discharge side of the fan. In exhaust systems, a negative static pressure will exist on the inlet side of the fan. When a fan is installed midway between the inlet and discharge of a duct system, it is normal to have a negative static pressure at the fan inlet and positive static pressure at its discharge.

Total pressure is the combination of static and velocity pressures, and is expressed in the same units. It is an important and useful concept to use because it is easy to determine and, although velocity pressure is not easy to measure directly, it can be determined easily by subtracting static pressure from total pressure. This subtraction need not be done mathematically. It can be done automatically with the instrument hook-up.

Sensing Static Pressure

For most industrial and scientific applications, the only air measurements needed are those of static pressure, total pressure and temperature. With these, air velocity and volume can be quickly calculated.

To sense static pressure, six types of devices are commonly used. These are connected with tubing to a pressure indicating instrument. Fig. 1-A shows a simple thru-wall static pressure tap. This is a sharp, burr-free opening through a duct wall provided with a tubing connection of some sort on the outside. The axis of the tap or opening must be perpendicular to the direction of flow. This type of tap or sensor is used where air flow is relatively slow, smooth and without turbulence. If turbulence exists, impingement, aspiration or unequal distribution of moving air at the opening can reduce the accuracy of readings significantly.

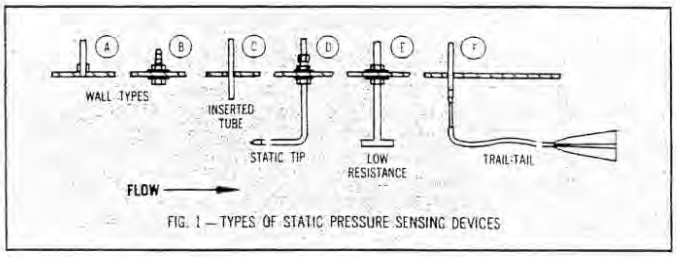


FIG. 1 – TYPES OF STATIC PRESSURE SENSING DEVICES

Fig. 1-B shows the Dwyer No. A-308 Static Pressure Fitting. Designed for simplified installation, it is easy to install, inexpensive, and provides accurate static pressure sensing in smooth air at velocities up to 1500 FPM.

Fig. 1-C shows a simple tube through the wall. Limitations of this type are similar to wall type Fig. 1-A.

Fig. 1-D shows a static pressure tip which is ideal for applications such as sensing the static pressure drop across industrial air filters and refrigerant coils. Here the probability of air turbulence requires that the pressure sensing openings be located away from the duct walls to minimize impingement and aspiration and thus insure accurate readings. For a permanent installation of this type, the Dwyer No. A-301 or A-302 Static Pressure Tip is used. It senses static pressure through radially-drilled holes near the tip and can be used in air flow velocities up to 12,000 FPM.

Fig. 1-E shows a Dwyer No. A-305 low resistance Static Pressure Tip. It is designed for use in dust-laden air and for rapid response applications. It is recommended where a very low actuation pressure is required for a pressure switch or indicating gage – or where response time is critical.

Under field conditions, air turbulence in a duct or plenum often makes it impossible to quickly install and align a rigid static pressure sensor to take accurate readings. Under these circumstances, the Dwyer Trail-Tail® Static Pressure Sensor (Fig. 1-F), can be quickly inserted through a small hole in the duct and will trail into automatic alignment with the air stream. The pressure sensing holes in this device are thus presented at a 90° angle to actual air flow assuring quick, consistent, accurate readings.

Measuring Total Pressure and Velocity Pressure

In sensing static pressure we make every effort to eliminate the effect of air movement. To determine velocity pressure, it is necessary to determine these effects fully and accurately. This is usually done with an impact tube which faces directly into the air stream. This type of sensor is frequently called a "total pressure pick-up" since it receives the effects of both static pressure and velocity pressure.

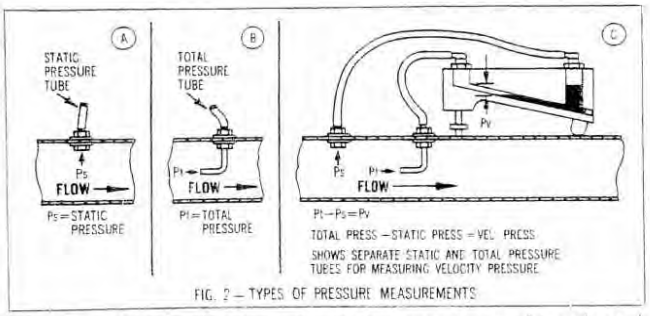


FIG. 2 – TYPES OF PRESSURE MEASUREMENTS

In Figure 2, note that separate static connections (A) and total pressure connections (B) can be connected simultaneously across a manometer (C). Since the static pressure is applied to both sides of the manometer, its effect is cancelled out and the manometer indicates only the velocity pressure.

To translate velocity pressure into actual velocity requires either mathematical calculation, reference to charts or curves, or prior calibration of the manometer to directly show velocity. In practice this type of measurement is usually made with a Pitot tube which incorporates both static and total pressure sensors in a single unit.

Essentially, a Pitot tube consists of an impact tube (which receives total pressure input) fastened concentrically inside a second tube of slightly larger diameter which receives static pressure input from radial sensing holes around the tip. The air space between the inner and outer tubes permits transfer of pressure from the sensing holes to the static pressure connection at the opposite end of the Pitot tube and then, through connecting tubing, to the low or negative pressure side of a manometer. When the total pressure tube is connected to the high pressure side of the manometer, velocity pressure is indicated directly. See Figure 3.

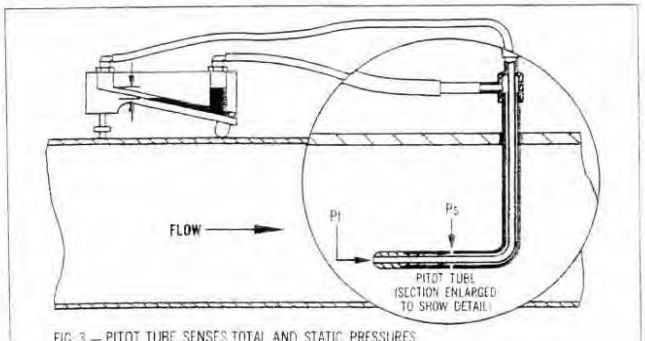


FIG. 3 – PITOT TUBE SENSES TOTAL AND STATIC PRESSURES. MANOMETER MEASURES VELOCITY PRESSURE – (DIFFERENCE BETWEEN TOTAL AND STATIC PRESSURES)

Since the Pitot tube is a primary standard device used to calibrate all other air velocity measuring devices, it is important that great care be taken in its design and fabrication. In modern Pitot tubes, proper nose or tip design – along with sufficient distance between nose, static pressure taps and stem – will minimize turbulence and interference. This allows use without correction or calibration factors. All Dwyer Pitot tubes are built to AMCA and ASHRAE standards and have unity calibration factors to assure accuracy.

To insure accurate velocity pressure readings, the Pitot tube tip must be pointed directly into (parallel with) the air stream. As the Pitot tube tip is parallel with the static pressure outlet tube, the latter can be used as a pointer to align the tip properly. When the Pitot tube is correctly aligned, the pressure indication will be maximum.

Because accurate readings cannot be taken in a turbulent air stream, the Pitot tube should be inserted at least 8½ duct diameters downstream from elbows, bends or other obstructions which cause turbulence. To ensure the most precise measurements, straightening vanes should be located 5 duct diameters upstream from the Pitot tube.

How to Take Traverse Readings

In practical situations, the velocity of the air stream is not uniform across the cross section of a duct. Friction slows the air moving close to the walls, so the velocity is greater in the center of the duct.

To obtain the average total velocity in ducts of 4" diameter or larger, a series of velocity pressure readings must be taken at points of equal area. A formal pattern of sensing points across the duct cross section is recommended. These are known as traverse readings. Figure 4 shows recommended Pitot tube locations for traversing round and rectangular ducts.

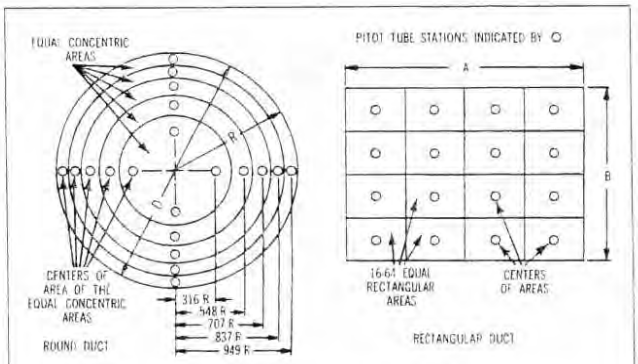


FIG. 4 – TRAVERSE ON ROUND AND SQUARE DUCT AREAS

In round ducts, velocity pressure readings should be taken at centers of equal concentric areas. At least 20 readings should be taken along two diameters. In rectangular ducts, a minimum of 16 and a maximum of 64 readings are taken at centers of equal rectangular areas. Actual velocities for each area are calculated from individual velocity pressure readings. This allows the readings and velocities to be inspected for errors or inconsistencies. The velocities are then averaged.

By taking Pitot tube readings with extreme care, air velocity can be determined within an accuracy of ±2%. For maximum accuracy, the following precautions should be observed:

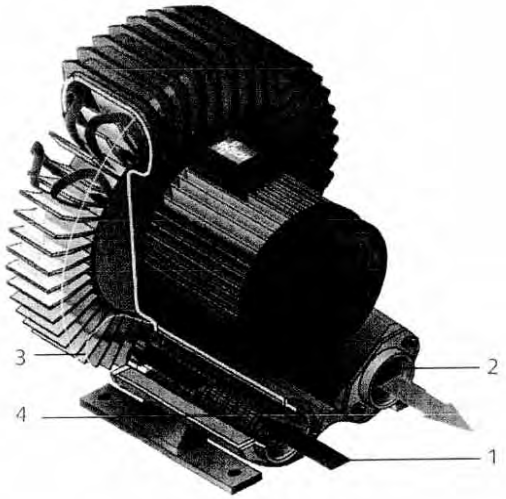
1. Duct diameter should be at least 30 times dia. of Pitot tube.
2. Locate the Pitot tube in a duct section providing 8½ or more duct diameters upstream and 5 or more diameters down stream of Pitot tube free of elbows, size changes or obstructions.
3. Provide an egg-crate type of flow straightener 5 duct diameters upstream of Pitot tube.
4. Make a complete, accurate traverse.

In small ducts or where traverse operations are otherwise impossible, an accuracy of ±5% can frequently be achieved by placing Pitot tube in center of duct. Determine velocity from the reading then multiply by 0.9 for an approximate average.

Regenerative Blowers

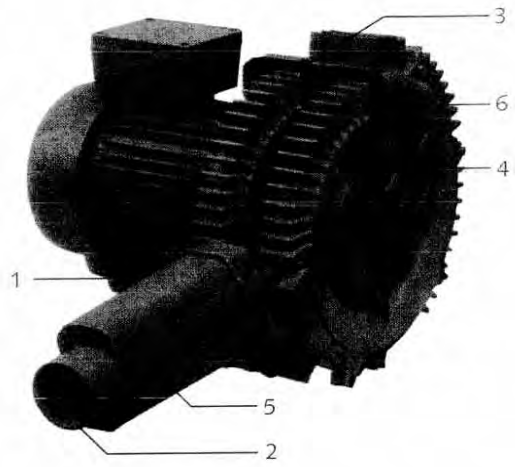
Operating Principle

Single-stage version



1. Gas Inlet
2. Gas outlet
3. Impeller
4. Silencer

Two-stage version



1. Gas inlet
2. Gas outlet
3. Impeller 1st stage
4. Impeller 2nd stage
5. Silencer
6. Side channel

Operating Principle

Gases are drawn in through the blower inlet. As the impeller rotates, it transfers kinetic energy to the gases being pumped. As a result, the gases move forward through a corkscrew shaped path and are compressed, then discharged through the pressure side exhaust silencer. The impeller is mounted directly on the motor shaft.

Applications

Pneumatic conveying

Transport and lifting system

Carton forming and packaging

Vacuum holddown

Materials handling

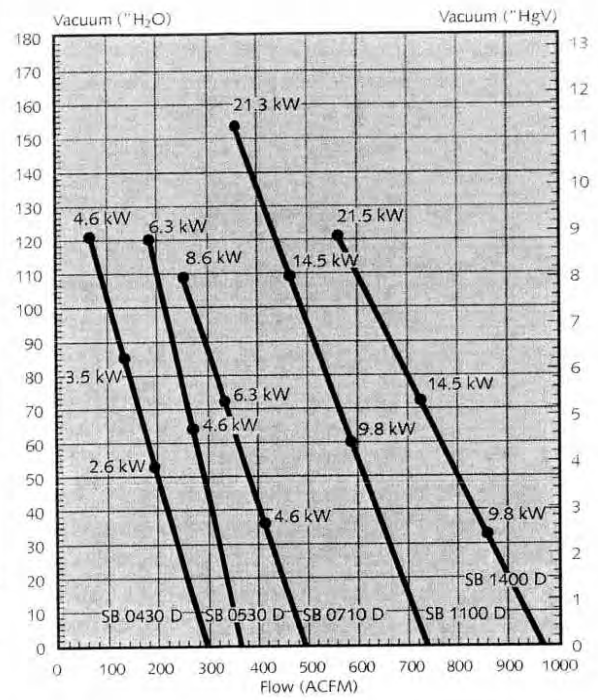
Soil remediation

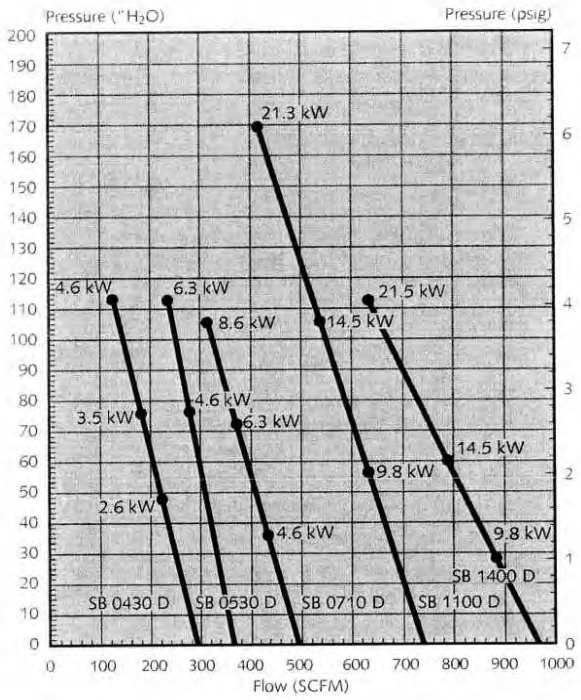
Trim removal

Wood routers

Printing industry applications

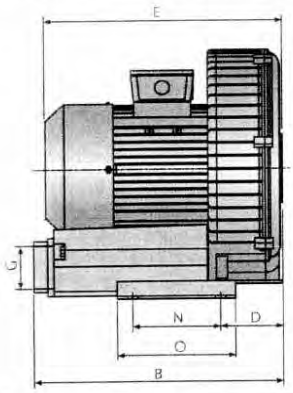
Technical Data Samos SB 0430 - 1400 D (single stage)

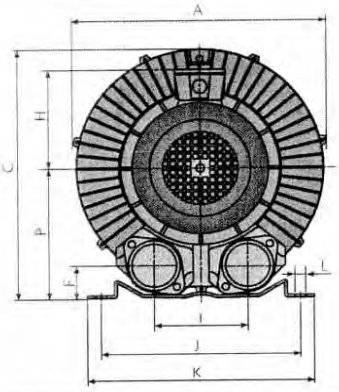




Technical Data	Nominal Pumping Speed	Max. Vacuum		Max Pressure		Motor (60 Hz)			Sound	Weight
Model	ACFM	"H2O	"Hg	"H2O	psig	kW	Hp	RPM	dB (A)	lbs
SB 0430 D	294	52	3.8	48	1.7	2.6	3.5	3450	73	64
SB 0430 D	294	85	6.2	76	2.7	3.5	4.7	3450	73	75
SB 0430 D	294	121	8.9	113	4.1	4.6	6.2	3450	73	92
SB 0530 D	365	64	4.7	56	2.0	4.6	6.2	3450	74	246
SB 0530 D	365	121	8.9	113	4.1	6.3	8.4	3450	74	251
SB 0710 D	494	36	2.6	36	1.3	4.6	6.2	3450	74	246
SB 0710 D	494	72	5.3	72	2.6	6.3	8.4	3450	74	277
SB 0710 D	494	109	8.0	105	3.8	8.6	11.5	3450	74	282
SB 1100 D	736	60	4.4	56	2.0	9.8	13.1	3450	79	378
SB 1100 D	736	109	8.0	105	3.8	14.5	19.4	3450	79	420
SB 1100 D	736	153	11.2	169	6.1	21.3	28.6	3450	79	449
SB 1400 D	968	32	2.3	28	1.0	9.8	13.1	3450	80	383
SB 1400 D	968	72	5.3	64	2.3	14.5	19.4	3450	80	425
SB 1400 D	968	121	8.9	113	4.1	21.5	28.8	3450	80	453

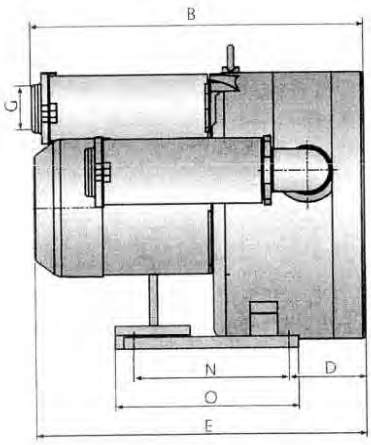
Dimensions Samos SB 0050 - 1400 D (single stage)

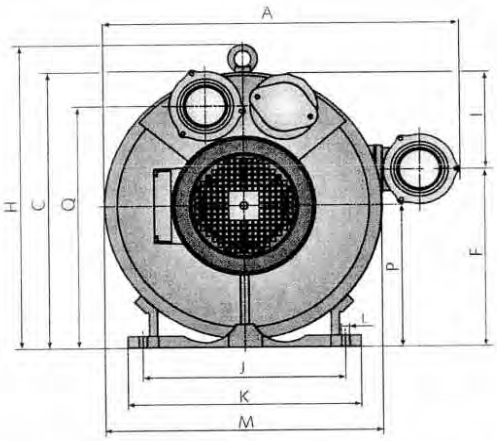




Model	A	B	C	D	E	F	G (NPT)	H	I	J	K	L	N	O	P
SB 0050 D	9 3/4	9 1/16	9 13/16	2 13/16	10 3/16	1 9/16	1 1/4	4 3/8	3 9/16	8 1/16	9 1/16	3/8	3 1/4	4 1/4	5 1/8
SB 0080 D	9 3/4	9 1/16	9 13/16	2 13/16	10 3/16	1 9/16	1 1/4	4 3/8	3 9/16	8 1/16	9 1/16	3/8	3 1/4	4 1/4	5 1/8
SB 0140 D	11 5/16	9 1/2	12	3	10 11/16	1 13/16	1 1/2	5 3/16	4 1/2	8 7/8	10 1/16	1/2	3 3/4	5 1/8	6 1/8
SB 0200 D	13 1/4	11 3/4	13 3/8	3 7/16	12 1/2	1 7/8	2	6 1/4	4 3/4	10 1/4	11 5/8	9/16	4 1/2	6 1/8	6 15/16
SB 0310 D	15 1/16	13 1/8	15 3/16	4 5/16	14 15/16	2 1/8	2	7 3/16	4 15/16	11 7/16	12 13/16	9/16	5 1/2	7 1/16	7 7/8
SB 0430 D	14 7/8	14 3/16	15 3/16	3 7/8	17 5/16	2 1/8	2	5 13/16	4 15/16	11 7/16	12 13/16	9/16	5 1/2	7 1/16	7 7/8
SB 0530 D	19 11/16	19 1/2	20 5/16	1 3/8	18 5/8	3 3/16	2 1/2	NA	5 11/16	14 3/8	16 9/16	9/16	11	12 7/16	10 1/2
SB 0710 D	19 11/16	19 1/2	20 5/16	11/16	19 7/16	3 3/16	2 1/2	NA	5 11/16	14 3/8	16 9/16	9/16	11	12 7/16	10 1/2
SB 1100 D	21 15/16	28 5/8	24 7/8	4 1/4	24 15/16	3 9/16	4	NA	8 1/8	14 3/16	16 5/16	9/16	23 7/16	NA	11 7/8
SB 1400 D	21	24 13/16	22 3/8	4 1/4	27 11/16	3 9/16	4	7 3/4	8 1/8	14 3/16	16	9/16	23 7/16	NA	11 7/8

Dimensions Samos SB 0530 D2 (two stage)





Model	A	B	C	D	E	F	G (NPT)	H	I	J	K	L	M	N	O	P	Q
SB 0530 D2	25 1/8	23 3/4	20 5/16	5 9/16	23 11/16	13 1/8	2 1/2	22 3/8	7 3/16	14 3/8	16 9/16	9/16	19 11/16	11	12 7/16	10 1/2	17 15/16

All dimensions in inches unless otherwise noted.

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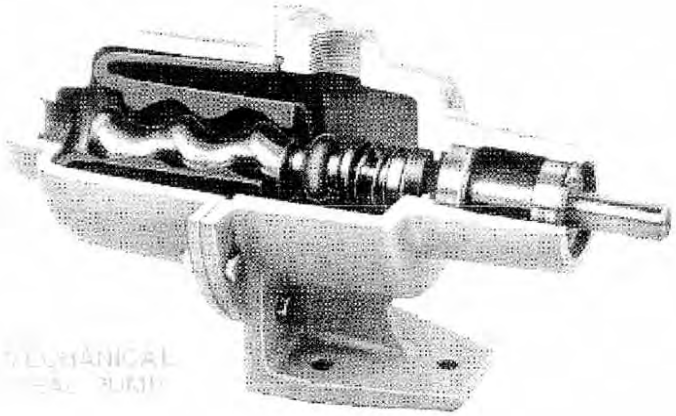
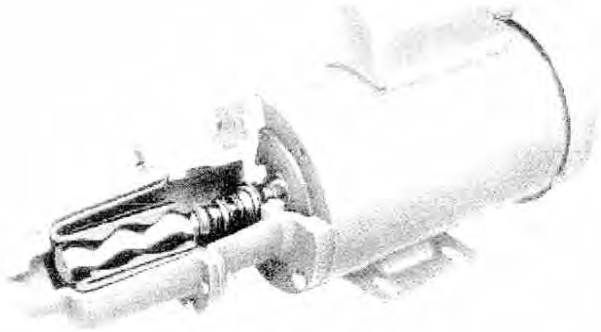
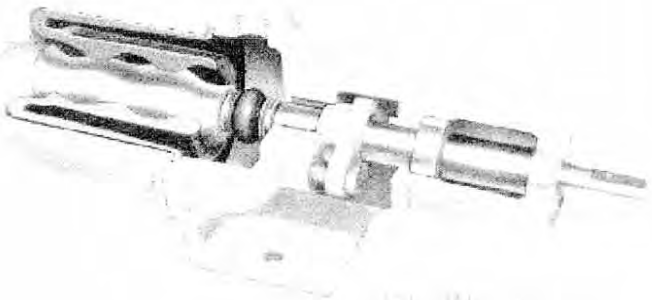


ONLY ONE MOVING PART!





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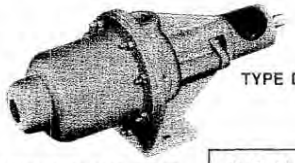
LOW COST COMPACT UNITS for every requirement!

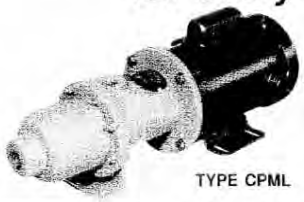
TYPE M

MECHANICAL SEAL PUMP



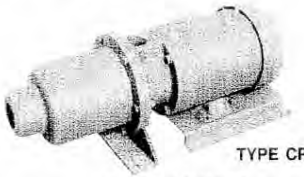
TYPE D

PACKING GLAND PUMP



TYPE CPML

CLOSE COUPLED MOTOR-DRIVEN PUMP



TYPE CPM

CLOSE COUPLED MOTOR-DRIVEN PUMP

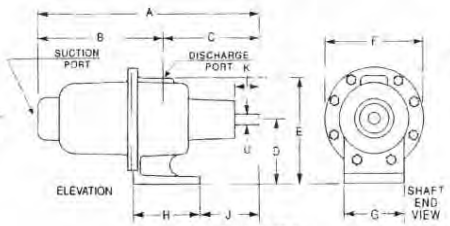
CONTINENTAL PROGRESSING CAVITY PUMP MODELS TYPE

• PUMP FRAME SIZES •	•PORT SIZES• NPT		• PUMP TYPE • MATERIALS OF CONSTRUCTION								• DIMENSIONS • SEE NOTE BELOW											SHIPPING WEIGHTS (APPROXIMATE)
			BODY CASTINGS		ROTORS	STATORS			SEALS													
	INLET SUCTION	OUTLET DISCHARGE	"C" CAST IRON	"S" STAINLESS STEEL	"S" STAINLESS STEEL	"Q" BUNA	"B" EPDM	"F" VITON	"M" MECHANICAL	"D" PACKING GLAND	A	B	C	D	E	F	G	H	J	K	U	
CP-15 • CP-22 • CP-33 • CP-44	3/4"	3/4"	✓	✓	✓	✓	✓	✓	✓		12-7/16"	6-13/16"	5-5/8"	3-1/2"	5-3/4"	5-1/2"	3-1/4"	3-1/16"	3-3/8"	1-7/16"	5/8"	15 Lbs.
CP-15 • CP-22 • CP-33 • CP-44	3/4"	3/4"	✓	✓	✓	✓	✓	✓		✓	14-3/4"	6-1/4"	8-1/2"	3-1/2"	5-13/16"	5-1/2"	3-1/4"	3"	6-7/16"	1-7/16"	5/8"	18 Lbs.
CPM-15 • CPM-22 • CPM-33 • CPM-44	3/4"	3/4"	✓		✓	✓	✓	✓	✓		18-5/16"	11-1/2"	6-13/16"	3-1/2"	5-7/8"	6-5/8"	6-1/2"	4-1/2"	10-5/8"	7"		48 Lbs.
CPML-15 • CPML-22 • CPML-33 • CPML-44	3/4"	3/4"	✓	✓	✓	✓	✓	✓	✓		20-9/16"	13-3/4"	6-13/16"	3-1/2"	5-7/8"	6-5/8"	6-1/2"	4-1/2"	12-7/8"	7"		52 Lbs.
CP-56	1-1/2"	1-1/4"	✓	✓	✓	✓	✓	✓	✓		16-11/16"	9-3/4"	6-15/16"	4-9/32"	7-9/32"	7-1/2"	6"	4-3/4"	3-9/16"	2-3/8"	3/4"	40 Lbs.
CP-56	1-1/2"	1-1/4"	✓	✓	✓	✓	✓	✓		✓	18-13/16"	9-3/4"	9-1/16"	4-9/32"	7-9/32"	7-1/2"	6"	4-3/4"	5-11/16"	2-3/8"	3/4"	44 Lbs.
CPM-56	1-1/2"	1-1/4"	✓		✓	✓	✓	✓	✓		22-1/4"	12-1/2"	9-3/4"	4-1/2"	7-1/2"	7-1/2"	9"	10"	12-1/4"	8-1/4"		80 Lbs.
CPML-56	1-1/2"	1-1/4"	✓	✓	✓	✓	✓	✓	✓		24-11/16"	14-15/16"	9-3/4"	4-1/2"	7-1/2"	7-1/2"	9"	10"	14-11/16"	8-1/4"		85 Lbs.
CP-67	2"	2"	✓	✓	✓	✓	✓	✓	✓		19-9/16"	11-15/16"	7-5/8"	4-1/2"	8-1/4"	8-1/4"	6"	4-7/8"	4-9/16"	2-1/8"	1"	85 Lbs.
CP-67	2"	2"	✓	✓	✓	✓	✓	✓		✓	22"	12"	10"	4-1/2"	8-1/4"	8-1/4"	6"	4-3/4"	7-1/8"	2-1/8"	1"	90 Lbs.
CPM-67	2"	2"	✓		✓	✓	✓	✓	✓		24-5/8"	12-5/8"	12"	4-1/2"	7-3/4"	8-1/4"	9"	10"	14-5/8"	8-5/8"		117 Lbs.
CPML-67	2"	2"	✓	✓	✓	✓	✓	✓	✓		27-1/16"	15-1/16"	12"	4-1/2"	7-3/4"	8-1/4"	9"	10"	17-1/16"	8-5/8"		125 Lbs.

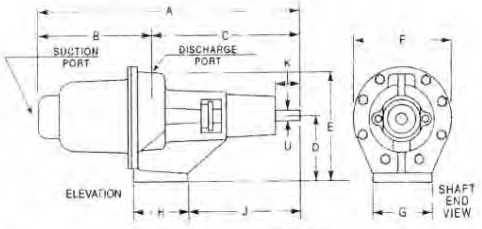
NOTE: TYPE PUMP DESIGNATION:
AFTER PUMP FRAME SIZE
1ST LETTER - BODY CASTING - "C" OR "S"
2ND LETTER - ROTOR - "S"
3RD LETTER - STATOR - "Q", "B" OR "F"
4TH LETTER - TYPE OF SEAL - "M" OR "D"

EXAMPLES OF COMPLETE MODEL DESIGNATIONS
FRAME CP-15-CSQM
FRAME CP-15-SSQD
FRAME CPM-56-CSQM
FRAME CPML-56-CSQM
FRAME CP-67-CSQD

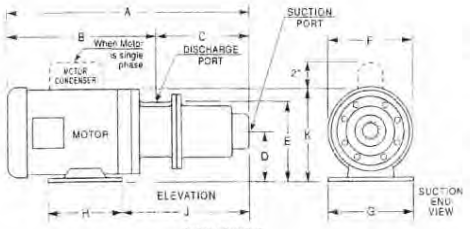
NOTE: ALL DIMENSIONS, EXCEPT "U" MAY VARY BY 1/8".
DO NOT USE ABOVE DIMENSIONS FOR LIMITED SPACE INSTALLATIONS.
REQUEST CERTIFIED DRAWING.
WHERE "U" IS 5/8", -.000"-.002" SHAFT HAS FLAT KEYSEAT 1/16" DEEP x 1" LONG
"U" IS 3/4", -.000"-.002" SHAFT HAS FLAT KEYSEAT 1/16" DEEP x 1" LONG
"U" IS 1", -.000"-.002" KEYWAY 1/4" WIDE x 1/8" DEEP x 2" LONG



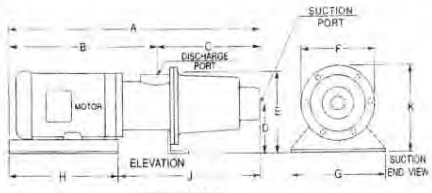
PUMP MODELS
CP-15M • CP-22M • CP-33M • CP-44M • CP-56M • CP-67M
MECHANICAL SEAL-TYPE



PUMP MODELS
CP-15D • CP-22D • CP-33D • CP-44D • CP-56D • CP-67D
PACKING GLAND TYPE



PUMP MODELS
CPM-15 • CPM-22 • CPM-33 • CPM-44 • CPML-15 • CPML-22 • CPML-33 • CPML-44
CLOSE COUPLED MOTOR DRIVEN TYPE



PUMP MODELS
CPM-56 • CPML-56 • CPM-67 • CPML-67
CLOSE COUPLED MOTOR DRIVEN TYPE

. . . YIELD OUTSTANDING PERFORMANCE

APPLICATION OF CONTINENTAL PROGRESSING CAVITY PUMPS

Speed, temperature, viscosity, suction lift, discharge pressure, abrasive content and corrosive action of the liquid to be handled should all be considered in applying these pumps. Pump should always be filled with the liquid to be handled before running. The liquid serves as a lubricant and is easily poured into pump through the discharge port before final assembly of the piping or hose connections. A filling tee with a plug or valve can be installed above the discharge port for ease in filling.

