ENVIRONMENTAL RESOURCES MANAGEMENT

FINAL
100% SUBMITTAL
ENGINEER'S REPORT OPERABLE UNIT II REMEDIAL DESIGN

Metro-North Harmon Yard
Croton-on-Hudson, New York
Site No. 3-60-010

17 February 2000
Revised 11 October 2000

Prepared for:

Metro-North Commuter Railroad
347 Madison Avenue
New York, NY 10017

Prepared by:

Environmental Resources Management, Inc.
475 Park Avenue South, 29th Floor
New York, New York 10016

and

Environmental Resources Management, Inc.
175 Froehlich Farm Boulevard
Woodbury, New York 11797

ERM

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1.0 INTRODUCTION

The Operable Unit II Engineer's Report was prepared by Environmental Resources Management (ERM) on behalf of the Metro-North Commuter Railroad Company (Metro-North) for Operable Unit II (OU-II) of the Harmon Railroad Yard Wastewater Treatment Area (Site No. 3-60-010). This document, which contains a description of the OU-II Remedial Design, has been prepared in accordance with: (1) Sections VI.D. and V.B. of the Stipulation of Discontinuance between the New York Department of Environmental Conservation (NYSDEC) and Metro-North (Index 383-89); and (2) the Harmon Yard OU-II Record of Decision (ROD) dated March 27, 1998.

1.1 SITE DESCRIPTION AND REGULATORY BACKGROUND

The Harmon Railroad Yard (i.e., "Yard") is located in the Village of Croton-on-Hudson, New York, and is bounded by Route 9 on the east and Croton Point Park to the west (Figure 1-1). The Yard is approximately 100 acres in size, and has been an active rail yard for over 100 years.

The Yard is currently being addressed under two New York State Department of Environmental Conservation (NYSDEC) programs. They are: (1) the Inactive Hazardous Waste Disposal Site Program; and (2) the Spills program for petroleum releases. The Harmon Railroad Yard Wastewater Treatment Area, which was placed on the New York State Inactive Hazardous Waste Disposal Site Registry in 1985, is governed under the former program while the remainder of the Yard was removed from that list and is now being addressed under the Spills Program.

The September 1992 NYSDEC ROD divided the remediation of the Harmon Railroad Yard Wastewater Treatment Area into two operable

units, Operable Unit I (OU-I) and Operable Unit II (OU-II). OU-I constituted the remediation of: (1) the lagoon and pond system (the "lagoon"); (2) soils above the seasonal high ground water table adjacent to the lagoon; and (3) the contaminated components of the Old Wastewater Treatment Plant (the "Old Plant"). Sampling conducted after the OU-I ROD was issued determined that the Old Plant was not contaminated above acceptable levels. The Old Plant has since been decommissioned for operational reasons, as described in the Decommissioning and Demolition Plan for the Old Wastewater Treatment Plant (ERM, 1994a). Construction of the OU-I remedy was completed in September 1996. The final OU-I Closure Report was submitted to the NYSDEC on 12 May 2000.

The components of the Harmon Yard OU-II were first identified in the OU-I ROD. They were:

- non-aqueous phase liquid (NAPL) located around the former wastewater treatment plant lagoon;
- ground water located in the vicinity of the former wastewater treatment plant lagoon;
- soil located along the former wastewater discharge line; and
- sediment in Croton Bay near the outfall area for the former and the currently active wastewater and storm water discharge lines.

As discussed in previous remedial investigation and evaluation documents prepared for the Site, OU-II NAPL consists of diesel fuel that has accumulated and floats on the ground water table due to its low density (i.e., free phase NAPL) and NAPL present in residual saturation above the water table. The OU-II NAPL is located in four areas around the former wastewater treatment plant lagoon. These areas are referred to as NAPL Areas L1, L2, L3 and L4.

A remedy for Harmon Yard OU-II was selected by the NYSDEC in the Harmon Yard OU-II ROD, dated March 27, 1998, based on the information presented in the Remedial Investigation (RI) report (ERM; January 24, 1997) and the Feasibility Study (FS) report (ERM; January 14, 1998). The Harmon Yard OU-II ROD selected Alternative 5, Vacuum Enhanced NAPL Removal (VENR), as the remedial action alternative to be implemented at the site to remove OU-II NAPL.

In addition, the ROD for OU-II also includes the installation and sampling of one additional Harmon Yard perimeter ground water monitoring well. The ROD for OU-II concluded that the potential risks to human health and the environment that may be posed by ground water, Croton Bay sediment and discharge line soil at the OU-II site, if any, do not require active remediation.

The remedial action objectives (RAOs) for OU-II NAPL, which were developed in the NYSDEC-approved OU-II FS, are to:

- prevent further off-site migration of OU-II NAPL;
- remove OU-II NAPL to the extent practical; and
- continue to prevent direct contact with subsurface OU-II NAPL in the vicinity of the former lagoon.

1.2 *PILOT TESTING RESULTS*

As a condition of the OU-II ROD, pilot testing of the VENR technology was required prior to commencement of the Remedial Design. This testing was conducted to confirm the effectiveness of the VENR technology for remediation of the OU-II NAPL and to collect the information needed to prepare the Remedial Design.

VENR is an innovative NAPL remediation technology that combines physical NAPL recovery, in-situ biodegradation of primarily petroleum-related organic compounds and vapor extraction of volatile compounds. In VENR applications, air, which is supplied to the formation through air inlet wells, is drawn through the subsurface soil using a series of vacuum wells. This induced airflow:

- transports free phase NAPL through subsurface soil to the recovery wells where the organic compounds and, in particular, the petroleum-related organic compounds that comprise OU-II NAPL, are then removed from the recovery wells;
- promotes the biodegradation of the NAPL in the unsaturated zone above the NAPL layer (i.e., residual saturation); and
- promotes the volatilization of volatile organic compounds in the OU-II NAPL.

Following issuance of the OU-II ROD, a Pilot Testing Work Plan (PTWP) was prepared for the Site. This plan, which was approved by the NYSDEC, included pneumatic testing in two of the four NAPL Areas at the Site, NAPL Areas L1 and L4. These are the two largest OU-II NAPL Areas. As discussed in the PTWP, the following two VENR methods were selected for OU-II pilot testing:

Method 1: simultaneous vacuum extraction of soil gas, ground water and NAPL under vacuum conditions; and

Method 2: simultaneous vacuum extraction of soil gas and NAPL under vacuum conditions – no ground water removal.

Under either VENR method, the well is sealed and soil gas is withdrawn from the formation under vacuum conditions. The withdrawal of soil gas promotes the transport of NAPL into the recovery wells. The difference between the two NAPL removal methods is the manner in which they transfer the NAPL from the well aboveground.

VENR Method 1 utilizes a drop tube placed above the ground water interface within the NAPL layer to simultaneously remove NAPL and soil gas from the recovery well. Due to vacuum control limitations, ground water is generally recovered along with the NAPL and soil gas using Method 1; thus all three phases (i.e., soil gas, NAPL and water) are generally simultaneously removed from the well using Method 1.

In contrast, VENR Method 2 utilizes separate systems to remove NAPL and soil gas. Using Method 2, soil gas is removed under vacuum conditions from the well through a suction line installed at the top of the well. The NAPL that has accumulated in the well is then removed using a NAPL-only pump installed in the well; thus minimizing the amount of ground water that is recovered along with the NAPL.

During testing of these two VENR methods, various measurements were collected to:

- evaluate the overall effectiveness of the VENR technology for removal of OU-II NAPL;
- evaluate the effectiveness of the two (2) VENR methods;
- evaluate the relative effectiveness of the three VENR mechanisms for NAPL removal (i.e., volatilization, recovery of free phase NAPL and biodegradation); and
- gather information for the full-scale design.

In addition to the VENR pilot testing, fluids treatment pilot testing was also identified in the PTWP. This pilot testing was conducted to determine the treatment requirements for the recovered fluids mixture (i.e., water and NAPL).

Following NYSDEC approval of the PTWP, VENR and fluids pilot testing was conducted in the spring and summer of 1999. The results of this

pilot testing work were documented in the OU-II Pilot Testing Results Report (PTRR), prepared in July 1999 along with a response to NYSDEC's comments and an Addendum, dated October 18, 1999.

As discussed above, the three VENR removal mechanisms (i.e., free-phase NAPL removal, biodegradation and volatilization) were to be evaluated during the pilot testing. Review of the VENR pilot testing results indicated that sufficient testing had not been conducted to evaluate the biodegradation mechanism. Because the VENR system was generally shutdown during unstaffed hours and the subsurface was only aerated during active VENR testing periods, the OU-II subsurface was not continuously aerated. Consequently, aerobic subsurface conditions were not maintained during VENR pilot testing and the biological activity did not sufficiently increase.

Additional pilot testing was therefore conducted to simulate conditions under full-scale VENR remedial activities. The results of this additional testing, which showed considerable biological activity with sustained aerobic conditions, was presented in the Addendum to the PTRR, dated October 18, 1999.

In addition to the extended aeration testing, pneumatic testing in NAPL Areas L2 and L3 was also conducted during this additional testing. As discussed above, NAPL Areas L1 and L4 were included in the VENR pilot testing. Due to the variable VENR results in these two OU-II NAPL Areas, it was determined that limited pneumatic testing was needed in the remaining two NAPL Areas. These results are also included in the Addendum to the PTRR. The collective pilot testing results documentation (i.e., the PTRR, Addendum No. 1 to the PTRR and ERM's responses to NYSDEC's comments on the PTRR) were verbally approved by NYSDEC on 10 November 1999.

In summary, the main findings of the VENR, fluids treatment and additional pilot testing were as follows:

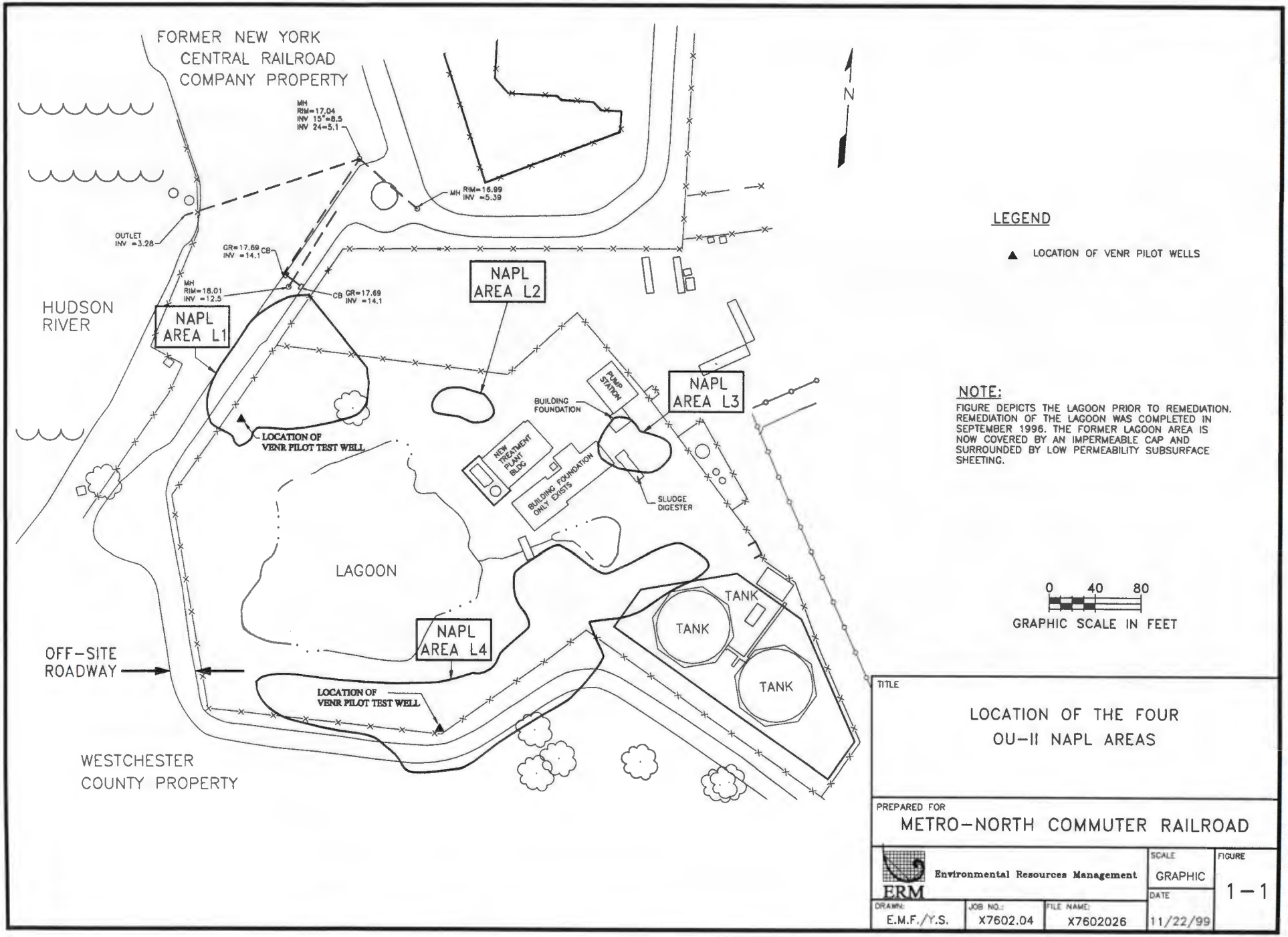
- variable pneumatic effective radii of influence (EROI) were observed in the four NAPL Areas;
- air radii of influence were consistently greater than the pneumatic EROIs;
- soil gas withdrawal promoted the accumulation of NAPL in the recovery wells;
- biodegradation of OU-II NAPL was evident under aerobic conditions;
- minimal volatilization of the OU-II NAPL occurred;
- given the distribution of NAPL (i.e., more in residual saturation than free phase) and the biological activity results, biodegradation of OU-II NAPL is expected to be the predominant OU-II NAPL removal mechanism;
- VENR Method 2 was the more effective VENR method;
- VENR Method 1 was not able to minimize the amount of ground water withdrawn during removal of the OU-II NAPL from the recovery wells – as a result, considerably more water was removed than previously estimated in the OU-II FS report;
- due to low air permeability in the NAPL Area L4 subsurface, forced air injection will be needed in this area to provide air to the subsurface – passive air inlet wells will be sufficient in the other three NAPL Areas; and
- the fluids treatment system was able to sufficiently treat the recovered fluids mixture.

1.3 *DESCRIPTION OF THE OU-II REMEDY*

The components of the OU-II remedy were defined in the OU-II ROD. With the exception of an additional perimeter ground water monitoring well to address a NYSDEC comment on the PTRR, the components of the Harmon Yard OU-II remedy have remained the same. They are:

- annual ground water monitoring in two OU-II perimeter ground water monitoring wells;
- continued access and use restrictions through existing Metro-North procedures;
- site preparation;
- installation of a vertical sheeting barrier in NAPL Area L1;
- installation of VENR systems in the four OU-II NAPL areas (e.g., NAPL recovery wells equipped with VENR systems and air injection/inlet wells in all four NAPL areas);
- off-Site disposal of construction-related waste materials;
- Site restoration following construction;
- operation and maintenance (O&M) of the VENR systems; and
- off-Site disposal of recovered OU-II NAPL and wastewater treatment residuals.

Additional information regarding these system components is provided in the following sections of the Engineer's Report. The pilot testing results are used in the detailed design of these remedial components.



TITLE

LOCATION OF THE FOUR OU-II NAPL AREAS

PREPARED FOR

METRO-NORTH COMMUTER RAILROAD

ERM Environmental Resources Management				SCALE: GRAPHIC	FIGURE: 1-1
DRAWN: E.M.F./Y.S.	JOB NO.: X7602.04	FILE NAME: X7602026		DATE: 11/22/99	

2.0 SOIL GAS EXTRACTION AND NAPL REMOVAL SYSTEM

As discussed in Section. 1.3, the selected remedial alternative for OU-II NAPL is vacuum enhanced NAPL removal (VENR). As such, a VENR system will be installed in each of the four OU-II NAPL Areas. The components of the VENR are:

- soil gas extraction/NAPL recovery wells in all four NAPL Areas;
- air inlet wells in the high air permeability NAPL Areas (i.e., NAPL Areas L1, L2 and L3);
- forced air injection wells in the low air permeability NAPL Area (i.e., NAPL Area L4);
- NAPL-only recovery units - automated in NAPL Area L4 and non-automated in NAPL Areas L1, L2 and L3;
- soil gas extraction blowers;
- recovery well vaults and pull boxes, piping and buildings;
- vapor control units;
- sheeting downgradient of NAPL Area L1; and
- ground water monitoring wells.

A summary and the locations of the major VENR equipment for each of the NAPL Areas are provided in Table 2-1.

This section presents a description of above-referenced OU-II remedial components (Section 2.1), the instrumentation and controls for the remedy (Section 2.2) and the site security (Section 2.3).

2.1 DESCRIPTION OF SYSTEM COMPONENTS AND APPURTENANCES

This section provides a description of the OU-II remedial components identified in Table 2-1. A detailed equipment list, which includes major

Table 2-1
Summary of VENR Equipment By NAPL Area
Metro-North Harmon Yard OU-II

NAPL Area	Conservative Pneumatic EROI (ft)	Soil Gas Extraction/ NAPL Recovery Wells	Recovery Well Vaults	Recovery Well Pull Boxes	Non-Automated NAPL Recovery Units	Automated NAPL Recovery Units	Air Inlet Wells	Forced Air Injection Wells
L1	21	11	11	1	5/11	-	16	-
L2	25	1	-	-	1	-	3	-
L3	23	3	-	-	3	-	6	-
L4	25	13	13	2	-	3/13	-	25
TOTAL		**28**	**24**	**3**	**9**	**3**	**25**	**25**

NAPL Area	Piping & Conduits	Soil Gas Extraction Equipment	NAPL Removal Units	NAPL Storage Equipment	Buildings/ Enclosures	Other Equipment
L1	SGE, N*	2 blowers 1 liquid/vapor separator 2 condensate drums 2, G-11 GAC units	Non-automated	NAPL Area L4 tank	Building	Sheeting Wall
L2	SGE	See NAPL Area L1	Non-automated	NAPL Area L4 tank	See NAPL Area L1	
L3	SGE	1 blower 1 liquid/vapor separator 2 condensate drums 2, G-1 GAC units	Non-automated	NAPL Area L4 tank	Enclosure (Blower Only)	
L4	SGE, AI, N	1 blower 1 liquid/vapor separator 2 condensate drums 2, G-2 GAC units	Automated	500 gallon aboveground storage tank	Building	Blower for air injection; compressor for automated NAPL recovery pumps

Notes:
SGE: soil gas extraction transfer piping
N: NAPL recovery conduits with transfer tubing
N*: NAPL recovery conduits installed for potential future use – no tubing installed
AI: air injection piping

7.0 REMEDIAL DESIGN DOCUMENTS

In accordance with the Stipulation of Discontinuance, Biddable Quality documents, a Contingency Plan, HASP and Citizen Participation Plan (Fact Sheet) have been prepared for the vacuum-enhanced NAPL Recovery at OU-II. These deliverables, which are described below in Section 7.1.1, are included with this Final design submittal for NYSDEC approval. Additional documents, which are described in Section 7.1.2, will be submitted after the Remedial Design is approved.

7.1 DOCUMENTS SUBMITTED WITH REMEDIAL DESIGN PACKAGE

7.1.1 Design Drawings and Specifications

ERM has prepared a set of drawings and specifications for the installation and start-up of the vacuum-enhanced NAPL recovery system in the four OU-II NAPL areas. The design basis for the vacuum-enhanced NAPL recovery systems (i.e., well spacing, vacuum rates) were defined in the Pilot Test Results Report (PTRR) prepared in July 1999 along with a response to NYSDEC's comments and an Addendum, dated October 18, 1999.

AutoCad design drawings have been prepared for this final design submittal and are included as Attachment A. A list of design drawings prepared for this project is included on Table 7-1.

Technical specifications, which describe the construction contractor's responsibilities, have also been prepared. The specifications have been prepared in the 16 division format of the Construction Specifications Institute (CSI). An equipment list which is included as part of the specifications is provided on Table 2-2. The drawings and specifications will define the technical requirements for the remedial contractor. A list

of the titles of the specification sections is presented in Table 7-2. The design drawings and specifications constitute the "Biddable Quality" documents that will be used along with Metro-North's Contract Terms and Conditions and other contract documents to solicit bids from qualified contractors. The final design drawings and specifications are signed and stamped by a New York State licensed Professional Engineer.

7.1.2 *Construction Contingency Plan*

A Construction Contingency Plan has been prepared to protect human health and the environment during construction of the OU-II Remedy (i.e. VENR). Contingency measures such as spill response methods are discussed in the Plan.

The Contingency Plan also discusses the additional testing that will be conducted during the Remedial Construction to confirm that the well spacings in NAPL Areas L2 and L4 are adequate. Potential activities following this testing (e.g., additional well installation) are also discussed in this plan.

7.1.3 *Health and Safety Plan*

A short-form Health and Safety Plan (HASP) has been prepared in accordance with 29 CFR 1910 by a certified health and safety professional for the protection of persons at and in the vicinity of the site during construction. The short-form HASP is included at the end of Specification Section 01351. The HASP for system operation will be included in the O&M Plan which will be completed after system construction. The remedial contractor shall be required to prepare and implement its own Safety, Health and Environmental Control Plan.

As part of the HASP preparation, community air monitoring limits have been designated. These air monitoring limits provide adequate protection of the surrounding communities while construction activities proceed. Air emissions from the soil gas extraction system generated during the operational phase will be monitored in accordance with the requirements of the NYSDEC equivalency permit for the three (3) emission points.

7.1.4 *Citizen Participation Plan*

Based on discussions with NYSDEC, distribution of a new Fact Sheet will be the only Citizen's Participation requirement for the OU-II Remedial Design and Construction. A new fact sheet containing a description of the project has been prepared. The fact sheet is provided with this design submittal in Appenidx D. Upon NYSDEC approval of this remedial design document, the new fact sheet will be distributed to the appropriate parties.

7.1.5 *Effectiveness Monitoring Plan*

The purpose of the Effectiveness Monitoring Plan (EMP) will be to evaluate the effectiveness of the remedy during implementation of the Remedial Action. This will be accomplished through collection and evaluation at a variety of information. This information will include, but not be limited, to NAPL volume estimates, subsurface biodegradation information, NAPL gauging (both on-site and off-site) and soil sampling.

The EMP will also provide a brief description of some of the measures that can be taken to improve the performance of the VENR remedy selected in the OU-II ROD in the unlikely event that this technology, without improvements, cannot achieve the remedial action objectives. The EMP is included with the Final design submittal for NYSDEC review and approval.

7.2 *DOCUMENTS TO BE SUBMITTED AFTER REMEDIAL DESIGN IS APPROVED*

7.2.1 *Operation and Maintenance Plan*

A comprehensive and detailed remedial program operation and maintenance (O&M) plan will be prepared by the Engineer and submitted within 60 days after completion of construction activities.

7.2.2 *Record Drawings*

Record Drawings reflecting "as-built" conditions will be prepared by the Engineer based on red-lined design drawings submitted by the remedial contractor. The Record Drawings will be signed and stamped by New York State Professional Engineer and submitted within 60 days after completion of construction activities.

7.2.3 *Final Engineer's Certification*

Prior to achieving substantial completion of construction, the Oversight Engineer will conduct a pre-final inspection and issue a punch list of outstanding items. A final inspection will be conducted to verify that these items have been adequately addressed. After completing the pre-final and final inspections, the Oversight Engineer will prepare a final report certifying that the approved Remedial Design was properly constructed by the Remedial Contractor. All significant changes to the approved Remedial Design will be described along with reasons for each change. The report will be signed and stamped by a New York State Professional Engineer and submitted within 60 days after completion of construction activities.

TABLE 7-1

LIST OF DESIGN DRAWINGS

Vacuum-Enhanced NAPL Recovery at OU-II
Metro-North Harmon Yard, Croton, New York

Drawing No.	Title
T-1	Title Sheet with List of Drawings and Site Location Map
C-1	Existing Site Plan and Survey Control
C-2	Site Plan with Locations at Proposed Wells and Sheet Piling
C-3	Underground Field Piping Layout for NAPL Areas L1, L2 and L3
C-4	Underground Field Piping Layout For NAPL Area L4
C-5	NAPL Recovery System Schematic for NAPL Area L4 and Vault Details
C-6	Well Cross-Sections and Schedules
C-7	Sheet Piling and Miscellaneous Civil Details
C-8	Soil Erosion Control Details
PID-1	Symbols and Legend for Process and Instrumentation Diagrams (P& IDs)
PID-2	NAPL Area L1/L2 Soil Gas Extraction System Process and Instrumentation Diagram
PID-3	NAPL Area L3 Soil Gas Extraction System Process and Instrumentation Diagram
PID-4	NAPL Area L4 Soil Gas Extraction System And Air Injection P& ID
PID-5	NAPL Area L4 Automated NAPL-Only Recovery System P&ID for Area L4
F-1	Concrete Foundation Plan with Penetration Locations
F-2	NAPL Area L1/L2 and L4 Concrete Foundation Details and Miscellaneous Construction Details
F-3	NAPL Area L1/L2 and L4 Masonry and Concrete Foundation Details
EA-1	Equipment Arrangement and Piping Layout For Area L1/L2
EA-2	Equipment Arrangement and Piping Layout For Area L3

EA-3	Equipment Arrangement and Piping Layout For Area L4
E-1	Electrical Site Plan
E-2	Single Line Diagrams and Control Panel Layout
E-3	Conduit and Cable Schedule
E-4	Electrical Lighting Plan with Receptacle Locations

TABLE 7-2

LIST OF TECHNICAL SPECIFICATIONS

For Vacuum Enhanced NAPL Removal at OU-II
Metro-North Harmon Yard
Croton-on-Hudson, New York

DIVISION 1 – GENERAL REQUIREMENTS

Section	01010	Summary of Work
	01180	Piping and Equipment Identification, Warning Tapes and Fencing
	01190	Environmental Definitions and Standards
	01330	Environmental Submittals
	01343	Environmental Coordination
	01351	Site Health and Safety
	01352	Surveys and Contractor As-Built Drawings
	01354	Environmental Protection
	01400	Quality Requirements
	01455	Field Services for Testing Laboratories
	01500	Temporary Facilities and Controls
	01600	Materials and Equipment
	01631	Approvals and Substitutions
	01700	Execution Requirements

DIVISION 2 – SITE WORK

Section	02055	Fill Materials
	02200	Site Preparation
	02252	Ground Water Monitoring Wells
	02253	Soil Gas Extraction Wells, Air Inlet / Air Injection Wells
	02300	Earthwork and Sheeting
	02370	Erosion Control
	02745	Pavement Repair

DIVISION 3 – CONCRETE

Section	03300	Cast-In-Place Concrete
	03420	Pre-Cast Concrete Vaults and Pull Boxes

DIVISION 4 – MASONRY

Section	04065	Masonry Mortar
	04810	Unit Masonry and Accessories

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

Section	07840	Firestop Systems
	07900	Caulking and Sealants

DIVISION 8 – DOORS AND WINDOWS

Section	08100	Metal Doors and Frames

DIVISION 11 – EQUIPMENT

Section	11370	Forced Air Injection Equipment
	11374	Soil Gas Extraction - Equipment
	11376	NAPL Recovery Skimmers
	11377	NAPL Recovery Pumps and Appurtenances

DIVISION 13 – SPECIAL CONSTRUCTION

Section	13205	Aboveground Storage Tank
	13420	Instrumentation and Operating System Description

DIVISION 15 – MECHANICAL

Section	15272	Yard Piping
	15273	Interior and Exposed Piping
	15275	Pipe and Valve Schedules
	15996	System Startup/Commissioning/Maintenance

DIVISION 16 – ELECTRICAL

Section	16000	Electrical Work – General Requirements
	16121	Medium Voltage Cable
	16402	Interior Wiring Systems
	16470	Panelboards
	16600	Control Panels

8.0 ENGINEER'S ESTIMATE OF CONSTRUCTION COSTS

A construction cost-estimate for the vacuum-enhanced NAPL removal system at OU-II is presented as Table 8-1. The format of the table is based on a Schedule of Values that provides a detailed breakdown. The construction cost estimate will be used by Metro-North to request funding under the Environmental Quality Bond Act (EQBA).

The cost table and backup information were developed based on estimates and quotes from equipment vendors, *Building Construction Cost Data – 2000* by RS Means, and on ERM's experience in designing and overseeing the construction of similar systems. The construction cost estimate is based on the following assumptions:

- Remedial work will be bid and constructed under one (1) contract
- Construction contractor will be responsible for twelve (12) months of O&M duties
- Contractor will be required to carry Pollution Liability Insurance and Builders Risk Insurance
- Contractor employees and subcontractors will be paid prevailing wages
- Project material costs are tax-exempt
- All work will be performed in Level D
- Metro-North forces will bring main electrical power feed to pole EP-2 located just inside fenced area.
- 480 volt power will be fed to each remediation area via underground PVC conduit encased in concrete.

Cost for items of work to be provided by Metro-North forces are included in this cost estimate.

Table 8-2 provides the construction cost estimate in a format similar to the bid form that contractors will complete during the bid process.

TABLE 8-1
CONSTRUCTION COST ESTIMATE
Vacuum Enhanced NAPL Removal at OU-II
Metro-North Commuter Railroad
Harmon Yard, Croton, New York

Item No.	Description	*Estimated Quantity*	Material and Equipment Cost	Labor Cost	Total Cost
1	Miscellaneous General Requirements (1)	*1*	$0	$15,000	$15,000
2	Mobilization and Temporary Facilities	*1*	$5,000	$2,280	$7,280
3	Surveys and Record Drawings	*1*	$0	$7,000	$7,000
4	Utility Locating and Protection	*1*	$0	$800	$800
5	Implementation of HASP (2)_	*1*	$0	$1,200	$1,200
6	Erosion Control	*1*	$310	$1,110	$1,420
7	Clearing and Grubbing (3 areas)	*1*	$0	$3,420	$3,420
8	Pull Boxes	*3*	$4,333	$3,828	$8,161
9	Wellhead Vaults	*24*	$34,666	$30,622	$65,288
10	Bollards	*8*	$728	$3,090	$3,818
11	Common Fill	*100 C.Y.*	$1,400	$700	$2,100
12	Removal, replacing, and installation of fence (3 areas)	*1*	$5,048	$6,282	$11,330
13	Foundation Slab (3) & Tank Slab (1) with Penetrations	*1*	$8,490	$32,480	$40,970
14	Buildings	*2*	$11,400	$32,100	$43,500
15	Gravel for Vaults & Pull Boxes (see notes)	*14 c.y.*	$450	Labor incl. in yard piping	$450
16	Final Grading, Topsoil and Seeding	*1*	$11,669	$7,853	$19,522
17	Asphalt Paving & Replace Berm (if necessary)	*1*	$553	$4,907	$5,460
18	Soil Gas Extraction System & Forced Air Injection System (Equipment and Appurtenances)	*1*	$71,940	$31,092	$103,032
19	NAPL Skimmers and Appurtenances	*9*	$9,574	$500	$10,074
20	Automated NAPL Recovery Equipment, Compressor and Appurtenances	*3*	$23,540	$2,700	$26,240
21	Electric Actuated Butterfly Valves	*2*	$3,000	Labor incl. in equipment installation & aboveground piping (Item No. 18)	$3,000

TABLE 8-1
CONSTRUCTION COST ESTIMATE
Vacuum Enhanced NAPL Removal at OU-II
Metro-North Commuter Railroad
Harmon Yard, Croton, New York

Item No.	Description	*Estimated Quantity*	Material and Equipment Cost	Labor Cost	Total Cost
22	GAC Vessels (3 areas)	*1*	$8,036	Labor incl. in equipment installation & aboveground piping (Item No. 18)	$8,036
23	Exhaust Stacks	*2*	$1,400	$5,000	$6,400
24	**Yard Piping Area L1& L2**				
24a	Soil Gas Extraction Yard Piping (area L1 & L2) including fittings	*970 L.F.*	$3,987		$3,987
24b	Product Secondary Containment for Automated NAPL System including fittings (area L1 & L2)	*500 L.F.*	$10,507		$10,507
24c	Labor Yard Piping Area L1& L2			$23,400	$23,400
	Subtotal for Yard Piping (Items 24)		*$14,494*	*$23,400*	*$37,894*
25	**Yard Piping (Area L3)**				
25a	Soil Gas Extraction Yard Piping (area L3) including fittings	*120 L.F.*	$300	$22,060	$22,360
26	**Yard Piping Area L4**				
26a	Forced Air Injection Yard Piping including fitting (area L4)	*4910 L.F.*	$6,206		$6,206
26b	Soil Gas Extraction Yard Piping including fitting (area L4)	*2480 L.F.*	$4,861		$4,861
26c	Air Supply & Product Hose for Automated NAPL System including fitting (area L4)	*630 L.F.*	$10,122		$10,122
26d	Product Secondary Containment Sleeve including fitting (area L4)	*630 L.F.*	$9,738		$9,738
26e	Labor Yard Piping Area L4			$101,464	$101,464
	Subtotal for Yard Piping (Items 26)		*$30,927*	*$101,464*	*$132,391*
	Subtotal for Yard Piping (Items 24,25 & 26)		***$45,721***	***$146,924***	***$192,645***

TABLE 8-1
CONSTRUCTION COST ESTIMATE
Vacuum Enhanced NAPL Removal at OU-II
Metro-North Commuter Railroad
Harmon Yard, Croton, New York

Item No.	Description	*Estimated Quantity*	Material and Equipment Cost	Labor Cost	Total Cost
27	NAPL Storage Tank and Appurtenances	*1*	$10,717	$2,338	$13,055
28	Three Condensate Drums with Containment Pallet (3 areas)	*1*	$2,312	Labor incl. in equipment installation & aboveground piping (Item No. 18)	$2,312
29	Aboveground Piping Fittings (3 areas)	*1*	$34,754	Labor incl. in equipment installation & aboveground piping (Item No. 18)	$34,754
30	HVAC Equipment	*1*	$3,000	$1,000	$4,000
31	Lighting (including 13 X.P. lights in equipment rooms)	*8*	$18,100	$7,300	$25,400
32	Interior Electrical Work including power panels and motor starters	*1*	$10,000	$16,800	$26,800
33	Field Electrical Power Distribution and Transformer (to 3 areas)	*1*	$55,350	$70,550	$125,900
34	Utility Poles	*2*	$1,400	$2,600	$4,000
35	Main Control Panels/Autodialers & Instrumentation	*3*	$18,600	Incl. In Item No. 32	$18,600
36	Telephone Service	*1*	$1,400	$2,200	$3,600
37	Site Cleanup	*1*	$0	$2,500	$2,500
38	Demobilization (at end of the project)	*1*	$0	$2,000	$2,000
39	Freight	*1*	$10,000	$0	$10,000
	Project Subtotals		***$412,891***	***$446,175***	***$859,066***
40	Ground Water Monitoring Wells (2"dia.)	*2*	$1,210	$1,210	$2,420
41	Soil Gas Extraction Wells (4"dia.)	*28*	$14,700	$14,700	$29,400
42	Forced Air Injection Wells (2"dia.)	*25*	$13,125	$13,125	$26,250
43	Air Inlet Wells (Passive) (2"dia.)	*25*	$13,125	$13,125	$26,250
	Subtotal for Wells (item no. 40-43)		**$42,160**	**$42,160**	**$84,320**
	Project Subtotal including well installation		***$455,051***	***$488,335***	***$943,386***

TABLE 8-1
CONSTRUCTION COST ESTIMATE
Vacuum Enhanced NAPL Removal at OU-II
Metro-North Commuter Railroad
Harmon Yard, Croton, New York

Item No.	Description	*Estimated Quantity*	Material and Equipment Cost	Labor Cost	Total Cost
44	Bid Bond	*1*		Incl. in overhead	$0
45	Performance and Payment Bonds	*1*			$8,591
46	Insurance (2% project cost)	*1*			$17,181
47	Railroad Protective Liability Insurance (0.5% project cost)	*1*			$4,295
	Project Subtotal including Bonds & Insurance				***$973,454***
48	Equipment Startup and Phase I Startup	*1*	$1,000	$3,000	$4,000
49	Phase II Startup	*1*	$2,500	$14,500	$17,000
50	10 months of O & M Services	*1*	$20,300	$45,852	$66,152
	Subtotal (Contractor)				***$1,060,606***
51	Sheeting Wall (BID OPTION NO. 1)	*200 L.F.*	$59,500	$18,834	$78,334
52	Add'l Well Drilling (BID OPTION NO. 2)	*140 L.F.*	$2,100	$3,920	$6,020
	TOTALS (Contractor)				***$1,144,960***

TABLE 8-1
CONSTRUCTION COST ESTIMATE
Vacuum Enhanced NAPL Removal at OU-II
Metro-North Commuter Railroad
Harmon Yard, Croton, New York

Item No.	Description	*Estimated Quantity*	Material and Equipment Cost	Labor Cost	Total Cost
	METRO-NORTH ITEMS (Non-Contractor Costs)				
	A - Main Power Feed				
	Power Department	400 amp, 460 V, 3ph/60hz			$78,000
	Structures Department				$55,500
	Subtotal, Main Power Feed				$133,500
	B -Sampling and Disposal of Drill Cuttings, Trench Spoils and Disposal of Development Water	1280 c.y. & 4 drums			$152,920
	C - Utility Markouts				$11,000
	D - Start-up Year Sampling and Disposal of NAPL, Condensate, Carbon	4 vac truck loads			$25,500
	E - Site Security				$30,000
	F - Construction Oversight (6)				$216,357
	TOTALS (Non-Contractor)				**$569,277**
	TOTAL CAPITAL COST				**$1,714,237**

Notes/Assumptions:
(1) Misc. General Requirements include but are not limited to shop drawings and other submittals, system testing, progress drawings, O&M Manuals, site meetings, etc.
(2) This item assumes work is performed in Level D protection. A separate allowance item (for labor only) shall be used if upgrade to Level C or Level B Protection is required.
(3) Includes excavation and earthwork.
(4) Includes Workers Compensation Insurance, Commercial General Liability Insurance, Automobile Ins., All Risk Builders Ins., and Pollution Liability Insurance.
(5) Project costs are tax exempt.
(6) Construction oversight cost is estimated at 15% of total of Contractor costs and M-N cost items A through C.

TABLE 8-2
ENGINEER'S COST ESTIMATE
IN FORMAT OF METRO-NORTH'S BID SHEET
For Vacuum-Enhanced NAPL Removal at OU-II
Harmon Yard, New York

BID ITEM NO.	BID ITEM	COST
(1)	All labor, material, and equipment required for all miscellaneous civil/earthwork.	$157,140
(2)	All labor, material, and equipment required for all well installations.	$84,900
(3)	All labor, material, and equipment required for all yard piping.	$194,100
(4)	All labor, material, and equipment required for the installation of the Forced Air Injection System including appurtenances.	$51,264
(5)	All labor, material, and equipment required for the installation of the Soil Gas Extraction System including appurtenances.	$117,280
(6)	All labor, material, and equipment required for the installation of NAPL Skimmers and the Recovery Systems, with appurtenances.	$49,370
(7)	All labor, material, and equipment required for the construction of all Buildings and Foundations.	$99,800
(8)	All labor, material, and equipment required for the installation of Instrumentation and Control Panels.	$19,200
(9)	All labor, material, and equipment required for the installation of the Electrical Supply and Distribution and Telephone Service.	$198,300
(10)	All labor, material, and equipment required for performing the Equipment Start-up and the Phase I Start-up	$4,000
(11)	All labor, material, and equipment required for performing the Phase II Start-up	$17,000

TABLE 8-2
ENGINEER'S COST ESTIMATE
IN FORMAT OF METRO-NORTH'S BID SHEET
For Vacuum-Enhanced NAPL Removal at OU-II
Harmon Yard, New York

(12)	All labor, material, and equipment required for performing the 10-month system operation and maintenance period.	$66,152
(13)	All labor, material, and equipment required for replacing unsuitable soil with common fill as defined by Specification Section 02055. (100 cubic yards)	$2,100
(14) **Bid Option No. 2**	All labor, material, and equipment required for additonal well drilling above that covered by Item No. 2 (assume 140 additional linear feet)	$6,020
(15) **Bid Option No. 1**	All labor, material, and equipment required for the erection of the sheeting wall specified in Specification Section 02300, Dwg. C-7, and other associated contract documents.	$78,334
TOTAL	**GROSS SUM BID (Item Nos. 1 through 15)**	**$1,144,960**

Note: Costs for general project requirements including overhead and administrative items (e.g. mobilization, submittals, insurance) have been apportioned to several capital cost items shown on this table.

9.0 CERTIFICATION

I certify that the Remedial Design was prepared in accordance with the Stipulation of Discontinuance between Metro-North and NYSDEC, Index No.: 383-89 and the Harmon Yard Operable Unit II ROD dated March 27, 1999.

Brian P. Morrissey

Brian P. Morrissey, P.E.
Senior Project Manager
Environmental Resources Management

10/11/2000
Date

5.0 *QUALITY CONTROL AND QUALITY ASSURANCE*

The quality assurance objectives for the implementation of the Remedial Design for VENR at OU-II are listed below:

1. To ensure that all construction activities are implemented in accordance with the Stipulation of Discontinuance, design drawings and specifications, and the Health and Safety Plan (HASP). These construction activities include but are not limited to:

   a. the use of proper construction practices, means, methods and techniques;

   b. the use of appropriate materials of construction, as required by the drawings and specifications, or as commonly accepted in the construction industry;

   c. the preparation of proper documentation to track and identify that all activities related to the Remedial Design construction activities were conducted in accordance with the Remedial Design contract documents.