Liquid to be pumped should never exceed 190°F temperature. Maximum speed that any of these pumps should be run is 2,800 rpm and then only in handling thin, abrasive-free liquids. Preferably the speed should be 1,750 rpm for longest life. When liquid contains abrasive material or is viscous, the speed should be reduced.

For various viscosities of abrasive-free liquids, the maximum operating speed of the pump is set forth below:

SUGGESTED MAXIMUM OPERATING SPEED OF PUMP							
2000 RPM	1750 RPM	1150 RPM	870 RPM	580 RPM	430 RPM	290 RPM	190 RPM
VISCOSITY (Centipoise)							
1 to 100	1 to 100	100 to 500	500 to 1000	1000 to 3000	3000 to 5000	5000 to 10,000	10,000 to 20,000
Water	Gasoline, Milk	30 Weight Oil	Table Syrup	Honey	Molasses	Paste	Peanut Butter
ABRASIVE FLUIDS							
None	None	None	Light	Medium	Medium	Heavy	Heavy
	Clear Water, Gasoline		Dirty Water	City Slurries, Petroleum Cracked		Lapping Compounds, Mill Scale in Water	

Capacity and life of these pumps will depend upon the liquid being handled.

Piping to pump should be properly selected and should not be smaller in size than the suction and discharge ports of the pump. All pipe and hose fitting joints should be tight. Discharge lines should be open or if pump is operated in an enclosed system, provision should be made for pressure relief when the pump pressure exceeds the limits as set forth for each model pump.

Pump bearings do not require lubrication as they are pre-lubricated.

We recommend that the pump be flushed after its use.

PUMP SHOULD NOT BE RUN DRY.

We will be glad to collaborate on any proposed applications.

Fill in CDP/CMP/CP PUMP DATA Sheet and return for a prompt recommendation. Request copies if not with this Bulletin.

hundreds of different applications for . . . .

INDUSTRY
COMMERCE
AGRICULTURE

PERFORMANCE DATA							
MODEL NO.	DISCHARGE PRESSURE	CAPACITY-Gallons per Minute (Water at 70°F) PUMP SPEED					MOTOR HORSE POWER
		1750 rpm	1150 rpm	870 rpm	580 rpm	430 rpm	
CP 15	0	3.0	1.3	1.0	7	5	1/2
	25	1.7	1.0	5	2	1	
	50	1.5	.9	2			
	75	1.2	.8				
	100	1.0	.7				
	125	.8	.5				
	150	.6	.4				
CP 22	0	4.9	3.2	2.4	1.6	1.2	1/2
	25	4.1	2.7	2.0	1.3	.9	
	50	3.4	2.2	1.6	1.0	.7	
	75	2.6	1.7	1.3	.8	.6	
	100	2.0	1.5	1.0	.6	4	
CP 33	0	9.4	6.0	4.6	3.1	2.3	1/2
	25	7.0	4.5	3.4	2.3	1.7	
	50	4.2	2.7	2.0	1.3	.9	
CP 44	0	15.0	9.7	7.3	4.9	3.5	1/2 - 3/4
	25	12.0	7.8	5.9	4.0	2.9	
	50	8.4	6.1	4.6	3.1	2.3	
CP 66	0	24.0	15.5	11.7	7.9	5.8	1
	25	22.0	14.3	10.7	7.2	5.3	
	35	20.5	13.3	10.0	6.7	4.9	
	50	19.5	12.7	9.5	6.4	4.1	
CP 67	0	53.0	44.5	25.0	17.5	13.0	1
	10	45.0	31.0	23.4	15.8	11.7	
	20	43.6	28.0	21.0	14.0	10.3	
	35	34.8	27.0	16.5	11.0	8.1	1 1/2
	50	29.0	16.3	12.3	8.3	6.1	2

CT Series

High Pressure Centrifugal Pumps
½ - 2½ HP
Heads to 140 Feet
Capacities to 95 GPM

MYERS CT SERIES LINE OF HIGH PRESSURE CENTRIFUGAL PUMPS PROVIDES QUALITY AT A COMPETITIVE PRICE. The complete line of ½ to 2½ HP units provide strong pressures up to 140 feet and flows up to 95 gpm.

The rugged cast iron body construction is available with either a corrosion resistant composite or brass impeller. The brass impeller unit is equipped with a high temperature, viton seal for more demanding applications. The heavy duty motor features a double ball bearing, 50° C ambient, dual voltage design for dependable service. The compact, back pullout design provides easy installation and serviceability.

The quality features of the CT series will provide dependable service for a wide variety of applications.

SPECIFICATIONS

HP	Catalog No. Composite Impeller	Catalog No. Brass Impeller	Pipe Tapping Sizes Suction (NPT)	Pipe Tapping Sizes Discharge (NPT)	Motor Voltage	Phase	Approx Wt Lbs
½	CT05	CT05B	1¼"	1"	115/230	1	41
	CT053	CT05B3			208-230/460	3	41
¾	CT07	CT07B			115/230	1	43
	CT073	CT07B3			208-230/460	3	43
1	CT10	CT10B			115/230	1	45
	CT103	CT10B3			208-230/460	3	45
1½	CT15	CT15B			115/230	1	49
	CT153	CT15B3			208-230/460	3	49
2	CT20	CT20B			115/230	1	54
	CT203	CT20B3			208-230/460	3	54
2½	CT25	CT25B	2"	1½	115/230	1	62
	CT253	CT25B3			208/230/460	3	62

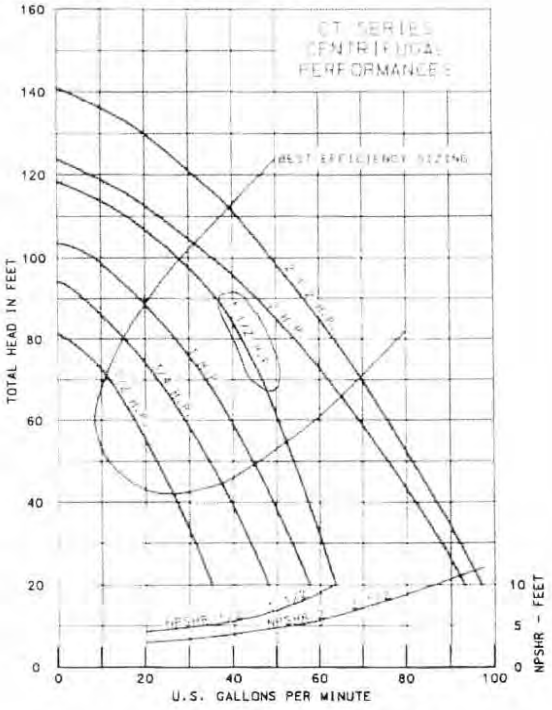
ADVANTAGES BY DESIGN

- Heavy duty cast iron construction.
- Back pull-out design.
- Dependable double ball bearing motor
- Continuous duty rating motor.
- Choice of brass or composite impeller.
- Brass impeller pumps rated 212° F.
- Composite impeller pumps rated 140° F.
- Maximum working pressure of 125 psi.
- CSA listed.

Applications

- Booster service
- Irrigation
- Circulating
- Cooling towers
- Air conditioning
- Liquid transfer
- Sprinkling systems
- General industrial service

PUMP PERFORMANCE



WHERE INNOVATION MEETS TRADITION

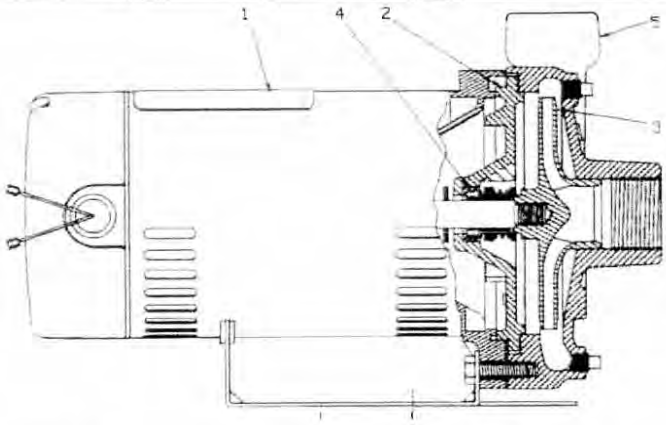
Myers®
Pentair Pump Group

ISO 9001 Registered Quality System

CT Series

High Pressure Centrifugal Pumps
½ - 2½ HP
Heads to 140 Feet
Capacities to 95 GPM

1. MOTOR
- NEMA standard
- Double ball bearing
- Open drip proof
- 60 Hz, 3450 rpm
- Stainless steel shaft
- Single phase with built-in overload protection
- Three phase require overload protection in starter unit
- Non-overloading
- Continuous duty
- Strong capacitor start design

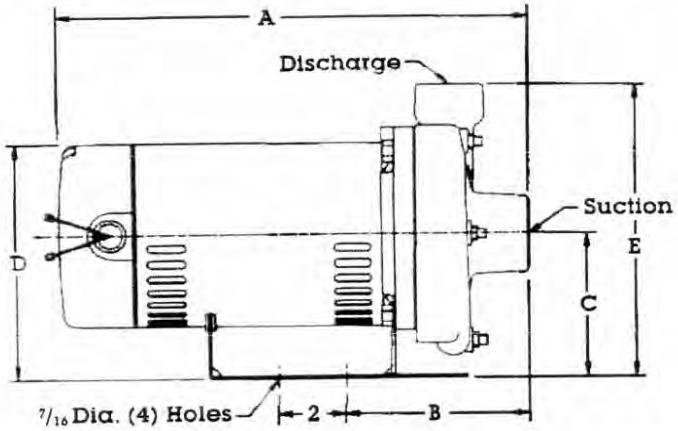


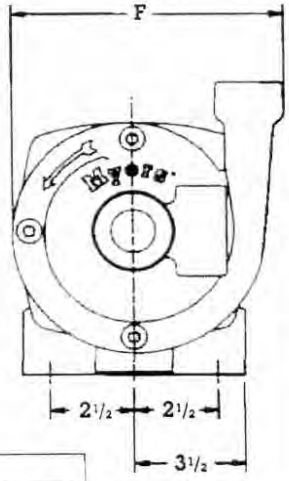
2. SEAL PLATE
- Heavy duty cast iron for dependable service and long life

3. IMPELLER
- Reinforced composite for applications to 140° F.
- Threaded SST insert on composite impellers
- Brass for applications to 212° F.
- Enclosed design for high efficiencies
- Balanced for smooth operation

4. MECHANICAL SEAL
- Standard carbon/ceramic faces, Buna elastomers, 300 series SST components (standard for pumps with composite impellers)
- High temperature carbon/ceramic faces, viton elastomers, 300 series SST components (standard for pumps with brass impellers)

5. CASING
- Heavy duty cast iron construction
- Back pull-out design
- Discharge can be rotated in four positions
- Tapped openings for priming, venting and draining.
- Vertical discharge standard





HP	Dimensions, inches							
	A	B	C	D	E	F	Suct.	Disch.
	13	5	4				1	1
	14	5	4				1	1
	15	5	4				1	1
1	15	5	4				1	1
2	16	5	4				1	1
2½	16½	6¼	4½	7½	9½	8⅞	2	1½

K3807 3/01
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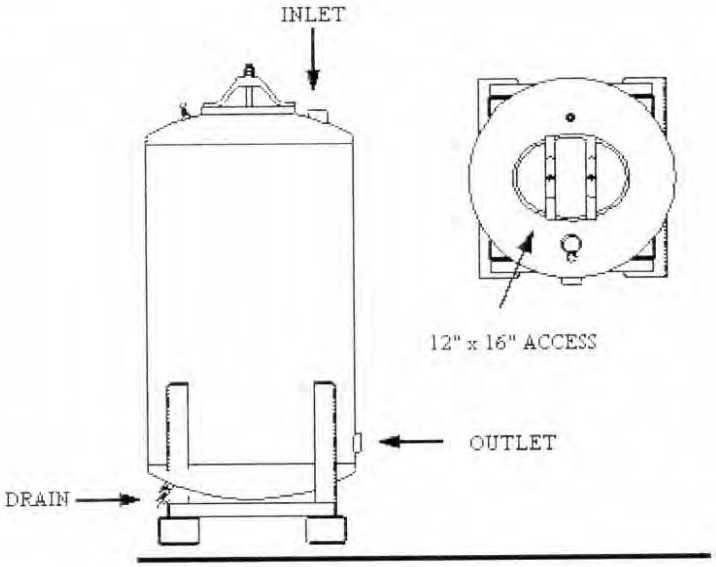
Myers®
Pentair Pump Group

F. E. Myers, 1101 Myers Parkway, Ashland, Ohio 44805-1969
419/289-1144, FAX: 419/289-6658, www.femyers.com

Myers (Canada), 269 Trillium Drive, Kitchener, Ontario N2G 4W5
519/748-5470, FAX: 519/748-2553

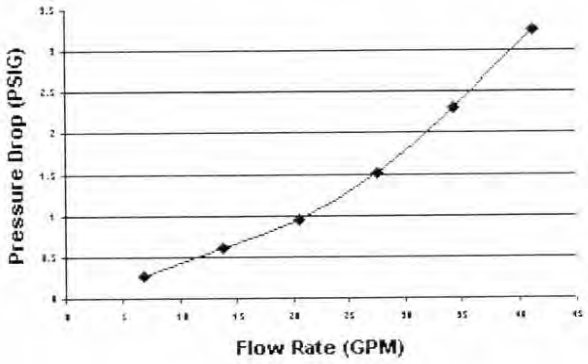
Liquid Phase Carbon

HPAF-500 SPECIFICATIONS			
Overall Height	5'11"	Vessel/Internal Piping Materials	CS (SA-36) / SCH 40 PVC
Diameter	30"	Internal Coating	Polyamide Epoxy Resin
Inlet / Outlet (FNPT)	2"	External Coating	Epoxy Mastic
Drain / Vent (FNPT)	1/2" / 1/4"	Maximum Pressure / Temp	75 PSIG / 140° F
GAC Fill (lbs)	500	Cross Sectional Bed Area	4.9 FT^2
Shipping / Operational Weight (lbs)	850/1,770	Bed Depth/Volume	3.4 FT / 16.7

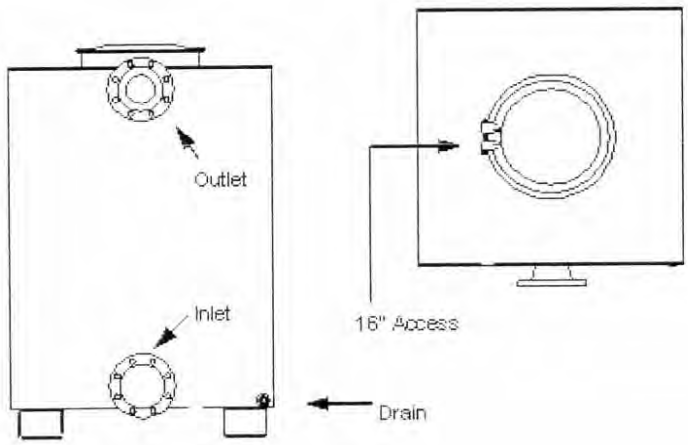


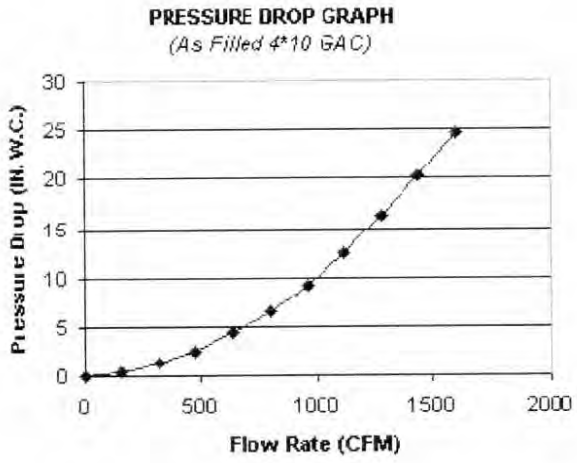
PRESSURE DROP GRAPH

*(As Filled - 9*30)*



VF-1000 SPECIFICATIONS			
Overall Height	4'8''	Vessel/Internal Piping Materials	CS/ CS (False Floor)
Footprint	4' x 4'	Internal Coating	Polyamide Epoxy Resin
Inlet / Outlet (150# FLNG)	6"	External Coating	Epoxy Mastic (Light Grey)
Drain / Vent (FNPT)	1/2"	Maximum Pressure / Temp	3 PSIG / 250° F
GAC Fill (lbs)	1000	Cross Sectional Bed Area	16 FT^2
Shipping / Operational Weight (lbs)	1,450/1,600	Bed Depth/Volume	2.2 FT / 36 FT^3





NORWESCO LST VERTICAL STORAGE TANKS

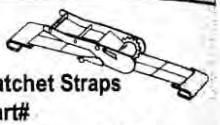
NORWESCO

Pre-season Discounts May Be Available on Norwesco Tanks-Call For Pricing.

Special Discounts on Full Loads-Call For Pricing

TO COMPARE QUALITY, COMPARE THE WARRANTIES OF OTHER BRANDS.

Don't be fooled by claims of quality, because a tank is made of crosslink or crossblend materials. Quality is due to thickness and workmanship and backed by a good warranty.



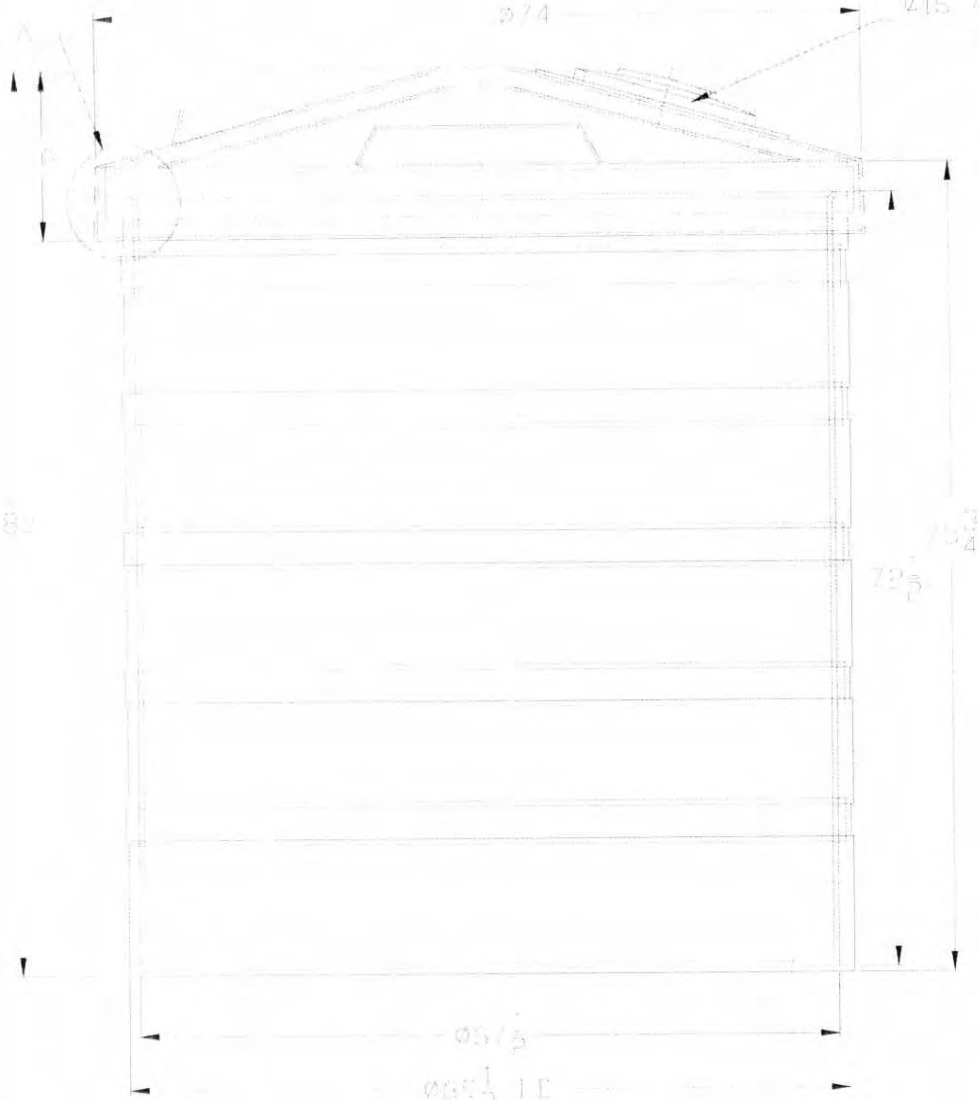
Ratchet Straps
Part#
List Price $48.00

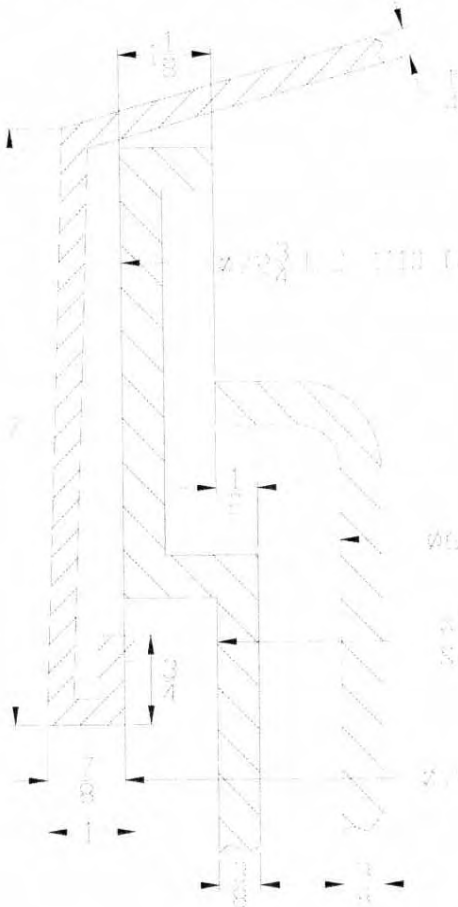
Tie-down slots to prevent slipping chains; a definite convenience for you.

For maximum drainage, our vertical storage tanks feature 2" or 3" polyethylene fittings with siphon tubes.

Snug fitting, self-vented, slosh-proof lids are standard on the NOR-WESCO LST line.

Vertical Storage Capacity	Diameter	Height	PART#	Premium Grade For 14# Solutions 3 Yr. Warranty List Price	H.D. Blue For 16# Solutions 5 Yr. Warranty List Price
10,000	141"	159"	NOR10000VERT	10,346.00	-HD 11,682.00
9000	141"	144"	NOR9000VERT	8,571.00	-HD 9,666.00
7800	120"	176"	NOR7800VERT	7,764.00	-HD 8,772.00
6500	120"	144"	NOR6500VERT	6,487.00	-HD 7,335.00
6000	102"	180"	NOR6000VERT	5,936.00	-HD 6,733.00
5000	102"	151"	NOR5000VERT	5,126.00	-HD 5,817.00
4000	102"	125"	NOR4000VERT	3,601.00	———
3000	95"	105"	NOR3000VERT	2,319.00	-HD 2,628.00
2500	95"	89"	NOR2500VERT	1,838.00	-HD 2,083.00
2100	87"	87"	NOR2100VERT	1,601.00	-HD 1,813.00
1700	87"	70"	NOR1700VERT	1,183.00	-HD 1,340.00
1550	87"	64"	NOR1550VERT	1,073.00	-HD 1,215.00
1500	64"	128"	NOR1500VERT	1,498.00	-HD 1,695.00
1100	87"	49"	NOR1100VERT	848.00	———
1000	64"	84"	NOR1000VERT	1,107.00	-HD 1,255.00
750	48"	102"	NOR750VERT	865.00	———
550	67"	42"	NOR550VERT	620.00	———
500	48"	70"	NOR500VERT	639.00	———
300	35"	78"	NOR300VERT	485.00	———
250	30"	89"	NOR250VERT	480.00	———
210	32"	69"	NOR210VERT	440.00	
200	30"	72"	NOR200VERT	450.00	———
165	31"	55"	NOR165VERT	375.00	----------
105	23"	63"	NOR105VERT	279.00	———
100	28"	43"	NOR100VERT	267.00	———
75	23"	50"	NOR75VERT	240.00	———
65	23"	38"	NOR65VERT	222.00	----------
50	18"	53"	NOR50VERT	183.00	———





NOTE: PRIMARY TANK - TC66/2AA
SECONDARY TANK - TL69/20C
CONTAINER TANK - C69CVDC

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OF ANY INFORMATION CONTAINED HEREIN

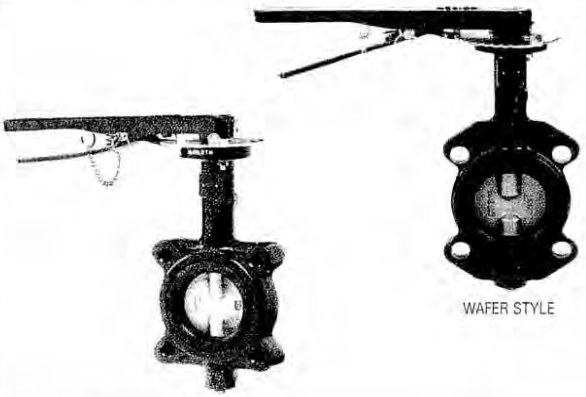
ALL DIMENSIONS SHOWN ARE OUTSIDE PART DIMENSIONS IN INCHES.
AND VARY BY THE STANDARD ROTATIONAL MOLDING TOLERANCE OF ±3%

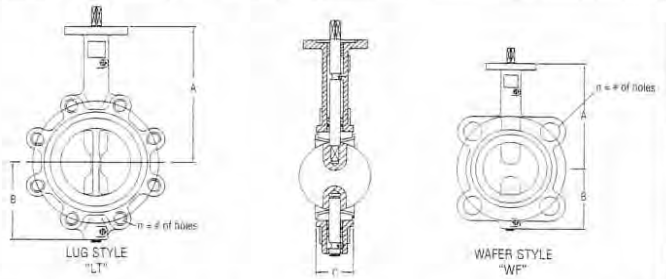
CHEM-TAINER

Series BFV

Butterfly Valves

Low Cost, Lever Operated, Lug or Wafer Pattern, 225 psig





DIMENSIONS (in)

Size	A	B	C	n, WF	n, LT	Cv	Weight	Size	A	B	C	n, WF	n, LT	Cv	Weight
2"	6.34	3.15	1-3/4	4	4	135	5.5	6"	8.9	5.47	2-1/4	8	8	1579	17.2
2-1/2"	6.89	3.5	1-7/8	4	4	220	7.05	8"	10.24	6.89	2-1/2	8	8	3136	29.1
3"	7.13	3.74	1-7/8	4	4	302	7.93	10"	11.5	7.99	2-3/4	12	12	5340	42.33
4"	7.87	4.49	2-1/8	4	8	600	10.8	12"	13.27	9.53	3-1/8	12	12	8250	71.65
5"	8.39	5	2-1/4	8	8	1022	15.43								

Series BFV Butterfly Valves

- Phenolic backed cartridge seat design for extended service and ease of replacement. Can be used for vacuum service.
- Extended neck for insulation - no fabricated extensions required.
- Machined flats attach disc/stem - no pins.
- Valve features a retainer lip for dead end service.
- Triple seal reduces possibility of external leakage.
- Silicone free from the factory - no aftermarket cleaning required.

The most critical aspect of the Series BFV Butterfly Valves is the cartridge seat design, which alleviates installation problems associated with common "dove tail design" seats. Valve torque is lower and more consistent because the seat dynamics do not rely on being mated between two flanges. Precision machining of the disc and body allow the cartridge design to maintain a tighter disc to seat tolerance, providing a perfect low torque seal each and every time the valve is cycled. Seat to disc seal is independent of flange support and capable of full rated dead end service. Select from wafer or lug patterns with either a 10-position locking handle lever or manual gear operator. Standard valves provide bubble tight sealing to 225 psi (15.5 bar) and are designed to comply with MSS-SP-67 and API-609.

SPECIFICATIONS

VALVE BODY

Service: Compatible liquids, gases, and steam.
Line Size: 2" to 12".
Body Style: 2-way, wafer or lug butterfly.
End Connections: Flange, to be used with flanges that are ANSI Class 125 (B16.1) and ANSI Class 150 (B16.5) dimensions.
Pressure Limit: 225 psi (15.5 bar) WOG.

Wetted Materials:
Body Material: Ductile iron.
Disc: 316 SS.
Seat and O-ring: EPDM or PTFE.
Stem: 410 SS.
Temperature Limits: Disc: EPDM: -50 to 250°F (-46 to 121°C). PTFE: 0 to 300°F (-18 to 149°C).
Bearings: Nylatron.
Flow Rate: See Cv chart.
Operator: 2 to 6": 10-position locking hand lever. 8 to 12": manual gear.

APPLICATIONS

- Perfect for on-off or throttling service
- Ideal for shut-off of water in chillers, cooling towers, and thermal storage systems
- Air dampers
- Irrigation systems
- Tank trucks
- Sewage systems, waste water treatment

Cv VALUES

	DEGREE OPENING								FULL OPEN
Size	10°	20°	30°	40°	50°	60°	70°	80°	90°
2"	0.1	5	12	24	45	64	90	125	135
2-1/2"	0.2	8	20	37	65	98	144	204	220
3"	0.3	12	22	39	70	116	183	275	302
4"	0.5	17	36	78	139	230	364	546	600
5"	0.8	29	61	133	237	392	620	930	1022
6"	2	45	95	205	366	605	958	1437	1579
8"	3	89	188	408	727	1202	1903	2854	3136
10"	4	151	320	694	1237	2047	3240	4859	5340
12"	5	234	495	1072	1911	3162	5005	7505	8250

Cv is the number of U.S. GPM of 60°F water that will pass through the valve with a 1 PSI pressure drop.