2. To ensure that all safety related activities are implemented in accordance with the Stipulation of Discontinuance, the Remedial Design contract documents and the HASP. These activities include but are not limited to:

   a. the implementation of proper OSHA requirements during construction activities;

   b. the implementation of all applicable federal, state, and Metro-North requirements when personnel are working in areas of potential exposure to the chemicals of concern; and

   c. the execution of proper site-specific health and safety measures to prevent the injury of individuals at or near the site who are not directly involved with the construction activities being conducted.

3. To ensure that the constructed Remedial Design functions in accordance with the intent of the Stipulation of Discontinuance and the Remedial Design, and meets the performance standards established for the site.

5.1 *QUALITY CONTROL PROCEDURES*

This section presents a general overview of the QA/QC procedures that will be implemented by the Oversight Engineer, Contractor and their suppliers and subcontractors during construction of the Remedial Design.

5.1.1 *Construction Oversight*

Proper oversight of the Remedial Contractor selected to perform the construction phase of the Remedial Design is a major component of quality control. Before construction activities are initiated at the site, Metro-North will select an Oversight Engineer who will perform the construction oversight activities described herein.

While the Oversight Engineer will oversee and document the construction for the Remedial Design, the Oversight Engineer will not have control over or charge of and will not be responsible for the following items:

- construction means, methods, techniques, sequences or procedures;
- safety precautions and programs in connection with such work;
- the acts or omissions of the Contractor; or
- the failure of the Contractor to carry out work in accordance with the Contract Documents.

The Oversight Engineer will have the following duties:

- observe, document, inspect, sample and review progress and completion of the project by the Contractor;
- report to Metro-North any deviations by Contractor performing such Work, of which the Oversight Engineer becomes aware or in the course of reasonable care should become aware;
- conduct additional pneumatic testing in NAPL Area L2 and L4 to determine the need for additional soil gas extraction/NAPL recovery wells and air inlet/injection wells; and

- provide a Professional Engineer's sealed certification to the Department and Metro-North attesting to the compliance of the remedial construction with the approved remedial design.

5.1.2 *Construction*

All site work shall conform to the design drawings and specifications. At a minimum, all materials brought on site for backfilling or other site work purposes will be tested to ensure compliance with the design criteria stated in the Remedial Design Report and the Contract Documents.

All permanent and temporary piping used at the site will be pressure tested prior to being placed in service. In addition, all water and NAPL storage vessels will be filled and tested with potable water to ensure leak-tight joints and fittings prior to using them for storing potentially contaminated fluids.

The Contract Terms and Conditions for the construction contract will include the requirement for the Contractor to guarantee all work and materials supplied for a period of at least one year after completion of construction of the Remedial Design. The one year period will begin upon final acceptance by Metro-North, or at a minimum of four months after the Contractor leaves the site.

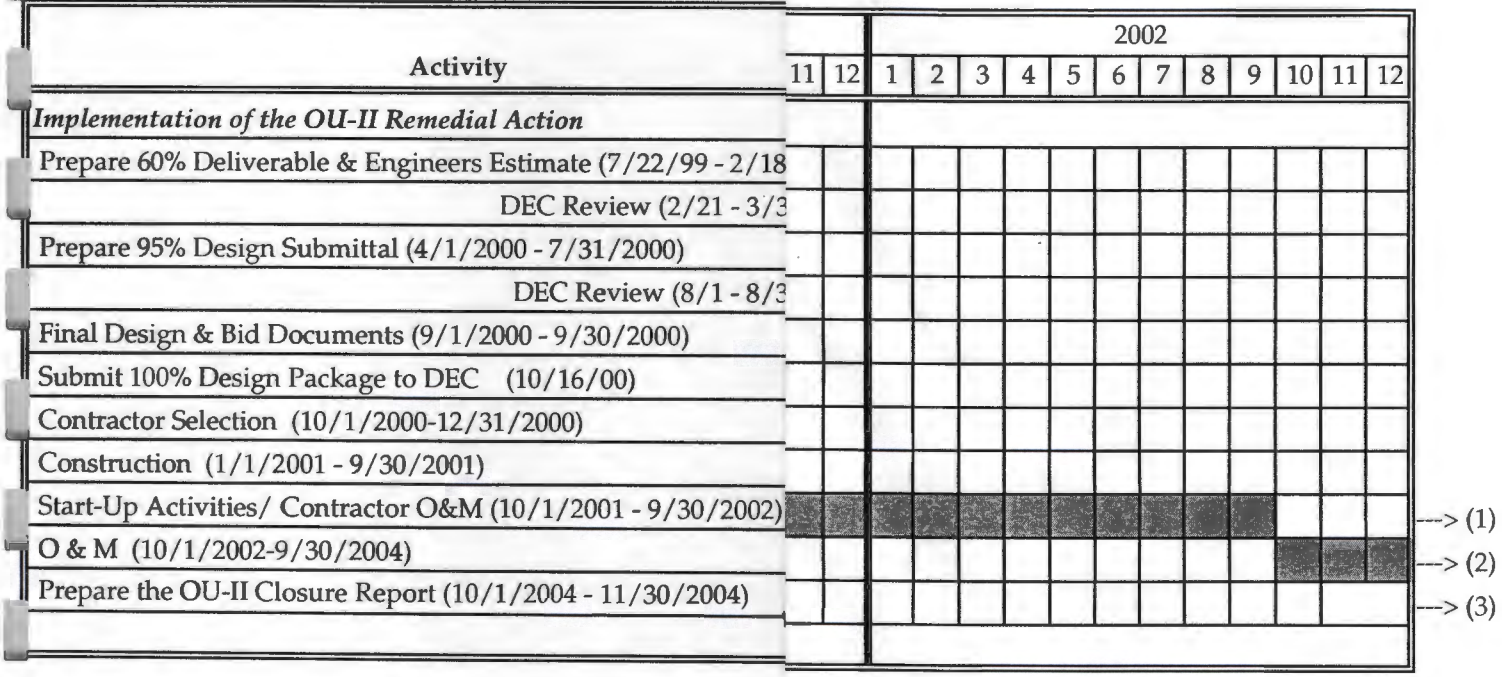
Specific QA/QC procedure to be implemented by the Contractor, including testing and inspection requirements, are provided in the Specifications. The Specifications are discussed in Section 7.1.1 of this report.

6.0 SCHEDULE

The proposed schedule for construction and O&M of the remedial action for vacuum-enhanced NAPL system at OU-II is presented as Figure 6-1. This schedule assumes that approval of the 100% remedial design is received from the NYSDEC by 31 October 2000. In order to expedite the overall project schedule, the bid documents for installation of the vacuum-enhanced NAPL Recovery System will be issued prior to receiving final NYSDEC approval. Contractors will be allowed approximately four (4) weeks to provide a bid for the specified work. Once the bids have been received, they will be reviewed and a successful Contractor will be selected. Contract award is expected to occur by the end of December 2000. Construction would then commence in January 2001 and be completed by the end of September 2001.

Once the construction has been completed, system start-up activities will begin. The Contractor will be required to provide twelve (12) months combined start-up and O&M services. Following one-year of start-up and O & M services, a time period of one to two years has been estimated for operation of the remedy. This is an estimate and has been based on our experience at other sites. Since it is an estimate, it is subject to change and operation may last for more than two years. The operation variables for the VENR system, evaluation of system improvements, such as nutrient or heat addition or biosparging, and ultimately shutdown of the VENR systems will be evaluated in accordance with the EMP.

Figure 6-1
Project Schedule for Implementation of Vacuu
Harmon Yard, Croton-on-Hudson, NY



Notes:

(1) Contractor will perform start-up and O&M activities for the

(2) Operation and Maintenance of the OU-II remedy is projected

(3) The closure report will be prepared at the end of OU-II O&M

ATTACHMENT A

Design Drawings

APPENDIX A

Evaluation and Selection of NAPL – Only Recovery Units

EVALUATION AND SELECTION OF NAPL-ONLY RECOVERY SYSTEMS FOR THE VACUUM ENHANCED NAPL REMOVAL SYSTEM AT OU-II

Harmon Railroad Yard Operable Unit II
Croton-on-Hudson, New York
Site No. 3-60-010

19 November 1999

Prepared for:

METRO-NORTH COMMUTER RAILROAD
347 Madison Avenue
New York, NY 10017

Prepared by:

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1.0 *INTRODUCTION*

Environmental Resources Management (ERM) has been commissioned by Metro North Commuter Railroad (Metro-North) to conduct the design of a remediation system for the Harmon Yard Operable Unit II (OU-II) site, located at Croton-on-Hudson, NY. The objective of the remediation is the removal of light non-aqueous phase liquid (NAPL) from the subsurface surrounding the former lagoon area.

The proposed remediation system will involve application of a vacuum at a number of extraction wells throughout the OU-II site to draw air through the formation. The withdrawal of air/soil gas will have two purposes: (1) to supply oxygen to the subsurface and thus enhance aerobic biodegradation of the NAPL in residual saturation; and (2) to promote movement of the NAPL to the extraction wells where NAPL-only recovery systems will remove the NAPL as it accumulates.

As determined during the OU-II pilot testing and documented in the NYSDEC approved Pilot Test Results Report (PTRR) and its Addendum, NAPL-only recovery is the most effective means of removing accumulated NAPL from the OU-II extraction wells. However, since the proposed remedial action for the OU-II site involves the simultaneous application of a vacuum to the extraction well and withdrawal of air/soil gas from the subsurface, the automated NAPL-only recovery system must be capable of operating effectively under such conditions. In addition, as was observed during the pilot studies, the withdrawal of air/soil gas from the formation can result in the formation of an emulsified mixture of NAPL and water with a specific gravity less than water. This mixture can cause operational difficulties, which must also be taken into consideration when selecting the most suitable NAPL-only recovery system. Therefore, the

selected system must be able to operate under a number of site specific conditions. The operational requirements are:

- ability to operate under vacuum conditions;
- ability to operate under variable ground water elevations;
- ability to handle emulsified NAPL; and
- provide automated, unstaffed NAPL-only recovery.

1.1 PURPOSE

The purpose of this document is to select the most suitable NAPL-only recovery system that addresses the above conditions. Both automated and non-automated systems were evaluated. The evaluation procedure, outlined below, considered the following:

- In-field experience;
- manufacturers' literature; and
- discussions with vendor representatives

2.0 *NON-AUTOMATED NAPL-ONLY RECOVERY EQUIPMENT*

Non-automated NAPL-only recovery systems passively collect free phase NAPL from an extraction well. The system components are located inside the well and are removed and either emptied or replaced periodically. The most common automated NAPL-only recovery systems are:

- Filter canisters; and
- Absorbent socks.

2.1 *FILTER CANISTERS*

Filter canisters consist of an intake port through which the NAPL enters and is stored in a collection canister. The filter canister is periodically removed from the well and emptied based on the accumulation of NAPL in the collection canister. There are two main types of canisters: (i) static, and (ii) floating. The canisters can be fitted with hydrophobic or specific gravity float assemblies to minimize the amount of water that is collected.

2.2 *ABSORBENT SOCKS*

Absorbent socks are most commonly used in wells that have a limited NAPL thickness. They are suspended in the well across the NAPL/water interface and are constructed of a hydrophobic, oileophilic material that absorbs NAPL. Absorbent socks must be periodically removed and disposed, although some types can be wrung out and re-used several times.

3.0 *TYPES OF AUTOMATED NAPL-ONLY RECOVERY EQUIPMENT*

Automated NAPL-only recovery systems remove free phase NAPL from an extraction well with the use of a pump. The primary system components are located inside the well, while other components can be located in a remote location on the surface. The most common automated NAPL-only recovery systems are:

- Filter canisters with floating skimmers and pneumatic pump operated discharge;
- Phase separating canister with surface mounted pneumatic pump;
- Automated level seeking submersible pump ; and
- Belt skimmers.

3.1 *FILTER CANISTERS WITH FLOATING SKIMMERS AND PNEUMATIC PUMP OPERATED DISCHARGE*

The filter canister is fitted with a skimmer float assembly, which allows NAPL to pass into and accumulate in the canister at the rate at which it recharges into the well. With the introduction and release of compressed air, the pump then draws NAPL from the skimmer float assembly and pumps it to a NAPL storage tank located at the surface.
The skimmer assembly floats in the extraction well and can move with the fluctuating water table. There are two types of skimmer assemblies available: (i) hydrophobic skimmers; and (ii) specific gravity skimmers.

The first type consists of a hydrophobic, oileophilic screen, which repels water but allows NAPL to pass into the pump chamber. The second type of skimmer assembly consists of a fluid intake located on top of a buoyant float. This skimmer assembly floats slightly above the NAPL/water interface and recovers any fluid with a specific gravity less than or equal to 0.85. Clean Environment Equipment manufactures filter canisters with

both types of skimmer assemblies. Examples are the selective oil skimmer (SOS) and the specific gravity skimmer (SPG).

3.2 *PHASE SEPARATING CANISTER WITH SURFACE MOUNTED PNEUMATIC PUMP*

This type of NAPL-only recovery system consists of a static or floating screen which allows both water and NAPL to enter the pumping chamber. The difference in the specific gravity of the NAPL and the water, enable effective phase separation within the pump chamber. Compressed air, supplied by a surface mounted compressor, is injected into the well chamber on a timed cycle, forcing the chamber contents to be discharged. A density sensitive ball check valve, located at the base of the pump chamber, allows the water to be discharged back into the well, while the NAPL is forced up the discharge line to the surface. An example of such a device is the Alpha Ferret Separator Pump manufactured by QED Environmental Systems.

3.3 *AUTOMATIC LEVEL SEEKING SUBMERSIBLE PUMPS*

This type of NAPL-only recovery system combines an electric pump with two water sensors. The control system automatically raises and lowers the probe, positioning the assembly with the pump inlet just above the water/product interface, in the well. Once in position, the pump switches on and recovers the NAPL. When no further NAPL is present the pump begins to draw in air. This triggers the pump to shut-off. The system is equipped with an electronic chip that enables the automatic level seeker to optimize product removal by continually adjusting the pump inlet level. This type of recovery system is intended for aggressive recovery where there is adequate NAPL recharge into the well. The control system and automatic level seeker are surface mounted directly above the well. Spill Buster manufactures such a pump.

3.4 *BELT SKIMMER*

A belt skimmer uses a continuous loop of oileophilic material that slowly cycles down into and out of the well, adsorbing NAPL as it moves through the water surface. The adsorbed NAPL is then squeezed or scraped off the belt at the top and transferred to a collection tank before the belt moves back down the well. Although these skimmers can operate in wells of 2-inch diameter or larger, they are better suited for small-scale open container skimming operations. The motor and mechanism that drives the continuous loop are surface mounted, located directly above the well.

4.0 *SELECTION OF EQUIPMENT*

The proposed remedial action for the OU-II site is vacuum enhanced NAPL removal (VENR). This will be comprised of two main components:

1. Application of a vacuum at the extraction wells to draw air through the formation, thus stimulating biodegradation of the NAPL in residual saturation and promoting movement of the free phase NAPL towards the extraction wells; and

2. Installation of automated and/or non-automated NAPL-only recovery systems in the extraction wells to recover the free phase NAPL as it accumulates.

Selection of a suitable NAPL-only recovery system requires consideration of a number of operational conditions. As discussed in Section 1.0, both the automated and non-automated systems will need to have the following capabilities:

- ability to operate under vacuum conditions;
- ability to operate under variable ground water elevations;
- ability to handle emulsified NAPL; and
- provide automated, unstaffed NAPL-only recovery.

4.1 *SELECTION OF NON-AUTOMATED NAPL-ONLY RECOVERY EQUIPMENT*

As discussed in the NYSDEC approved PTRR and its Addendum, non-automated NAPL-only recovery systems will be installed in NAPL Areas L1, L2, and L3. As discussed in Section 3.0 of this document, two types of non-automated NAPL-only recovery systems will be evaluated: (i) filter canisters; and (ii) absorbent socks. Of these technologies, the filter canister equipped with a floating skimmer, is recommended. The reasons for this choice are outlined below.

- Filter canisters sit in the extraction well and allow NAPL to enter and accumulate in the canister at the rate at which it recharges into the well. The canister is then periodically removed and emptied when it has filled with NAPL.
- The filter canisters can be equipped with either a static (fixed) screen or a floating skimmer assembly. The floating skimmer assembly can move with the fluctuating water table which is important for this application since upwelling of the NAPL-water interface is likely to occur when the proposed vacuum extraction system is in simultaneous operation. The fixed screen models do not move with fluctuating interface levels and thus can become flooded with water when the water levels rise. This can result in operational and maintenance problems in addition to inability to recover NAPL.
- Absorbent socks are reasonably effective at slowly removing free-phase NAPL. However, due to the nature of the absorbent material, these types of recovery devices may clog up the well and prevent the passage of air. This could cause operational concerns during simultaneous soil gas withdrawal. Conversely, filter canisters come in standard sizes to fit the wells and allow air to pass around them.
- Since the floating filter canisters can be emptied and reused repeatedly, the associated operational costs, over the life of the project, are lower than for the absorbent socks. In contrast, although the absorbent socks have the ability to be squeezed out and reused, their reuse is limited and they will ultimately have to be disposed of which would add to the overall disposal costs.
- This type of float assembly filter canister is currently in use in other areas of Harmon Yard with favorable success.

4.2 *SELECTION OF AUTOMATED NAPL-ONLY RECOVERY EQUIPMENT*

A number of technologies are available to actively remove free-phase NAPL from the ground water surface. As discussed in Section 2.0, four automated NAPL-only recovery technologies were evaluated. They are: (i) filter canisters with floating skimmers and pneumatic pump operated discharge; (ii) phase separating canister with surface mounted pneumatic pump; (iii) automatic level seeking submersible; and (iv) belt skimmers. Of these technologies, the floating skimmer was judged to be the most suitable for this application. The reasons for its selection are outlined below.

Filter Canisters with Floating Skimmers

The filter canister is fitted with a skimmer assembly which allows NAPL to pass into and accumulate in the canister at the rate at which it recharges into the well. The skimmer assembly floats in the extraction well and can move with the fluctuating water table. This is important since upwelling of the NAPL-water interface is likely to occur when the proposed vacuum extraction system is operated simultaneously. A static skimmer assembly could easily become flooded with water when the water levels rise above the skimmer top. This could result in operational and maintenance problems in addition to inability to recover NAPL.

There are two types of skimmer float assemblies available: (i) hydrophobic skimmers; and (ii) specific gravity skimmers. The first type consists of a hydrophobic, oileophilic screen, which repels water but allows NAPL to pass through. The second type of skimmer consists of a buoyant float with a fluid intake located on top of the float. This skimmer assembly floats slightly above the NAPL/water interface and recovers any fluid with a specific gravity less than or equal to 0.85.

During the pilot testing, a layer of emulsified NAPL and water was observed under certain vacuum operating conditions. This emulsified layer formed between the NAPL and the water layers. This emulsion was a mixture of NAPL, water and air. In addition, after aeration of NAPL Area L1 for a number of days during the pilot testing, a bioslime material was observed mixed in with the emulsion. This biological growth separated out from, and floated between, the NAPL and water layers when left to stand for a period of time. However, the exact characteristics of this material are unknown.

The two types of skimmer assemblies discussed above would handle this emulsion very differently. The hydrophobic screen works based on polarity. The non-polar hydrocarbons are attracted to the screen, while the polar water molecules are repelled. According to the manufacturer of the skimmer, in the event that an emulsion of the sort described above, came in contact with the screen the hydrocarbon portion would still be attracted to the screen while the water portion would be repelled. This would aid somewhat in the separation of the mixture into its phases but there is still the potential that some water would pass through, entrained in the NAPL. The proportion of water that would pass through would depend on the relative proportions of NAPL and water in the mixture. However, over time the quantity of water that would breakthrough would increase until there was total breakthrough, at which time the screen would have to be removed and re-primed.

The other type of skimmer assembly is designed to sit approximately one inch above the NAPL water interface. The intake of the assembly would not discriminate between NAPL, emulsion, and bioslime. Instead it would allow any fluid with a specific gravity less than 0.85 (specific gravity of water being 1.0) to pass into the canister. In doing so, all but a one-inch layer of fluid above the water level would be recovered. Due to the occurrence of emulsified product, the use of the hydrophobic screen assembly is not recommended. The assembly that recover product based on specific gravity should provide optimum NAPL recovery.

Phase Separating Canister

During the pilot studies the phase separating canister with surface mounted pneumatic pump was tested. Although this pump worked well to recover pure NAPL, a few operational difficulties were encountered. The simultaneous withdrawal of air/soil gas through the extraction well tended to cause the NAPL and water to emulsify into a mixture that was less dense than pure water. The recovery unit, which allows water to be

discharged back into the well and the NAPL to be forced to the surface, was unable to distinguish between the pure NAPL and the emulsified NAPL/water mixture and the mixture was discharged to the NAPL collection tank. In order to overcome this, a prolonged period of time was needed to allow adequate phase separation of the emulsified mixture. However, some of the mixture inevitably did not separate out. Due to the prolonged time period needed for separation, this system would note be suitable for OU-II NAPL removal. .

Automatic Level Seeking Submersible Pumps

The automatic level seeking submersible pumps are usually intended for aggressive NAPL recovery and therefore require high NAPL recharge into the well. NAPL Area L4 does not exhibit a high NAPL recharge rate. As such, there would be long periods of inactivity for the pump. The water level sensing probes can become coated during these long periods of inactivity and thus become inoperable since the pump relies on the ability of the probes to detect the NAPL/water interface and position the intake in the NAPL layer. In addition, the automatic level seeking reel must be located through the top of the recovery well. This prevents sealing of the recovery wells. Due to the NAPL Area L4 recharge rates and the well contraints, the use of this pump system is not technically feasible. For these reasons, this system is not suitable for the OU-II site.

Belt Skimmers

Belt skimmers are best suited for smaller scale skimming sumps and usually require that the driving motor and mechanism is located directly above the well. This would require an open well head and a closed system is needed under the OU-II application to maintain a vacuum. For these reasons, this system is not suitable for the OU-II site.

Based on the above evaluation, automated filter canisters with floating skimmers and pneumatic pumps have bee selected as the most appropriate recovery system for NAPL Area L4.

5.0 *SELECTION OF MANUFACTURER*

As discussed above, the most appropriate NAPL-only recovery systems are:

- non-automated filter canisters with floating skimmer for NAPL Areas L1, L2, and L3; and
- automated filter canister with floating skimmer and pneumatic pump operated discharge for NAPL Area L4.

There are several companies that manufacture non-automated and automated filter canisters with floating skimmer assemblies. After review of the system requirements and the equipment available, Clean Environment Equipment has been selected to supply the NAPL-only recovery systems. The reasons for this selection are as follows:

- Metro-North has an established relationship with CEE. CEE NAPL recovery systems are currently being used in other areas of the Harmon Yard site with favorable success.
- CEE manufactures both of the selected types of non-automated and automated filter canister recovery systems. Having both types of system supplied by the same manufacturer, allows for ease of operation, maintenance and servicing of the equipment.
- The CEE non-automated floating filter canister skimmers have the ability to be converted to automated systems with little effort. Therefore, should automated recovery become desirable in NAPL Areas L1 the non-automated units could be converted to automated units.

APPENDIX B

Process Control Narrative

CONTROL SYSTEM NARRATIVE DESCRIPTION
Soil Gas Extraction/Air Injection and NAPL Removal System at Operable Unit II
Metro-North Commuter Railroad
Croton-on-Hudson, NY

INTRODUCTION

Metro-North Commuter Railroad (Metro-North) is currently undertaking measures to remediate subsurface non-aqueous phase liquid (NAPL) at its Harmon Yard Railroad facility in Croton-on-Hudson, New York. The cleanup efforts include the design and construction of a soil gas extraction/air injection system to facilitate the biodegradation of NAPL in the vadose zone and also to remove floating NAPL collected in the soil gas extraction wells.

The purpose of this document is to describe the automated functions for the overall plant control system contractor with a scope of programming requirements.

GENERAL DESCRIPTION

The main components of the soil gas extraction (SGE)/air injection (FA) / passive air inlet (AI) and NAPL removal systems, as shown on the process and instrumentation diagrams (P&IDs), are:

Area L1/L2
- two (2) soil gas extraction blowers
- one liquid vapor separator
- liquid condensate pump
- run time meter (analog)
- two (2) actuated butterfly valves
- pressure transmitter
- temperature transmitter
- programmable logic controller (PLC)
- autodialer

Area L3
- one soil gas extraction blower
- one liquid vapor separator
- liquid condensate pump
- run time meter (analog)
- pressure transmitter
- temperature transmitter
- programmable logic controller (PLC)
- autodialer

Area L4

- one soil gas extraction blower
- one air injection blower
- run time meter (analog)
- aftercooler
- one liquid vapor separator
- liquid condensate pump
- air compressor
- active NAPL removal pumps
- Tank Full Shut Off Panel
- electric high level sensor
- air dryer
- pressure transmitter
- temperature transmitter
- programmable logic controller (PLC)
- autodialer

The system control for each area shall interact with the equipment, instrumentation, and operator setpoints to allow for continuous, automated, unstaffed operation of the system. A general outline of the control system functions is provided below, followed by more detailed descriptions in subsequent sections.

Each soil gas extraction blower shall be connected to an analog run time meter to monitor the length of any shut down conditions and for routine maintenance of the systems. The SGE blower system shall include several automated controls and safety shutdown features, including high blower differential pressure and high discharge temperature. The high differential pressure shutdown will prevent the pressure across the blowers from exceeding the maximum recommended value for the blowers. The high temperature shutdown on the blower discharge will prevent the blowers from overheating.

Liquid level control shall be used to activate the condensate pump when the condensate level in the liquid vapor separator reaches a high point. The condensate will then be pumped into water storage drum. If the condensate level in the liquid vapor separator continues to rise above the high level, a high-high level alarm will trigger a total system shutdown (i.e blower and condensate pump).

The automated NAPL removal system located in Area L4 will be equipped with several safety shutdown features. A high level in the recovery tank will prevent the recovery pumps from further removing NAPL. Any shutdown of the blower or condensate pump shall not cause the NAPL removal compressor to shut down. Also, in Area L4, a shutdown of the NAPL removal system will not shut down the SGE and FA systems.

Similar to the SGE blowers, in Area L4 the air injection blower shall also be protected against high differential pressure and high temperature. Furthermore, any shutdown of the SGE blowers or liquid vapor separator shall also trigger the shutdown of the air injection blower.

AREA L1/L2 SOIL GAS EXTRACTION BLOWER OPERATION AND CONTROL

As shown on PID-2, the system will consist of a process inlet valve from two operating zones, two electrically actuated valves, a fresh air inlet valve, liquid vapor separator, SGE blowers, and two granular activated carbon drums piped together in that order.

During normal operation, the SGE blowers will extract air from the subsurface and send it to the granular activated carbon (GAC) drums located in the building. A Programmable Logic Controller (PLC) will control the operation of opening and closing the actuated valves for the two operating zones. A timer within the PLC will trigger the closure of one zone while other zone valve is opened. Upon restart of the SGE system after a system shut down, the PLC will open both actuated valves, preventing backpressure in the piping system, and will then close one zone valve, leaving the other zone valve open.

Once the SGE blower system is running, there are several conditions that shall cause an automatic system shutdown:

1. *SGE blower high differential pressure alarm (DPT201, DPT202):* If the differential pressure across either SGE blower exceeds an operator selected setpoint in the system control, then the system control shall shut down both SGE blowers. Blower differential pressure shall be continuously monitored by the pressure transmitter located across each blower.

2. *SGE blower high discharge temperature alarm (TT201):* If the discharge temperature of the combined SGE blower discharge exceeds an operator selected setpoint on the temperature switch, then the system control shall shut down both SGE blowers. Blower discharge temperature shall be continuously monitored based on the signal from the temperature transmitter on the combined blower discharge.

3. *Liquid vapor separator high-high level alarm (LSHH201):* If the condensate level in the liquid vapor separator exceeds the high level alarm switch, then the system control shall shut down both SGE blowers. Condensate level shall be continuously monitored based on the signal from the level transmitter on the liquid vapor separator.

4. *Condensate drum high level alarm (LSH202):* If the level in the condensate collection drum activates the drum high level switch, then the system control shall shut down the transfer pump and send a signal to an autodialer notify the operator of the condition.

5. *High %LEL alarm (LEL201):* If the %LEL in the building exceeds the operator selected setpoint in the system control, then the system control

shall shut down both soil gas extraction blowers, activate the ventilation fan and activate a visual alarm.

The control panel for the area shall include a PLC with an autodialer. The PLC shall continuously monitor all analog inputs (AI), all digital inputs and digital outputs (DI, DO) and the appropriate calculated variables (CV).

Each AI shall be stored as a 5 minute average. Each change in DI and DO status shall be date and time stamped and stored. Every significant change in a CV shall be date and time stamped and stored.

Under normal operations, the stored information shall be downloaded to the User's System every 24 hours. The User's System will confirm the data has been properly received and at the time the PLC may then delete archived data and begin storing new data. This data shall be formatted such that the User's System may generate log reports and trend graphs.

Under any abnormal/alarm condition, the PLC shall provide a local alarm consisting of a horn and lighting the appropriate indicating light and shall take the necessary control action. Additionally, the PLC shall immediately notify the Operator of any such abnormal/ alarm condition.

The PLC shall include a visual Operator Interface and a Control Pad such that the Operator may monitor signals and enter setpoint/alarm setting data.

Table 1-1. Area L1 soil gas extraction system control features.

Control	Triggering Mechanism	Setpoint	Action
Differential Pressure Transmitter DPT201/202	High pressure differential across blower	95 inches w.c.	Shut down SGE blowers
Temperature Transmitter TT201	Elevated temperature at blower outlet	220 ^{0}F	Shut down SGE blower
Condensate High-high level LSHH201	High-high water level in liquid moisture separator	Mechanical Float	Shut down SGE blower
High Level Switch LSH202	High liquid level in the condensate drum	Mechanical Float	Shut down condensate transfer pump
High LEL Alarm LEL201	Elevated explosive gas level in equipment building	10% LEL	Shut down SGE blower, turn on ventilation fan, turn on warning light

TREATMENT ZONE SELECTION

The system control shall determine which operational treatment zone of NAPL Area L1 is subject to SGE by actuating control valves on the SGE pipelines to each zone. Zone switchover shall be possible without shutting down the SGE blowers. An operator selected time on the PLC-based system control shall determine the length of time either of the operational zones will be open.

Under normal operation, the system control shall open the valve on the SGE pipelines to zone A, and close the valve to the zone B for the time duration entered. When this time expires, the system control shall open the valve on the zone B and then close the valve on the zone A in that order. The system control shall always sequence valve operations so that the valve on the zone coming online is fully opened (confirmation provided by limit switch signals) before initiating closure of the valves on the zone going offline. This will prevent the SGE blowers from operating against closed inlet valves.

After a shutdown condition has occurred for the SGE blower system, no change shall occur to the valves. Upon restart of the SGE system, a PLC shall default to an open condition for both valves. The last valve operating open prior to shut down shall remain open with the other zone valve closing.

AREA L3 SOIL GAS EXTRACTION BLOWER OPERATION AND CONTROL

As shown on PID-3, the system will consist of a process inlet valve, fresh air inlet valve, liquid vapor separator, SGE blower, and two granular activated carbon drums piped together in that order.

During normal operation, the SGE blower will extract air from the subsurface and send it to the GAC drums located next to the system enclosure. The startup of the blower will be done at the local blower control panel located next to the system enclosure.

Once the SGE blower system is running, there are several conditions that shall cause an automatic system shutdown:

1. *SGE blower high differential pressure alarm (DPT301):* If the differential pressure across the SGE blower exceeds an operator selected setpoint in the system control, then the system control shall shut down the SGE blower. Blower pressure shall be continuously monitored by the differential pressure transmitter across the blower.

2. *SGE blower high discharge temperature alarm (TT301):* If the discharge temperature of the SGE blower exceeds an operator selected setpoint on the temperature switch, then the system control shall shut down the SGE blower. Blower discharge temperature shall be continuously monitored

based on the signal from the temperature transmitter on the blower discharge.

3. *Liquid vapor moisture separator high-high level alarm (LSHH301):* If the condensate level in the liquid vapor separator exceeds the high level alarm switch, then the system control shall shut down the SGE blower. Condensate level shall be continuously monitored based on the signal from the level transmitter on the liquid vapor separator.

4. *Condensate drum high level alarm (LSH302):* If the level in the condensate collection drum activates the drum high level switch, then the system control shall shut down the transfer pump and send a signal to an autodialer to notify the operator of the condition.

The control panel for the area shall include a PLC with an autodialer. The PLC shall continuously monitor all analog inputs (AI), all digital inputs and digital outputs (DI, DO) and the appropriate calculated variables (CV).

Each AI shall be stored as a 5 minute average. Each change in DI and DO status shall be date and time stamped and stored. Every significant change in a CV shall be date and time stamped and stored.

Under normal operations, the stored information shall be downloaded to the User's System every 24 hours. The User's System will confirm the data has been properly received and at the time the PLC may then delete archived data and begin storing new data. This data shall be formatted such that the User's System may generate log reports and trend graphs.

Under any abnormal/alarm condition, the PLC shall provide a local alarm consisting of a horn and lighting the appropriate indicating light and shall take the necessary control action. Additionally, the PLC shall immediately notify the Operator of any such abnormal/ alarm condition.

The PLC shall include a visual Operator Interface and a Control Pad such that the Operator may monitor signals and enter setpoint/alarm setting data.

AREA L4 SOIL GAS EXTRACTION AND AIR INJECTION BLOWER OPERATION AND CONTROL, AND ACTIVE NAPL REMOVAL

As shown on PID-4, the soil gas extraction system will consist of a process inlet valve, fresh air inlet valve, liquid vapor separator, SGE blower, and two granular activated carbon drums piped together. The air injection system will consist of an air inlet / silencer, an air injection blower and an aftercooler connected to the injection wells, piped in that order.

Table 1-2. Area L3 soil gas extraction system control features.

Control	Triggering Mechanism	Setpoint	Action
Differential Pressure Transmitter DPT301	High pressure differential pressure across blower	50 inches w.c.	Shut down SGE blower
Temperature Transmitter TT301	Elevated temperature at blower outlet	200^{0}F	Shut down SGE blower
High-high level switch LSHH301	High-high liquid level in liquid moisture separator	Mechanical Float	Shut down SGE blower
High Level Switch	High liquid level in condensate drum	Mechanical Float	Shut down transfer pump

During normal operation, the SGE blower will extract air from the subsurface and send it to the GAC drums located next to the system enclosure while the air injection blower will force air into the subsurface. The startup of each blower will be done at the local blower control panel located in the system building.

Once the soil gas extraction and the air injection blowers are running, there are several conditions that shall cause an automatic system shutdown:

1. *Air injection blower high differential pressure alarm (DPT402):* If the differential pressure of the air injection blower exceeds an operator selected setpoint in the system control, then the system control shall shut down the air injection blower. Blower differential pressure shall be continuously monitored based on the signals from the pressure transmitter on the blower discharge.

2. *Air injection blower high temperature alarm (TT402):* If the discharge temperature of a air injection blower exceeds the operator selected setpoint in the system control, then the system control shall automatically shut down the blower. Blower discharge temperature shall be continuously monitored based on the signals from the temperature transmitter on the blower discharge.

3. *SGE blower high differential pressure alarm (DPT401):* If the differential pressure of the SGE blower exceeds an operator selected setpoint in the system control, then the system control shall shut down the blower. Blower differential pressure shall be continuously monitored based on the signals from the pressure transmitter across the SGE blower.

4. *SGE blower high temperature alarm (TT401):* If the discharge temperature of a SGE blower exceeds the operator selected setpoint in the system control, then the system control shall automatically shut down the blower. Blower

discharge temperature shall be continuously monitored based on the signals from the temperature transmitter on the SGE blower discharge.

5. *Liquid vapor separator high-high level alarm (LSHH-401):* If the condensate level in the liquid vapor separator reaches the high-high level alarm switch, then the system control shall shut down the SGE blower. Condensate level shall be continuously monitored based on the signal from the level transmitter on the liquid vapor separator.

6. *Condensate drum level alarm (LSH-402):* If the level in the condensate collection drum activates the drum high level switch, them the control system shall shut down the liquid vapor separator transfer pump and send a signal to the autodialer to notify the operator of the condition.

7. *SGE blower alarm shutdown:* If for any reason the SGE blower experiences an automatic shutdown due to an alarm condition then the system control shall shut down the air injection blower. An alarm shutdown of air injection blower will be based on signals from the PLC control panel.

8. *High %LEL alarm (LEL401):* If the %LEL in the building exceeds the operator selected setpoint in the system control, then the system control shall shut down both soil gas extraction and air injection blowers, the ventilation fan and activate a visual alarm.

The control panel for the area will contain a PLC and autodialer. Each of the above conditions will result in a signal being sent to the PLC which will store the signal. The PLC will the follow the prescribed action based on the signal and forward the alarm condition to the autodialer. The autodialer will transmit a call to the operator and other contact(s) designated for alarm conditions.

The control panel for the area shall include a PLC with an autodialer. The PLC shall continuously monitor all analog inputs (AI), all digital inputs and digital outputs (DI, DO) and the appropriate calculated variables (CV).

Each AI shall be stored as a 5 minute average. Each change in DI and DO status shall be date and time stamped and stored. Every significant change in a CV shall be date and time stamped and stored.

Under normal operations, the stored information shall be downloaded to the User's System every 24 hours. The User's System will confirm the data has been properly received and at the time the PLC may then delete archived data and begin storing new data. This data shall be formatted such that the User's System may generate log reports and trend graphs.

Under any abnormal/alarm condition, the PLC shall provide a local alarm consisting of a horn and lighting the appropriate indicating light and shall take the necessary control

action. Additionally, the PLC shall immediately notify the Operator of any such abnormal/ alarm condition.

The PLC shall include a visual Operator Interface and a Control Pad such that the Operator may monitor signals and enter setpoint/alarm setting data.

Table 1-3. Area L4 soil gas extraction system control features.

Control	Triggering Mechanism	Setpoint	Action
Differential Pressure Transmitter DPT402	High pressure differential pressure across blower	80 inches w.c.	Shut down AI blower
Temperature Transmitter TT402	Elevated temperature at blower outlet	260^{0}F	Shut down AI blower
Differential Pressure Transmitter DPT401	High pressure differential pressure across blower	75 inches w.c.	Shut down SGE blower
Temperature Transmitter TT402	Elevated temperature at blower outlet	220 ^{0}F	Shut down SGE blower
High-High Level Switch LSHH401	High-high water level in liquid moisture separator	Mechanical Float	Shut down SGE blower
High Level Switch	High liquid level in liquid moisture separator	Mechanical Float	Shut down SGE blower
Lower Explosive Limit LEL401	Elevated explosive gas in equipment building	10% LEL	Shut down SGE blower, turn on ventilation fan, turn on warming light

AUTOMATED PRODUCT RECOVERY SYSTEM

The automated product recovery system consists of a 3 Hp compressor, air dryer, Tank Full Shut Off (TFSO) control panel, tank high level switch, product pumps, product skimmers and a product recovery collection tank, in that order.

During normal operation the compressor will provide air to the product pumps that will pump any NAPL collected in the skimmer to the product recovery collection tank. The startup of the product recovery system will be done in the Area L4 building.

Once the active recovery system is running, there are several conditions that shall cause an automatic shutdown of the system:

1. *Tank Full Shut Off (TF401):* If either the bubble sensor (activated by backpressure of 3 to 4 inches of water) or the float sensor (liquid level in the tank activates the system trip button) is tripped then the flow of air to the downstream pumps will be stopped, thus preventing further recovery of NAPL from the wells.

2. *Low level oil switch (OS401):* If a low oil condition for the air compressor exists the low level switch will be shut down the air compressor and prevent the pumps from recovering NAPL from the wells.

3. *NAPL recovery tank high level alarm (LSH402):* If the NAPL level in the NAPL recovery tank exceeds the high level alarm switch, then the system control shall shut down the air compressor for the NAPL recovery system, start a visual alarm and send a signal to the autodialer to notify the operator of the condition. NAPL level shall be continuously monitored based on the signal from the level transmitter on the NAPL recovery tank.

The control panel for the area shall include a PLC with an autodialer. The PLC shall continuously monitor all analog inputs (AI), all digital inputs and digital outputs (DI, DO) and the appropriate calculated variables (CV).

Each AI shall be stored as a 5 minute average. Each change in DI and DO status shall be date and time stamped and stored. Every significant change in a CV shall be date and time stamped and stored.

Under normal operations, the stored information shall be downloaded to the User's System every 24 hours. The User's System will confirm the data has been properly received and at the time the PLC may then delete archived data and begin storing new data. This data shall be formatted such that the User's System may generate log reports and trend graphs.

Under any abnormal/alarm condition, the PLC shall provide a local alarm consisting of a horn and lighting the appropriate indicating light and shall take the necessary control action. Additionally, the PLC shall immediately notify the Operator of any such abnormal/ alarm condition.

The PLC shall include a visual Operator Interface and a Control Pad such that the Operator may monitor signals and enter setpoint/alarm setting data.

Table 1-4. Area L4 automated product recovery system control features.