OPERATING TORQUE VALUES (INCH LB)

EPDM Seats	Size (inches)								
Service Pressure	2	2-1/2	3	4	5	6	8	10	12
50 psi	86	126	179	295	540	750	1440	2466	3510
100 psi	108	144	195	310	610	780	1490	2910	4100
150 psi	126	150	210	335	699	847	1549	3360	5560
200 psi	150	198	297	400	725	940	1800	3890	7558

PTFE Seats	Size (inches)								
Service Pressure	2	2-1/2	3	4	5	6	8	10	12
50 psi	125	130	195	390	650	890	1690	3699	5265
100 psi	130	145	210	430	690	940	1710	4365	6150
150 psi	142	160	248	443	720	974	1770	5040	8340
200 psi	180	220	340	490	795	1020	1890	5835	11367

Size	Liner	Model	Price
2"	EPDM	BFV202WFB311HL0	$44.75 (B)
	PTFE	BFV202WFB341HL0	87.50 (B)
	EPDM	BFV202LTB311HL0	44.75 (B)
	PTFE	BFV202LTB341HL0	87.50 (B)
2-1/2"	EPDM	BFV225WFB311HL0	51.00 (B)
	PTFE	BFV225WFB341HL0	105.00 (B)
	EPDM	BFV225LTB311HL0	51.00 (B)
	PTFE	BFV225LTB341HL0	105.00 (B)
3"	EPDM	BFV203WFB311HL0	61.00 (B)
	PTFE	BFV203WFB341HL0	121.00 (B)
	EPDM	BFV203LTB311HL0	61.00 (B)
	PTFE	BFV203LTB341HL0	121.00 (B)
4"	EPDM	BFV204WFB311HL0	85.50 (B)
	PTFE	BFV204WFB341HL0	166.00 (B)
	EPDM	BFV204LTB311HL0	85.50 (B)
	PTFE	BFV204LTB341HL0	166.00 (B)
5"	EPDM	BFV205WFB311HL0	114.00 (B)
	PTFE	BFV205WFB341HL0	211.00 (B)
5"	EPDM	BFV205LTB311HL0	$114.00 (B)
	PTFE	BFV205LTB341HL0	211.00 (B)
6"	EPDM	BFV206WFB311HL0	143.00 (B)
	PTFE	BFV206WFB341HL0	258.00 (B)
	EPDM	BFV206LTB311HL0	143.00 (B)
	PTFE	BFV206LTB341HL0	258.00 (B)
8"	EPDM	BFV208WFB312MG0	295.00 (B)
	PTFE	BFV208WFB342MG0	444.00 (B)
	EPDM	BFV208LTB312MG0	295.00 (B)
	PTFE	BFV208LTB342MG0	444.00 (B)
10"	EPDM	BFV210WFB312MG0	468.00 (B)
	PTFE	BFV210WFB342MG0	678.00 (B)
	EPDM	BFV210LTB312MG0	468.00 (B)
	PTFE	BFV210LTB342MG0	678.00 (B)
12"	EPDM	BFV212WFB312MG0	653.00 (B)
	PTFE	BFV212WFB342MG0	1075.00 (B)
	EPDM	BFV212LTB312MG0	653.00 (B)
	PTFE	BFV212LTB342MG0	1075.00 (B)

BFV202WFB311HL0 WF=Wafer Pattern LT=Lug Pattern

(B)Items subject to schedule B discounts.

Valves

Series ABFV Automated Butterfly Valve

Resilient Seated, Direct Mount Actuators

Pneumatic

Electric

*Please see website for dimensional drawings

The ABFV Series is offered with standard 316 SS disc, a through shaft that does not come in contact with the media, and choices of EPDM, BUNA-N, or fluoroelastomer liners for great chemical compatibility. Valve design has integral ISO mounting for direct mount actuators creating a more compact automated package. Body is epoxy coated for durable and attractive finish. Liner fully covers the body and assures tight seal with mating flanges without additional gaskets. One-piece shaft ensures positive valve positioning and is an anti-blowout design.

ABFV valves come in two-way and three-way packages. Three-way assemblies include valves and actuators mounted onto a 125# cast iron tee. When ordering you have the choice of valve arrangement for mixing or diverting applications. Valves come in lug or wafer style and wafer models have guide holes for bolts.

ABFV is an economical automated valve package with either an electric or pneumatic actuator. Electrically actuated models are weatherproof, NEMA 4, powered by standard 115 VAC supply, and are available in either two-position or proportional control. Two-position actuators use the 115 VAC input to drive each of the valve ports open or closed, while the modulating actuator accepts a 4 to 20 mA input for infinite valve positioning. Actuator features include thermal overload protection to withstand stall conditions, visual position indication and a permanently lubricated gear train.

The pneumatic double acting actuator uses an air supply to drive each of the actuator ports. Spring return pneumatic actuators use the air supply to drive the valve stem one direction, and internally loaded springs return the valve to its original position. Also available is the SV3 solenoid valve to electrically switch the supply pressure between the air supply ports. Actuators are constructed of anodized aluminum and are epoxy coated for years of corrosion free service.

Cv Values

Valve Size	10°	20°	30°	40°	50°	60°	70°	80°	90°
2"	0.1	5	12	24	45	64	90	125	135
2-1/2"	0.7	8	20	37	65	98	144	204	220
3"	0.3	12	22	39	70	116	183	275	302
4"	0.5	17	36	78	139	230	364	546	600
5"	0.8	29	61	133	237	392	620	930	1022
6"	2	45	95	205	366	605	958	1437	1539
8"	3	89	188	408	727	1202	1903	2854	3136
10"	4	151	320	694	1237	2034	3240	4859	5340
12"	5	234	495	1072	1911	3162	5005	7507	8250

SPECIFICATIONS

Valve Body

Service: Compatible liquids and gases.

Body: 2-way or 3-way.

Line Size: 2" to 12".

End Connections: Wafer or lug pattern designed for flanges to ANSI B16.1, BS4504, DIN 2501.

Pressure Limits: Up to 8": 225 psi (15.5 bar); 10" – 12": 150 psi (10.3 bar).

Wetted Materials: Disc: 316 SS; Liner: EPDM BUNA-N, or Fluoroelastomer.

Temperature Limits: EPDM: -30 to 275°F (-34 to 135°C); BUNA-N: 10 to 180°F (-12.2 to 82.2°C); Fluoroelastomer: 400°F (204°C).

Other Materials: Shaft: 316SS; Bottom/Top Bushing: bronze; Body: cast iron; Shaft Seal: EPDM.

ACTUATORS

Electric "U" and "V" Series

Power Requirements: 115 VAC, 50/60 Hz, single phase. Optional 220 VAC, 24 VAC, 12 VDC, and 24 VDC.

Power Consumption: (Locked Rotor Current): U_1, V_1: .55A; U_2, 3, 4, V_2, 3, 4: 0.75A; U_ 5, 6, 7, V_5, 6, 7: 1.1A; U_ 8, V_8: 2.6A; U_9, V_9: 2.9A. (Only for 115 VAC, for other voltages contact the factory).

Cycle Time: (sec. per 90°): U_1, V_1: 2.5; U_2, 3, V_2, 3: 5; U_4, V_4: 10; U_ 5, 6, V_5, 6: 15; U_7, V_7: 30; U_ 8, V_8: 12; U_9, V_9: 14. (Only for 115 VAC, for other voltages contact the factory).

Duty Cycle: U_1: 75%; U_2 to 7: 25%; U_8, 9: 100%; V_1 to 7: 75%; V_8, 9: 100%.

Enclosure Rating: NEMA 4. Optional NEMA 7 (Class 1, Div. II Groups A, B, C, D).

Housing Material: Aluminum with thermal bonding polyester powder finish.

Temperature Limit: 0 to 15 (-18 to 65°C).

Conduit Connection: 1/2" NPT.

Modulating Input (V Serie 20 mA.

Standard Features: Manu ride and visual position ir except modulating units.

Pneumatic "DA" and "SR"

Type: DA series is double and SR series is spring retu and pinion).

Normal Supply Pressure: (5.5 bar).

Maximum Supply Pressu psig (8 bar).

Air Connections: DA1 to SR2 to 5: 1/8" female NPT, ers: 1/4" female NPT.

Air Consumption: (cu. stroke) DA1: 2.32, DA2: 6.5 12.14, DA4: 16.32, DA5: 30. 45.3, DA7: 61.0, DA8: 106. 137.9, DAA: 220.1, DAB: DAC: 915.4, SR2: 7.7, SR SR4: 17.2, SR5: 32.4, SR SR7: 85.4, SR8: 122.1, SR9: SRA: 215.1, SRB: 462.6, 945.9.

Cycle Time: (sec. per 90° .03, DA2: .04., DA3: .08, DA DA5: .19, DA6: 0.27, DA DA8: .66, DA9: .93, DAA: 1. 1.7, DAC: 4.5, SR2: .09, SF SR4: .22, SR5: .33, SR6: .4 .78, SR8: .90, SR9: .97, SR SRB: 2.19, SRC: 6.20.

Housing Material: Anodiz minum body and epoxy coat minum end caps.

Temperature Limit: -4 to 1 (-20 to 82°C).

Accessory Mounting: standard.

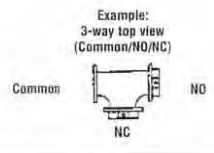
Standard Features: Visual indicator.

Valves

Series ABFV Automated Butterfly Valve

Complete Model Chart - See next page for built model numbers with prices

Example	ABFV	3	03	WFB	3	3	1	DA3	E	SV	ABFV303WFB331DA3E-SV
Construction	ABFV										Automated Butterfly Valve
Configuration		2									Two-Way
		3									Three-Way
Size			02								2"
			25								2-1/2"
			03								3"
			04								4"
			05								5"
			06								6"
			08								8"
			10								10"
			12								12"
Body				WFB							Wafer
				LTB							Lug
Stem					3						316 SS
Disc						3					316 SS
Liner							1				EPDM
							2				Buna-N
							3				Fluoroelastomer
Actuator Type								DA1			Direct Acting Rack and Pinion Actuator, Size 32
								DA2			Direct Acting Rack and Pinion Actuator, Size 52
								DA3			Direct Acting Rack and Pinion Actuator, Size 63
								DA4			Direct Acting Rack and Pinion Actuator, Size 75
								DA5			Direct Acting Rack and Pinion Actuator, Size 85
								DA6			Direct Acting Rack and Pinion Actuator, Size 100
								DA7			Direct Acting Rack and Pinion Actuator, Size 115
								DA8			Direct Acting Rack and Pinion Actuator, Size 125
								DA9			Direct Acting Rack and Pinion Actuator, Size 140
								DAA			Direct Acting Rack and Pinion Actuator, Size 160
								DAB			Direct Acting Rack and Pinion Actuator, Size 200
								DAC			Direct Acting Rack and Pinion Actuator, Size 270
								SR2			Spring Return Rack and Pinion Actuator, Size 52
								SR3			Spring Return Rack and Pinion Actuator, Size 63
								SR4			Spring Return Rack and Pinion Actuator, Size 75
								SR5			Spring Return Rack and Pinion Actuator, Size 85
								SR6			Spring Return Rack and Pinion Actuator, Size 100
								SR7			Spring Return Rack and Pinion Actuator, Size 115
								SR8			Spring Return Rack and Pinion Actuator, Size 125
								SR9			Spring Return Rack and Pinion Actuator, Size 140
								SRA			Spring Return Rack and Pinion Actuator, Size 160
								SRB			Spring Return Rack and Pinion Actuator, Size 200
								SRC			Spring Return Rack and Pinion Actuator, Size 270
								U_1			Electric Two Position, Size 100
								U_2			Electric Two Position, Size 200
								U_3			Electric Two Position, Size 300
								U_4			Electric Two Position, Size 400
								U_5			Electric Two Position, Size 675
								U_6			Electric Two Position, Size 1000
								U_7			Electric Two Position, Size 1500
								U_8			Electric Two Position, Size 2000
								U_9			Electric Two Position, Size 3800
								U_A			Electric Two Position, Size 5000
								V_1			Electric Modulating, Size 100
								V_2			Electric Modulating, Size 200
								V_3			Electric Modulating, Size 300
								V_4			Electric Modulating, Size 400
								V_5			Electric Modulating, Size 675
								V_6			Electric Modulating, Size 1000
								V_7			Electric Modulating, Size 1500
								V_8			Electric Modulating, Size 2000
								V_9			Electric Modulating, Size 3800
								V_A			Electric Modulating, Size 5000
Arrangement									A		2-Way, Normally Open
									C		2-Way, Normally Closed
									E		3-Way, Common/NO/NC
									G		3-Way, Common/NC/NO
									I		3-Way, NO/Common/NC
									K		3-Way, NC/Common/NO
									L		3-Way, NO/NC/Common
									M		3-Way, NC/NO/Common
Options										SV	Factory Mounted Solenoid Valve (Pneumatic Only)
										EX	Explosion-Proof Electric Actuator (Electric Only)



For Electric U and V actuators middle term, V_1, is the power supply required. Model Code 1 is for 120 VAC, 2 is for 220 VAC, 3 is for 24 VAC and 4 is for 24 VDC. Example, U11, is 120 VAC two position. Consult factory for pricing.

575 VOLT ELECTRIC MOTOR DATA

Model	Horse Power	Phase	Hz	Volts	RPM	NEMA Frame	Enclosure Type	Full Load Amperes	Service Factor	Thermal Overload
ACA- 3181/2 -5	1/3	3	60	575	1725	56	TEFC	.52 .56	1.15	NO
ACA- 3241/2 -5	1/3	3	60	575	1140	56	TEFC	.52 .56	1.15	NO
ACA- 3301/2 -5	1/2	3	60	575	1140	56	TEFC	1.08	1.15	NO
ACA- 4301/2 -5	1/2	3	60	575	1140	56	TEFC	1.08	1.15	NO
ACA- 6301/2 -5	1	3	60	575	1140	56	TEFC	1.6	1.15	NO
ACA- 3361/2 -5	1	3	60	575	1140	56	TEFC	1.6	1.15	NO
ACA- 4361/2 -5	1	3	60	575	1140	56	TEFC	1.6	1.15	NO
ACA- 6361/2 -5	3	3	60	575	1725	182T	TEFC	3.3	1.15	NO
ACA- 6421/2 -5	5	3	60	575	1140	213T	TEFC	5.9	1.15	NO
ACA- 6481/2 -5	5	3	60	575	1140	213T	TEFC	5.9	1.15	NO
ACA- 6541/2 -5	7.5	3	60	575	1140	254T	TEFC	8.0	1.15	NO
ACA- 6601/2 -5	10	3	60	575	1140	256T	TEFC	10.5	1.15	NO

COMMON DATA

Model	Air Flow		Sound Level dB(A) @ 7ft	Weight		Serviceable Core
	CFM	m^3/s		w/ motor	w/o motor	
ACA-3181/2	1550	0.731	72	131	111	NO
ACA-3241/2	2900	1.36	76	154	134	NO
ACA-3301/2	4450	2.10	76	184	160	NO
ACA-4301/2	4450	2.10	76	211	187	NO
ACA-6301/2	4450	2.10	76	343	305	YES
ACA-3361/2	6350	2.99	79	243	205	NO
ACA-4361/2	6350	2.99	79	289	251	NO
ACA-6361/2	10500	4.95	91	402	342	YES
ACA-6421/2	14300	6.75	87	636	443	YES
ACA-6481/2	18700	8.82	88	753	560	YES
ACA-6541/2	23350	11.02	91	938	691	YES
ACA-6601/2	29300	13.83	91	1104	835	YES

NOTES:

TEFC = Totally Enclosed, Fan Cooled

To estimate the sound level at distances other than 7 feet (2.1 meters) from the cooler, add 6 db for each halving of distance, or substract 6 db for each doubling of the distance.

Example:
The Sound Level of the ACA-3181/2 is 72 dB at 7ft. At 3.5ft (7ft x 0.5 = 3.5ft) the sound level is 66 dB (72dB - 6dB = 66dB). At 14ft (7ft x 2 = 14ft) the sound level is 78dB (72dB + 6dB = 78dB).

Pressure Drop Graphs (see page 220)

Each graph represents a specific pressure drop at differing flow rates and inlet pressures. The four graphs for each model series size represents the more popular milestone pressure differentials commonly applied.

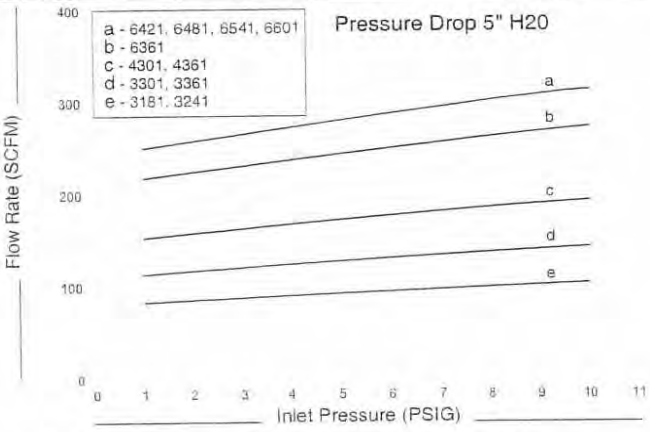
To use the graphs for selection purposes follw the steps below.

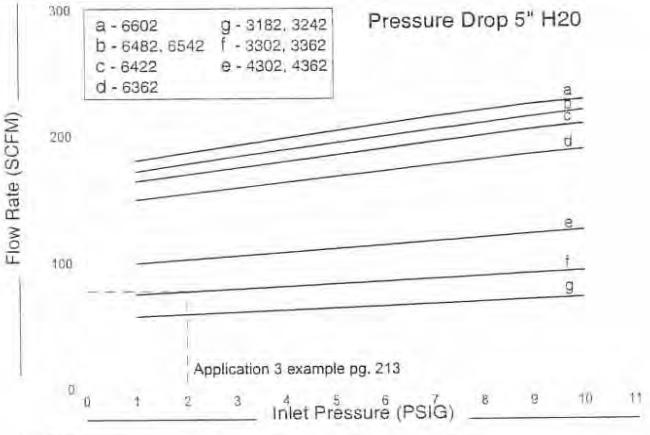
1) Locate the operating pressure at the bottom of the desired pressure drop chart.
2) Locate the flow rate in SCFM at the left end of the chart.
3) Follow the "Pressure" line vertically and the "Flow" line horizontally until they cross, note the location.
4) The curve on, or closest above will be exact or less pressure drop than requested and suitable for the application.
5) There may be several units shown above the intersection point. all of which will produce less than the desired pressure drop at the required flow.

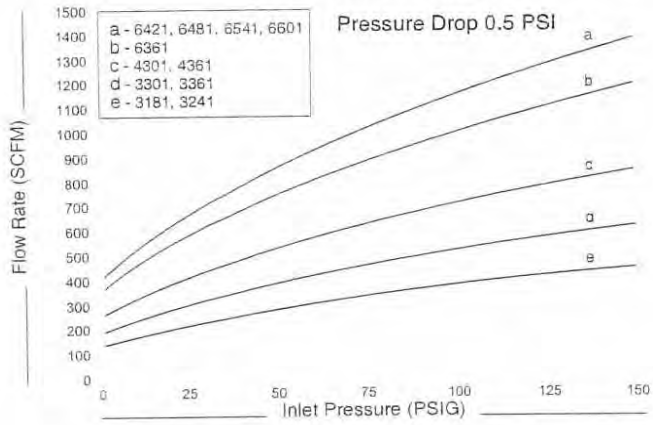
Example: Application 3 Low Pressure Blower

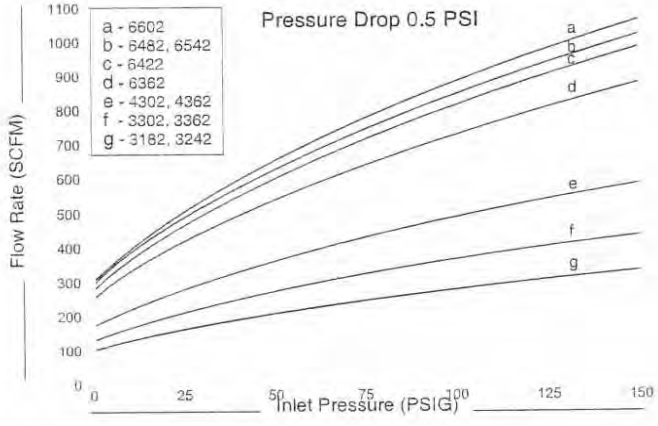
Flow = 76 SCFM
Operating pressure = 2 PSIG
Initial selection from graph page 215 = ACA-3302
Desired pressure drop = 5" H2O or less. (USE the "Pressure Drop 5" H20" curves page 220)
From the pressure drop graph, page 220. Acceptable choice - ACA-3302 is on the line. ACA-3242 is well below the line. The ACA-3302 meets the pressure drop requirement, but exceeds the capacity requirement. However, even though the ACA-3242 exceeds 5" of water pressure drop, other considerations should be made prior to selection such as unit physical size, cost, availability, and port size.

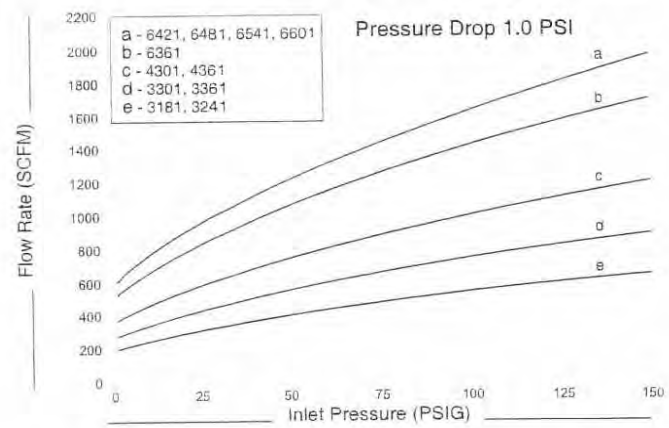
ACA Series *pressure drop graphs*

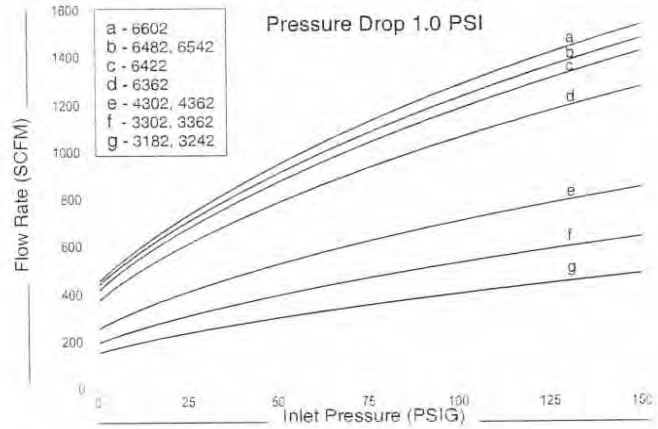


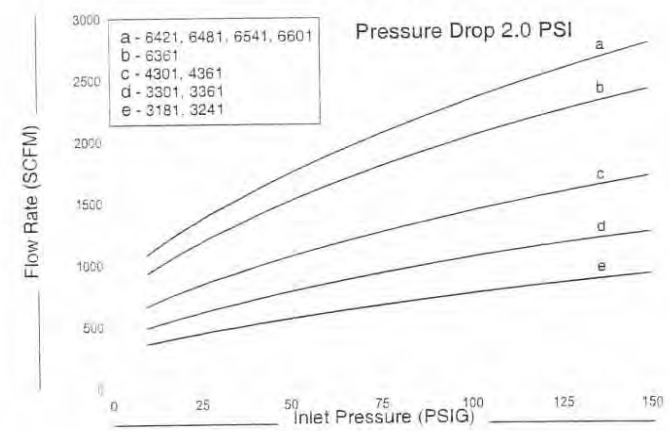


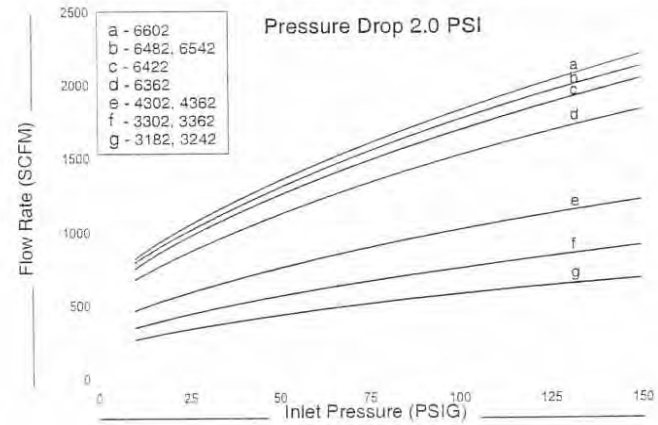












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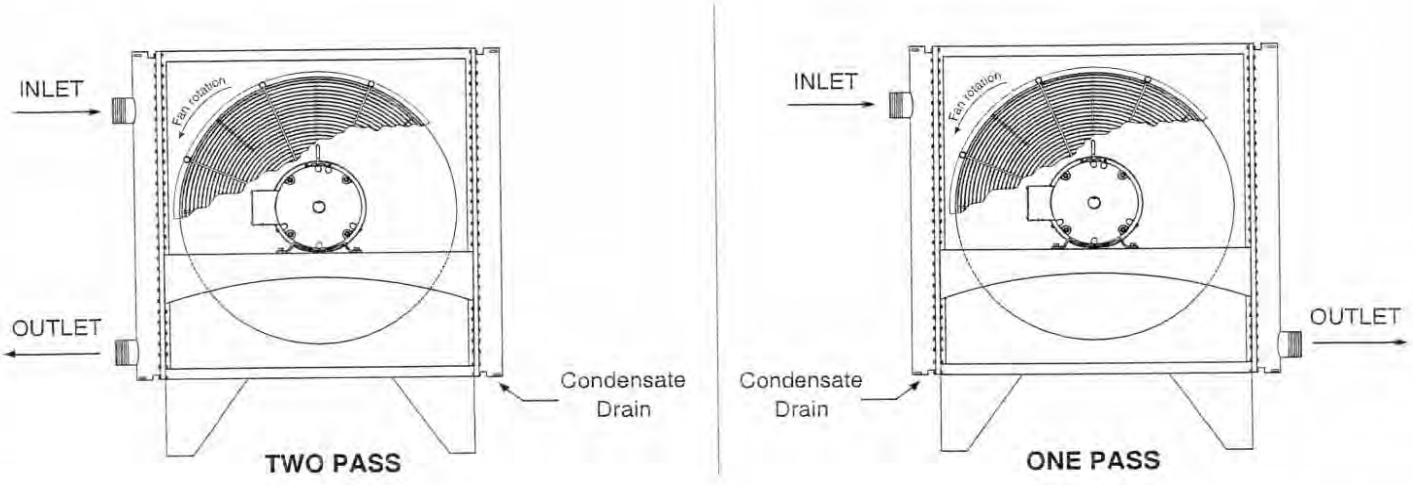
PIPING HOOK UP



Receiving:

a) Inspect unit for any shipping damage before uncrating. Indicate all damages to the trucking firms' delivery person and mark it on the receiving bill before accepting the freight. Make sure that the core and fan are not damaged. Rotate the fan blade to make sure that it moves freely. The published weight information located in this brochure is approximate. True shipment weights are determined at the time of shipping and may vary. Approximate weight information published herein is for engineering approximation purposes and should not be used for exact shipping weight. *Since the warranty is based upon the unit date code located on the model identification tag, removal or manipulation of the identification tag will void the manufacturers warranty.*

b) When handling the ACA heat exchanger, special care should be taken to avoid damage to the core and fan. All units are shipped with wood skids for easy forklift handling

c) Standard Enamel Coating: American Industrial provides its standard products with a normal base coat of oil base air cure enamel paint. The enamel paint is applied as a temporary protective and esthetic coating prior to shipment. While the standard enamel coating is durable, American Industrial does not warrantee it as a long-term finish coating. It is strongly suggested that a more durable final coating be applied after installation or prior to long-term storage in a corrosive environment to cover any accidental scratches, enhance esthetics, and further prevent corrosion. It is the responsibility of the customer to provide regular maintenance against chips, scratches, etc... and regular touch up maintenance must be provided for long-term benefits and corrosion prevention.

Installation:

a) American Industrial recommends that the equipment supplied should be installed by qualified personal who have solid understanding of system design, pressure and temperature ratings, and piping assembly. Verify the service conditions of the system prior to applying any ACA series cooler. If the system pressure or temperature does not fall within the parameters on ACA rating tag located on the heat exchanger, contact our factory prior to installation or operation.

b) In order for the heat exchanger to properly function, installation should be made with minimum airflow obstruction distance of not less than twenty (20) inches on both fan intake and exiting side of the heat exchanger.

c) Process piping should be as indicated above with the process flow entering into the upper port and exiting out the lower port (see illustration). This configuration will allow for condensate moisture to drain completely from the equipment. It is recommended that an air separator or automatic drip leg be applied to the outlet side of the heat exchanger to trap any moisture that develops.

d) Flow line sizes should be sized to handle the appropriate flow to meet the system pressure drop requirements. If the nozzle size of the heat exchanger is smaller than the process line size an increased pressure differential at the heat exchanger may occur.

e) ACA series coolers are produced with both brazed ACA-3181 through ACA-4362, and serviceable core® ACA-6301 through ACA-6602 style coils. A brazed construction coil does not allow internal tube access. A serviceable core® will allow full accessibility to the internal tubes for cleaning and maintenance. ACA series coolers are rated for 150 PSIG working pressure, and a 400°f working temperature.

f) Special Coatings: American Industrial offers as customer options, Air-Dry Epoxy, and Heresite (Air-Dry Phenolic) coatings at additional cost. American Industrial offers special coatings upon request, however American Industrial does not warrantee coatings to be a permanent solution for any equipment against corrosion. It is the responsibility of the customer to provide regular maintenance against chips, scratches, etc... and regular touch up maintenance must be provided for long-term benefits and corrosion prevention.

g) Electric motors should be connected only to supply source of the same characteristics as indicated on the electric motor information plate. Prior to starting, verify that the motor and fan spin freely without obstruction. Check carefully that the fan turns in the correct rotation direction normally counter clockwise from the motor side (fan direction arrow). Failure to operate the fan in the proper direction could reduce performance or cause serious damage to the heat exchanger or other components. Fan blades should be rechecked for tightness after the first 100 hours of operation.

Maintenance

Regular maintenance intervals based upon the surrounding and operational conditions should be maintained to verify equipment performance and to prevent premature component failure. Since some of the components such as, motors, fans, load adapters, etc... are not manufactured by American Industrial maintenance requirements provided by the manufacture must be followed.

a) Inspect the entire heat exchanger and motor/fan assembly for loosened bolts, loose connections, broken components, rust spots, corrosion, fin/coil clogging, or external leakage. Make immediate repairs to all affected areas prior to restarting and operating the heat exchanger or its components.

b) Heat exchangers operating in oily or dusty environments will often need to have the coil cooling fins cleaned. Oily or clogged fins should be cleaned by carefully brushing the fins and tubes with water or a non-aggressive degreasing agent mixture (Note: Cleaning agents that are not compatible with copper, brass, aluminum, steel or stainless steel should not be used). A compressed air or a water stream can be used to dislodge dirt and clean the coil further. Any external dirt or oil on the electric motor and fan assembly should be removed. Caution: Be sure to disconnect the electric motor from its power source prior to doing any maintenance.

c) In most cases it is not necessary to internally flush the coil. In circumstances where the coil has become plugged or has a substantial buildup of material, flushing the coil with water or a solvent may be done. Flushing solvents should be non-aggressive suitable for the materials of construction. Serviceable Core® models can be disassembled and inspected or cleaned if required.

d) Most low horsepower electric motors do not require any additional lubrication. However, larger motors must be lubricated with good quality grease as specified by the manufacture at least once every 6-9 months or as directed by the manufacture. T.E.F.C. air ventilation slots should be inspected and cleaned regularly to prevent clogging and starving the motor of cooling air. To maintain the electric motor properly see the manufactures requirements and specifications.

e) Fan blades should be cleaned and inspected for tightness during the regular maintenance schedule when handling a fan blade care must be given to avoid bending or striking any of the blades. Fan blades are factory balanced and will not operate properly if damaged or unbalanced. Damaged fan blades can cause excessive vibration and severe damage to the heat exchanger or drive motor.