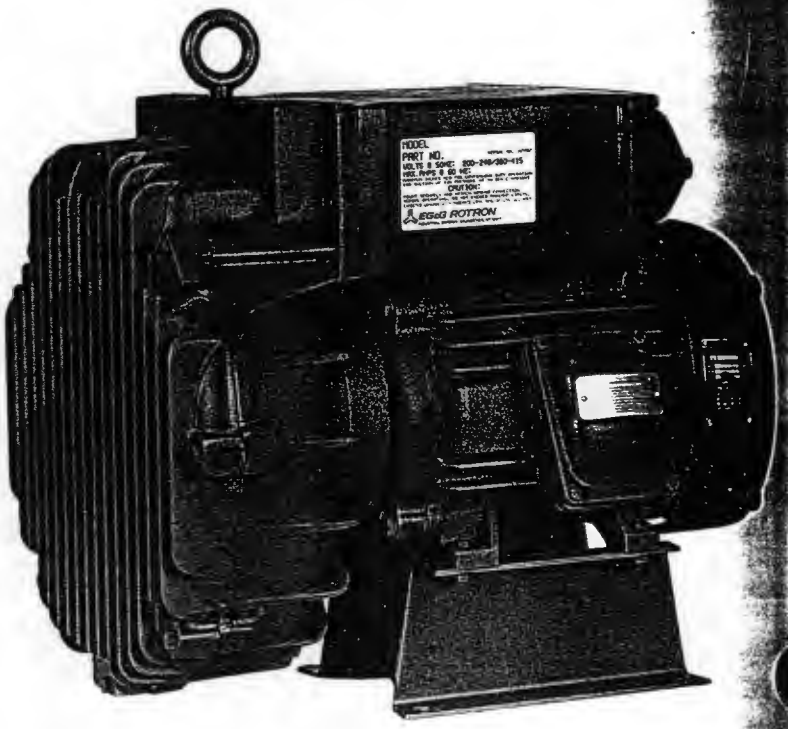
Control	Triggering Mechanism	Setpoint	Action
Tank Full Shut Off TF401	High liquid level in product storage tank	3-4 inches w.c.	Stop compressed air flow to product pumps
Low level oil switch OS401	Low oil level in the air compressor	Mechanical	Shut down air compressor, send signal to autodialer
High level switch LSH402	High liquid level in the product storage tank	Mechanical Float	Shut down air compressor, turn on warning light, send signal to autodialer

APPENDIX C

Equipment Manufacturers' Literature

EN/CP 909
Explosion-Proof Regenerative Blower

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

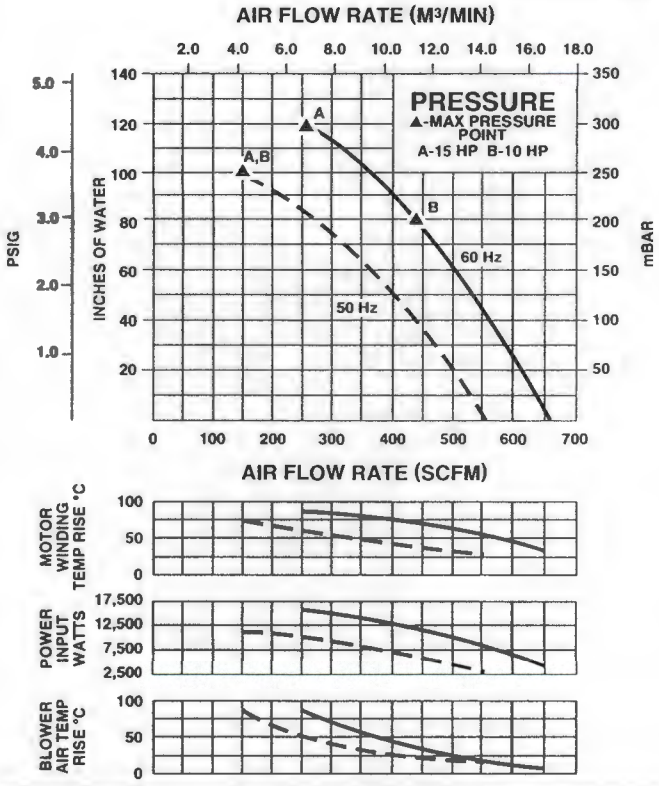


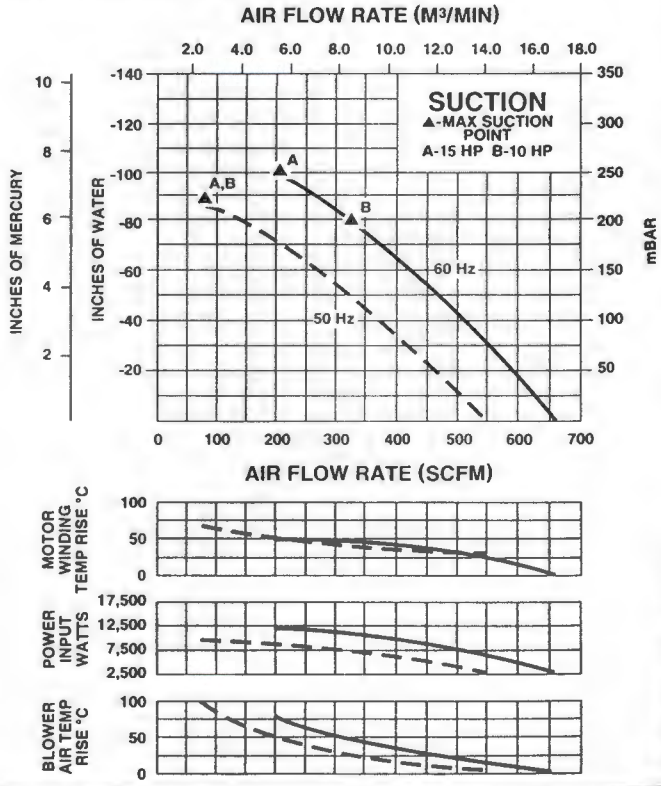
MOTOR OPTIONS
- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

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

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

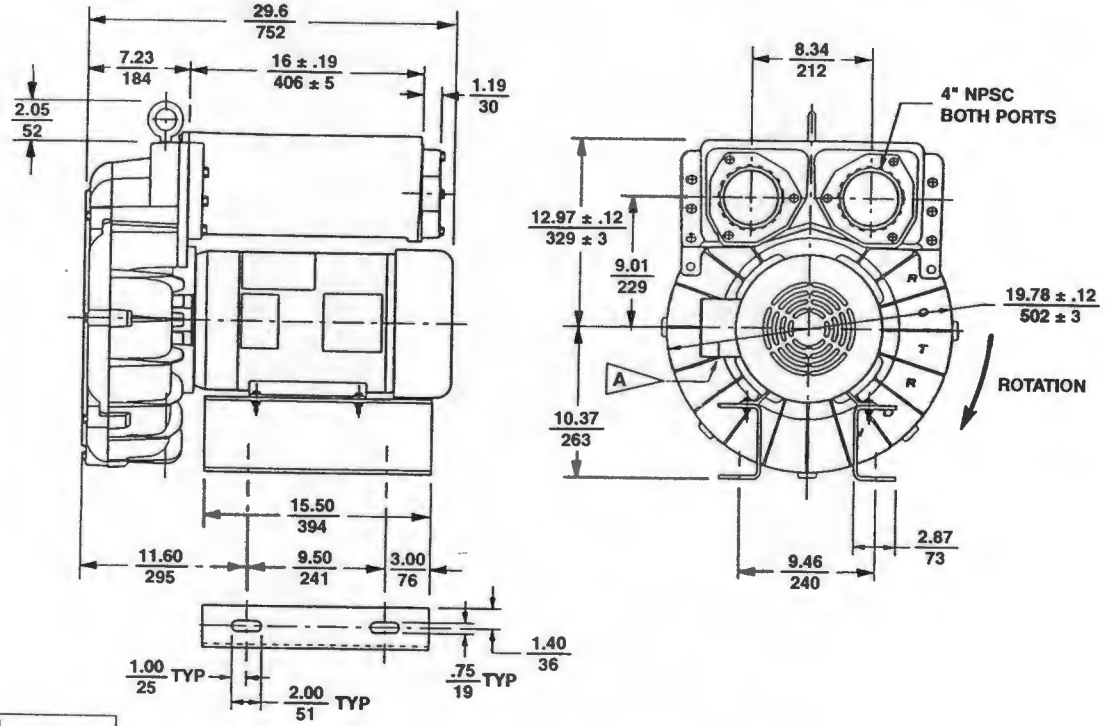
BLOWER PERFORMANCE AT STANDARD CONDITIONS





EG&G ROTRON, SAUGERTIES, N.Y. 12477 • 914/246-3401 • FAX 914/246-3802

EN/CP 909
Explosion-Proof Regenerative Blower



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

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

SPECIFICATIONS

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

[1] Rotron motors are designed to handle a broad range of world voltages and power supply variations. Our dual voltage 3 phase motors are factory tested and certified to operate on both: **208-230/415-460 VAC-3 ph-60 Hz** and **200-220/400-440 VAC-3 ph-50 Hz**. Our dual voltage 1 phase motors are factory tested and certified to operate on both: **104-115/208-230 VAC-1 ph-60 Hz** and **100-110/200-220 VAC-1 ph-50 Hz**. All voltages above can handle a ±10% voltage fluctuation. Special wound motors can be ordered for voltages outside our certified range.

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

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

Specifications subject to change without notice. Please contact factory for specification updates.

TN/CP 404
Explosion-Proof Regenerative Blower

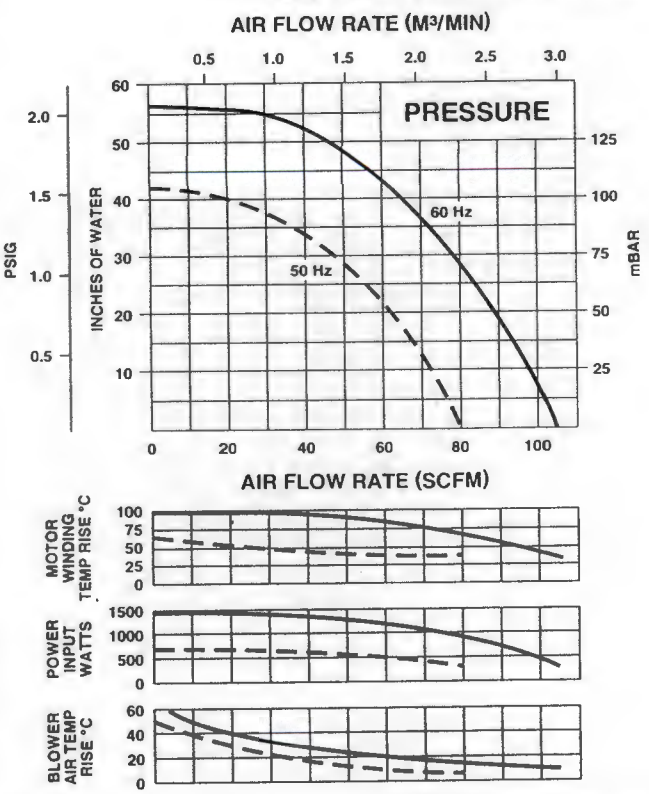
FEATURES
- Manufactured in the USA
- Maximum flow: 107 SCFM
- Maximum pressure: 57 IWG
- Maximum vacuum: 52 IWG
- Standard motor: 1.0 HP, explosion-proof
- Cast aluminum blower housing, cover, impeller & manifold; cast iron flanges (threaded); teflon lip seal
- UL & CSA approved motor with permanently sealed ball bearings for explosive gas atmospheres Class I Group D minimum
- Sealed blower assembly
- Quiet operation within OSHA standards

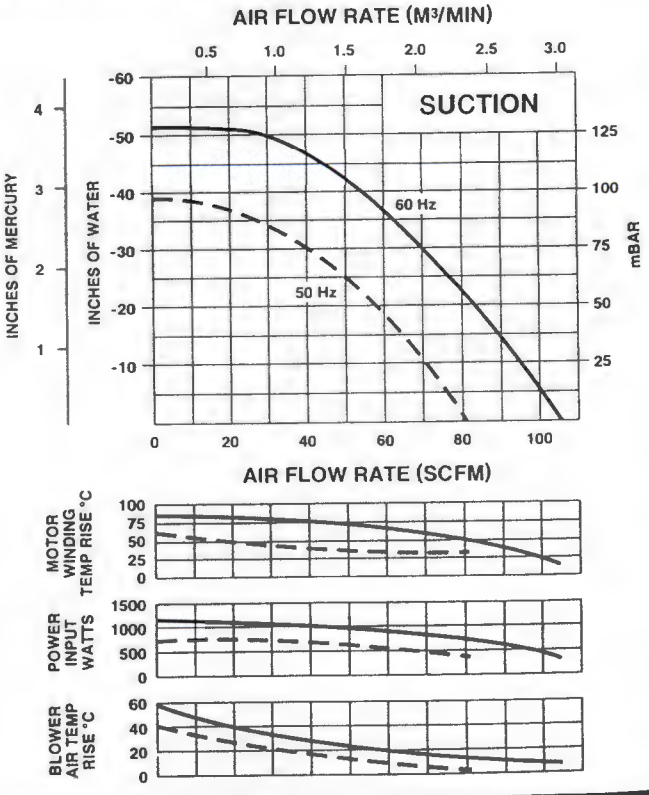
MOTOR OPTIONS
- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

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

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

BLOWER PERFORMANCE AT STANDARD CONDITIONS





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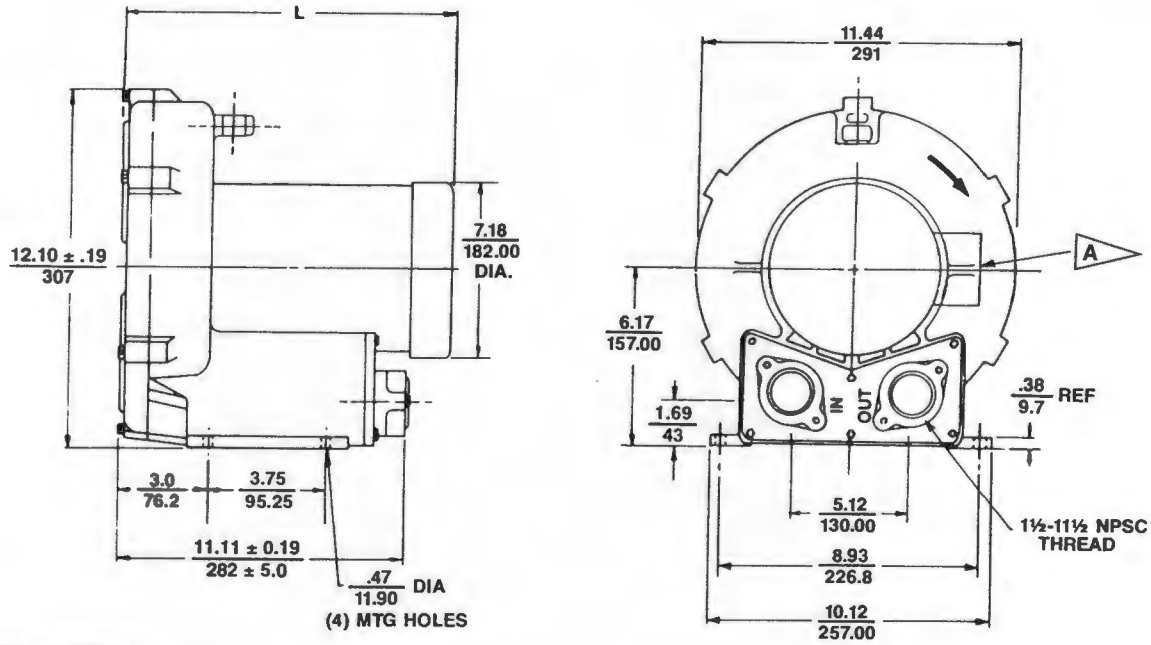
EN/CP 404
Explosion-Proof Regenerative Blower



DIMENSIONS: IN / MM
TOLERANCES: .XX ± .08 / 2.0
.XXX ± .030 / .800
(UNLESS OTHERWISE NOTED)

MODEL	L (IN) ± .30	L (MM) ± 8
EN/CP404AR72ML	15.40	391
EN/CP404AR58ML	15.52	394

A 0.75" NPT CONDUIT CONNECTION AT 12 O'CLOCK POSITION

SPECIFICATIONS

MODEL	EN404AR58ML		EN404AR72ML		CP404FQ58MLR	CP404FQ72MLR
Part No.	038173		038174		–	038958
Motor Enclosure – Shaft Material	Explosion-proof – **CS**		Explosion-proof – **CS**		Chem XP – **SS**	Chem XP – **SS**
Horsepower	1.0		1.0		Same as EN404AR58ML – 038173 except add Chemical Processing (CP) features from catalog inside front cover	Same as EN404AR72ML – 038174 except add Chemical Processing (CP) features from catalog inside front cover
Phase – Frequency [1]	Single - 60 Hz		Three - 60 Hz			
Voltage [1]	115	230	208-230	460		
Motor Nameplate Amps	11.4	5.69	3.5-3.2	1.6		
Max. Blower Amps [3]	14.5	7.2	4.2	2.1		
Inrush Amps	72	36	20.2	10.1		
Starter Size	0	00	00	00		
Service Factor	1.0		1.0			
Thermal Protection [2]	Class B - Automatic		Class B - Pilot Duty			
XP Motor Class – Group	I-D, II-F&G		I-D, II-F&G			
Shipping Weight	72 lb (33 kg)		65 lb (30 kg)			

[1] Rotron motors are designed to handle a broad range of world voltages and power supply variations. Our dual voltage 3 phase motors are factory tested and certified to operate on both: **208-230/415-460 VAC-3 ph-60 Hz** and **200-220/400-440 VAC-3 ph-50 Hz**. Our dual voltage 1 phase motors are factory tested and certified to operate on both: **104-115/208-230 VAC-1 ph-60 Hz** and **100-110/200-220 VAC-1 ph-50 Hz**. All voltages above can handle a ±10% voltage fluctuation. Special wound motors can be ordered for voltages outside our certified range.

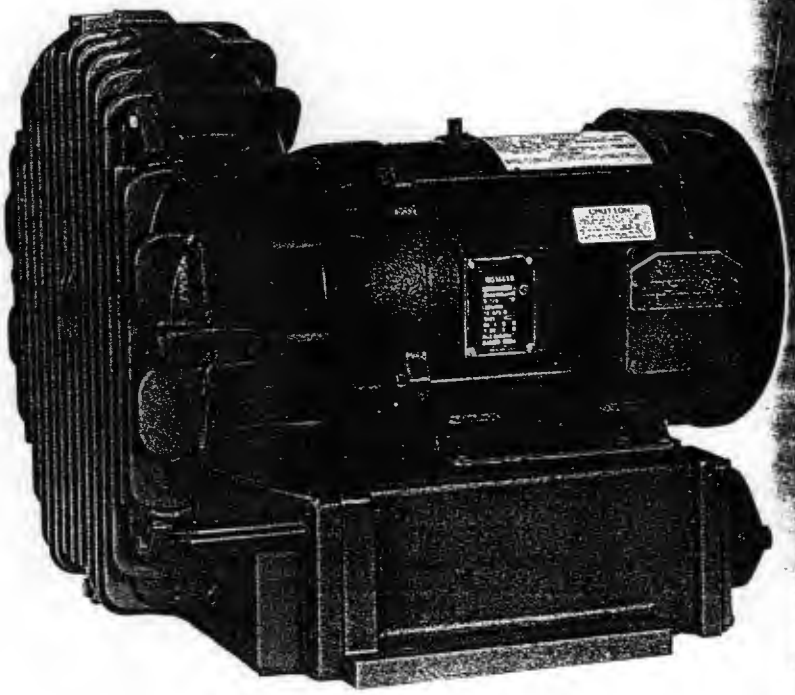
[2] Maximum operating temperature: Motor winding temperature (winding rise plus ambient) should not exceed 140°C for Class F rated motors or 120°C for Class B rated motors. Blower outlet air temperature should not exceed 140°C (air temperature rise plus inlet temperature). Performance curve maximum pressure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

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

Specifications subject to change without notice. Please contact factory for specification updates.