Replace any damaged fan with an American industrial suggested replacement.

f) ACA heat exchanger cabinets are constructed using 7ga. through 18ga. steel that may be bent back into position if damaged. Parts that are not repairable can be purchased through American Industrial.

g) Coil fins that become flattened can be combed back into position. This process may require removal of the coil from the cabinet.

h) It is not advisable to attempt repairs to brazed joints of a brazed construction coil unless it will be done by an expert in silver solder brazing. Brazed coils are heated uniformly during the original manufacturing process to prevent weak zones from occurring. Uncontrolled reheating of the coil may result in weakening of the tube joints surrounding the repair area. In many instances brazed units that are repaired will not hold up as well to the rigors of the system as will a new coil. American Industrial will not warranty or be responsible for any repairs done by unauthorized sources. Manipulation in any way other than normal application will void the manufactures warranty.

i) Units containing a Serviceable Core® have bolted manifold covers that can be removed for cleaning or repair purposes.

Servicing Sequence

American Industrial has gone to great lengths to provide components that are repairable. If the ACA unit requires internal cleaning or attention the following steps will explain what must be done to access the internal tubes. Be sure to order gasket kits or repair parts prior to removal and disassembly to minimize down time.

a) To clean the internal tubes first remove all connection pipes from the unit.

b) Be sure the unit is drained of all water etc...

c) Place the ACA unit in an area that it can be accessed from all sides.

d) Remove the manifold cover bolts and hardware and place them into a secure place.

e) The manifold covers are tightly compressed and may need some prying to separate them from the gasket, physically remove the cover assemblies from both sides.

f) The tubes are now accessible for cleaning. We suggest a mild water-soluble degreaser be used with a brush. Tubing I.D. is .325 a plastic bristle brush on a rod will work best for cleaning the tubes. Steel brushes should be avoided since the steel is harder than the copper tubing and may heavily score the tubes if used.

g) If there are any leaking tubes you may plug them be forcing a soft metal plug into the hole and tapping it tight. You may in some cases weld the leaking tube shut however, care should be taken since excessive heat may cause surrounding tube joints to loosen and leak.

3905 Route 173 Zion, IL 60099 tel: 1 (847) 731-1000 fax: 1 (847) 731-1010 www.aihti.com

S/J 2622767

American Industrial Heat Transfer, Inc.

3905 Route 173 Zion, Illinois 60099 Toll free 1-800-338-5959 www.aihti.com

Customer: **Seneca**

Model Selection: **ACA** 4 36 2 - 3

Required Sq.ft: **41.6** Date: March 11, 2009

Unit Design Sq.Ft: **41.8** Job:

Performance of One Unit

	TUBE SIDE			FAN SIDE		
Vapor Circulated		AIR				AIR
Specific Gravity		1.00		Elevation	feet	0
Flow Rate	scfm	**220.00**		FAN Flow		6350
Calc Flow Rate	scfm	220.0				
Flow Rate	acfm	**0.0**			Fs	4566
Compressor	Discharge/Inlet acfm	278.9 / 220.0				
Operating Pressure	psig	**1.0**		Atmospheric Pressure	psia	14.696
Operating Presssure	in. water	0.0				
Temperature Entering	F	**255.0**	**68.00**			**100.0**
Temperature Exiting	F	**107.9**				105.3
Approach Temperature	F	7.9				
Specific Heat	Btu / lb-f	0.2505				0.2502
Viscosity	centipoise	0.0170				0.0186
Conductivity	Btu/hr ft^2 F/ft	0.0140				0.0157

Calculation

Total Heat Load	Btu/hr	36074				36074
Dry Air	Btu/hr	35734	969.7	lbs/hr		
Vapor	Btu/hr	339	5.1	lbs/hr		
Condensed	Btu/hr	0	0.0	lbs/hr		
Density	lb / ft^3	0.0582				0.0709
Flow Rate	lbs / Hr	974.8				27012.0
Mass Velocity	lbs / Hr-ft^2	23832				5138
Pressure Differential	Inches H2O	16.5	Static Pressure		Inches H2O	0.21
Pressure Differential	psi	0.595	Face Velocity		ft / min	715
Velocity Tubes	Ft / sec	113.66	Fin Velocity		ft / min	1207.87
Nr		15716				5525
U clean	Btu / hr ft^2 F	20.1				
Fouling Requested	hr ft^2 F / btu	0.0005			Material	218

Selection

Required Surface	Sq. ft.	**41.59**		LMTD	43.6
Effective Surface	Sq. ft.	**41.82**	Service	Btu / hr ft^2 F	19.9

Configuration

Tube Diameter	inch	0.375	Fins Per Inch		8
Tube Wall	inch	0.025	Estimated I=		2
Length Tubes	inch	**36.0**	Enter Number Passes		2
Parallel Tube Rows		**4**	Estimated Nozzle	inch	2.7
Number Tubes		142	Nozzle size	inch	**2.50**
Coil Weight Empty	lbs	106.2	Manifold	inch	3.00

Construction Materials

Tubes	Copper	Fins	Aluminum	Cabinet	Carbon Steel	
Tanks	Steel	Tube-Sheets	Steel	Gaskets	Hypalon	
Coating	Enamal			Fan	Nylon Composite	
Coil Size	36 X 36			Nozzle	2.5 NPT	
HP 1	Phase 3	Hertz/Volts	60/208 230-460	Class	**TEFC**	RPM 1140
Brazed coil core	**X**	Serviceable core				

INLET VACUUM AIR FILTERS

"CSL" Series 3" - 6" MPT

APPLICATIONS

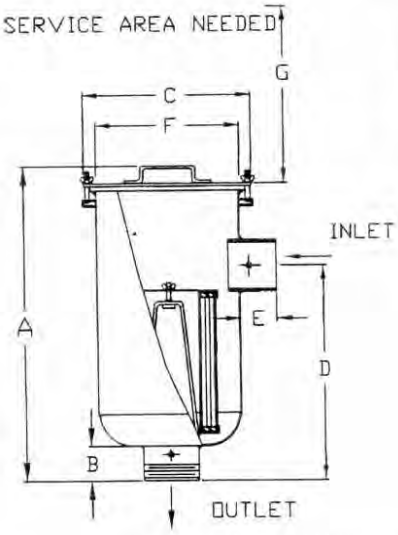
- Vacuum Pumps & Systems – PD, Side Channel, Rotary Vane, Screw, Piston
- Vacuum Packaging
- Vacuum Furnaces
- Central Vacuum Systems
- Intake Suction Filters
- Blowers - Fan & PD Type
- Pneumatic Conveying Systems
- Remote Installations for Piston, Centrifugal, and Screw Compressors
- Factory Automation Equipment
- Ash Handling
- Chemical Processing
- Food Processing
- Paper Processing
- Glass, Ceramic Processing
- Waste Water Treatment
- Woodworking Industry
- Cement
- Bag House Systems
- Envelope Manufacturing
- Medical Industry

FEATURES & SPECIFICATIONS

- Vacuum level: Typically $1x10^{-3}$ mmHg ($1.3x10^{-3}$ mbar)
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Heavy duty T bolts for easy maintenance
- Baked enamel finish
- Rugged all steel construction
- Low pressure drop
- Positive sealing O-ring seal system
- Large dirt holding capacity and easy field cleaning, especially when mounted horizontally or inverted
- Hydrostatically tested to 0.5 bar pressure for vacuum tightness
- Inlet air enters canister above element
- Inlet/outlet 1/4" pressure gauge taps standard
- Temp (continuous) min: -15°F (-26°C) max: 220°F (104°C)
- Filter change out differential: 10"-15" H_2O Over Initial Delta P

OPTIONS (Inquiries Encouraged)

- Various media available
- Larger sizes available
- Support brackets
- Available in ***Stainless Steel***
- Epoxy coated housings
- Special connections, BSPT/Metric
- Activated carbon prefilter to reduce



Dimension tolerance ± 1/8"

I = Industrial Duty S = Severe Duty E = Extreme Duty

	with Polyester Element	with Paper Element	MPT Inlet & Outlet	DIMENSIONS - inches A	B	C	D	E	F	G	Rated Flow SCFM Nominal Rating	Element Rating	Approx. Wt. lbs
I	CSL-235P-300	CSL-234P-300	3"	27 1/8	3	14	18 1/2	3	12	10	300	570	47
S	CSL-335P-300	CSL-334P-300	3"	27 1/8	3	14	18 1/2	3	12	15	300	800	50
I	CSL-235P-400	CSL-234P-400	4"	27 1/8	3	14	18 1/2	3	12	10	520	570	52
S	CSL-335P-400	CSL-334P-400	4"	27 1/8	3	14	18 1/2	3	12	15	520	800	55
I	CSL-245P-500	CSL-244P-500	5"	28 1/8	3	18 1/2	19 1/2	3	16	10	800	880	82
S	CSL-345P-500	CSL-344P-500	5"	28 1/8	3	18 1/2	19 1/2	3	16	15	800	1100	88
I	CSL-275P-600	CSL-274P-600	6"	29 1/8	4	18 1/2	20 1/2	4	16	10	1100	1100	95
S	CSL-375P-600	CSL-374P-600	6"	29 1/8	4	18 1/2	20 1/2	4	16	15	1100	1500	97

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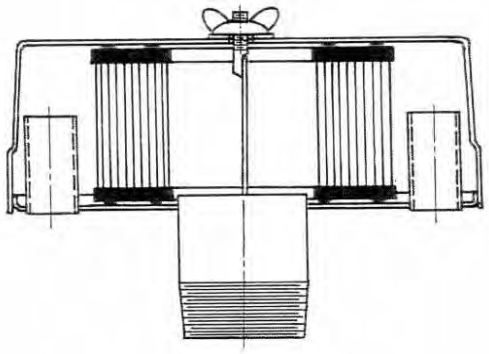
INTAKE FILTERS and FILTER SILENCERS



F64 Air Intake Filters and Filter Silencers

Air Intake Filter and Filter Silencer

The Series F64 Air Intake Filter and Filter Silencer is designed to mount directly on the inlet of an engine, blower or compressor. It will provide 16dB to 20dB noise reduction and the paper filter media has an efficiency of 99% on 1 micron particles.

SERVICE LIFE & CLEANING: The service life of the element is dependent upon the surrounding environment and cannot be predicted.

To prevent COLLAPSING of the filter element, STODDARD SILENCERS recommends the differential pressure across the filter element NOT exceed 15 inches of water column. Positive indication that the element requires cleaning or replacement can be provided with STODDARD SILENCERS model A40-108 Pressure Drop Indicator, at an extra charge.

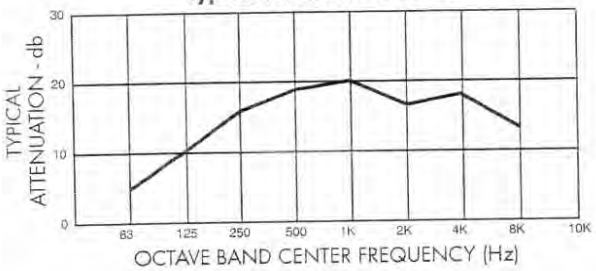
To extend service life, rap element gently to dislodge accumulated dirt. An alternate method is to direct compressed air (75 PSIG max) through the element opposite to the direction of air flow. THE FILTER ELEMENT MUST EVENTUALLY BE REPLACED.

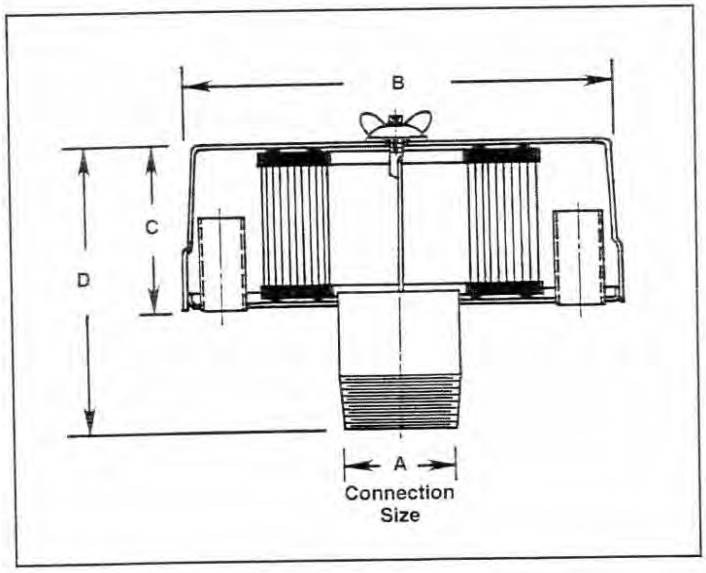
ALTERNATE FILTRATION MEDIA
AVAILABLE FOR F64

REFER TO PAGE FOUR

Pre-Filter wrap available at added cost
Consult Factory
(90% on 75 micron particles and larger)

Typical Attenuation Curve





F64 shown with optional A40-108 Pressure Drop Indicator.

F64 Series

Model	A Connection Size	B	C	D	Rated CFM	Wt.	Replacement Element Number
F64-1	1" NPT	10	4	7	35	9	F8-108
F64-1½	1½" NPT	10	4	7	80	9	F8-108
F64-2	2" NPT	10	4	7	135	10	F8-108
F64-2½	2½" NPT	10	4	7	180	10	F8-108
F64-3	3" NPT	16	5	8	285	20	F8-109
F64-4	4" NPT	16	5	8	520	20	F8-109
F64-5	5" NPT/FLG	16	5	8	750	23	F8-109
F64-6	6" Flange	20	5	8	1235	40	F8-110
F64-8	8" Flange	20	10	13	2125	50	F8-111
F64-10	10" Flange	26	15½	20	3335	95	F8-137
F64-12	12" Flange	26	15½	20	4675	100	F8-137
F64-14	14" Flange	26	15½	20	5655	115	F8-137

Sizes 10", 12" and 14" are FILTERS only

QED Air Stripper Model ver. c1.10 — 1/6/2009

Site Data

Name: Dan Nolan
e-mail: dnolan@senecaco.com
Project: Lilyblad
Units: English
Altitude: 150 ft
Air Temp: 55 F
Flow: 20 gpm
Water Temp: 55 F
Stripper: EZ-Stacker 4.xp -
Stripper Air Flow: 280 cfm
Stripper Max Flow: 40 gpm

Water Results

Contaminant	Influent (ppb)	Target (ppb)	4-Tray Results (ppb)	4-Tray %Removal	6-Tray Results (ppb)	6-Tray %Removal
p-xylene	2914	26000	< 1	100.000	< 1	100.000
ethylbenzene	748	6910	< 1	100.000	< 1	100.000
TPH (as benzene)	50000	1000	1.6	99.997	< 1	100.000
1,1,1-trichloroethane	25000	227	< 1	100.000	< 1	100.000
1,1,2-trichloroethane	3.9	227	< 1	100.000	< 1	100.000
1,1-dichloroethane	9600	37	4.1	99.957	< 1	100.000
1,1-dichloroethylene	870	1.9	< 1	100.000	< 1	100.000
1,2,4-trimethylbenzene	3363	26000	< 1	100.000	< 1	100.000
1,2-dichlorobenzene	523	100	< 1	100.000	< 1	100.000
1,2-dichloroethane	1981	37	38.1	98.077	5.3	99.732
1,3,5-trimethylbenzene	793	26000	< 1	100.000	< 1	100.000
1,4-dichlorobenzene	145	100	< 1	100.000	< 1	100.000
2-butanone (MEK)	843	100	735.8	12.716	730.4	13.357
4-methyl-2-pentanone (MIBK)	753	100	266.7	64.582	237.4	68.473
acetone	1370	100	1235.3	9.832	1228.6	10.321
benzene	773	23	< 1	100.000	< 1	100.000
benzo[a]anthracene	1	100	< 1	100.000	< 1	100.000
benzo[b]fluoranthene	1	100	1.0	0.000	1.0	0.000
benzo[k]fluoranthene	1	100	1.0	0.000	1.0	0.000
benzo[a]pyrene	1	100	1.0	0.000	1.0	0.000
bis(2-chloroethyl) ether	979	2.2	956.6	2.288	955.5	2.400
c-1,2-dichloroethylene	2280	5200	3.8	99.833	< 1	100.000
chlorobenzene	33	100	< 1	100.000	< 1	100.000

chrysene	1	100	1.0	0.000	1.0	0.000
dichloromethane	26925	100	33.5	99.876	1.0	99.996
isopropylbenzene	114	100	< 1	100.000	< 1	100.000
naphthalene	281	100	51.8	81.566	34.7	87.651
pentachlorophenol (PCP)	2643	3	2639.2	0.144	2639.1	0.148
tetrachloroethylene (PERC, PCE)	3324	3.3	< 1	100.000	< 1	100.000
toluene	15075	15000	< 1	100.000	< 1	100.000
TPH (as naphthalene)	33000	1000	6082.9	81.567	4071.1	87.663
trichloroethylene (TCE)	1138	30	< 1	100.000	< 1	100.000
vinyl chloride (chloroethylene)	445	2.4	< 1	100.000	< 1	100.000
Contaminant	Influent (ppb)	Target (ppb)	4-Tray Results (ppb)	4-Tray %Removal	6-Tray Results (ppb)	6-Tray %Removal

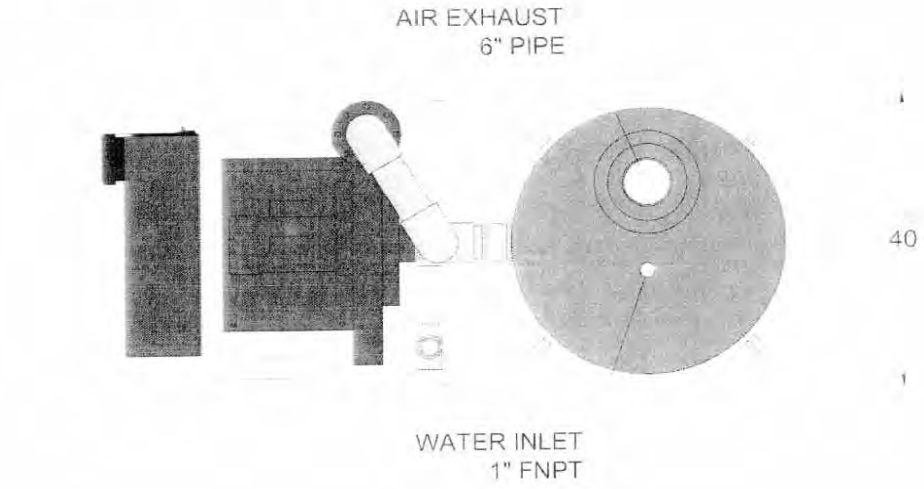
Air Results

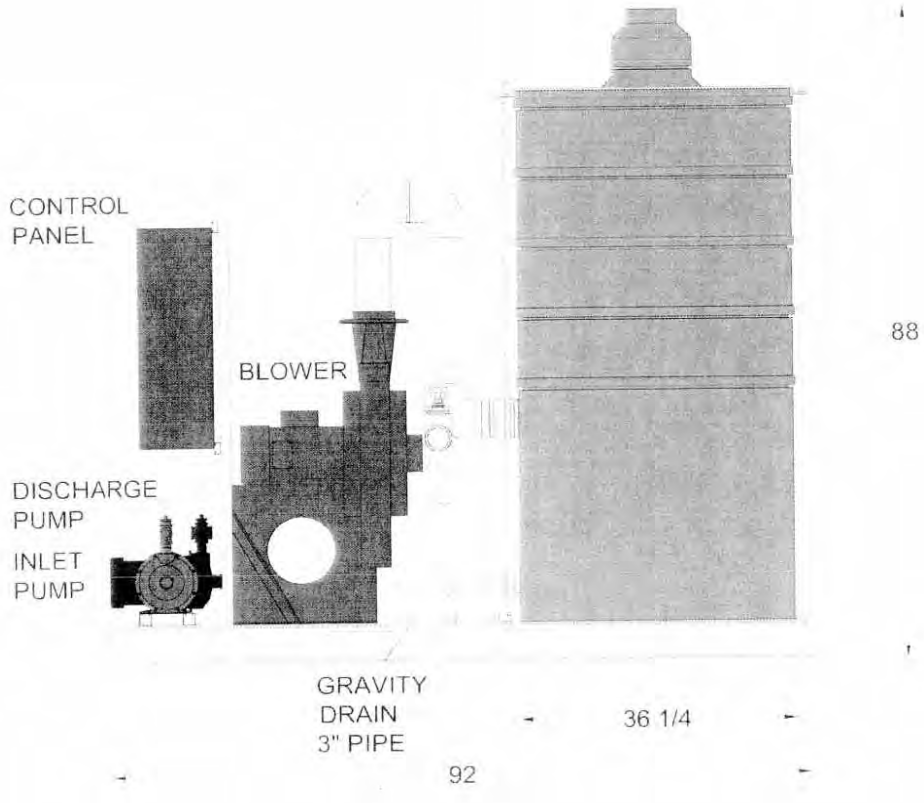
Contaminant	4-Tray (ppmV)	4-Tray (lb/hr)	6-Tray (ppmV)	6-Tray (lb/hr)
p-xylene	6.1799	0.02918	6.1802	0.02918
ethylbenzene	1.5864	0.00749	1.5864	0.00749
TPH (as benzene)	144.1232	0.50066	144.1277	0.50067
1,1,1-trichloroethane	42.1973	0.25034	42.1973	0.25034
1,1,2-trichloroethane	0.0052	0.00003	0.0062	0.00004
1,1-dichloroethane	21.8338	0.09609	21.8430	0.09613
1,1-dichloroethylene	2.0207	0.00871	2.0207	0.00871
1,2,4-trimethylbenzene	6.2996	0.03367	6.3001	0.03368
1,2-dichlorobenzene	0.8004	0.00523	0.8011	0.00524
1,2-dichloroethane	4.4206	0.01945	4.4953	0.01978
1,3,5-trimethylbenzene	1.4856	0.00794	1.4856	0.00794
1,4-dichlorobenzene	0.2219	0.00145	0.2221	0.00145
2-butanone (MEK)	0.3349	0.00107	0.3517	0.00113
4-methyl-2-pentanone (MIBK)	1.0933	0.00487	1.1591	0.00516
acetone	0.5221	0.00135	0.5483	0.00142
benzene	2.2281	0.00774	2.2282	0.00774
benzo[a]anthracene	0.0000	0.00000	0.0000	0.00000
benzo[b]fluoranthene	0.0000	-0.00000	0.0000	-0.00000
benzo[k]fluoranthene	0.0000	-0.00000	0.0000	-0.00000
benzo[a]pyrene	0.0000	-0.00000	0.0000	-0.00000
bis(2-chloroethyl) ether	0.0352	0.00022	0.0370	0.00024
c-1,2-dichloroethylene	5.2868	0.02279	5.2955	0.02283
chlorobenzene	0.0660	0.00033	0.0660	0.00033
chrysene	0.0000	-0.00000	0.0000	-0.00000
dichloromethane	71.2918	0.26928	71.3779	0.26960
isopropylbenzene	0.2136	0.00114	0.2136	0.00114
naphthalene	0.4027	0.00230	0.4327	0.00247
pentachlorophenol (PCP)	0.0032	0.00004	0.0033	0.00004
tetrachloroethylene (PERC, PCE)	4.5132	0.03328	4.5132	0.03328
toluene	36.8383	0.15095	36.8392	0.15095
TPH (as naphthalene)	47.2860	0.26953	50.8202	0.28968
trichloroethylene (TCE)	1.9502	0.01139	1.9502	0.01140
vinyl chloride (chloroethylene)	1.6032	0.00446	1.6032	0.00446

Warnings

WARNINGS
Warning: 1,2,4-trimethylbenzene concentration is > 25% of solubility -- see disclaimer. Typical water solubility is 3470 ppb.
Warning: benzo[k]fluoranthene concentration is > 25% of solubility -- see disclaimer. Typical water solubility is 0.55 ppb.
Warning: benzo[a]pyrene concentration is > 25% of solubility -- see disclaimer. Typical water solubility is 3.8 ppb.
Warning: chrysene concentration is > 25% of solubility -- see disclaimer. Typical water solubility is 1.6 ppb.
Warning: TPH (as naphthalene) concentration is > 25% of solubility -- see disclaimer. Typical water solubility is 34400 ppb.

QED EZ-Stacker Model 4.4P

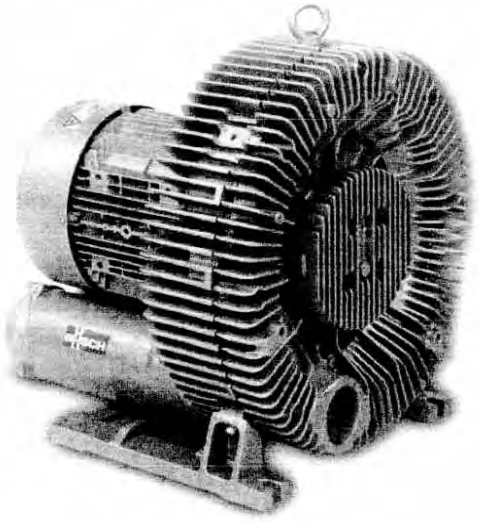




QED POLY AIR STRIPPERS

Model	Flow (GPM)	Dry Weight	Operation Weight	Shell Dimensions	No. Trays and Weight	Active Area	Nominal airflow
EZ-2.4P	1-25 GPM (4-94.6 LPM)	103 lb (46.72 Kg)	483 lb (219 Kg)	27 x 83 in (68.6 x 210.8 cm)	4 x 16 lb (4 x 7.3 Kg)	2.6 sq. ft (0.24 m2)	140 cfm (3.96 m3/min)
EZ-2.6P	1-25 GPM (4-94.6 LPM)	135 lb (61.3 Kg)	531 lb (240.9 Kg)	27 x 103 in (68.6 x 261.6 cm)	6 x 16 lb (6 x 7.3 Kg)	2.6 sq. ft (0.24 m2)	140 cfm (3.96 m3/min)
EZ-4.4P	1-40 GPM (4-151.4 LPM)	155 lb (70.3 Kg)	1,004 lb (455.4 Kg)	37 x 83 in (94.0 x 210.8 cm)	4 x 24 lb (4 x 10.9 Kg)	5.8 sq. ft (0.54 m2)	210 cfm (5.95 m3/min)
EZ-4.6P	1-40 GPM (4-151.4 LPM)	203 lb (92.1 Kg)	1,134 lb (514.4 Kg)	37 x 102 in (94.0 x 259.1 cm)	6 x 24 lb (6 x 10.9 Kg)	5.8 sq. ft (0.54 m2)	210 cfm (5.95 m3/min)

Samos
SB 0050 – 1400 D/D2



Samos SB 0530 D

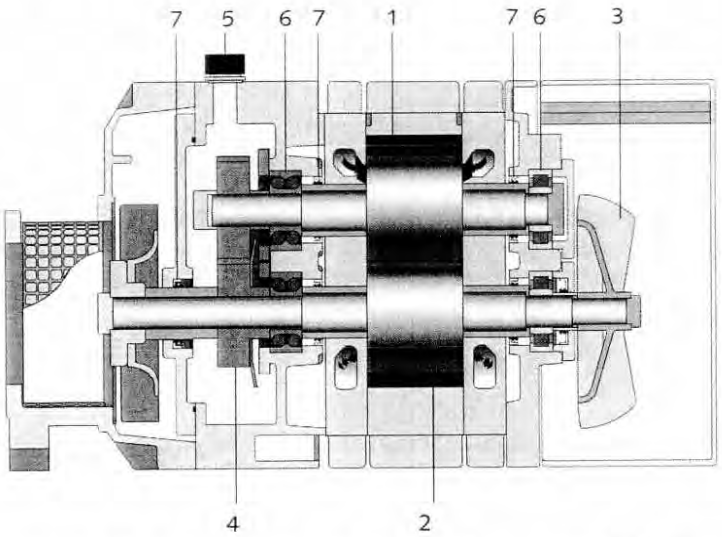
Description

Busch Samos SB regenerative blowers are designed for either pressure or vacuum. They are available in single and two stage models so they can operate over a wide range of flow and differential pressure.

Low Maintenance and Environmentally Friendly

Samos low maintenance features include: rugged construction, sealed-for-life bearings, a fan cooled motor and a non-contacting impeller. They are oil-free, have a low power consumption, and are quiet due to internal silencers. Samos blowers can be installed in either a vertical or horizontal position.

Mink Cutaway



1. Pumping chamber
2. Rotors
3. Cooling fan*
4. Timing gears
5. Oil fill plug
6. Bearings
7. Shaft seals

*33 watt, 115 volt, 1 phase, 60 Hz, electric cooling fan on models 1354-1502

Busch - all over the world in industry

ISO 9001 Registered Company

Busch, Inc. 516 Viking Drive Virginia Beach, VA 23452
Phone (757) 463-7800 FAX (757) 463-7407

www.buschpump.com
1-800-USA-PUMP

MINK DRY CLAW VACUUM PUMP

MI Series, Size Range 1502

Mink MI Standard Features

- Vibration Isolators
- Vacuum Relief Valve
- External Exhaust Silencer
- TEFC Motor
- Electric Cooling Fan
- 3 Year Warranty

DESCRIPTION

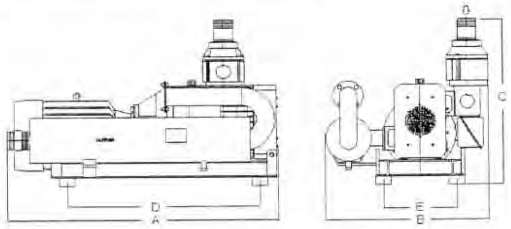
The Busch MI Series positive displacement vacuum pumps feature a compact rotary claw design that is air cooled, dry-running and non-contacting. These features along with quality construction results in a pump that offers extremely high reliability and a long service life.

TECHNICAL DATA

Model	Nominal Capacity	Max Vac. Continuous	Motor HP	Sound Level	Inlet Connection	Discharge Connection	Weight lbs.
MI1502.BV	325 ACFM	23.4" Hgv	15.0	85 dBa	3" NPT	3" NPT	950

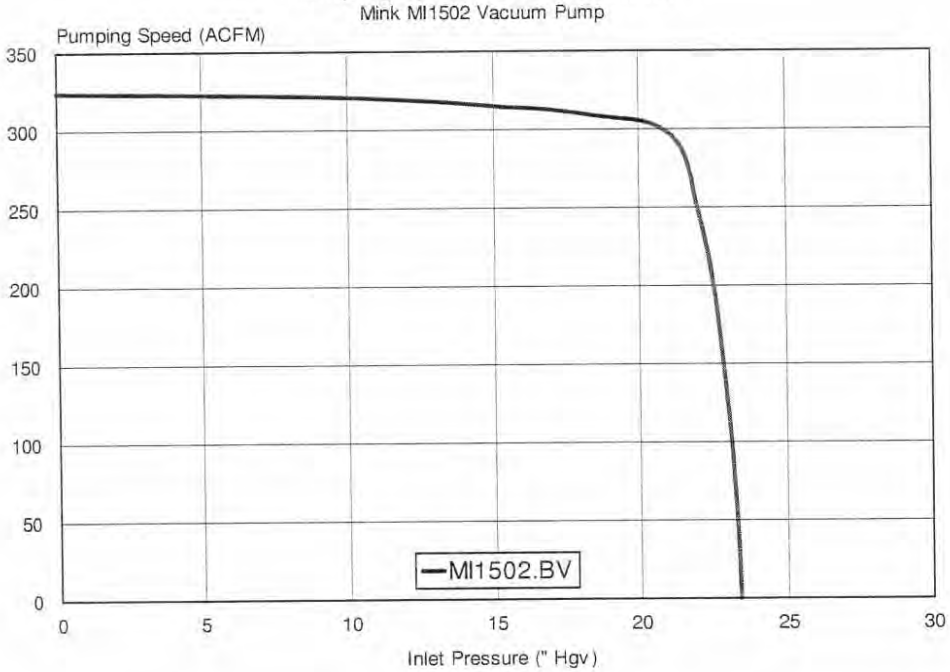
DIMENSIONAL DATA (INCHES)

Model	A	B	C	D	E
MI1502.BV	52.12	31.37	28.67	37.00	14.12



Pumping Speed vs. Inlet Pressure

Mink MI1502 Vacuum Pump



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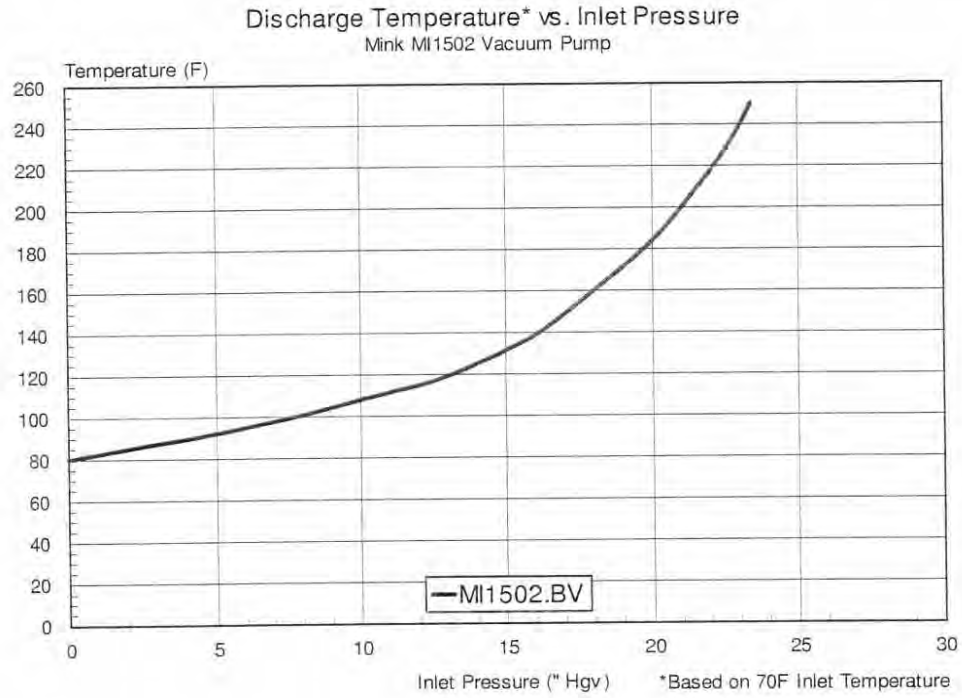
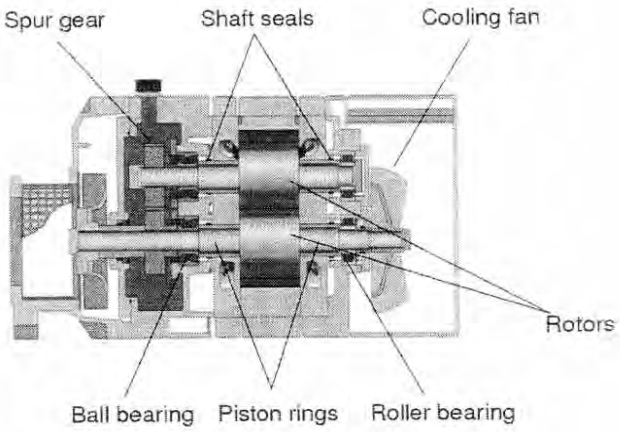
MINK DRY CLAW VACUUM PUMP

MI Series, Size Range 1502



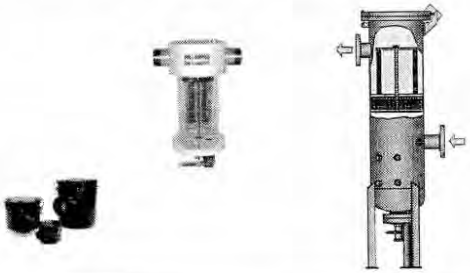
Mink MI Options

- Anti-Corrosive Aqua Coating
- Variable Speed Control
- Auto Purge
- Auto Flush
- Explosion Proof Motor
- Explosion Proof Cooling Fan



Busch Accessories

- Clear Trap Liquid Separators
- Knock Out Pots
- Inlet Filters
- Vacuum Gauges



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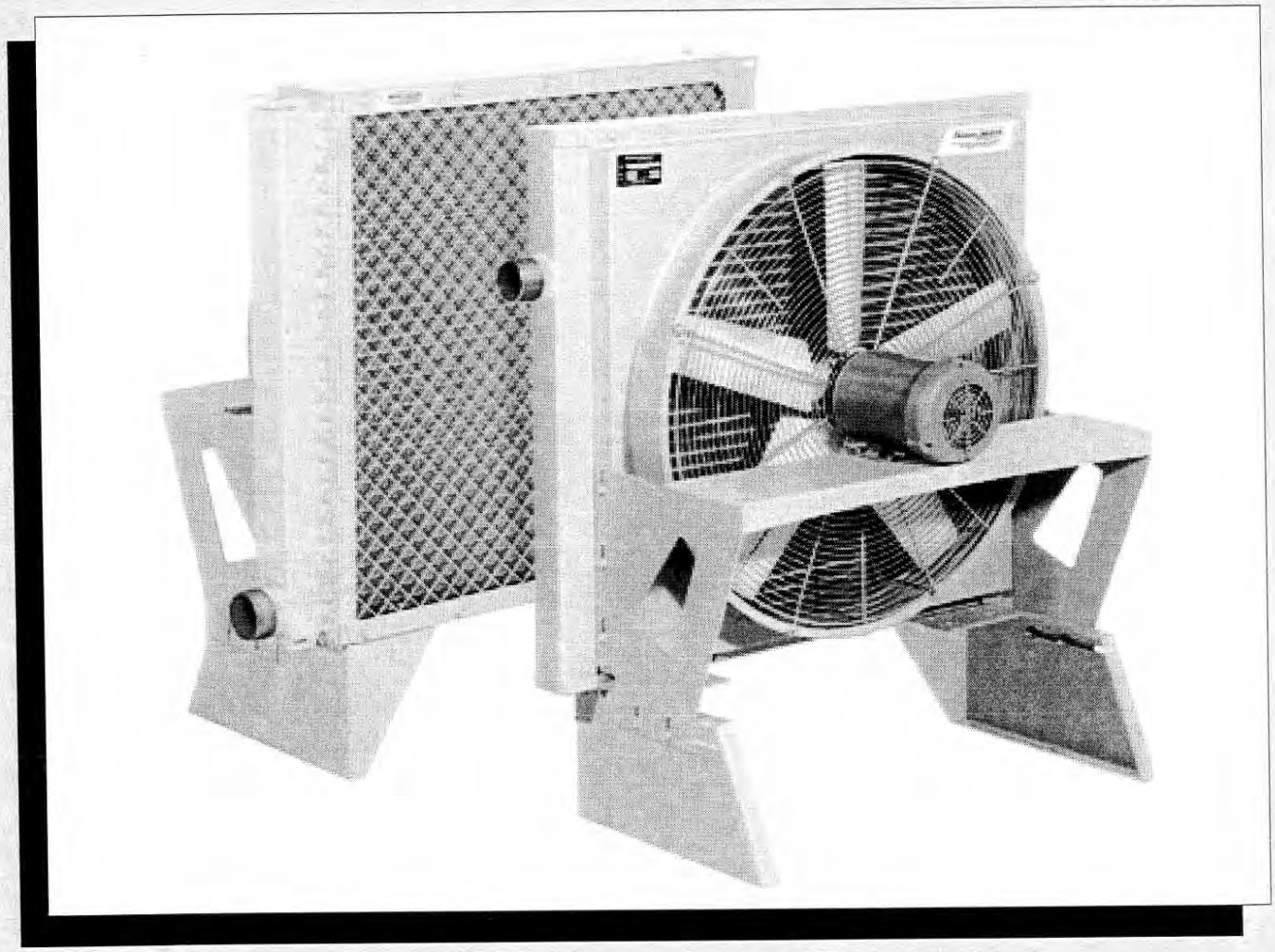
American Industrial Heat Transfer Inc.®

Manufacturer of Quality Heat Exchangers

ACA SERIES



AIR COOLED

AFTERCOOLERS

For Compressed Gas or Vapor

- Computer Selection.
- Low pressure drop available.
- Standard ports NPT, optional ANSI flange.
- Operating temperature of 400° F & pressure of 150PSI.
- Custom designs to fit your needs.
- Cools: Air, Compressors, Blowers, Steam vapors, Pneumatic systems, Vapor recovery systems etc...

note: AIHTI reserves the right to make reasonable design changes without notice.

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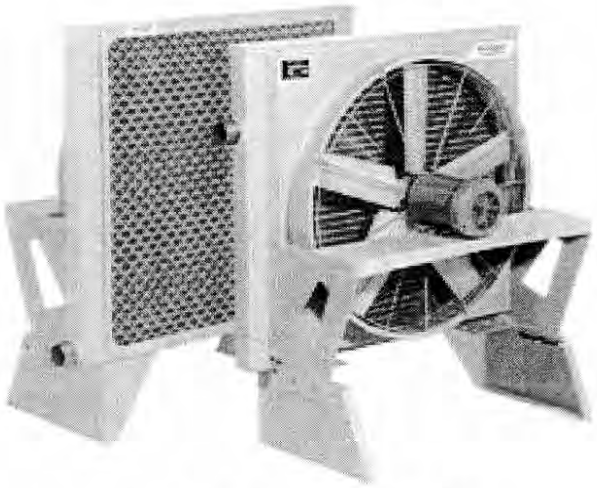
ACA - 3181 through ACA - 4362

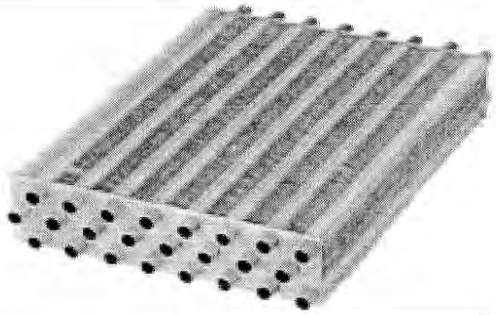


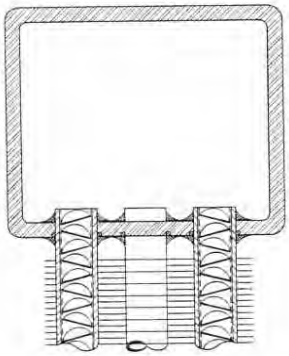
Brazed Core Construction

Air coolers are an essential part of any compressed air system, by cooling the air, and condensing water vapor into a liquid state for removal. When air is compressed, the compression induces heat into both the air and the water entrained in the air.
The American Industrial ACA series heat exchanger cools air with air, making it a simple inexpensive way to cool when compared to other water-cooled or refrigerant cooled systems. The unique compact brazed fin/tube design provides efficient cooling and low maintenance under the warmest environmental conditions. By using an ACA series air-cooled after cooler, machine tools will recieve cooler dryer air, provide longer trouble free life, experience less down time, and be cost effective to operate on a continuous basis.

SUPERIOR COOLING FINS

Copper tubes are mechanically bonded to highly efficient aluminum cooling fins. Die-formed fin collars provide a durable precision fit for maximum heat transfer. Custom fin design forces air to become turbulent and carry heat away more efficiently than old flat fin designs.





TANKS

State-of-the-art high temperature brazing method insures permanent bond and positive contact of tube to manifold, eliminating leaks and providing maximum service life.

CONSTRUCTION MATERIALS & RATINGS

Standard Construction Materials		Standard Unit Ratings	
Tubes	Copper	Operating Pressure	150 psig
Fins	Aluminum	Operating Temperature	400 °F
Cabinet & Pipes	Steel	Consult factory for optional materials and ratings.	
Fan Guard	Zinc Plated Steel		
Manifolds	Steel		

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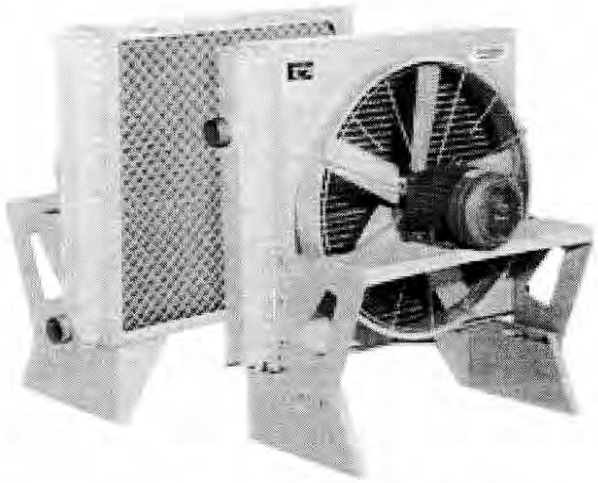
ACA - 6301 through ACA 6602



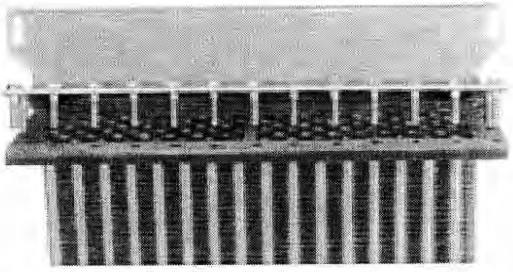
Serviceable Core® Construction

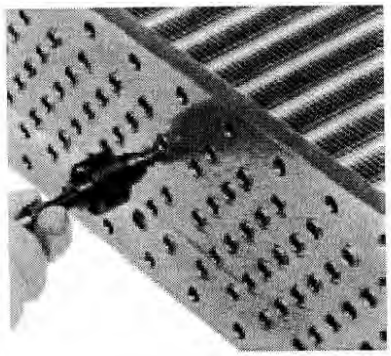
Air coolers are an essential part of any compressed air system, by cooling the air, and condensing water vapor into a liquid state for removal. When air is compressed, the compression induces heat into both the air and the water entrained in the air.

The American Industrial ACA series heat exchanger cools air with air, making it a simple inexpensive way to cool when compared to other water-cooled or refrigerant cooled systems. The unique compact *serviceable core®* design provides efficient cooling and low maintenance under the warmest environmental conditions. By using an ACA series air-cooled after cooler, machine tools will recieve cooler dryer air, provide longer trouble free life, experience less down time, and be cost effective to operate on a continuous basis.

SERVICEABLE CORE®

Core covers disassemble for easy access and cleaning. Repairable design for applications that require limited down time or in the event of a mishap requiring repair. Roller expanded tube to tube-sheet joint. 100% mechanical bond. Positive gasket seal is field replaceable for field maintenance or repair.





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CONSTRUCTION MATERIALS & RATINGS

Standard Construction Materials		Standard Unit Ratings	
Tubes	Copper	Operating Pressure	150 psig
Fins	Aluminum	Operating Temperature	400 °F
Cabinet & Pipes	Steel	Consult factory for optional materials and ratings.	
Fan Guard	Zinc Plated Steel		
Manifolds	Steel		

note: AIHTI reserves the right to make reasonable design changes without notice.

Compressed Air

Normally air compressors have airflow rates based upon the horsepower. Rotary Screw compressors normally discharge air at 180 °f - 200 °f, prior to after-cooling. Reciprocating compressors normally discharge air at 250 °f - 275 °f, prior to after-cooling. Compressors are rated in CFM or cubic feet per minute of free air at inlet conditions. For practical purpose we will use sea level at 68 °f and 36% relative humidity as a norm. Altitude, differing ambient conditions with respect to temperature and humidity will all affect heat exchanger performance to a degree. Moisture content in air actually increases the Btu/hr load requirement for cooling air by adding an additional condensing load to the gas load requirement. As air rapidly cools, moisture in the compressed air stream will condense and separate into droplets, the more humidity present the more condensation will occur.

Sizing

The performance curves provided are for air. However, gases other than air may be applied to this cooler with respect to compatibility by applying a correction factor. Please take time to check the operating specifications thoroughly for material compatibility, pressure, and size before applying an American Industrial heat exchanger into your system.

Terms

Approach Temperature is the desired outlet temperature of the compressed gas minus the inlet ambient air temperature of the external air flowing over the coil.

SCFM (Standard Cubic Feet per Minute)
A cubic foot of air at 68 °f, 14.696 psia, & 36% relative humidity, per minute.

CFM (Cubic Feet per Minute)
Air at inlet atmospheric conditions.

ACFM (Actual Cubic Feet per Minute)
Air at current pressure, temperature, & humidity conditions without reference to a standard.

To Determine the Heat Load

If the heat load (Btu/hr) is unknown a value can be calculated based upon system operational requirements. To properly calculate the heat load (Btu/hr) to be rejected, several items must be known with certainty (see below).

- Flow rate SCFM (standard cubic feet pr minute)
- Type of gas and its makeup.
- System inlet pressure to the heat exchanger.
- Ambient temperature where the heat exchanger will be located (hotest condition).
- Temperature of the gas at the heat exchanger inlet.
- Temperature of the gas desired at heat exchanger outlet.
- Maximum acceptable pressure loss or cooled gas.

Using The Chart

American Industrial has created a quick reference chart for selecting ACA heat exchangers for Rotary Screw compressors (see page 214) [This chart offers basic information based upon compressor horsepower and average airflow rates. To properly use the chart, select the compressor horsepower at the left or the air flow rate. Next select the approach to ambient that is desired. Where the two columns intersect is shown the proper ACA model number.]

Using The Graphs

American Industrial provides performance graphs for ease of model selection. The following calculation examples (page 213), illustrate formulas to determine model selection sizes. It should be noted that there are some assumptions made when applying the basic principles for calculation in the formula. Altitude, humidity, materials, pressures, etc... all contribute to the final selection. Contact American Industrial for more detailed calculation.

Selection

The selection process is important, many considerations should be made when selecting a heat exchanger. Once the proper Fs requirement is calculated, it is time to apply the data to the graph and make a selection.

1) Find the Flow rate in SCFM located at the bottom of the graph. Follow the graph line up until it matches the calculated Fs from your calculations. If the point falls just above one of the model graphed lines, select the next larger size. If the point is on a line select it as your choice.

2) Check carefully the pressure differential. Units with operating pressures from 70+ psig will have no greater than 2.0 psid within the published flow range. For lower inlet pressure see the pressure drop curves for more detail.

3) Calculate a Nozzle size using the nozzle size calculation to verify your selection has the proper port sizes for your required inlet pressure.

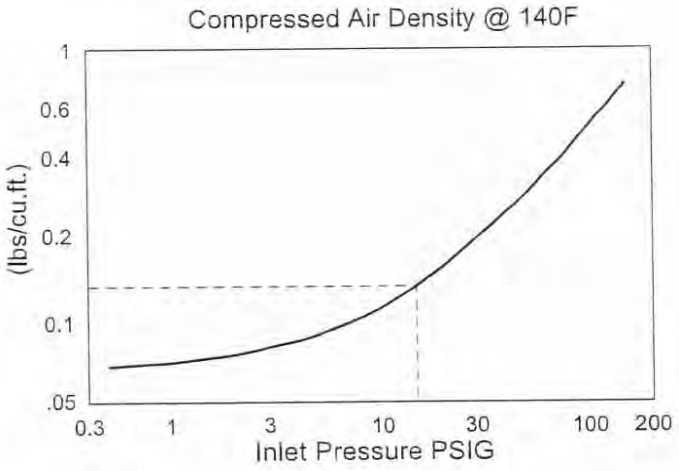
Formula: Nozzle Calculation

$$\text{Nozzle Size} = \sqrt{\left[\frac{\left(\frac{(\text{SCFM} \times 4.512)}{(270{,}000 \times d)} \times 144\right]}{.7854}}$$

All numbers in equation are constants except for SCFM and (d) "density".

Example:
Flow rate = 200 SCFM
Pressure = 15 psig
Density = (d) from Compressed Air Density Graph

$$\sqrt{\left[\frac{\left(\frac{(200 \times 4.512)}{(270{,}000 \times .14)} \times 144\right]}{.7854}} = 2.09\text{" or (2" Nozzle)}$$



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Examples: (Note: All air flow rates must be converted to SCFM)

Application 1 Air Rotary Screw Compressor

Determine the heat load "Q" =Btu/hr
T_1 = Inlet gas temperature: 200°f
T_2 = Outlet gas temperature: Ambient + 10°f= (95°f)
T_a = Ambient temperature: 85°f
Airflow rate: 350 SCFM
PSIG = Operating Pressure 100 psig
CF = Correction factor: 1.13
S = Specific gravity with air being 1.0
C = Specific heat (Btu/Lb °f): .25
Model Selection - ACA-4362

$Q = [SCFM \times CF \times (T_1-T_2)]$ or $[350 \times 1.13 \times 105°] = 41{,}528$ Btu/hr

Determine the Fs = $\frac{Btu/hr}{T_2 - T_a}$ or $\frac{41{,}528}{10}$ = **4,153 Fs** Refer to graph example on page 215

$CF = (.0753 \times S \times C \times 60)$ or $(.0753 \times 1.0 \times .25 \times 60) = 1.13$

$$\sqrt{\frac{\left[\frac{(350 \times 4.512)}{(270.000 \times .50)} \times 144\right]}{.7854}} = 1.46" \text{ or } (1.5" \text{ minimum nozzle})$$

Application 2 Methane Gas

Determine the heat load "Q" = Btu/hr
T_1 = Inlet gas temperature: 300°f
T_2 = Outlet gas temperature: 90°f
T_a = Ambient temperature: 60°f
Gas flow rate: 500 SCFM
PSIG = Operating pressure: 150 psig
CF = Correction factor: 1.428
S = Specific gravity with air being 1.0: .55
C = Specific heat (Btu/Lb °f)
Model Selection - ACA-6421

$Q = [SCFM \times CF \times (T_1-T_2)]$ or $[500 \times 1.428 \times 210°] = 149{,}940$ Btu/hr

Determine the Fs = $\frac{Btu/hr}{T_2 - T_a}$ or $\frac{149{,}940}{30}$ = **4,998 Fs** Refer to graph example on page 215

$CF = (.0753 \times S \times C \times 60)$ or $(.0753 \times .55 \times .575 \times 60) = 1.428$

$$\sqrt{\frac{\left[\frac{(500 \times 4.512)}{(270.000 \times .74)} \times 144\right]}{.7854}} = 1.44" \text{ or } (1.5" \text{ minimum nozzle})$$

Application 3 Low Pressure Blower

Determine the heat load "Q" = Btu/hr
T_1 = Inlet gas temperature: 250°f
T_2 = Outlet gas temperature: 100°f
T_a = Ambient temperature: 90°f
CF = Correction Factor: 1.13
PSIG = Operating pressure: 2 psig
Airflow rate: 90 ACFM
S = Specific gravity with air being 1.0
C = Specific heat (Btu/lb °f): .25
$\triangle P$ = 5" water column or less (example pg. 220)
Model Selection - ACA-3302

$Q = [SCFM \times CF \times (T_1-T_2)]$ or $[76 \times 1.13 \times 150°] = 12{,}882$ Btu/hr

Determine the Fs = $\frac{Btu/hr}{T_2 - T_a}$ or $\frac{12{,}882}{10}$ = **1,288 Fs** Refer to graph example on page 215

To Convert
ACFM to SCFM = $\frac{ACFM \times (PSIG + 14.7) \times 528}{(T_1 + 460) \times 14.7} = \frac{90 \times 16.7 \times 528}{710 \times 14.7} = 76$ SCFM

$$\sqrt{\frac{\left[\frac{(76 \times 4.512)}{(270{,}000 \times .075)} \times 144\right]}{.7854}} = 1.76" \text{ or } (2.0" \text{ minimum nozzle})$$

Pressure Drop (see page 220 for graphs)

Since gas is compressible the density of the gas changes from one temperature or pressure to the next. While the mass flow rate may not change, the pressure differential across the heat exchanger will change dramatically from high (70-125 psig) to low (1-5 psig) pressure. A low pressure condition requires larger carrying lines to move flow than does the same gas rate under a higher pressure. At lower pressures the differential pressure across the heat exchanger can be quite high compared to the same flow rate at a higher pressure. For that reason it is suggested that the pressure differential graphs on page 220 be consulted prior to making your final selection.

The ACA series heat exchanger is designed to be easily modified to accept larger port sizes in the event your system pressure requires larger nozzles. Consult our engineering department for more exacting information regarding pressure differential issues.

ACA Series *selection*

ROTARY SCREW COMPRESSORS
(200°F @125 PSI & 36% relative humidity)

Compressor Horse Power (HP)	Average Air Discharge Cubic feet per minute (SCFM)	Model Size Selection			
		*Approach Temperature °F (T_2 - T_a)			
		5°F	10°F	15°F	20°F
15	60	ACA - 3302	ACA - 3242	ACA - 3242	ACA - 3182
20	80	ACA - 3302	ACA - 3242	ACA - 3242	ACA - 3182
30	130	ACA - 3362	ACA - 3302	ACA - 3242	ACA - 3242
40	165	ACA - 3362	ACA - 3302	ACA - 3302	ACA - 3242
60	250	ACA - 4362	ACA - 3362	ACA - 3302	ACA - 3302
75	350	ACA - 6362	ACA - 4362	ACA - 3362	ACA - 3302
100	470	ACA - 6362	ACA - 6362	ACA - 3362	ACA - 3362
125	590	ACA - 6422	ACA - 6362	ACA - 4362	ACA - 3362
150	710	ACA - 6422	ACA - 6362	ACA - 6362	ACA - 4362
200	945	ACA - 6482	ACA - 6422	ACA - 6362	ACA - 6362
250	1160	ACA - 6482	ACA - 6422	ACA - 6362	ACA - 6362
300	1450	ACA - 6542	ACA - 6482	ACA - 6422	ACA - 6362
350	1630	ACA - 6542	ACA - 6482	ACA - 6422	ACA - 6362
400	1830	ACA - 6602	ACA - 6482	ACA - 6422	ACA - 6422
500	2150	ACA - 6602	ACA - 6542	ACA - 6482	ACA - 6422

***Approach Temperature**
the desired outlet temperature of the compressed gas minus the inlet ambient air temperature of the external air flowing over the coil.

T_2 - Outlet gas temperature

T_a - Ambient temperature

Example of a model:

ACA - 3242 - 3 - __ -____ - ____

- **Model**: ACA
- **Size**
- **Number of Passes**: 1P = 1 pass; 2P = 2 pass
- **Drive Type**: N = no motor; 1 = single phase; 3 = three phase; 1EXP = single phase; 3EXP = three phase; 5 = 575 Volt
- **Connections**: Blank = NPT; A = ANSI 150#RF Flange
- **Tubing**: Blank = Copper; U = 90/10 Cu Ni; C = Carbon Steel
- **Coating**: Blank = Enamel (standard); G = Galvanize (cabinet); T = Heresite (core); X = Epoxy (core & cabinet)

Using the performance graphs (page 215)

The Flow vs. Fs graph is calculated based upon SCFM units.

To convert volumetric Actual Cubic Feet per Minute (ACFM) into Standard Cubic Feet per Minute (SCFM) see page 213 application 3.

To select a model, locate the flow rate in SCFM located at the bottom of the graph. Proceed upward on the graph until the SCFM flow rate intersects with the calculated Fs. The curve closest, on or above the intersection point is the proper selection.

Using the one pass graph or two-pass graph depends upon pressure differential, flow, and performance requirements. The actual surface area for one or two pass units is the same. However, the airflow velocity in the tubes increases with the number of passes giving slightly higher pressure differentials and better cooling performance.