EN/CP 707
Explosion-Proof Regenerative Blower

FEATURES
- Manufactured in the USA
- Maximum flow: 295 SCFM
- Maximum pressure: 85 IWG
- Maximum vacuum: 87 IWG
- Standard motor: 5.0 HP, explosion-proof
- Cast aluminum blower housing, cover, impeller & manifold; cast iron flanges (threaded); teflon lip seal
- UL & CSA approved motor with permanently sealed ball bearings for explosive gas atmospheres Class I Group D minimum
- Sealed blower assembly
- Quiet operation within OSHA standards

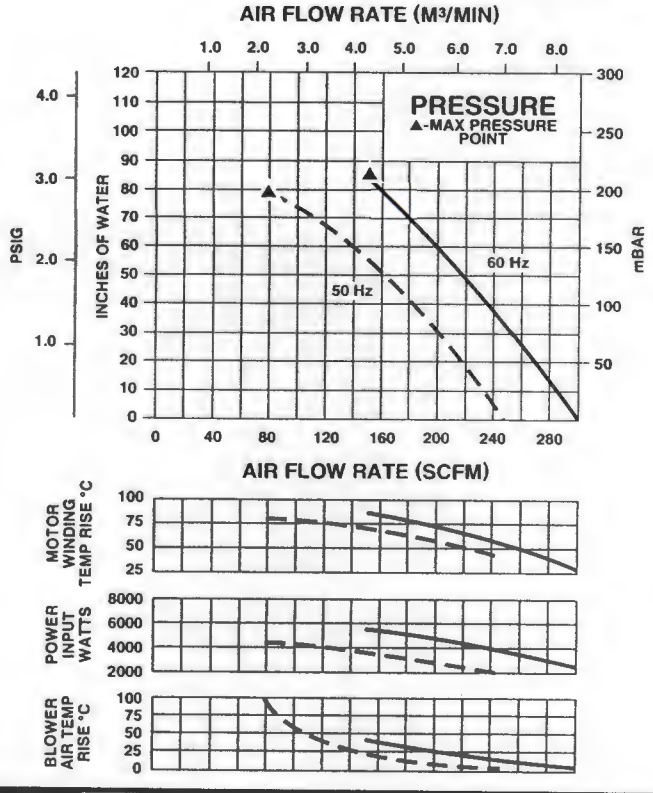


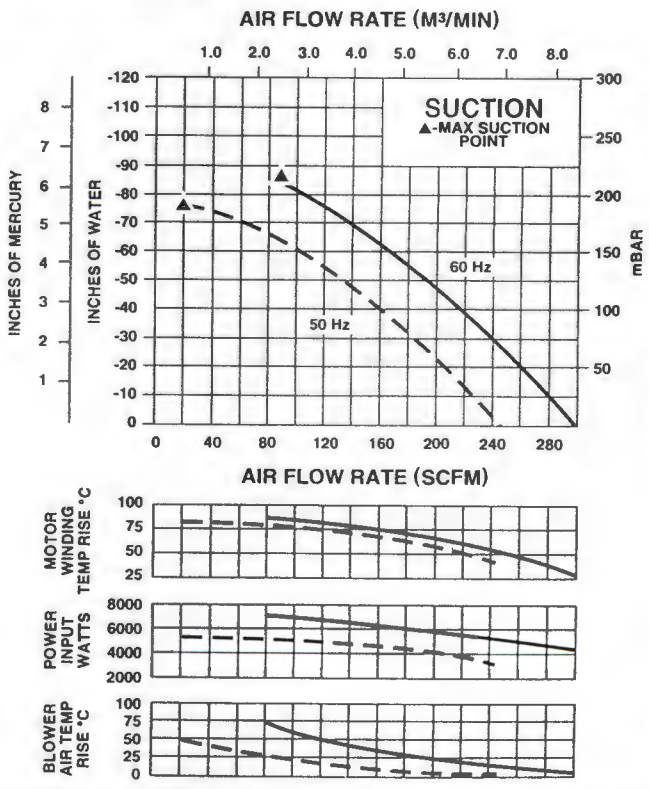
MOTOR OPTIONS
- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

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

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

BLOWER PERFORMANCE AT STANDARD CONDITIONS





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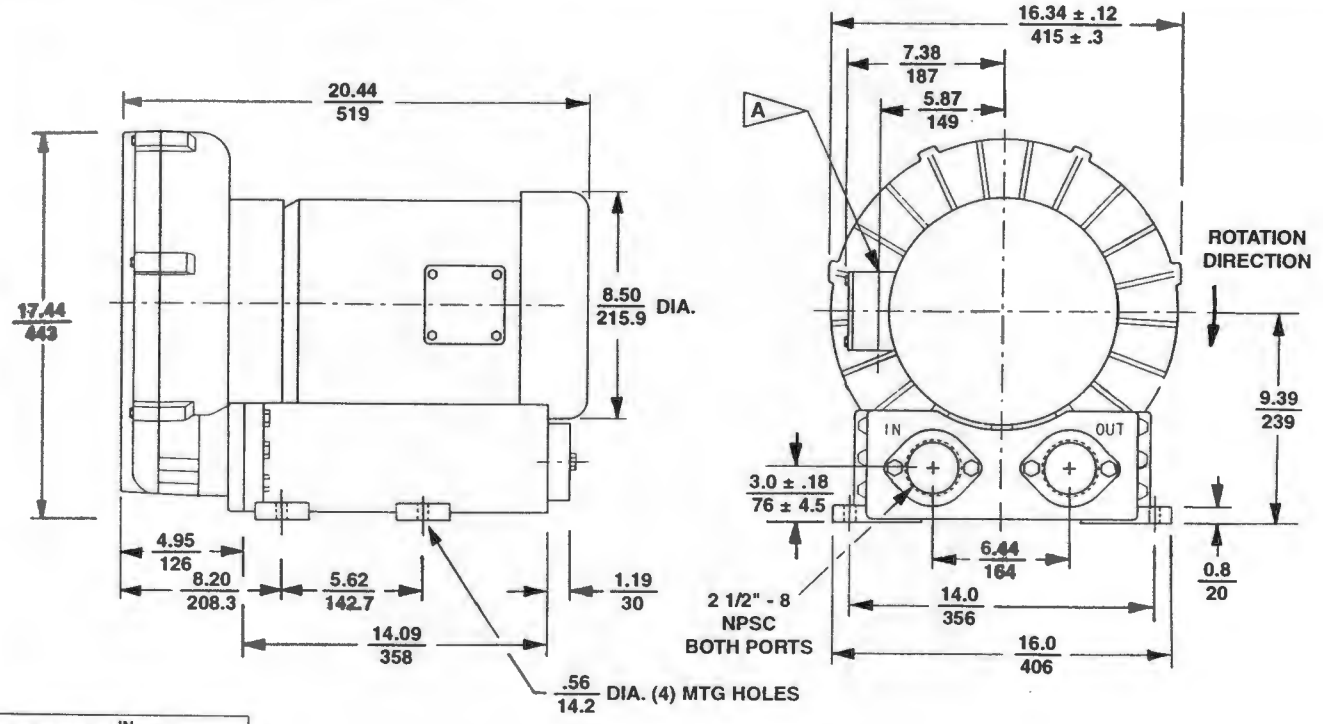
EN/CP 707
Explosion-Proof Regenerative Blower



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

A 0.75" NPT CONDUIT CONNECTION AT 12 O'CLOCK POSITION

SPECIFICATIONS

MODEL	EN707F72MXL		EN707F86MXL	CP707FW72MXLR
Part No.	038710		038711	038974
Motor Enclosure – Shaft Material	Explosion-proof – **CS**		Explosion-proof – **CS**	Chem XP – **SS**
Horsepower	5.0		5.0	Same as EN707F72MXL – 038710 except add Chemical Processing (CP) features from catalog inside front cover
Phase – Frequency [1]	Three - 60 Hz		Three - 60 Hz	
Voltage [1]	230	460	575	
Motor Nameplate Amps	14	7	5.7	
Max. Blower Amps [3]	15.8	7.9	6.3	
Inrush Amps	152	76	61	
Starter Size	1	0	0	
Service Factor	1.0		1.0	
Thermal Protection [2]	Class B - Pilot Duty		Class B - Pilot Duty	
XP Motor Class – Group	I-D, II-F&G		I-D, II-F&G	
Shipping Weight	174 lb (79 kg)		174 lb (79 kg)	

[1] Rotron motors are designed to handle a broad range of world voltages and power supply variations. Our dual voltage 3 phase motors are factory tested and certified to operate on both: **208-230/415-460 VAC-3 ph-60 Hz** and **200-220/400-440 VAC-3 ph-50 Hz**. Our dual voltage 1 phase motors are factory tested and certified to operate on both: **104-115/208-230 VAC-1 ph-60 Hz** and **100-110/200-220 VAC-1 ph-50 Hz**. All voltages above can handle a ±10% voltage fluctuation. Special wound motors can be ordered for voltages outside our certified range.

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

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

Specifications subject to change without notice. Please contact factory for specification updates.

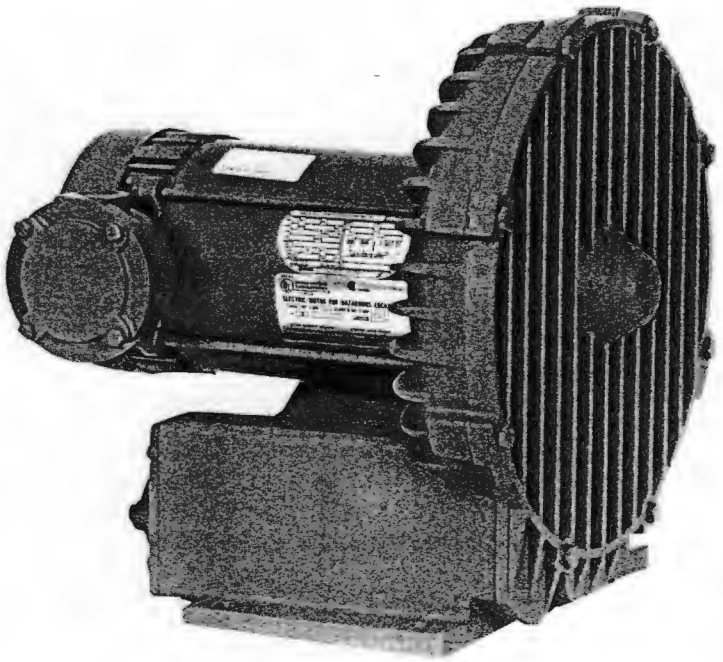
EN 513 & CP 513
Explosion-Proof Regenerative Blower

FEATURES
- Manufactured in the USA – ISO 9001 compliant
- Maximum flow: 78 SCFM
- Maximum pressure: 88 IWG
- Maximum vacuum: 75 IWG
- Standard motor: 1.5 HP, explosion-proof
- Cast aluminum blower housing, cover, impeller & manifold; cast iron flanges (threaded); teflon lip seal
- UL & CSA approved motor with permanently sealed ball bearings for explosive gas atmospheres Class I Group D minimum
- Sealed blower assembly
- Quiet operation within OSHA standards

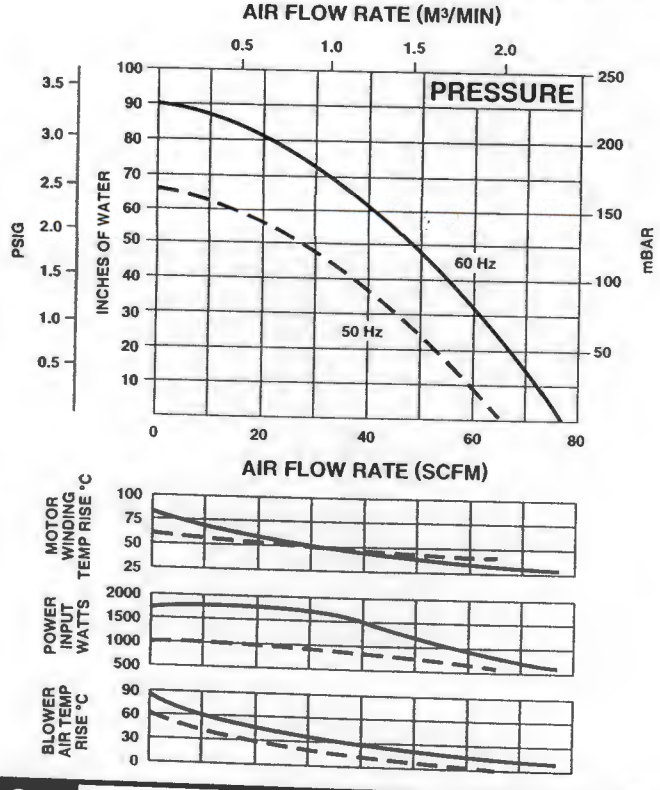
MOTOR OPTIONS
- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

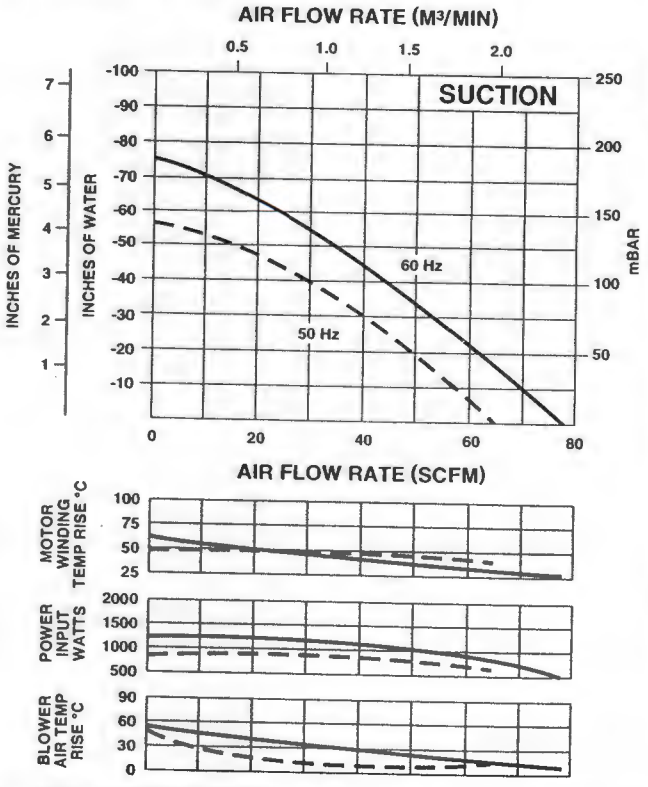
BLOWER OPTIONS
- Corrosion resistant surface treatments & sealing options
- Remote drive (motorless) models
- Slip-on or face flanges for application-specific needs

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



BLOWER PERFORMANCE AT STANDARD CONDITIONS





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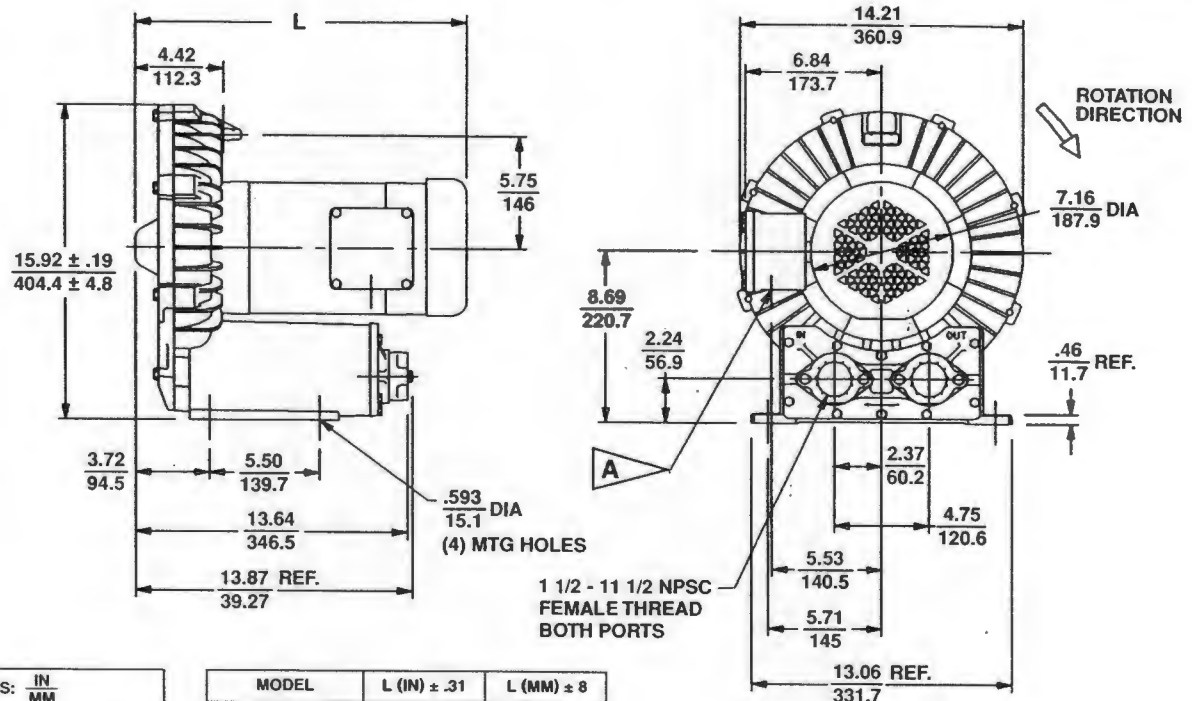
EN 513 & CP 513
Explosion-Proof Regenerative Blower

Scale CAD drawing available upon request.



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

MODEL	L (IN) ± .31	L (MM) ± 8
EN/CP513W58L	16.65	423
EN/CP513W72L	15.74	400

A 0.75" NPT CONDUIT CONNECTION AT 12 O'CLOCK POSITION

SPECIFICATIONS

MODEL	EN513W58L		EN513W72L		CP513FR58LR	CP513FR72LR
Part No.	038183		038037		–	038966
Motor Enclosure – Shaft Material	Explosion-proof – **CS**		Explosion-proof – **CS**		Chem XP – **SS**	Chem XP – **SS**
Horsepower	1.5		1.5		Same as EN513W58L – 038183 except add Chemical Processing (CP) features from catalog inside front cover	Same as EN513W72L – 038037 except add Chemical Processing (CP) features from catalog inside front cover
Phase – Frequency [1]	Single - 60 Hz		Three - 60 Hz			
Voltage [1]	115	208-230	230	460		
Motor Nameplate Amps	15	7.9-7.5	4.6	2.3		
Max. Blower Amps [3]	19.4	9.7-9.0	4.8	2.4		
Inrush Amps	96	48	32	16		
Starter Size	1	0	00	00		
Service Factor	1.0		1.0			
Thermal Protection [2]	Class B - Pilot Duty		Class B - Pilot Duty			
XP Motor Class – Group	I-D, II-F&G		I-D, II-F&G			
Shipping Weight	98 lb (45 kg)		92 lb (42 kg)			

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

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

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

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

Measurement Accessories

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

Gauges

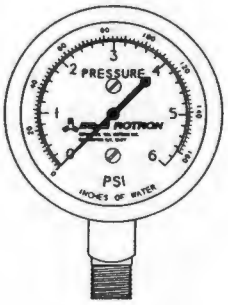
Rotron has a variety of gauges for pressure, vacuum and temperature measurements in various ranges. These gauges are reliable and rugged.

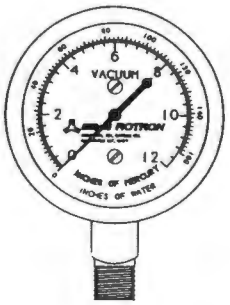
SPECIFICATIONS:

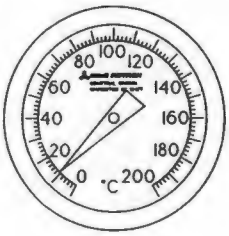
Pressure/Vacuum
CASE – Drawn Steel Finished in Black Enamel
DIAPHRAGM – Bronze
LENS – Clear Plastic
ACCURACY – 2%
WEIGHT – 1/2 lb.
CONNECTION – 1/4" NPT
FACE – 2 1/4" dia.

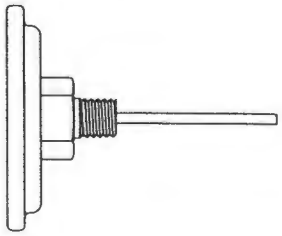
Temperature
CASE – Steel
LENS – Glass
ACCURACY – 1%
WEIGHT – 1/4 lb.

Pressure **Vacuum**









Temperature

Accessory	Part Number	Range
Gauge, Pressure	529427	0-60 IWG (2 PSIG)
Gauge, Pressure	271949	0-160 IWG (6 PSIG)
Gauge, Pressure	550407	0-280 IWG (10 PSIG)
Gauge, Vacuum	529428	0-60 IWG (4.5 IHG)
Gauge, Vacuum	271950	0-160 IWG (12 IHG)
Gauge, Vacuum	550408	0-280 IWG (20 IHG)
Gauge, Temperature	529380	0-200° Celsius (392°F)

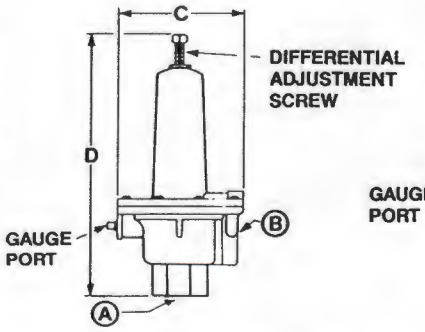
Relief Valve

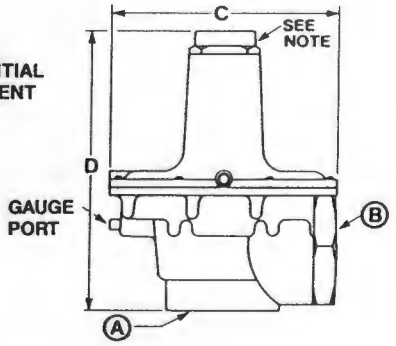
The Relief Valve is installed to prevent excessive system pressure or vacuum that could result from line restrictions. Relief valves should be installed at the blower outlet (downstream) in pressure systems and at blower inlet (upstream) in vacuum systems. These valves are suitable for air, natural gas, propane, and other non-corrosive service.

Note: Relief valves are not factory preset.

SPECIFICATIONS:

VALVE BODY – Aluminum (1"), Cast Iron (2")
VALVE SPRING – Steel
DIAPHRAGM – Nitrile





PRESSURE RELIEF: (B) is the system port and (A) is the vent or atmospheric port
VACUUM RELIEF: (A) is the system port and (B) is the vent or atmospheric port
NOTE: Replace cap after adjusting setting. Valve will not operate with cap removed. Differential adjustment screw is under the cap. For vacuum mode, customer must remove snap ring and screen.

Accessory	Part Number	Range	Reference Blower Model	Connection		Dimensions (Inches)			
				Inlet	Outlet	A	B	C	D
1" Relief Valve	515092	1.0-4.5 PSIG	B,C,D,E	1" NPT-F	1" NPSC-F	1.00	1.00	4.12	8.70
	529612	4.0-15.0 PSIG							
	529857	10.0-20.0 PSIG							
2" Relief Valve	529858	7.0-18.0 IWG	F,G	2" NPT-F	2" NPSC-F	2.00	2.00	7.12	9.00
	515093	1.75-7.0 PSIG							
	529859	4.0-10.0 PSIG							
2 1/2" Relief Valve	550246	4 PSIG	H	2.5" NPT	2.5" NPT-F	2.50	2.50	6.19	7.65
	550247	8 IHG							

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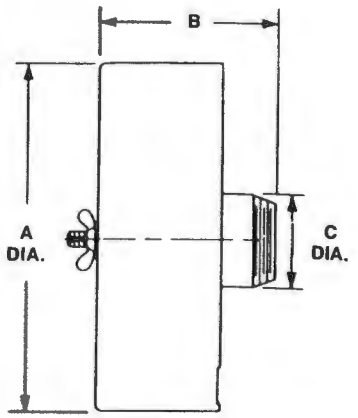
Filtration Accessories

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

Inlet Filter (Single Connection)

Inlet Filters protect the blower and the air distribution system from dust, and other airborne particles and contaminants. Normally used in pressure systems.



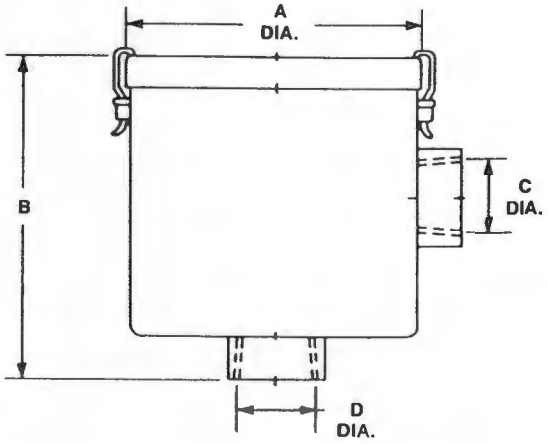
SPECIFICATIONS:

HOUSING – Steel
MEDIA – Polyester
EFFICIENCY – 97-98% (8 to 10 micron particle size)
FILTER ELEMENT – Replaceable (see filter elements)
NOTE: "Z" MEDIA (1 to 3 micron particle size) available

Part Number	Z Media Filter	Reference Blower Model	Connection Inlet	Dimensions (Inches) A	B	C	Filter Element
477411		A	2.00 SO	4.56	7.00	2.00	271078
516466	517865	B	1.00 NPT	6.00	6.50	1.00	515132
515122	517866	C,D	1.50 NPT	6.00	6.50	1.50	515132
515123	517867	E	2.00 NPT	7.75	7.25	2.00	515133
515124	517868	E	2.00 NPT	10.00	12.25	2.00	515134
515125	517869	F	2.50 NPT	10.00	12.50	2.50	515134
515145	517870	G	3.00 NPT	10.00	13.00	3.00	515134
515151	517871	H	4.00 NPT	10.00	14.00	4.00	515135
516511	517872	H	6.00 NPT	16.00	15.00	6.00	516515

Inline Filter (Dual Connection)

Inline Filters protect the blower from harmful dust and other particles that may be drawn into the blower through the air distribution system. Normally used in vacuum systems.



SPECIFICATIONS:

HOUSING – Steel
MEDIA – Polyester
EFFICIENCY – 97-98% (8 to 10 micron particle size)
FILTER ELEMENT – Replaceable (see filter elements)
NOTE: "Z" MEDIA (1 to 3 micron particle size) available

Part Number	Z Media Filter	Reference Blower Model	Connection Inlet	Connection Outlet	Dimensions (Inches) A	B	C	D	Filter Element
271200		A	1.75 SO	2.00 SO	5.25	8.31	2.00	1.75	271078
516461	517886	B	1.00 NPSC	1.00 NPSC	7.25	6.50	1.00	1.00	516434
515254	517887	C,D	1.50 NPSC	1.50 NPSC	7.00	6.50	1.50	1.50	516434
515255	517888	E	2.00 NPSC	2.00 NPSC	8.00	10.25	2.00	2.00	516435
515256	517889	F	2.50 NPSC	2.50 NPSC	8.00	10.25	2.50	2.50	516435
516463	517890	G	3.00 NPSC	3.00 NPSC	14.00	26.50	3.00	3.00	515135
516465	517891	H	4.00 NPSC	4.00 NPSC	14.00	27.00	4.00	4.00	515135
517611	517892	H	6.00 NPSC	6.00 NPSC	18.00	28.00	6.00	6.00	516515

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

Filtration Accessories

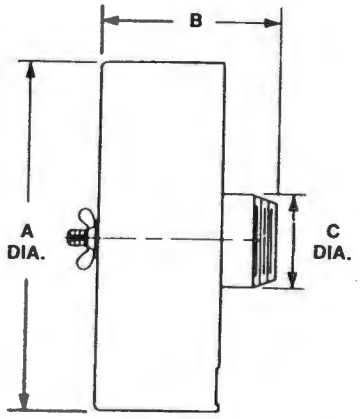
Filter Silencers (Single Connection)

* For Supplemental silencing only. (Used to augment existing muffling systems.)

Filter/Silencers reduce noise levels while ensuring clean air is provided to the blower and the air distribution system. Normally used in pressure applications.

SPECIFICATIONS:

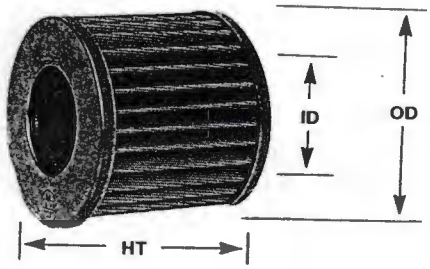
HOUSING – Steel
MEDIA – Polyester
EFFICIENCY – 97-98% (8 to 10 micron particle size)
FILTER ELEMENT – Replaceable (see filter elements)



Part Number	Z Media Filter	Reference Blower Model	Connection Inlet	Dimensions (Inches) A	B	C	Filter Element
516487	517878	B	1.00 NPT	6.00	6.50	1.00	515132
516489	517879	C,D	1.50 NPT	6.00	6.50	1.50	515132
516491	517880	E	2.00 NPT	10.00	7.25	2.00	515133
516493	517881	E	2.00 NPT	10.00	12.25	2.00	515134
516495	517882	F	2.50 NPT	10.00	12.50	2.50	515134
516497	517883	G	3.00 NPT	10.00	12.50	3.00	515134
516499	517884	H	4.00 NPT	16.00	14.00	4.00	515135
516513	517885	H	6.00 NPT	16.00	15.00	6.00	516515

Filter Element

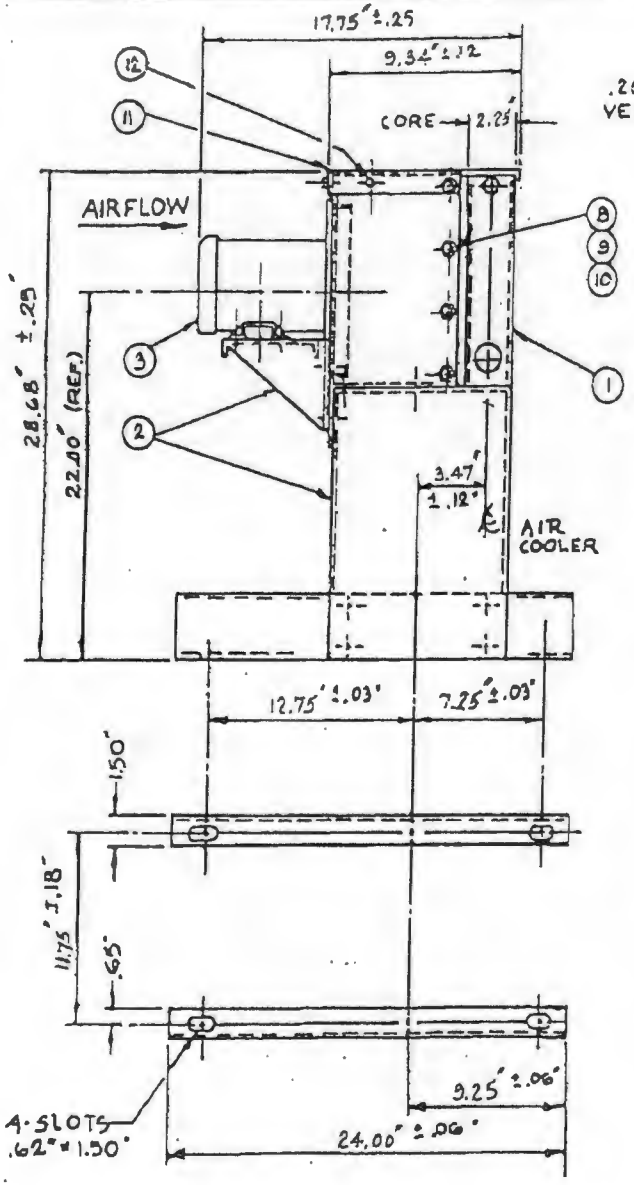
All Rotron Air Filters and Filter/Silencers have replaceable filter elements. The filter media is polyester designed for high efficiency over a wide spectrum of industrial applications. See filter element cross reference table.

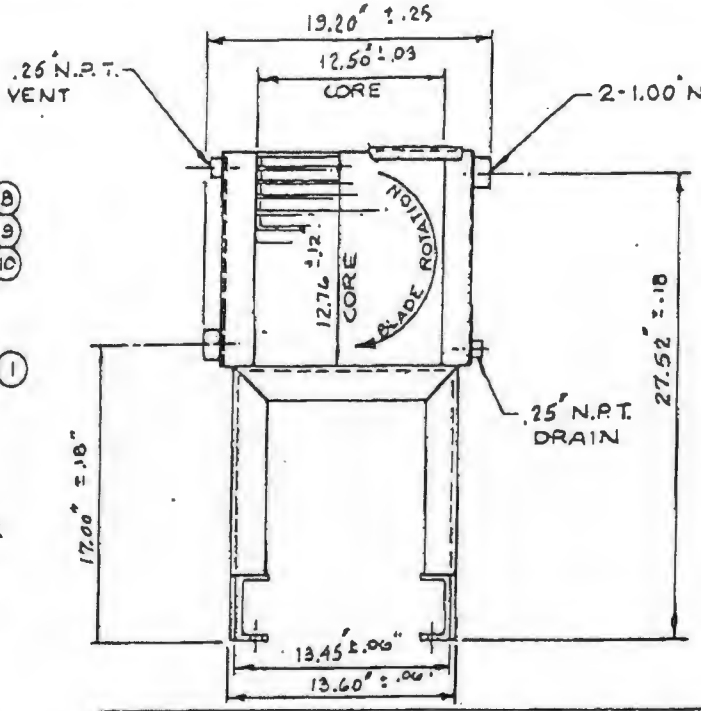


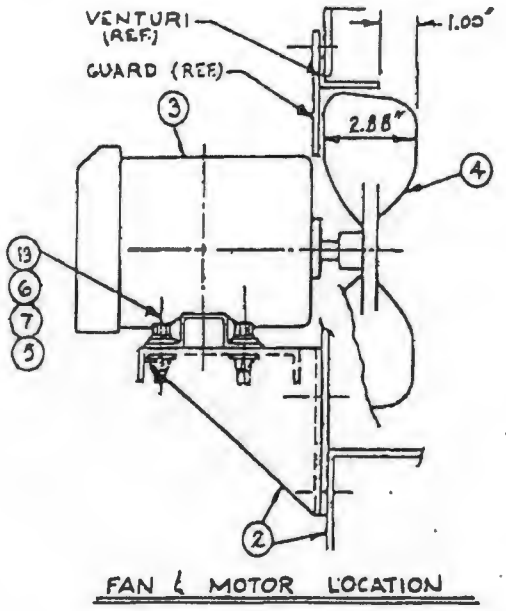
FOR DR BLOWER MODELS

Standard Replacement Filter Element Cross Reference Table					
271200	271078	515158	515134	516489	515132
477411	271078	515254	516434	516491	515133
515122	515132	515255	516435	516493	515134
515123	515133	515256	516435	516495	515134
515124	515134	516461	516434	516497	515134
515125	515134	516463	515135	516499	515135
515145	515134	516465	515135	516511	516515
515151	515135	516466	515132	516513	516515
515157	515133	516487	515133	517611	516515

Part Number	Z Media Filter	ID (Inches)	OD (Inches)	HT (Inches)	Area (Sq/Ft)
515132	517873	3.00	4.38	4.75	1.5
515133	517874	3.63	5.88	4.75	2.3
515134	517875	4.63	5.88	9.50	4.5
515135	517876	4.75	7.88	9.63	8.3
516434	517893	2.56	5.00	4.75	2.0
516435	517894	3.50	5.88	8.75	4.5
516515	517877	8.00	11.75	9.63	19.0







FAN & MOTOR LOCATION

ITEM NO.	PCS. PER UNIT	SC	PART NAME	DWG SIZE	DWG. PART NO.	OUT SIZE	REMARKS
13	4	FS	CAPSCREW HEX. HD. .31"-18NC x 1 LG.	A	150-0310		
12	6	FS	METAL SCREW #10 WASHER - HEX HD.	A	150-2030		
11	1	FS	COVER	A	120-2203		
10	8	FS	WASHER .25" STD.	A	152-0004		
9	8	FS	LOCK WASHER .25" HELICAL SPRING	A	152-0024		
8	8	FS	CAPSCREW HEX. HD. .25"-20NC x 1" LG.	A	150-0410		
7	8	FS	WASHER .31" STD.	A	152-0005		
6	8	FS	LOCK WASHER .31" HELICAL SPRING	A	152-0025		
5	4	FS	HEX NUT .31"-18NC	A	151-0009		
4	1	FS	FAN BLADE	A	199-9033		
3	1	FS	MOTOR, 1/6 HP, 1800 R.P.M., TEFC	A	199-9001		ELECTRIC
2	1	M	HOUSING ASS'Y.	C	012 012 003 HF		
1	1	M	AIR COOLER ASS'Y.	B	760-0301		

NO.	REVISION	BY	DATE
2	7.25" SUPPORT DIA WAS 12.75"	REB	9-9-92
1	WAS 760-0301	REB	4-7-92

AFTERCOOLER

MODEL # 3

HIGH PRESS.

BY: REB DATE: 3-6-92

AIR TECHNOLOGIES Division — AMERICAN PRECISION INDUSTRIES INC.

SIZE	DRAWING NUMBER	REV.
B	761-0301	2

INTERNAL DESIGN PRESSURE:
250 PSIG AT 400 °F

American Precision Industries, Air Technologies Division
274 Sandusky Road / Arcade, NY 14009 / (716) 496-5755 / Fax: (716) 496-5776

CUSTOMER J.E. Gasho & Associates
ADDRESS
PLANT LOCATION
SERVICE OF UNIT AfterCooler
CUSTOMER PART NO.

JOB NO.
REFERENCE NO.
PROPOSAL NO. PH9911235
DATE 1/24/00

MODEL 761-03011H

PERFORMANCE

		INSIDE AIR	OUTSIDE AIR
FLUID CIRCULATED		35 S CFM	540 CFM
FLOW RATE			
TOTAL FLUID ENTERING	Lbs/Hr	157.5	2748.9
NON-CONDENSIBLES	Lbs/Hr	157.5	2748.9
VAPOR	Lbs/Hr	0	0
LIQUID	Lbs/Hr	0	0
FLUID CONDENSED	Lbs/Hr	0	0
VISCOSITY @TEMP		.019 CPS @ 112 oF	.019 CPS @ 93 oF
SPECIFIC HEAT	BTU/Lbm-F	.241	.241
THERMAL CONDUCTIVITY	BTU/Hr-Ft-F	.016	.015
SPECIFIC GRAVITY or MOL. WEIGHT		28.966 (MW)	28.966 (MW)
TEMPERATURE IN	oF	200.0	90.0
TEMPERATURE OUT	oF	100.0	96.3
PRESSURE IN	psig	2	0
FACE VELOCITY	Ft/Min	230.62	610.34
PRESSURE DROP	(CALC)	.5 psi	.28 In-H2O
FOULING RESISTANCE		.0005	.0005
SURFACE AREA	sq-Ft	16.71	41.84
HEAT EXCHANGED-TOTAL 4154.6	BTU/Hr	TRANSFER RATE 15.13	BTU/Hr-Ft2-F
-SENSIBLE 4154.6	BTU/Hr	MTD CORRECTED 16.42	oF
-LATENT 0	BTU/Hr	EXCHANGER EFFECTIVENESS 99.66	%
N.T.U. 6.675		Cmin/Cmax .057	

CONSTRUCTION

FIN TYPE		OSF	TRI
FIN HEIGHT xFINS/Inch		.125 x 12	.375 x 12
NUMBER OF FLOW PASSAGES		22	23
FIN MATERIAL		ALUMINUM	ALUMINUM
FIN THICKNESS		.01 In	.006 In
PARTING SHEET THICKNESS		.024 In	N / A In
DESIGN PRESSURE		400 PSIG	20 PSIG
DESIGN TEMPERATURE		250 oF	250 oF
TEST PRESSURE		535 PSIG	N / A

CORE DIMENSIONS: NO-FLOW HEIGHT- 12.563 WIDTH- 12.5 DEPTH- 2.25
HEADER CONNECTIONS: INLET- 1" NPT OUTLET- 1" NPT

MECHANICAL EQUIPMENT

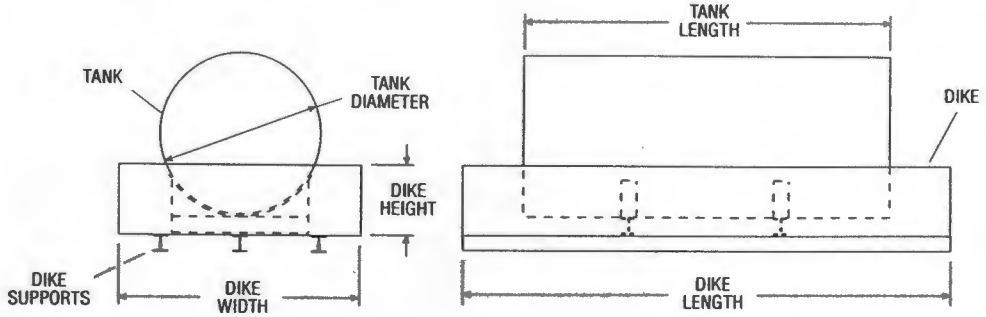
FAN MFR AIR TURBINE PROPELLER	MOTOR MFR. GENERAL ELECTRIC
NO. FANS 1 HP/FAN	NO. MOTORS 1 HP/MOTOR 1/6
FAN DIA. 10 NO. BLADES 4	RPM 1725
BLADE MATL. STEEL BLADE PITCH	VOLTS/CYCLES/PHASES 110 /60/1
RPM 1725 DRIVE DIRECT	ENCLOSURE X-PROOF

NOTES

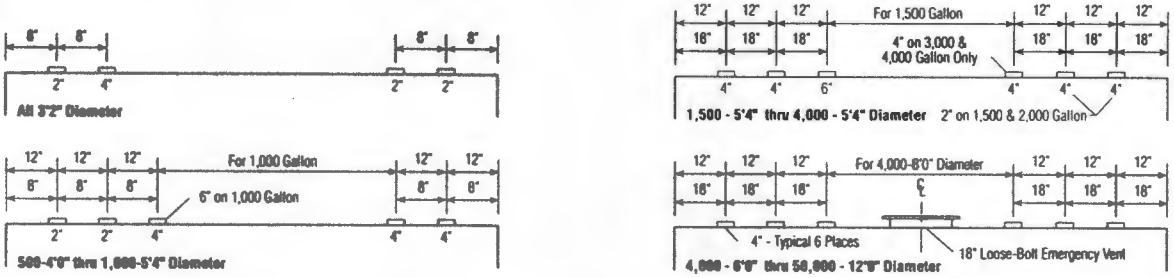
EXTERNAL FLUID MEASURED CONDITIONS: 90.0 F, 0% RH, 14.457 psia

Reliable, Durable, Easy to Install...