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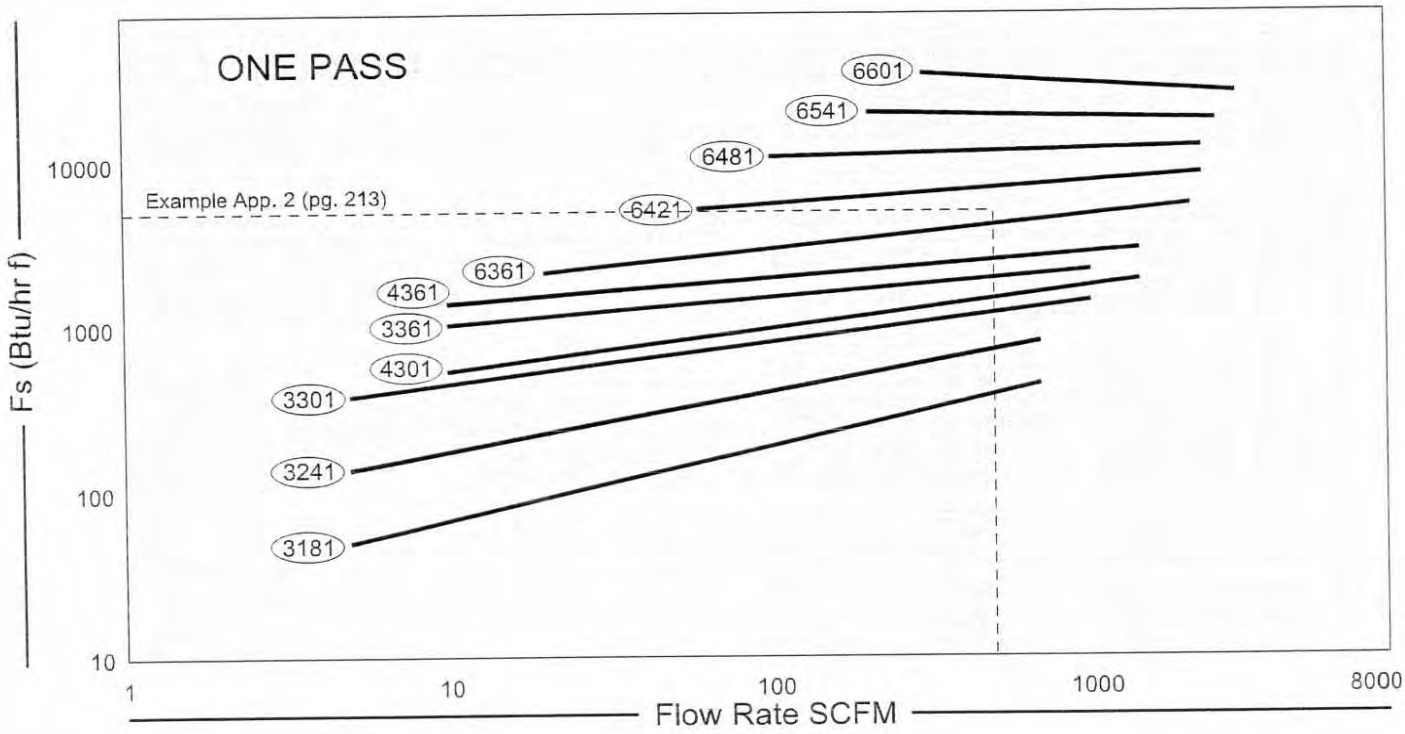
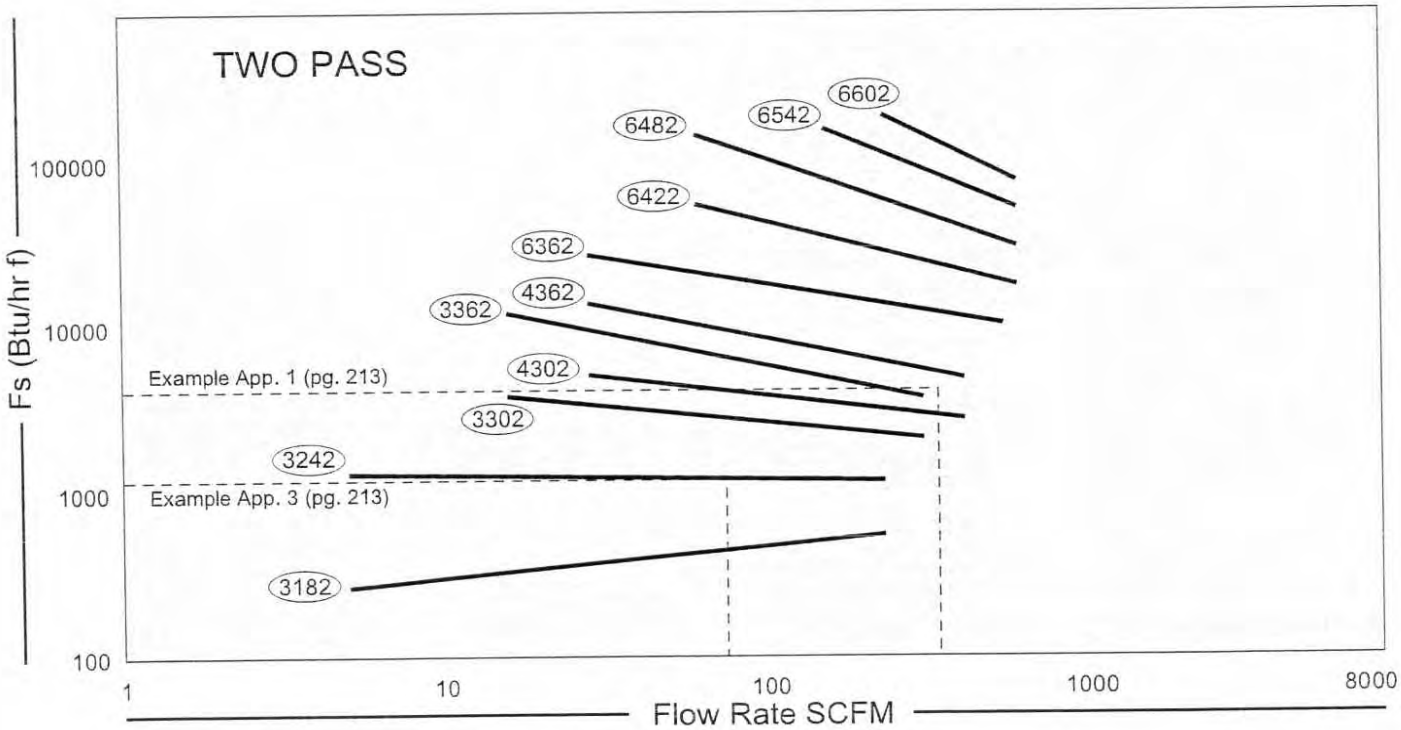


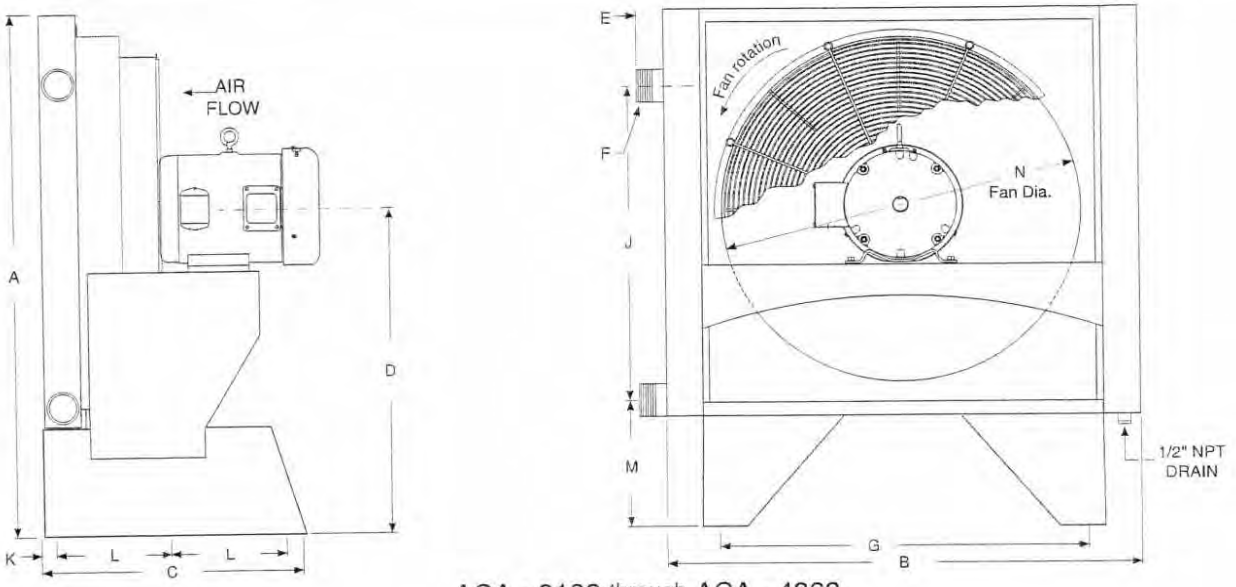


Example

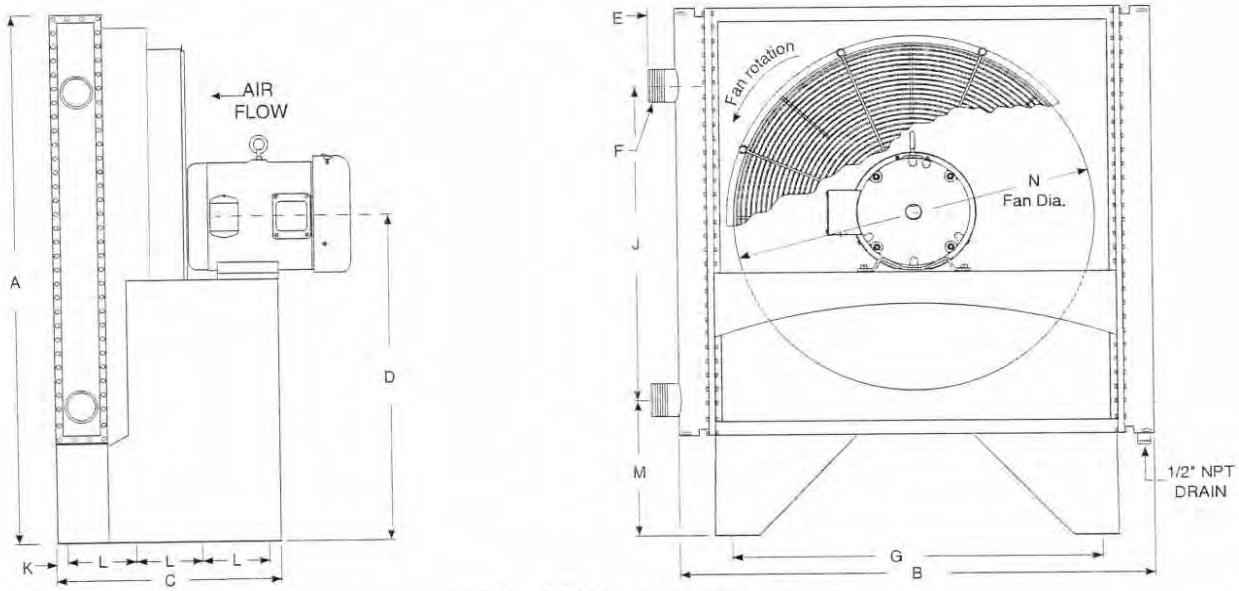
Application #3 (p.5)

$$Fs = \frac{\text{Heat Load (Btu/hr)}}{\text{Process exiting temperature } (T_2) \text{ from cooler} - \text{Ambient air entering the cooler } (T_a)}$$

SCFM = 76
ÐPSI required = 5" H2O
Model selection = ACA-6421-3
Fs = 1.288 Nozzle check (p.4) = 3.10 or 3"NPT



ACA - 3182 through ACA - 4362



ACA - 6302 through ACA - 6602

DIMENSIONS (inches)												
Model	A	B	C	D	E	F NPT	G	J	K	L	M	N
ACA - 3182	30.6	23.0	19.8	20.25	2.5	1.5	16.3	12.98	1.5	8.38	11.93	14.0
ACA - 3242	36.6	29.0	19.8	23.25	2.5	1.5	22.3	17.48	1.5	8.38	11.93	22.0
ACA - 3302	42.6	35.0	19.8	26.25	2.5	2.0	28.3	21.75	1.5	8.38	12.15	28.0
ACA - 4302	42.6	36.0	19.8	26.25	2.5	2.5	28.3	21.55	1.5	8.38	12.35	28.0
ACA - 6302	42.6	38.8	19.8	26.25	2.5	3.0	28.3	21.07	1.5	8.38	12.98	28.0
ACA - 3362	48.6	41.0	19.8	29.25	2.5	2.0	34.3	26.25	1.5	8.38	12.15	32.0
ACA - 4362	48.6	42.0	19.8	29.25	2.5	2.5	34.4	26.05	1.5	8.38	12.35	32.0
ACA - 6362	48.5	43.9	19.8	29.25	2.5	3.0	34.3	26.0	1.5	8.38	12.7	32.0
ACA - 6422	54.5	50.8	27.36	32.25	2.5	4.0	40.3	29.4	2.0	6.75	13.3	36.0
ACA - 6482	60.6	56.8	27.36	35.25	2.5	4.0	46.3	34.1	2.0	6.75	13.3	42.0
ACA - 6542	66.6	62.8	28.83	38.25	2.5	4.0	52.3	38.6	2.0	6.75	13.3	48.0
ACA - 6602	72.4	67.9	30.6	41.25	2.5	4.0	58.3	43.05	2.0	6.75	13.3	48.0

note: AIHTI reserves the right to make reasonable design changes without notice.

ACA Series *motor data*

ELECTRIC MOTOR DATA

Model	Horse Power	Phase	Hz	Volts	RPM	NEMA Frame	Enclosure Type	Full Load Amperes	Service Factor	Thermal Overload
ACA- 3181/2- 1	.25	1	60-50	115/230 - 90/190	1725-1440	48	TEFC	3.2/1.6/2.8-1.4	1.15	NO
ACA- 3181/2 -3	.25	3	60-50	208 - 230/460 - 190/380	1725-1440	48	TEFC	1.3/.65/1.1-.55	1.15	NO
ACA- 3241/2 -1	.25	1	60-50	115/230 - 90/190	1140-950	56	TEFC	6.8/3.1-3.4	1.15	NO
ACA- 3241/2 -3	.25	3	60-50	208 - 230/460 - 190/380	1140-950	56	TEFC	1.7/2.0/1.0	1.15	NO
ACA- 3301/2 -1	.5	1	60-50	115/230 - 90/190	1140-950	56	TEFC	9.6/4.7-4.8/10.4/5.2	1.15	NO
ACA- 3301/2 -3	.5	3	60-50	208 - 230/460 - 190/380	1140-950	56	TEFC	2.4-2.7/1.35-2.5/1.25	1.15	NO
ACA- 4301/2 -1	.5	1	60-50	115/230 - 90/190	1140-950	56	TEFC	9.6/4.7-4.8/10.4/5.2	1.15	NO
ACA- 4301/2 -3	.5	3	60-50	208 - 230/460 - 190/380	1140-950	56	TEFC	2.4-2.7/1.35-2.5/1.25	1.15	NO
ACA- 6301/2 -3	1.0	3	60-50	208 - 230/460 - 190/380	1140-950	56	TEFC	4/2-3.7/1.85	1.15	NO
ACA- 3361/2 -3	1.0	3	60-50	208 - 230/460 - 190/380	1140-950	56	TEFC	4/2-3.7/1.85	1.15	NO
ACA- 4361/2- 3	1.0	3	60-50	208 - 230/460 - 190/380	1140-950	56	TEFC	4/2-3.7/1.85	1.15	NO
ACA- 6361/2 -3	3.0	3	60-50	208 - 230/460 - 190/380	1725-1440	182T	TEFC	8.4-6.8/3.4	1.15	NO
ACA- 6421/2 -3	5.0	3	60-50	208 - 230/460 - 190/380	1140-950	213T	TEFC	8.2-7.6/3.8	1.15	NO
ACA- 6481/2 -3	5.0	3	60-50	208 - 230/460 - 190/380	1140-950	213T	TEFC	14.0/7.0	1.15	NO
ACA- 6541/2 -3	7.5	3	60-50	208 - 230/460 - 190/380	1140-950	254T	TEFC	20.4/10.2	1.15	NO
ACA- 6601/2 -3	10	3	60-50	208 - 230/460 - 190/380	1140-950	256T	TEFC	28.0/14.0	1.15	NO

ELECTRIC MOTOR NOTES:

1) Motor electrical ratings are an approximate guide and may vary between motor manufacturers. Consult ratings on motor data plate prior to installation and operation.

2) Explosion proof, high temperature, severe duty, chemical, IEC, Canadian Standards Association, and Underwriters Laboratory recognized motors are available upon request.

3) American Industrial reserves the right to enact changes to motor brand, type and ratings regarding horsepower, RPM,FLA,and service factor for standard products without notice. All specific requirements will be honored without change.

4) Fan rotation is clockwise when facing the motor shaft.

5) The above motors contain factory lubricated shielded ball bearings (no additional lubrication is required).

6) **Abbreviation Index**
TEFC.....Totally Enclosed, Fan Cooled
EXP.....Explosion Proof

CLASS I,DIV.1, GROUP D or CLASS II,DIV.2, GROUP F & G EXPLOSION PROOF MOTOR DATA

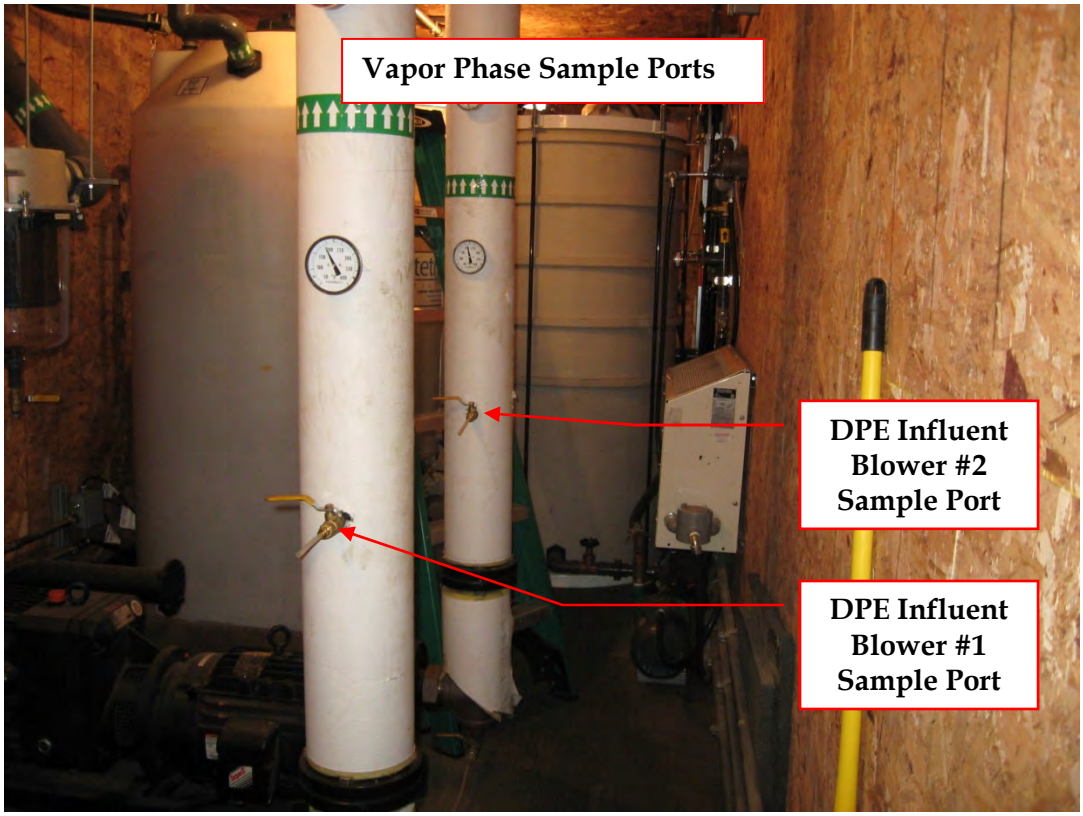
Model	Horse Power	Phase	Hz	Volts	RPM	NEMA Frame	Enclosure Type	Full Load Amperes	Service Factor	Thermal Overload
ACA- 3181/2 -1	.25	1	60	115/230	1725	48	EXP	5.8/2.8	1.0	YES
ACA- 3181/2 -3	.25	3	60	208-230/460	1725	48	EXP	1.4-1.3/.65	1.0	YES
ACA- 3241/2 -3	.33	1	60	115/230	1140	56	EXP	7.8/3.5	1.0	YES
ACA- 3241/2 -1	.33	3	60	208-230/460	1140	56	EXP	1.18-1.6/8	1.0	YES
ACA- 3301/2 -3	.75	1	60	115/230	1140	56	EXP	9.4/4.8	1.0	YES
ACA- 3301/2 -1	.75	3	60	208-230/460	1140	56	EXP	2.5-2.4/1.2	1.0	YES
ACA- 4301/2 -3	.75	1	60	115/230	1140	56	EXP	9.4/4.8	1.0	YES
ACA- 4301/2 -1	.75	3	60	208-230/460	1140	56	EXP	2.5-2.4/1.2	1.0	YES
ACA- 6301/2 -1	1.0	3	60	230/460	1140	56	EXP	3.8/1.9	1.0	YES
ACA- 3361/2 -3	1.0	3	60	230/460	1140	56	EXP	3.8/1.9	1.0	YES
ACA- 4361/2 -3	1.0	3	60	230/460	1140	56	EXP	3.8/1.9	1.15	YES
ACA- 6361/2 -3	3	3	60	230/460	1725	182	EXP	8.8/4.4	1.15	YES
ACA- 6421/2 -3	5	3	60	230/460	1160	215	EXP	15.0-13.8/6.9	1.15	YES
ACA- 6481/2 -3	5	3	60	230/460	1160	215	EXP	15.0-13.8/6.9	1.15	YES
ACA- 6541/2 -3	7.5	3	60	230/460	1160	256	EXP	21.6-20.4/10.2	1.15	YES
ACA- 6601/2 -3	10	3	60	230/460	1160	256	EXP	29-26/13	1.15	YES

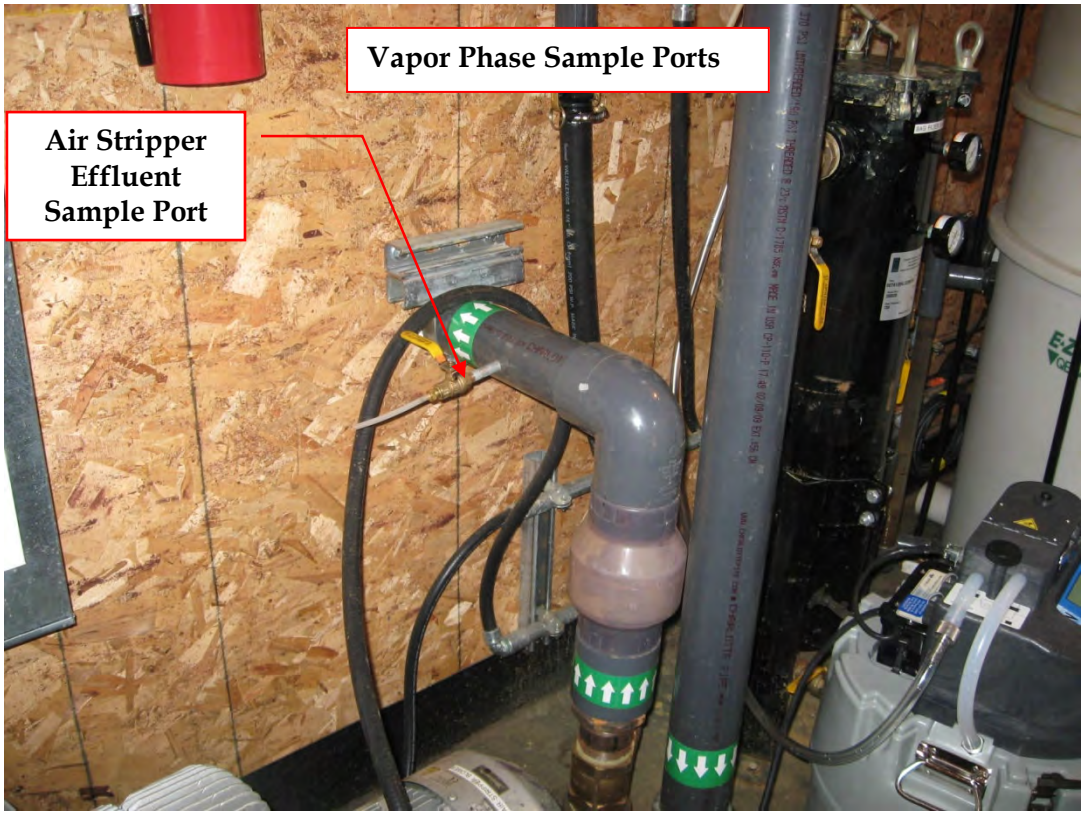
NOTE: Basic electric drive units are supplied with one of the corresponding above listed motors.

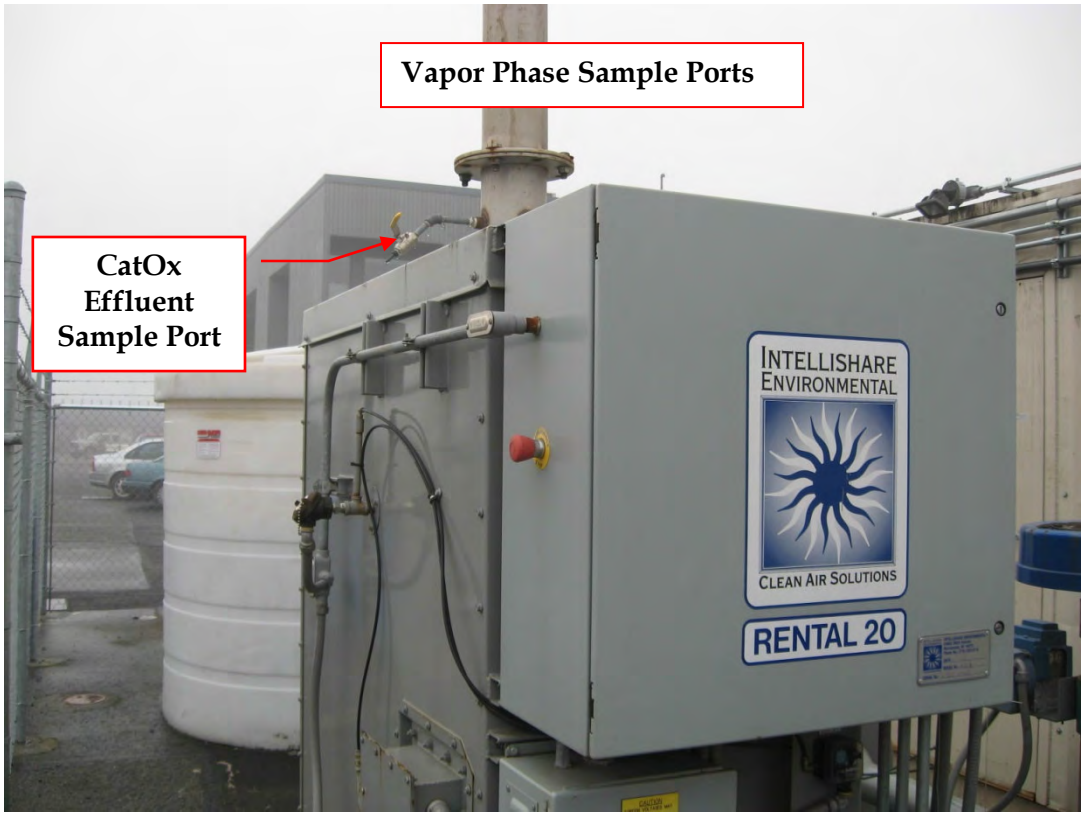
3905 Route 173 Zion, IL 60099 tel: 1 (847) 731-1000 fax: 1 (847) 731-1010 www.aihti.com

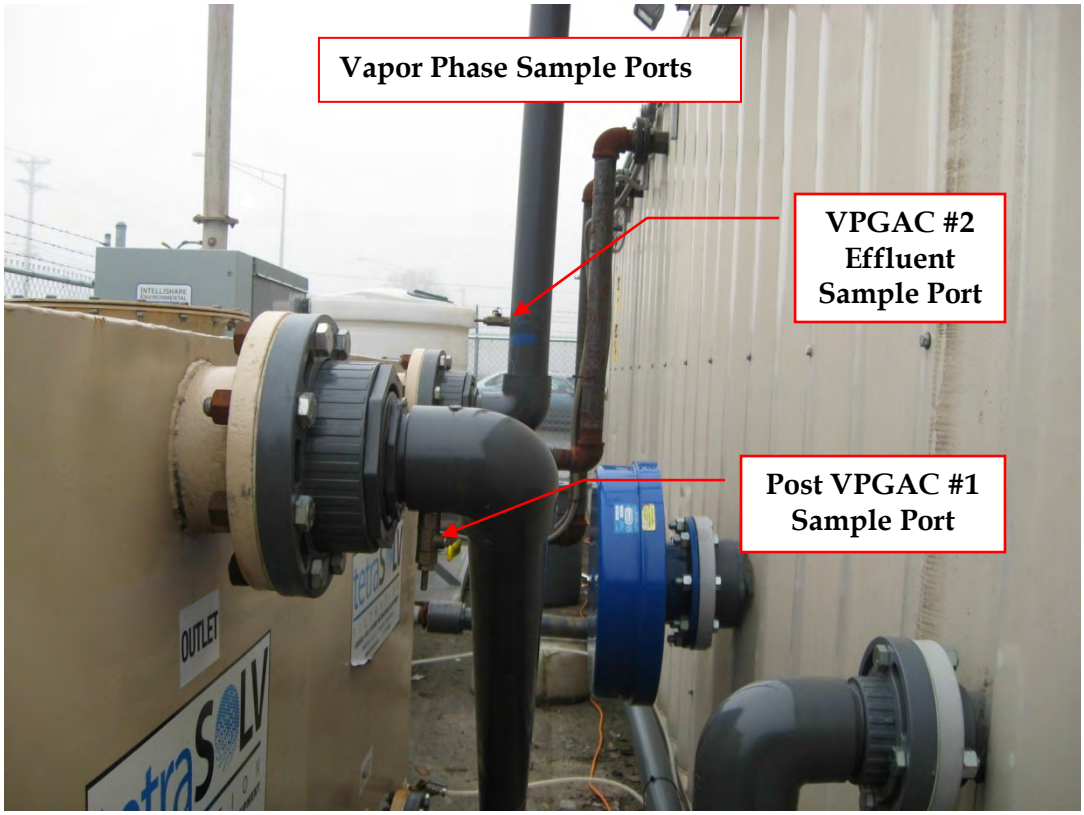
APPENDIX F

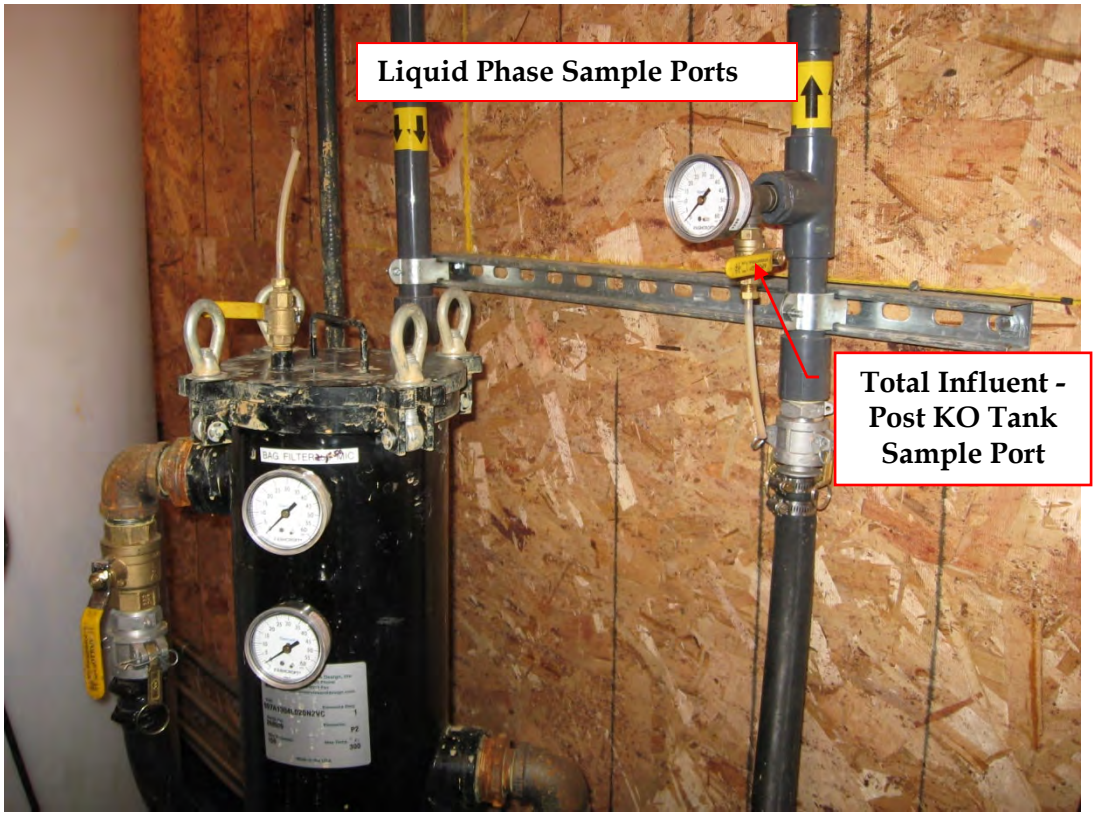
Equipment Pictures

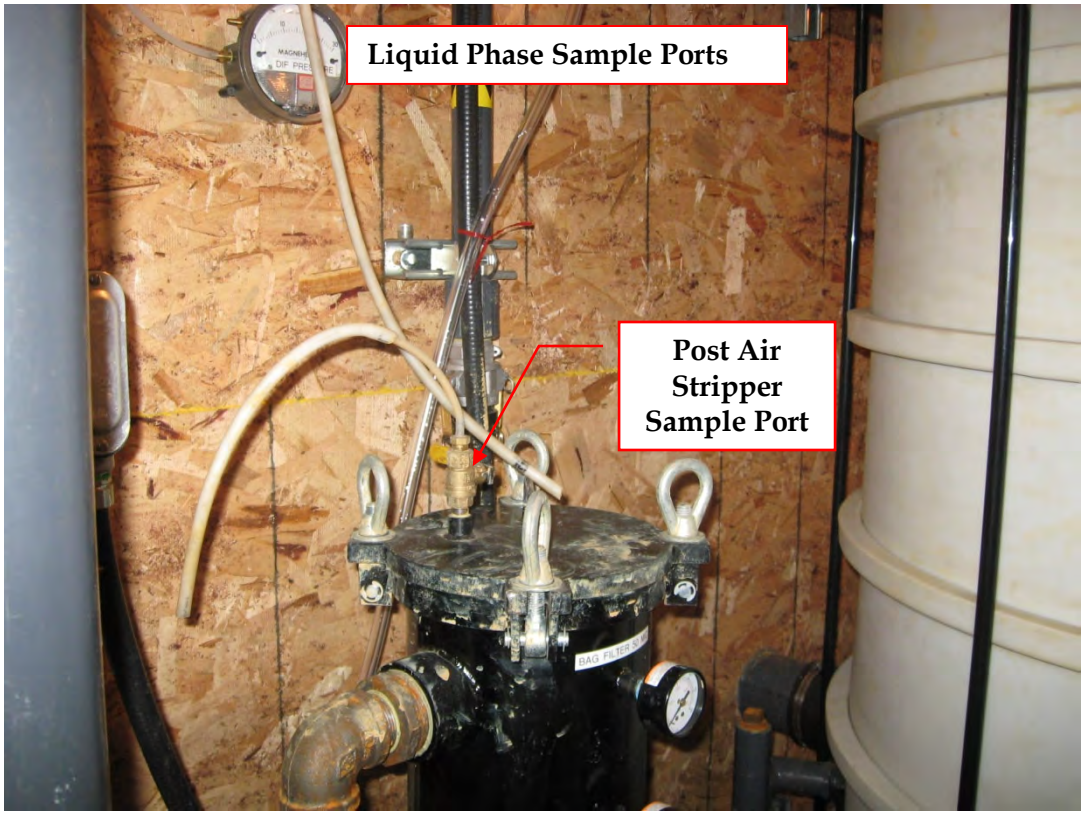

Vapor Phase Sample Ports
DPE Influent Blower #2 Sample Port
DPE Influent Blower #1 Sample Port

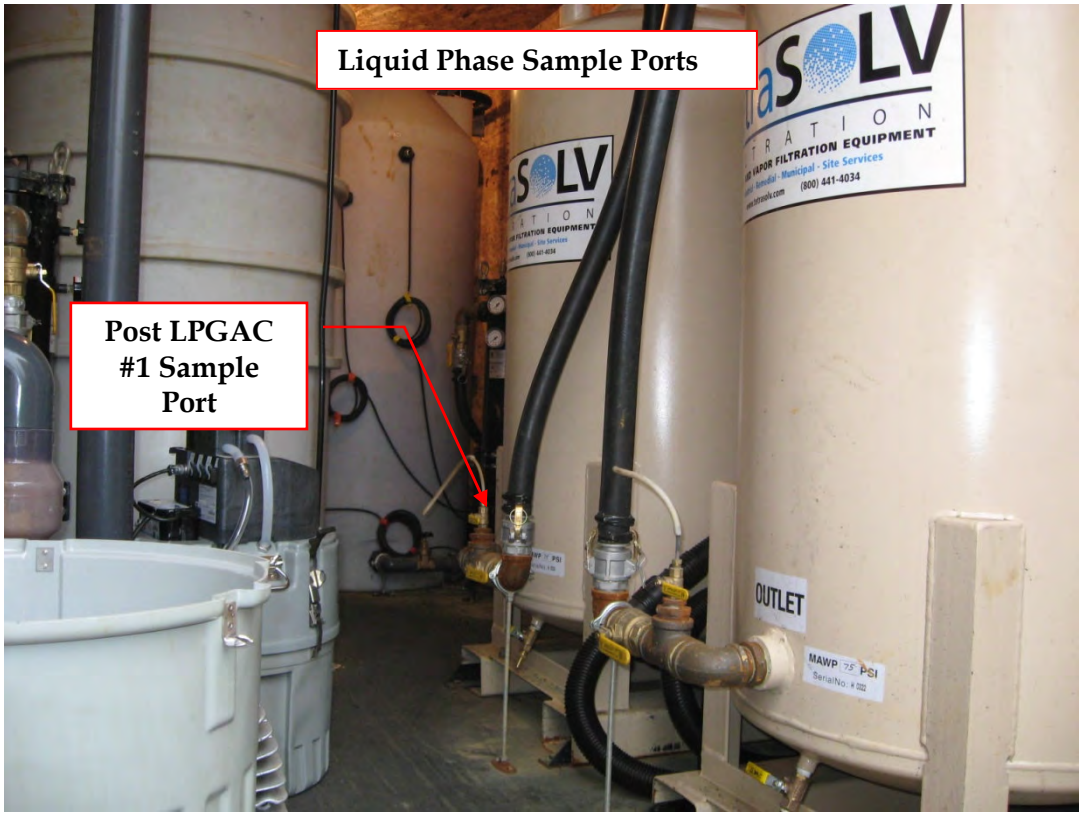

Vapor Phase Sample Ports
Air Stripper Effluent Sample Port

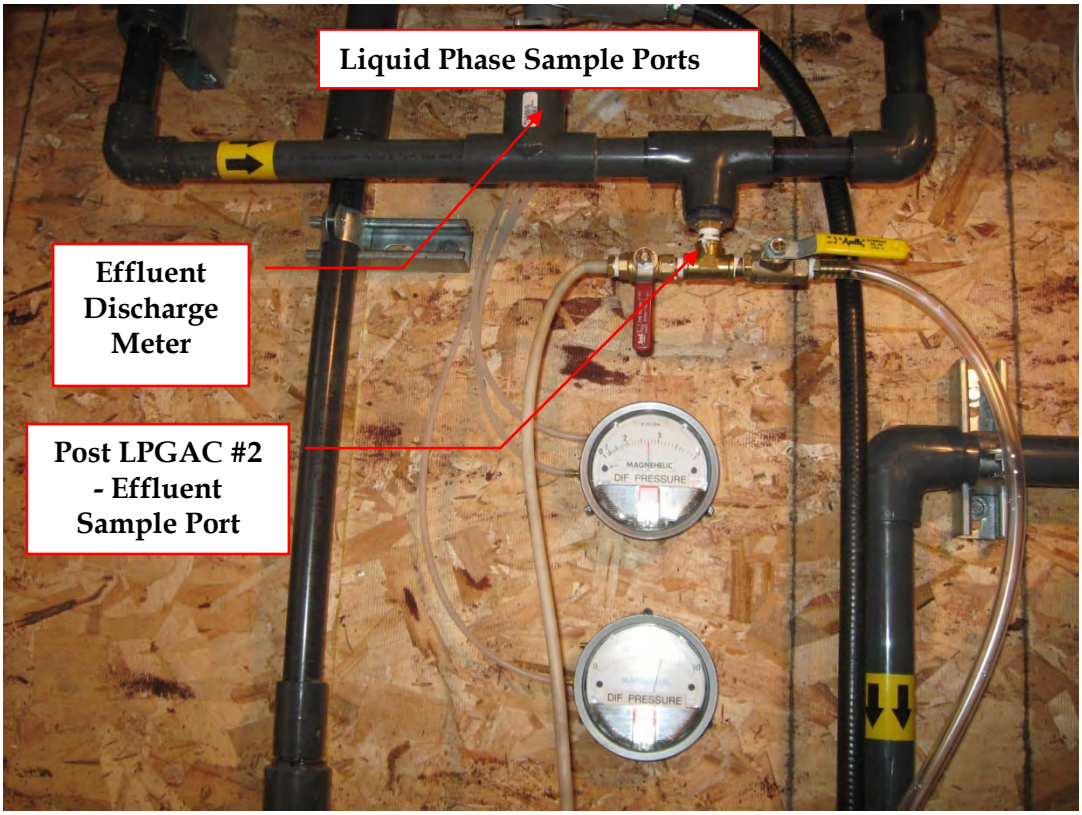

Vapor Phase Sample Ports
CatOx Effluent Sample Port
INTELLISHARE ENVIRONMENTAL
CLEAN AIR SOLUTIONS
RENTAL 20

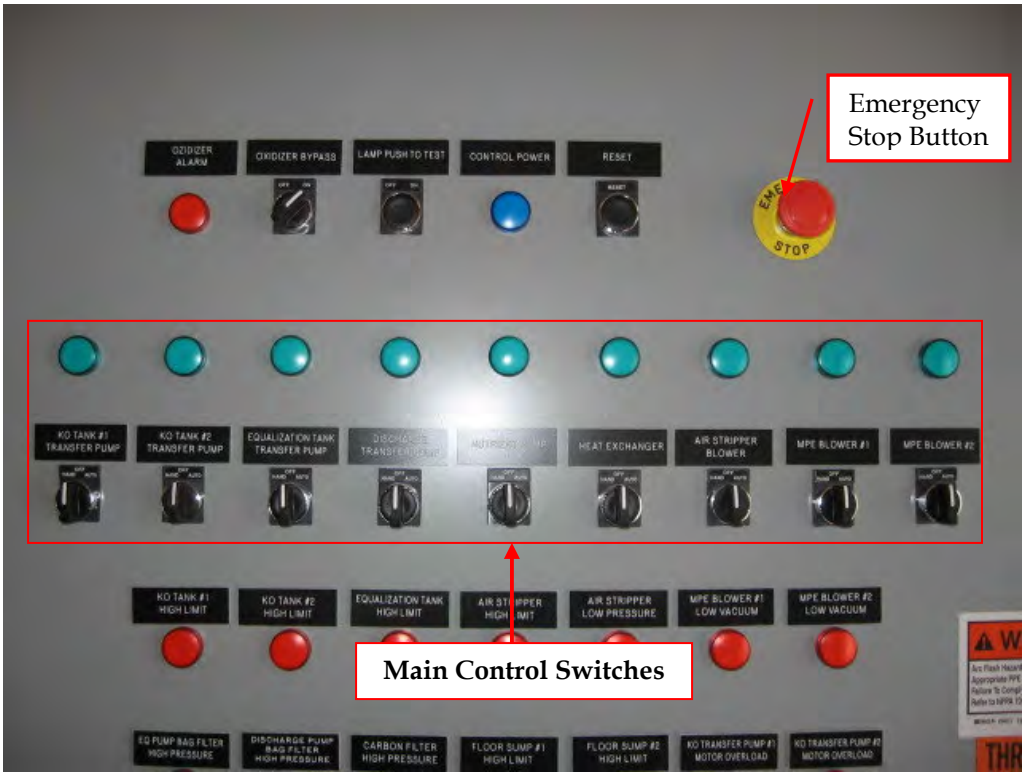

Vapor Phase Sample Ports
VPGAC #2 Effluent Sample Port
Post VPGAC #1 Sample Port
OUTLET

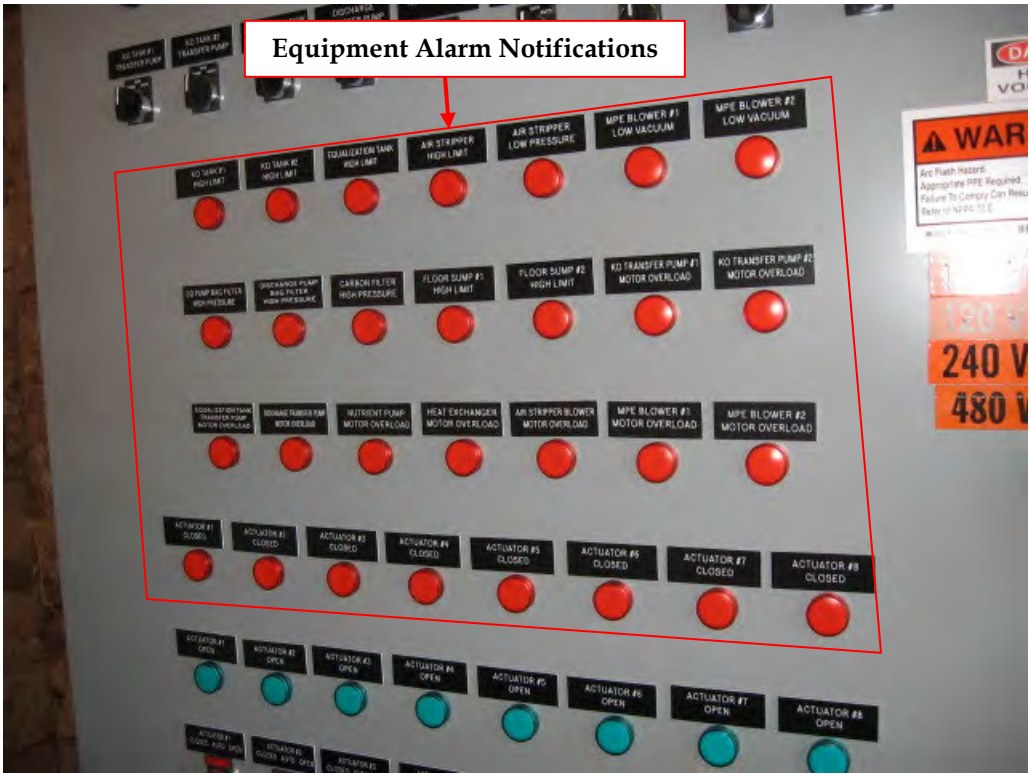

Liquid Phase Sample Ports
Total Influent - Post KO Tank Sample Port

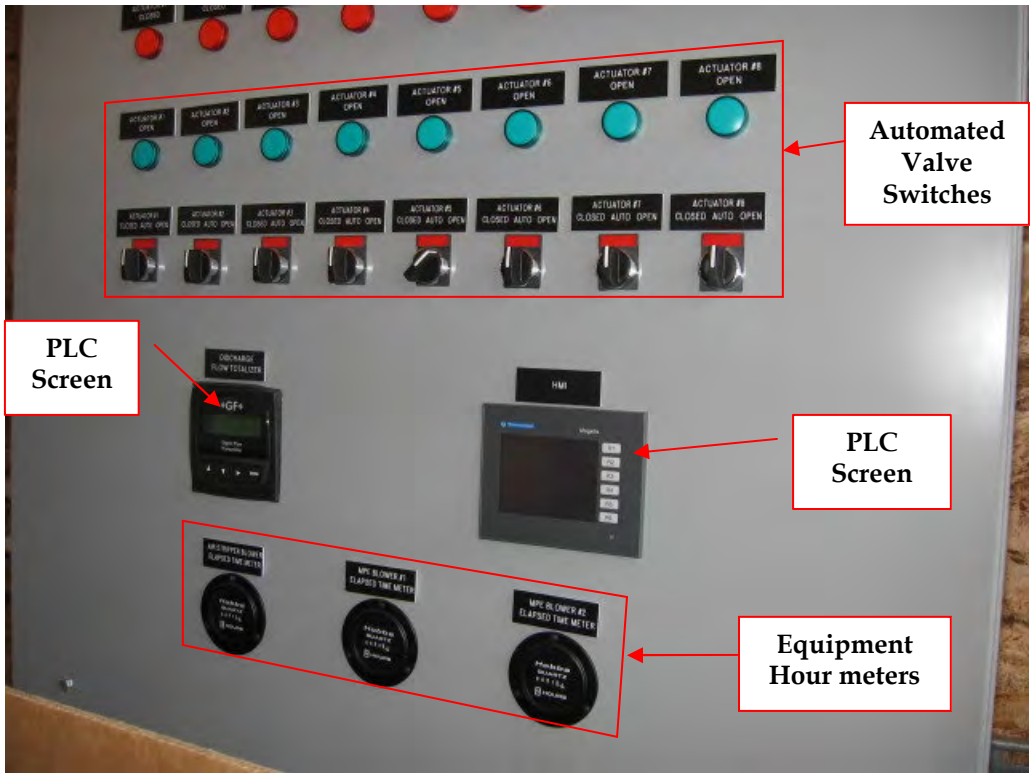

Liquid Phase Sample Ports
Post Air Stripper Sample Port

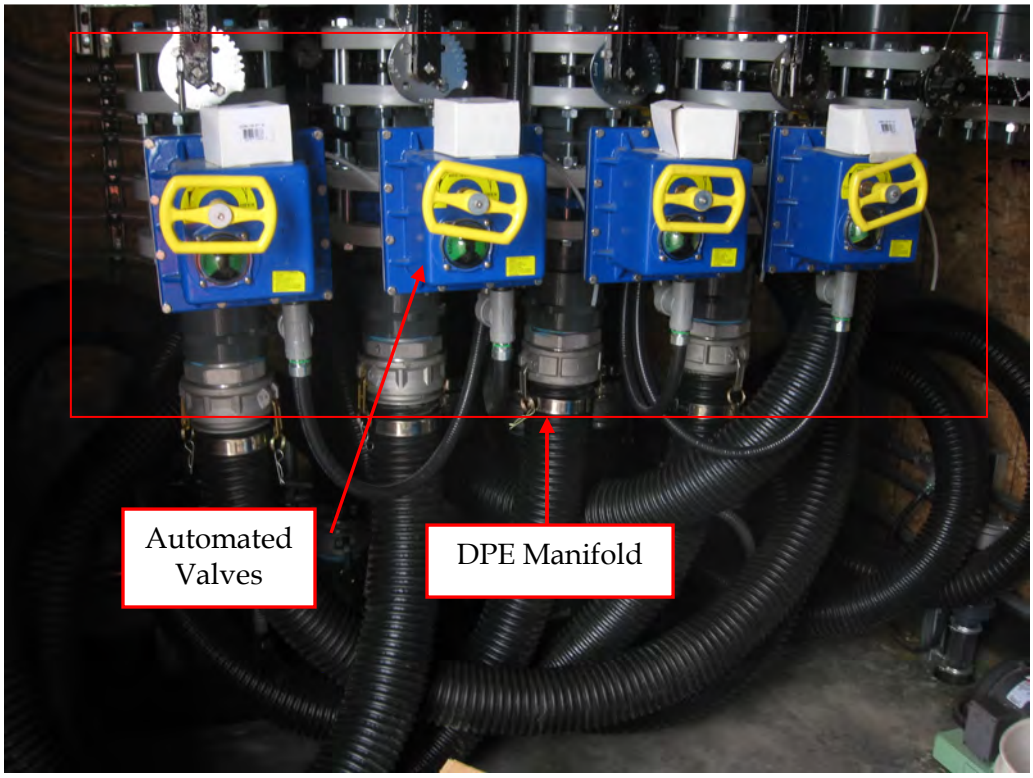

Liquid Phase Sample Ports
Post LPGAC #1 Sample Port
OUTLET

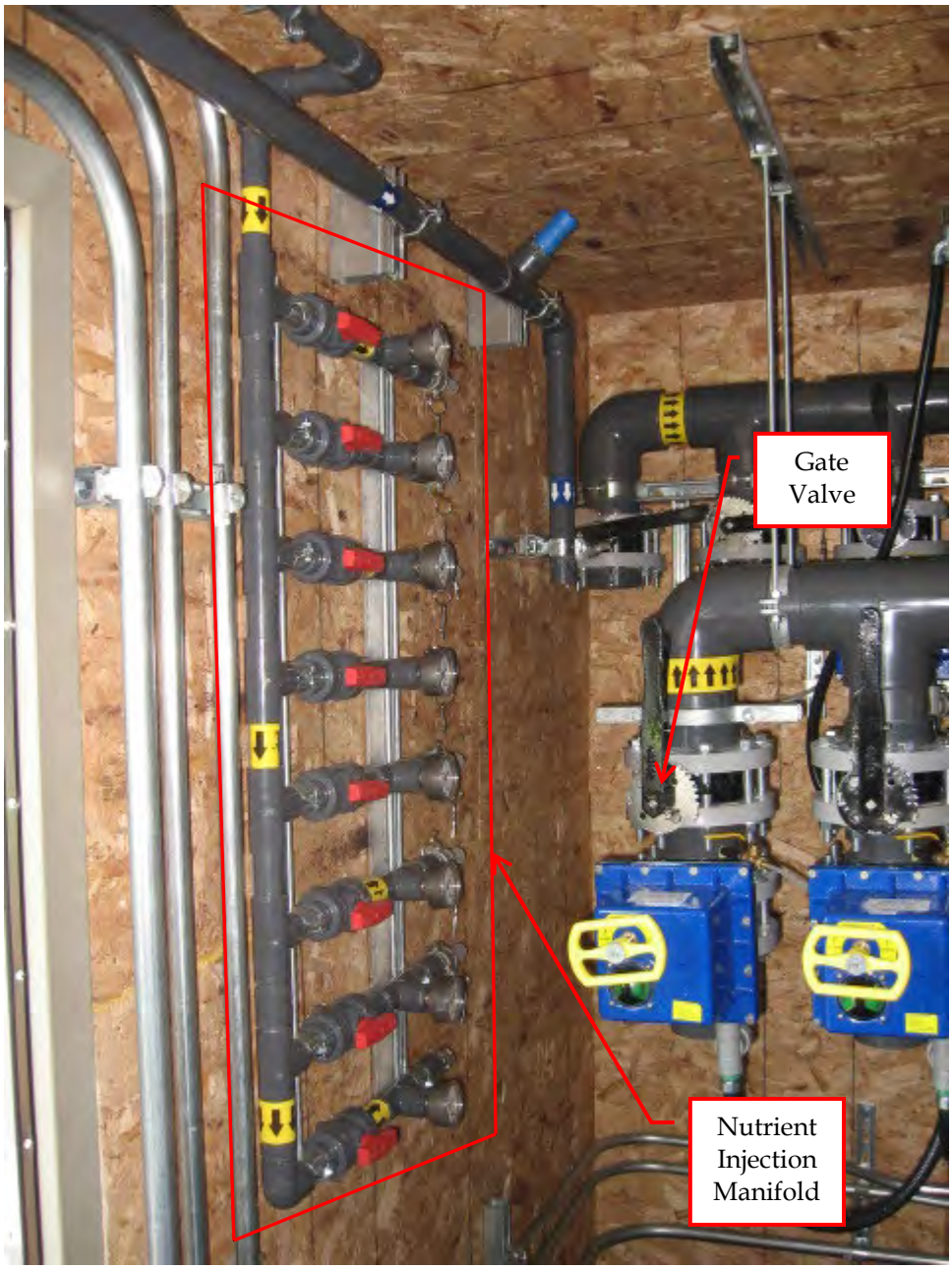

Liquid Phase Sample Ports
Effluent Discharge Meter
Post LPGAC #2 - Effluent Sample Port
DIF PRESSURE
DIF PRESSURE


Emergency Stop Button
OZIDIZER ALARM
OXIDIZER BYPASS
LAMP PUSH TO TEST
CONTROL POWER
RESET
EMERGENCY STOP
KO TANK #1 TRANSFER PUMP
KO TANK #2 TRANSFER PUMP
EQUALIZATION TANK TRANSFER PUMP
HEAT EXCHANGER
AIR STRIPPER BLOWER
MPE BLOWER #1
MPE BLOWER #2
KO TANK #1 HIGH LIMIT
KO TANK #2 HIGH LIMIT
EQUALIZATION TANK HIGH LIMIT
AIR STRIPPER LOW PRESSURE
MPE BLOWER #1 LOW VACUUM
MPE BLOWER #2 LOW VACUUM
Main Control Switches
EQ PUMP BAG FILTER HIGH PRESSURE
DISCHARGE PUMP BAG FILTER HIGH PRESSURE
CARBON FILTER HIGH PRESSURE
FLOOR SUMP #1 HIGH LIMIT
FLOOR SUMP #2 HIGH LIMIT
KO TRANSFER PUMP #1 MOTOR OVERLOAD
KO TRANSFER PUMP #2 MOTOR OVERLOAD

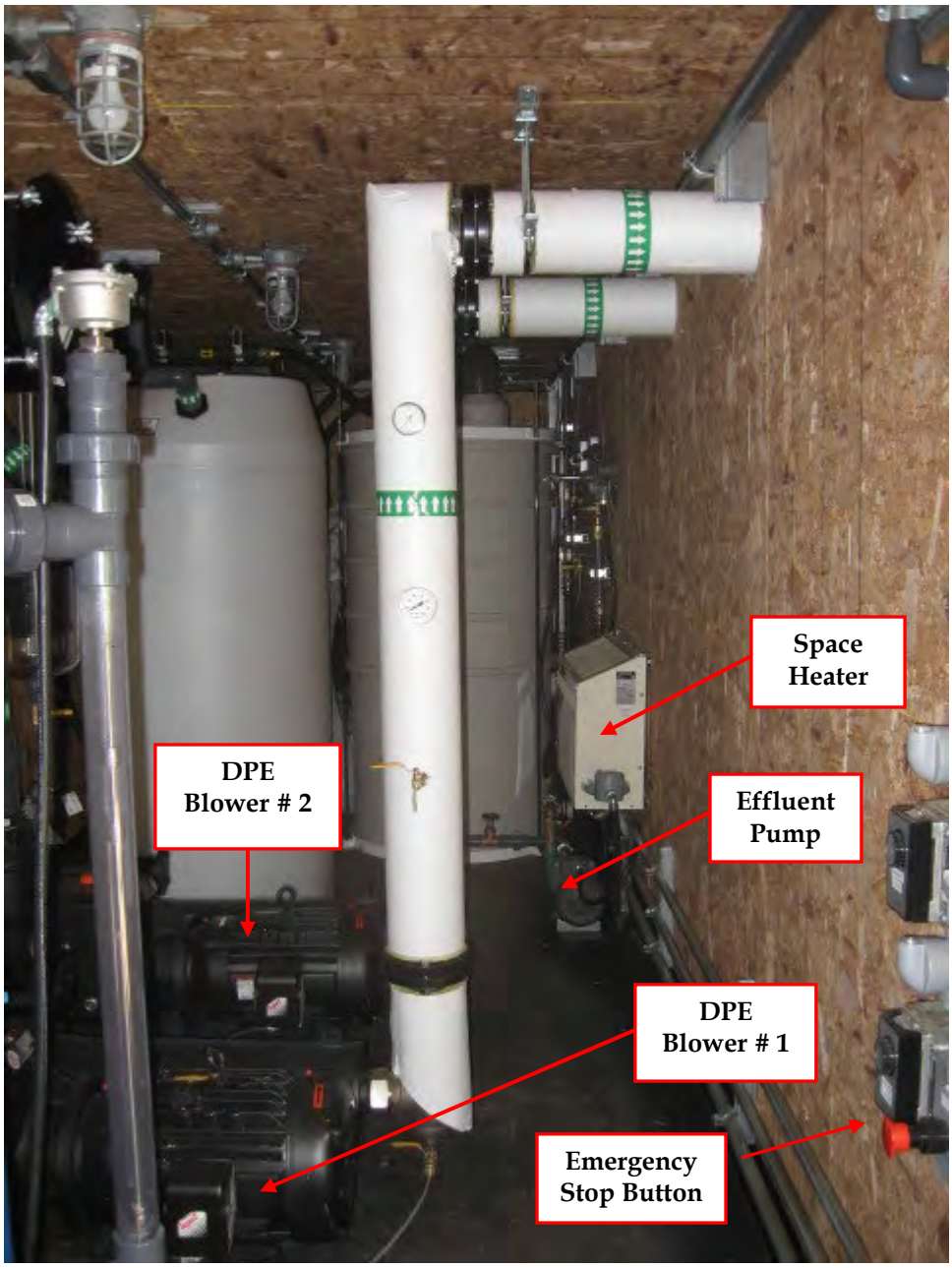

Equipment Alarm Notifications
AIR STRIPPER LOW PRESSURE
MPE BLOWER #1 LOW VACUUM
MPE BLOWER #2 LOW VACUUM
FLOOR SUMP #1 HIGH LIMIT
FLOOR SUMP #2 HIGH LIMIT
KO TRANSFER PUMP #1 MOTOR OVERLOAD
KO TRANSFER PUMP #2 MOTOR OVERLOAD
HEAT EXCHANGER MOTOR OVERLOAD
AIR STRIPPER BLOWER MOTOR OVERLOAD
MPE BLOWER #1 MOTOR OVERLOAD
MPE BLOWER #2 MOTOR OVERLOAD
ACTUATOR #5 CLOSED
ACTUATOR #6 CLOSED
ACTUATOR #7 CLOSED
ACTUATOR #8 CLOSED
ACTUATOR #5 OPEN
ACTUATOR #6 OPEN
ACTUATOR #7 OPEN
ACTUATOR #8 OPEN
240 V
480 V


Automated Valve Switches
PLC Screen
PLC Screen
Equipment Hour meters


Automated Valves
DPE Manifold

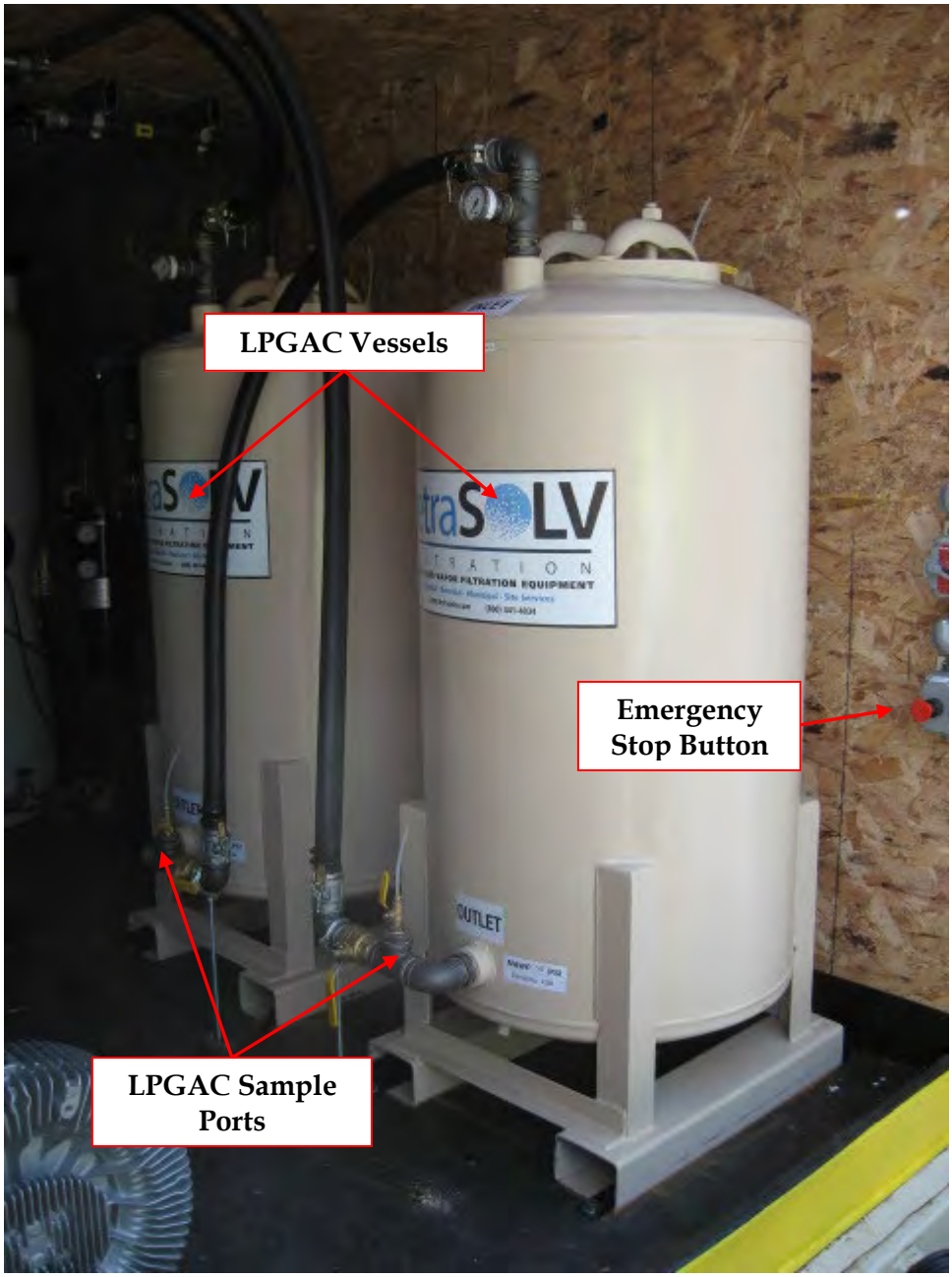

Gate
Valve
Nutrient
Injection
Manifold

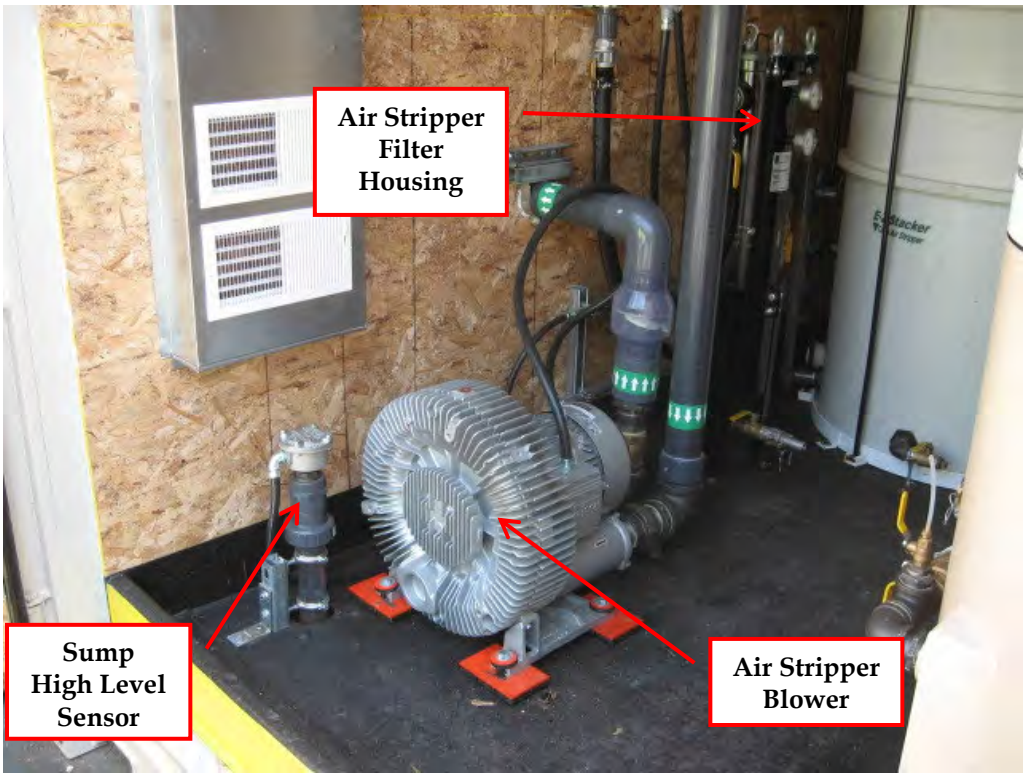

Inlet Air Filter (1 of 2)
KO Tank (1 of 2)
KO Tank Transfer Pump (1 of 2)

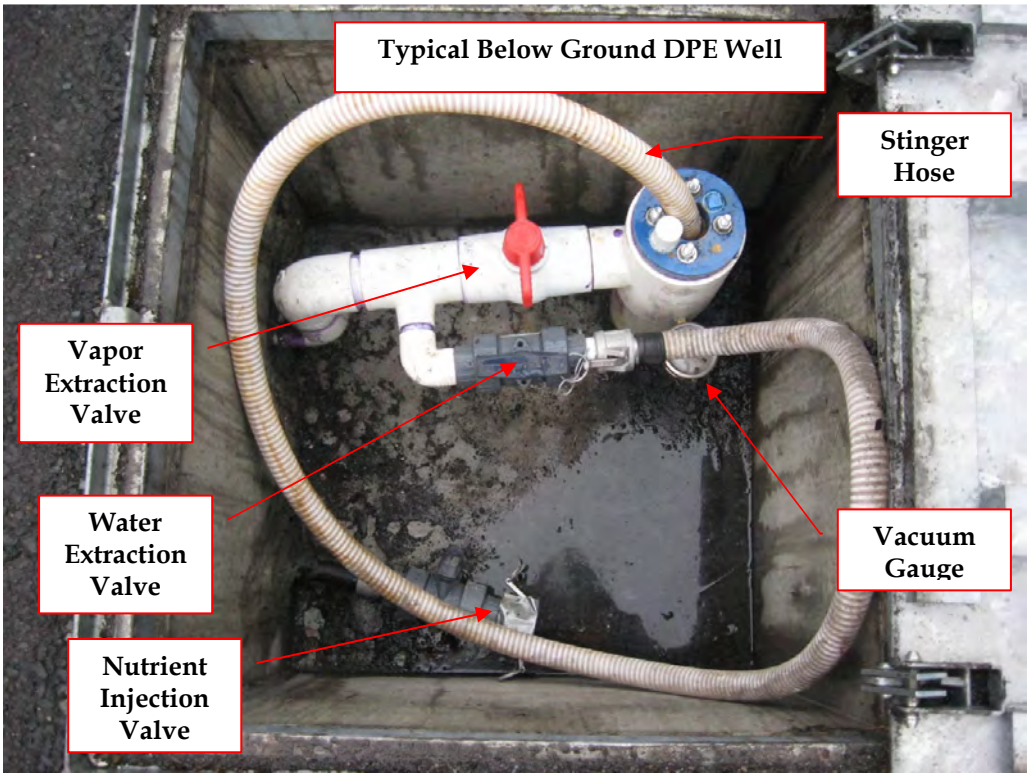

Space Heater
DPE Blower # 2
Effluent Pump
DPE Blower # 1
Emergency Stop Button

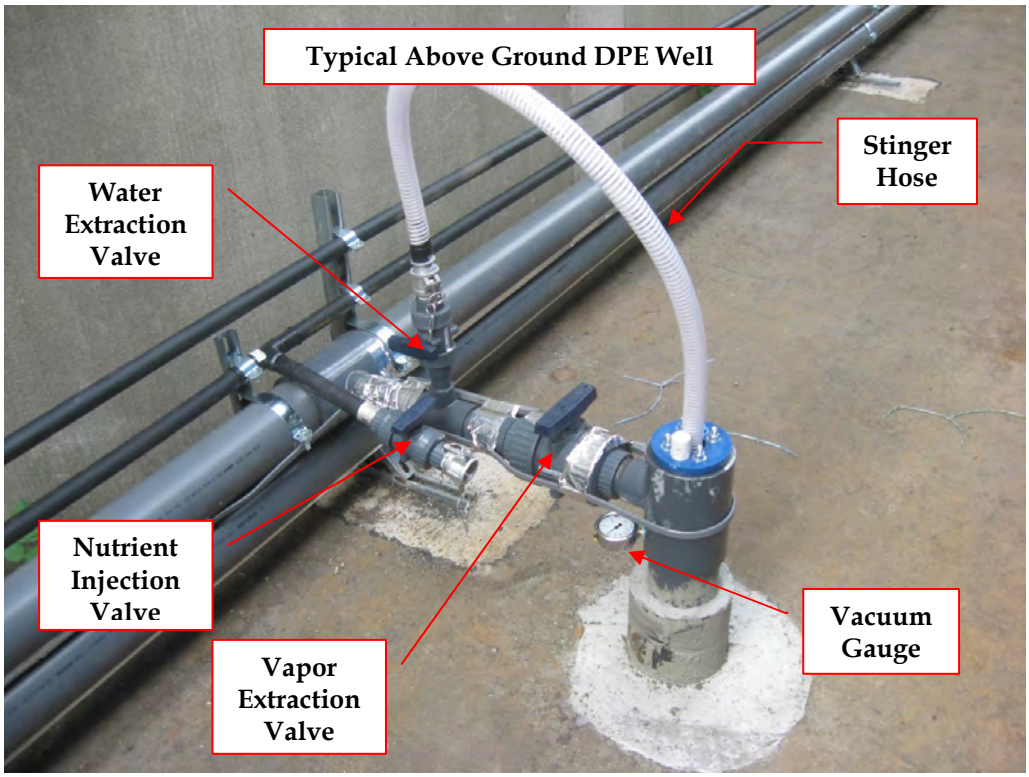

EQ Tank
Air Stripper
Tray System

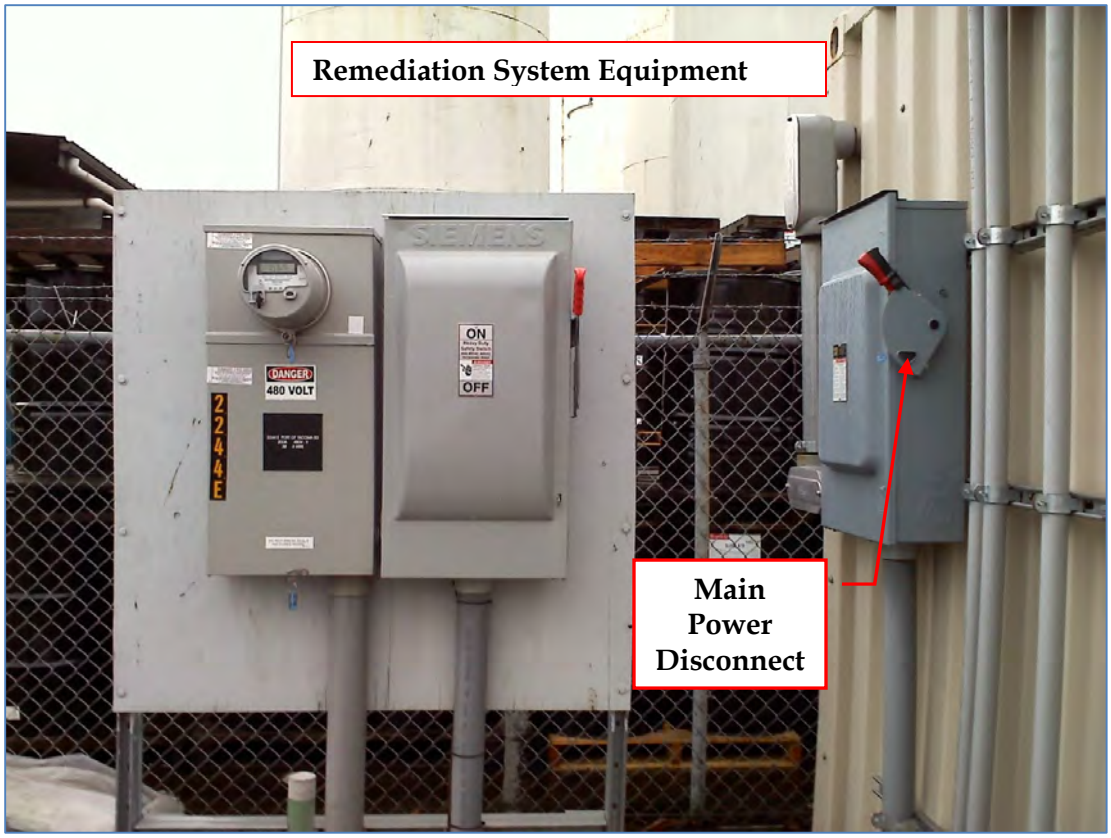

EQ Tank
Water Filter
Housing
EQ Tank
Transfer
Pump

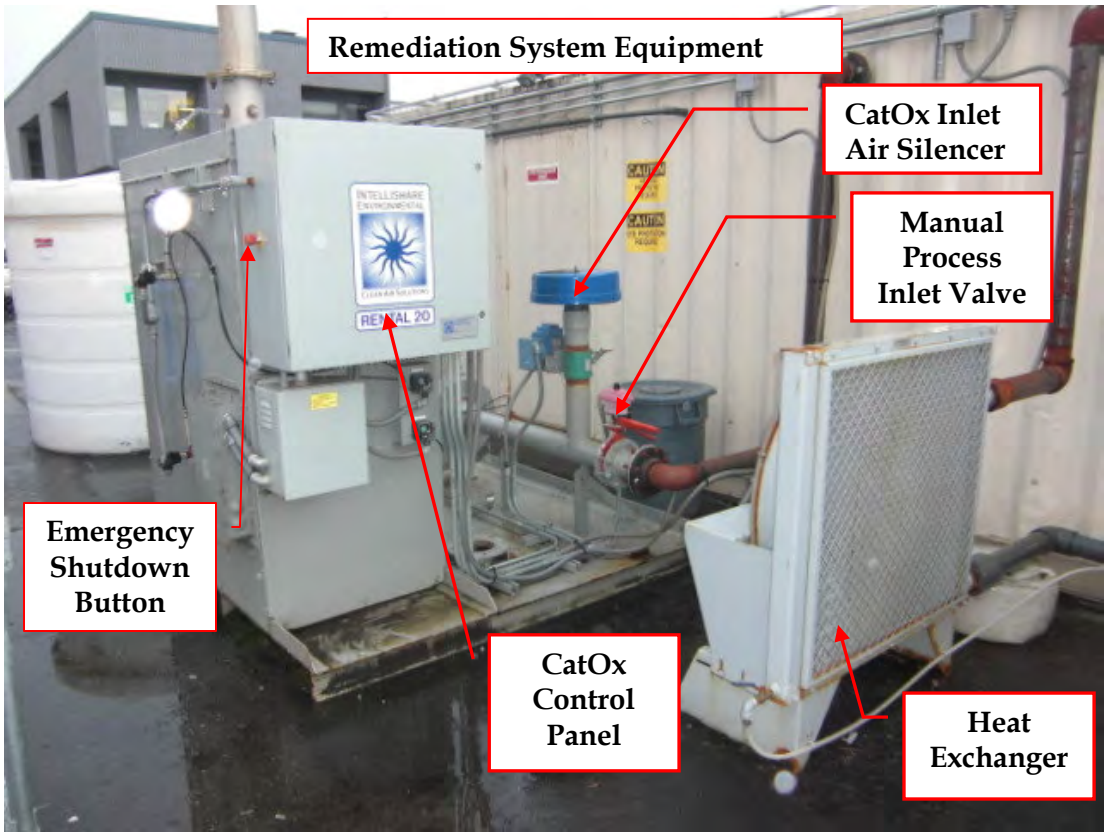

LPGAC Vessels
Emergency Stop Button
LPGAC Sample Ports
OUTLET

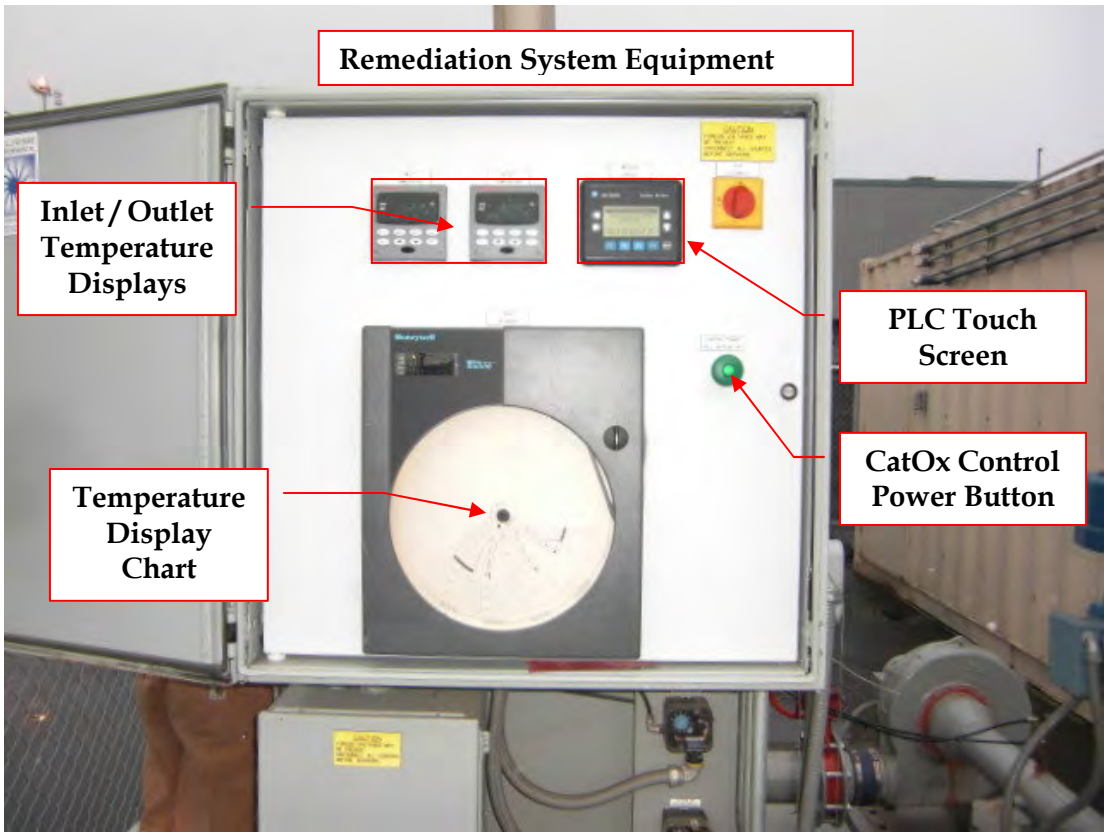

Air Stripper Filter Housing
Sump High Level Sensor
Air Stripper Blower

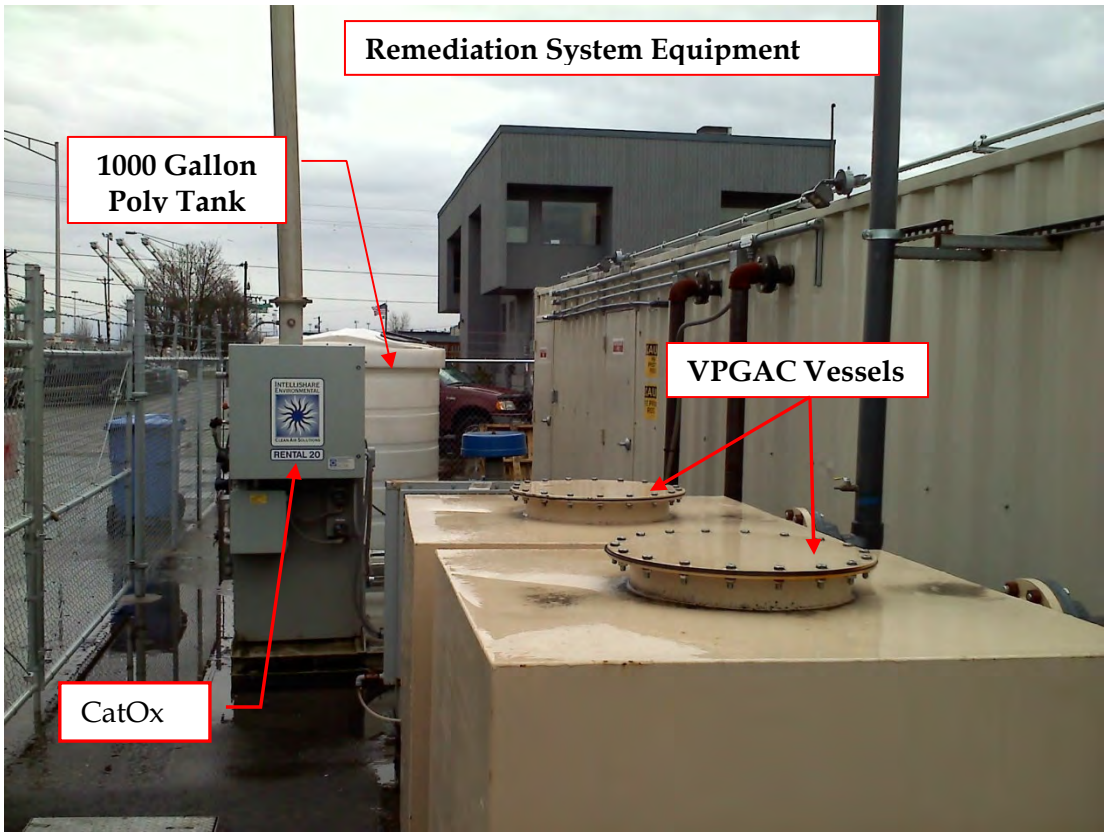

Typical Below Ground DPE Well
Stinger Hose
Vapor Extraction Valve
Water Extraction Valve
Nutrient Injection Valve
Vacuum Gauge


Typical Above Ground DPE Well
Stinger Hose
Water Extraction Valve
Nutrient Injection Valve
Vapor Extraction Valve
Vacuum Gauge


Remediation System Equipment
SIEMENS
ON
OFF
DANGER
480 VOLT
2244E
Main Power Disconnect


Remediation System Equipment
CatOx Inlet Air Silencer
Manual Process Inlet Valve
Emergency Shutdown Button
CatOx Control Panel
Heat Exchanger


Remediation System Equipment
Inlet / Outlet Temperature Displays
PLC Touch Screen
CatOx Control Power Button
Temperature Display Chart


Remediation System Equipment
1000 Gallon Poly Tank
VPGAC Vessels
CatOx

APPENDIX G

O&M Log Sheet

CH2MHILL

1100 112th Avenue NE
Suite 400
Bellevue, WA. 98004
TEL 425-453-5000
FAX 425-468-3100

REMEDIATION SYSTEM OPERATION LOG SHEET

ECY - Former Lilyblad Site Remediation, Tacoma, WA

Project Number: _____ Date: _____
Operator: _____ Time: Onsite _____
Weather Conditions: _____ Offsite _____

System Operating Upon Arrival?: _____ System Operating Upon Departure _____
If no, describe reason: _____

	HI	LOW		
Fields operating:			Totalizer Reading	(gal)
Total Vacuum (in Hg):			MPE Blower #1 Hour Meter:	(hrs)
Influent PID (ppm):			MPE Blower #2 Hour Meter:	(hrs)
			Air Stripper Blower Hour Meter:	(hrs)
			Oxidizer Hour Meter:	(hrs)

DPE - Vapor Phase Remediation System

High Concentration System			Low Concetration System		
Total Vacuum at KO Drum #1		(in Hg)	Vacuum at KO Drum #2		(in Hg)
Vacuum Before Inline Filter #1		(in Hg)	Vacuum Before Inline Filter #2		(in Hg)
Vacuum After Inline Filter #1		(in Hg)	Vacuum After Inline Filter #2		(in Hg)
Influent PID Reading Blower #1		(ppm)	Influent PID Reading at Blower #2		(ppm)
Air Temperature after MPE Blower #1		(F)	Temperature Before Heat Exch		(F)
Pressure after MPE Blower #1		(psi)	Temperature After Heat Exch		(F)
Electric Oxidizer Inlet Temperature		(F)	Pressure Before VPGAC #1		(psi)
Electric Oxidizer Outlet Temperature		(F)	Pressure After VPGAC #1		(psi)
Vacuum at Electric Oxidizer's Blower		(in H_2O)	PID After VPGAC #1		(ppm)
Flow Rate		(scfm)	Pressure After VPGAC #2		(psi)
Effluent PID		(ppm)	Flow Rate		(scfm)
			Effluent PID		(ppm)

DPE - Liquid Phase Remediation System

(Fill in the blanks when these components are operating)

Pressure at KO #1 Transfer Pump		(psi)	Pressure post inline Filter 2		(psi)
Pressure at KO #2 Transfer Pump		(psi)	Pressure before LPGAC Vessel #1		(psi)
Pressure at EQ Tank Transfer Pump		(psi)	Pressure after LPGAC Vessel #1		(psi)
Pressure prior to inline Filter #1		(psi)	Pressure after LPGAC Vessel #2		(psi)
Pressure post inline Filter #1		(psi)	Air Stripper Differential Pressure		(in H_2O)
Pressure at AS Transfer Pump		(psi)	Air Stripper Air Flow Rate		(scfm)
Pressure prior to inline Filter #2		(psi)	Air Stripper Effluent PID		(ppm)

Samples Collected Today?: _____

Total Influent (water)	____	TPH-SGT/HEM (1664), SVOCs (625), VOCs(624)
Post Air Stripper (water)	____	TPH-SGT/HEM (1664), SVOCs (625), VOCs(624)
Post GAC 1 (water)	____	TPH-SGT/HEM (1664), SVOCs (625), VOCs(624)
Post GAC 2 Effluent (water)	____	TPH-SGT/HEM (1664), SVOCs (625), VOCs(624), Metals (200.7), pH (150.1)
Total Vapor Influent # 1 (field?):	____	VOCs, SVOCs, TPH-G
Total Vapor Infuent # 2 (field?):	____	VOCs, SVOCs, TPH-G
VPGAC 1 Effluent:	____	VOCs, SVOCs, TPH-G
Air Stripper Effluent:	____	VOCs, SVOCs, TPH-G
VPGAC 2 Effluent:	____	VOCs, SVOCs, TPH-G, HCl
Catalytic Oxidizer Effluent:	____	VOCs, SVOCs, TPH-G, HCl

Additional Comments (modifications to system, repairs, shutdowns, carbon change outs, etc.)

APPENDIX H

O&M Training Log Sheet

CH2MHILL

1100 112TH Ave NE
Suite 400
Bellevue, WA. 98004
425453-5000
fax 425-468-3100

O&M TRAINING LOG SHEET

FORMER LILYBLAD SITE, TACOMA, WA

NAME:	SIGNATURE:	DATE:

APPENDIX I

Liquid Spill Prevention Plan

Former Lilyblad Petroleum Remediation System
Liquid Spill Prevention Plan

Liquids Generated	Source (Scenarios in Which Fluids Would Be Stored Outside of Remediation Building)	Dangerous Waste?	Routine Spill Prevention and Control Measures [a]
Contaminated groundwater	Purge water generated from monthly groundwater sampling	No	Purge water generated during groundwater sampling will be placed in the 1,000-gallon tank and processed through the remediation system following the sampling event.
Contaminated groundwater, mixed with entrained fine particulates, iron, and tap water/soap mixture	Cleaning of the remediation system tanks [air stripper, air-water separators (knockout tanks) and equalization tanks]	No	Liquids and solids generated during remediation system operation and maintenance activities will be placed in the 1,000-gallon tank. Onsite personnel must monitor this activity to ensure that the capacity of the 1,000-gallon tank would not be exceeded. The solids will be allowed to settle to the bottom, and the liquid will be pumped to the remedial groundwater treatment system.[b]
Contaminated groundwater	Groundwater from the liquid phase granular activated carbon (GAC) vessels to accommodate the changeout of the carbon.	No	Extracted groundwater would be pumped in the 1,000-gallon tank during this time. Onsite personnel must monitor this activity to ensure that the 1,000-gallon tank would not exceed capacity. This water must then be promptly processed through the system once the carbon changeout work is completed.

Liquids Generated	Source (Scenarios in Which Fluids Would Be Stored Outside of Remediation Building)	Dangerous Waste?	Routine Spill Prevention and Control Measures [(a)]
Liquids used for chemical and/or nutrient injections. At this time the type and amount of chemicals needed has not been specified; however, we anticipate mixtures of water and fertilizers or water mixed with chemical oxidants, dependent on the nature of the injection.	Activities associated with subsurface chemical and/or nutrients injection. This may also include the temporary storage of chemicals used for injections. (Note: detailed plans have not yet been completed for these types of activities. Any required permits will be obtained prior to injections.)	To be determined	During subsurface injection activities the 1,000-gallon tank will be used to store the fluids needed for injection. Appropriate measures will be taken to safely store any liquid and/or solids used for subsurface injections. **This plan will be updated prior to implementing chemical and/or nutrients injection.**

Notes:

(a) The 1,000-gallon tank located within the remediation compound has double wall containment and a cover (see attached sheet for tank specifications). Efforts will be made to process any water stored in the 1,000-gallon tank through the remediation system as soon as possible following generation of the liquid.

(b) Solid waste (i.e. bag filters, dry sediments, spent or new GAC) may also be temporarily stored outside the remediation system trailer. Any solid waste will be containerized in 55-gallon drums secured with a lid, labeled accordingly and stored within the fenced remediation system compound. Solid waste will be properly disposed of from the site within 90 days of generation.

Contingency Plans

It is expected that the 1,000-gallon double walled tank will provide sufficient temporary storage capacity for all planned remediation activities. There may be some unforeseen scenarios when more than 1,000 gallon capacity is needed for storage (i.e. system malfunction, larger than normal groundwater sampling event, etc.). In these cases, additional liquids would be temporarily stored onsite in 55-gallon drums. These drums would be properly labeled, secured with lids, stored within the fenced remediation compound, and placed on spill pallets to provide secondary containment. These drums would either be processed through the treatment system within 72 hours of generating the liquids or arrangements will be made for disposal at an appropriate offsite treatment system.

If substantially more storage capacity was needed (i.e. 1,200 gallons or more), a double-walled tank will be temporarily staged on site to store liquids. These liquids would be disposed of by either processing through the remediation system within 72 hours of generating the liquids or arrangements will be made for disposal at an appropriate offsite treatment system.