Dike Tank General Arrangement



Standard Fitting Locations



Horizontal Dike Tank

Highland's Dike Tank is one of the most versatile solutions for your aboveground containment needs! Available in single or multi-tank modules, Highland Dike Tanks are easy to install. Relocation, if necessary, is fast and easy! Both tank and dike are product compatible and possess the strength and impermeability of steel. They are ideal for the secure storage of petroleum, chemicals, hazardous wastes and fertilizers. The entire Dike Tank unit carries an Underwriters Laboratories142 label of approval and meets NFPA 30 codes. In addition to our standard sizes, vertical dike tanks, custom designs, special coatings and stainless steel fabrication are available. A wide variety of options and accessories is also available.

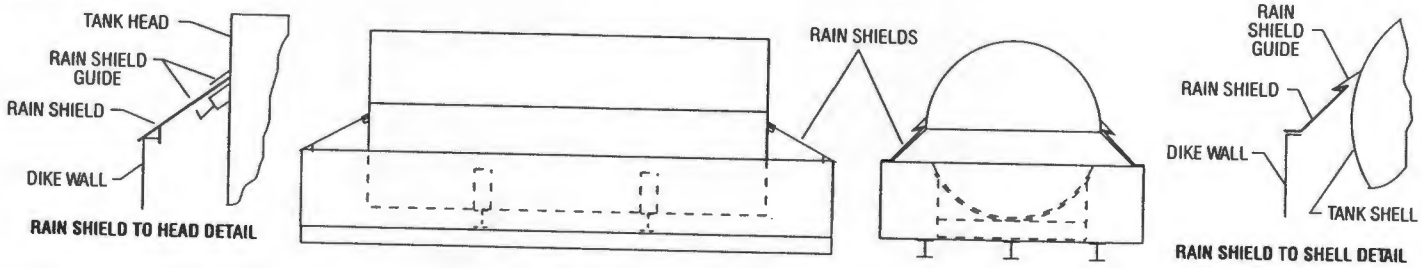
Description

Highland Dike Tanks consist of UL-142 Aboveground steel tanks, mounted on saddles and safely secured in the center of a steel containment dike, engineered to safely contain 110% or 150% of their largest tank's capacity. Our standard dike is fitted with two, 3" fittings for water control. All Dike Tanks are elevated on supports to allow visual inspection of the exterior bottom surfaces of the dike. Tank-to-dike hold down systems vary with capacity. Contact manufacturer for detail drawings and specifications for 150% capacity dikes. Standard design Dike Tanks are fabricated with threaded fittings in the configurations shown.

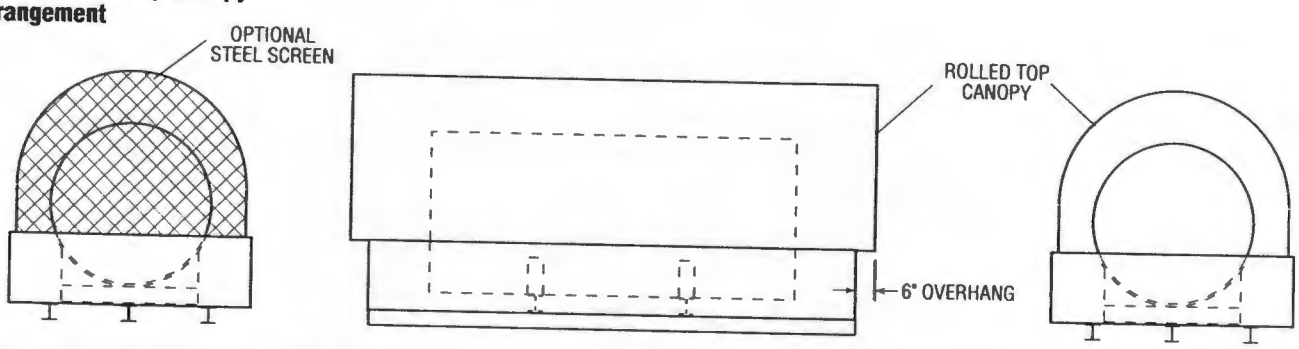
Nominal Tank Capacity (Gallons)	Tank Dimensions Diameter	Length	Nominal Dike Capacity (Gallons)	Dike Dimensions L x W x H	Approximate Wt. Dike Only (lbs.)	Approximate Wt. Tank & Dike (lbs.)
240	3'2"	4'0"	264	4'0" x 5'9" x 1'8"	570	740
300	3'2"	5'0"	330	7'0" x 4'0" x 1'8"	591	944
500	4'0"	5'5"	550	7'5" x 6'0" x 1'8"	926	1,746
1,000	4'0"	10'9"	1,100	12'9" x 6'0" x 2'0"	1,516	3,227
1,000	5'4"	6'0"	1,100	9'2" x 8'0" x 2'0"	1,653	2,782
1,500	5'4"	9'0"	1,650	13'10" x 8'0" x 2'0"	2,360	4,047
2,000	5'4"	12'0"	2,200	16'0" x 8'0" x 2'4"	3,333	5,718
2,500	5'4"	15'0"	2,750	17'6" x 8'0" x 2'10"	3,600	5,718
3,000	5'4"	18'0"	3,300	22'0" x 8'0" x 2'8"	4,951	4,951
4,000	5'4"	24'0"	4,400	28'0" x 8'0" x 2'8"	6,085	6,085
5,000	8'0"	13'4"	5,500	17'0" x 10'10" x 4'0"	6,330	8,725
6,000	8'0"	16'0"	6,600	20'6" x 10'10" x 4'0"	7,343	10,817
8,000	8'0"	21'4"	8,800	27'6" x 10'10" x 4'0"	10,487	12,552
10,000	8'0"	26'8"	11,000	35'0" x 10'10" x 4'0"	12,906	16,476
12,000	8'0"	32'0"	13,200	36'8" x 12'0" x 4'0"	14,728	20,044
15,000	10'0"	25'6"	16,500	31'0" x 12'0" x 6'0"	16,779	24,671
20,000	10'0"	34'0"	22,000	41'0" x 12'0" x 6'0"	21,532	27,533
25,000	10'0"	42'6"	27,500	51'0" x 12'0" x 6'0"	18,088	32,385
30,000	10'6"	46'6"	33,000	61'4" x 12'0" x 6'0"	21,345	39,995

Construction Details and Specifications

Dike Tank with Rain Shields
General Arrangement



Dike Tank With Rolled-Top Canopy
General Arrangement



Recommended Guide Specification
Short Form

Furnish and install an aboveground, single-wall, steel storage tank with an aboveground steel dike with a capacity equal to 110% (or 150%) of the contents of the single wall tank. The tank shall be in conformance with the Underwriters Laboratories' UL-142 specifications and so labeled. Tank and dike size will be noted on an attached reference drawing.

Long Form

Furnish and install a _____ gallon aboveground, single-wall, steel storage tank _____ inches in diameter by _____ long with an aboveground steel dike, _____ long, by _____ wide, by _____ high, having a capacity of _____ gallons (110% or 150% of the contents of the single wall tank). All items included in Dike Tank unit shall be coated with red oxide primer or receive a commercial grit blast (SSPC-6), epoxy primer coat and a polyurethane finish coating. The Dike Tank unit shall be manufactured in conformance with Underwriters Laboratories' UL-142 specifications and so labelled.

Dike Tank shall be fabricated with the following threaded connections :
_____ 2 inch, _____ 4 inch, _____ 6 inch as located on attached drawing.
AND/OR _____ 150# flanged connections with flange protectors. Flange sizes as follows (qty-size):
_____, _____, _____, with locations also indicated on drawing. See standard fitting location drawing for quantities and locations. Thread protectors shall be inserted in all threaded openings prior to shipment.

Tank is to be furnished with saddles or support legs per manufacturer's standard. Dike is to be furnished with supports per manufacturer's standard. Highland Dike Tanks are air tested at the factory but MUST be retested at the jobsite by the installer prior to installation.

Options & Accessories

____ Manway _____ inches in diameter with bolted and gasketed lid
____ Loosebolt manway _____ inches in diameter with bolted and gasketed lid
____ Emergency Vent
____ External Ladder
____ External Ladder Platform
____ External Stairway
____ Pump Platform
____ Walkway(s) with handrails
____ Pre-Engineered Rainshields
____ Pre-Engineered Rolled-Top Canopy
____ Exterior enamel paint; ___ tank, ___dike
____ Other external coating _____
____ Internal Ladder(s)
____ Internal Coating _____
____ Level Sensing System(s)
____ Overfill Containment Chamber

Dike Tank to be manufactured by Highland Tank; Stoystown, PA; Manheim, PA; Watervliet, NY or Greensboro, NC.

One Highland Road
Stoystown, PA 15563
814-893-5701
FAX 814-893-6126

99 West Elizabethtown Road
Manheim, PA 17545
717-664-0600
FAX 717-664-0617

958 19th Street
Watervliet, NY 12189
518-273-0801
FAX 518-273-1365

2700 Patterson Street
Greensboro, NC 27407
910-218-0801
FAX 910-218-1292

C E E

SOS & SPG

Active Selective Oil and Specific Gravity Skimmers

I N T R O D U C T I O N

There are two main types of skimmer technologies available from CEE: Selective Oil Skimmers (SOS) and Specific Gravity Skimmers (SPG). To help determine which skimmer is the better fit given the unique attributes associated with each site and the hydrocarbons present, following are some general guidelines and rules to follow.

SELECTIVE OIL SKIMMER (SOS)

The Selective Oil Skimmer (SOS) should be used under the following conditions:

- The product has a low viscosity, such as gasoline, diesel, and jet fuels (< 200 centistokes).
- If product needs to be removed to a sheen (≤ 0.01 inches).

SPECIFIC GRAVITY SKIMMER (SPG)

The Specific Gravity Skimmer (SPG) is extremely durable and removes high volumes of free-floating product when a 1-inch lense or greater is present. This skimmer should be used under any combination of the following conditions:

- The product is viscous (200-1000 centistokes).
- Hydrocarbon has a specific gravity of 0.85 or less.
- Large quantities of product exist or well recharge rates are high.
- Water drawdown is desired in a two-inch well.

Skimmer Selection Chart

CRITERIA	SOS	SPG
Viscosity (Centistokes)	1-200	201-1000
Specific Gravity (SpG)	< 1.0	≤ 0.85
Product Quantity / Lense Thickness	Small to Large	Large
Final Product Lense Thickness	≤ 0.01 inches	1 inch
Maximum Flow Rate	1000 GPD 3785 LPD	2160 GPD 8176 LPD
Dual Pump in 2-inch Well Capability	No	Yes
Dual Pump in 4-inch Well Capability	Yes	Yes

C E E

SPG

Specific Gravity Skimmers

S P E C I F I C A T I O N S

The family of Specific Gravity Skimmers (SPG) when coupled with shallow or deep-well product pumps, are designed to recover high volumes of free-floating hydrocarbon (≤ 0.85 Specific Gravity) from depths up to 250 feet (76m) while maintaining a thin product lense. The floating intake head follows water table fluctuations and with optional features such as High-Water Shut-Off (HWSO) will automatically turn off to prevent potential water contamination. Alternate size SPG Skimmers are available for operating in 2-inch (5cm), 4-inch(10cm), and 6-inch (15 cm) diameter wells. Tidal skimmers with extra long strokes are also available for sites with high and low tide considerations.

The SPG Skimmer is also designed to effectively draw water from below the skimmer in dual pump applications.

The SPG Skimmer consists of three main items: a Floating Intake Head, Guide Rod & Flexible Tube, and two Well-Centering Disks.

METHOD OF OPERATION

The skimmer is lowered into the well until the midpoint of the skimmer's travel is located at the fluid level in the well and then connected to a surface or down-well product pump.

The skimmer has a floating intake head that follows the fluctuating water table. Hydrocarbon first enters the skimmer through the floating intake head's product intake, down through a flexible, yellow tube, through the product pump, and into a product storage tank.

FLOATING INTAKE HEAD

All product which enters the floating intake head passes down through the flexible tube, up into the hollow guide tube, and is drawn out of the well by a product pump.

The Floating Intake Head:

- Consists of a monolithic cylindrical buoyant float made of a petroleum resistant engineering plastic having a fluid intake located on the top of the float.
- Floats slightly above the product-water interface in the well and automatically adjusts to any fluctuation of the groundwater within its travel range.
- Slides on a hollow, stainless steel guide tube which passes down through the center of the skimmer head.
- Is connected to the guide tube via a flexible (fuel rated) tube which hangs below the skimmer head and guide tube.

WELL-CENTERING DISKS

The Well-Centering Disks:

- Prevent the Skimmer Floating Intake Head from contacting the sides of the well casing.
- Reside on upper and lower ends of the skimmer.

FLOW RATES

Flow rates vary on skimmer size and pump used:

SKIMMER	DIAPHRAGM PUMP (DDP-1)	24-inch BLADDER PUMP	48-inch BLADDER PUMP
2-inch Specific Gravity Skimmer (SPG-2)	700 GPD (2650 LPD)	160 GPD (606 LPD)	320 GPD (1211 LPD)
4-inch Specific Gravity Skimmer (SPG-4)	2160 GPD (8160 LPD)	160 GPD (606 LPD)	320 GPD (1211 LPD)

DIMENSIONS

The 2-inch Specific Gravity Skimmer (SPG-2):

- Has a floating intake head at 1.75-inch (4.4 cm) in diameter and 8-inch (20 cm) in height.
- Is 36-inch (91 cm) long including a 30-inch (76 cm) guide tube and 1.8-inch (4.6 cm) diameter center guide disks.

The 4-inch Specific Gravity Skimmer (SPG-4):

- Has a floating intake head at 3.7-inch (9.4 cm) in diameter and 6-inch (15 cm) in height.
- Is 48-inch (122 cm) long including a 30-inch (76 cm) guide tube and 3.8-inch (9.6 cm) diameter center guide disks.

Skimmer Option

SPG Skimmers can have groundwater withdrawn directly through them. This is accomplished by a water extension pipe going down through the float. The standard SPG-2 is built with the water tubes in place. CEE can provide either pneumatic or electric water depression pumps, depending upon the water drawdown rate.

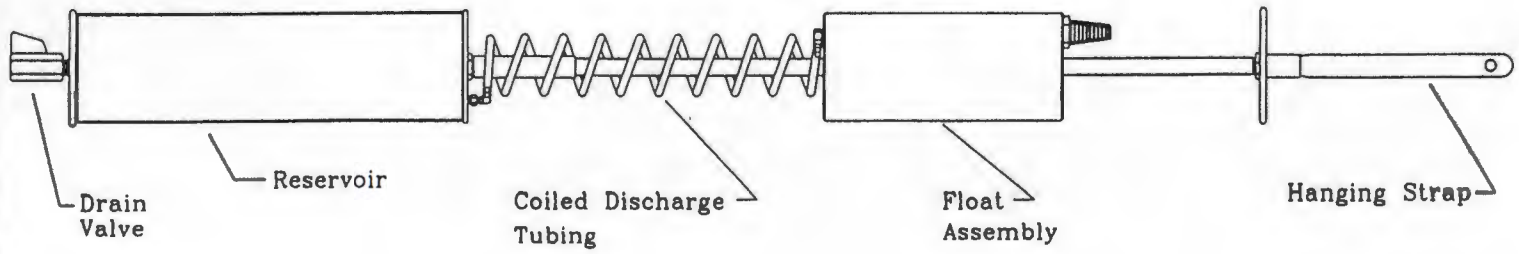
MATERIALS OF CONSTRUCTION

- Stainless Steel
- Viton
- Brass
- Polypropylene
- Delrin & other Engineering Plastics
- Teflon

COMPONENT AND SHIPPING WEIGHTS

ITEM	COMPONENT (lb./kg.)	SHIPPING (lb./kg.)
SPG-2	4.0 / 1.8	7 / 3.2
SPG-4	5.0 / 2.3	8 / 3.6

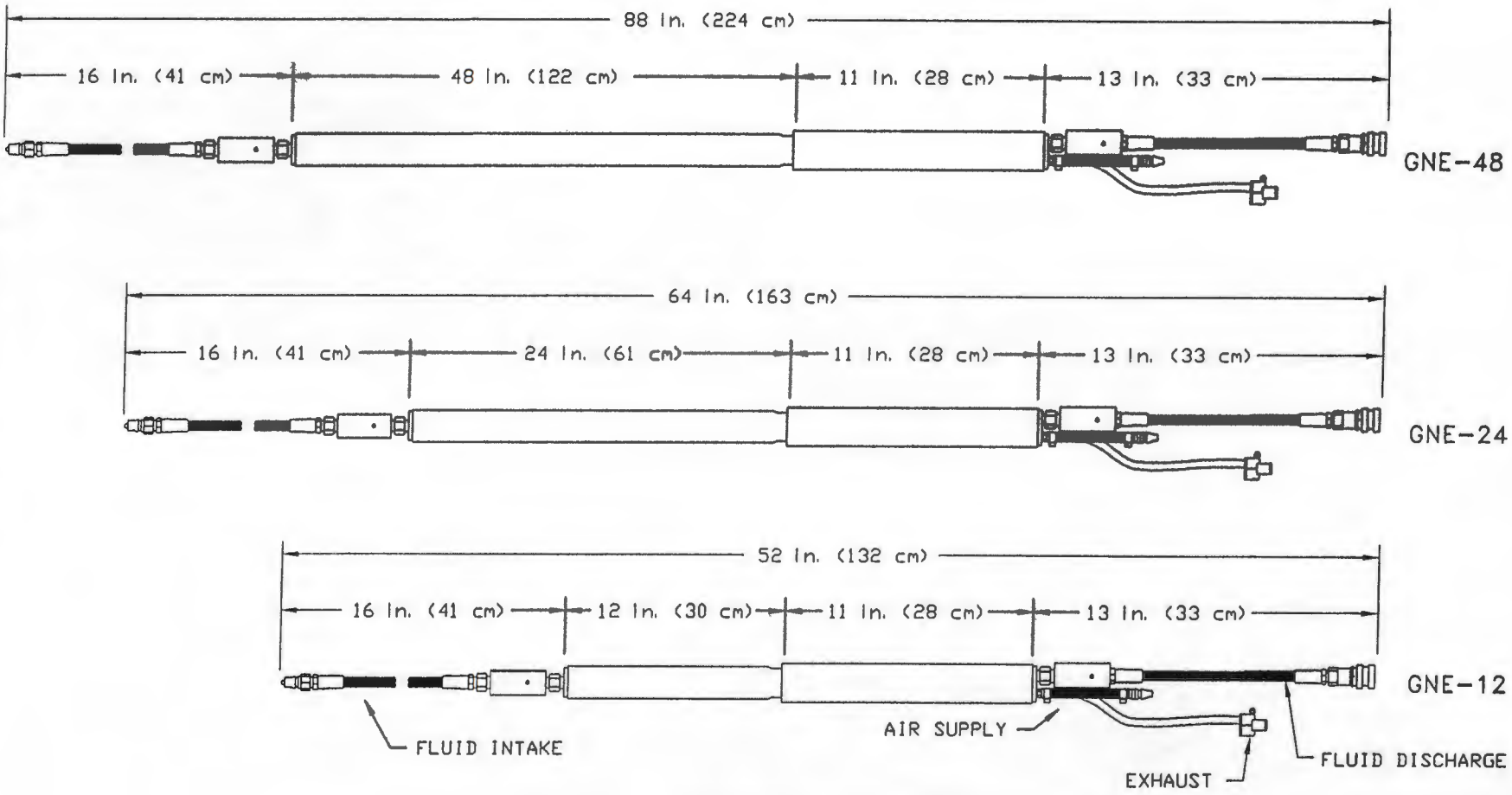
600291 04



SPECIFICATIONS	SPG-4P/1400	SPG-4P/2000	SPG-4P/3000	SPG-4P/6000 *
Minimum Fluid Depth Required	29.5" (75 cm)	32.5" (83 cm)	41.5" (105 cm)	58.5" (149 cm)
Effective Skimming Travel	15.5" (39 cm)	15.5" (39 cm)	15.5" (39 cm)	15.5" (39 cm)
Reservoir Capacity	1400 cc (47 fl oz)	2000 cc (65 fl oz)	3000 cc (100 fl oz)	6000 cc (200 fl oz)
Reservoir Length	15" (38 cm)	18" (46 cm)	27" (69 cm)	44" (112 cm)
Total Length	56" (142 cm)	69" (175 cm)	78" (198 cm)	95" (242 cm)
Outside Diameter	3.8" (10 cm)	3.8" (10 cm)	3.8" (10 cm)	3.8" (10 cm)
Weight	8 lb. (3.6 kg)	9 lb. (4 kg)	12 lb. (5.5 kg)	25 lb. (11.4 kg)

* S.S. Reservoir Only

Figure 7 - Four-Inch Passive Specific Gravity Skimmer (SPG-4P) Specifications

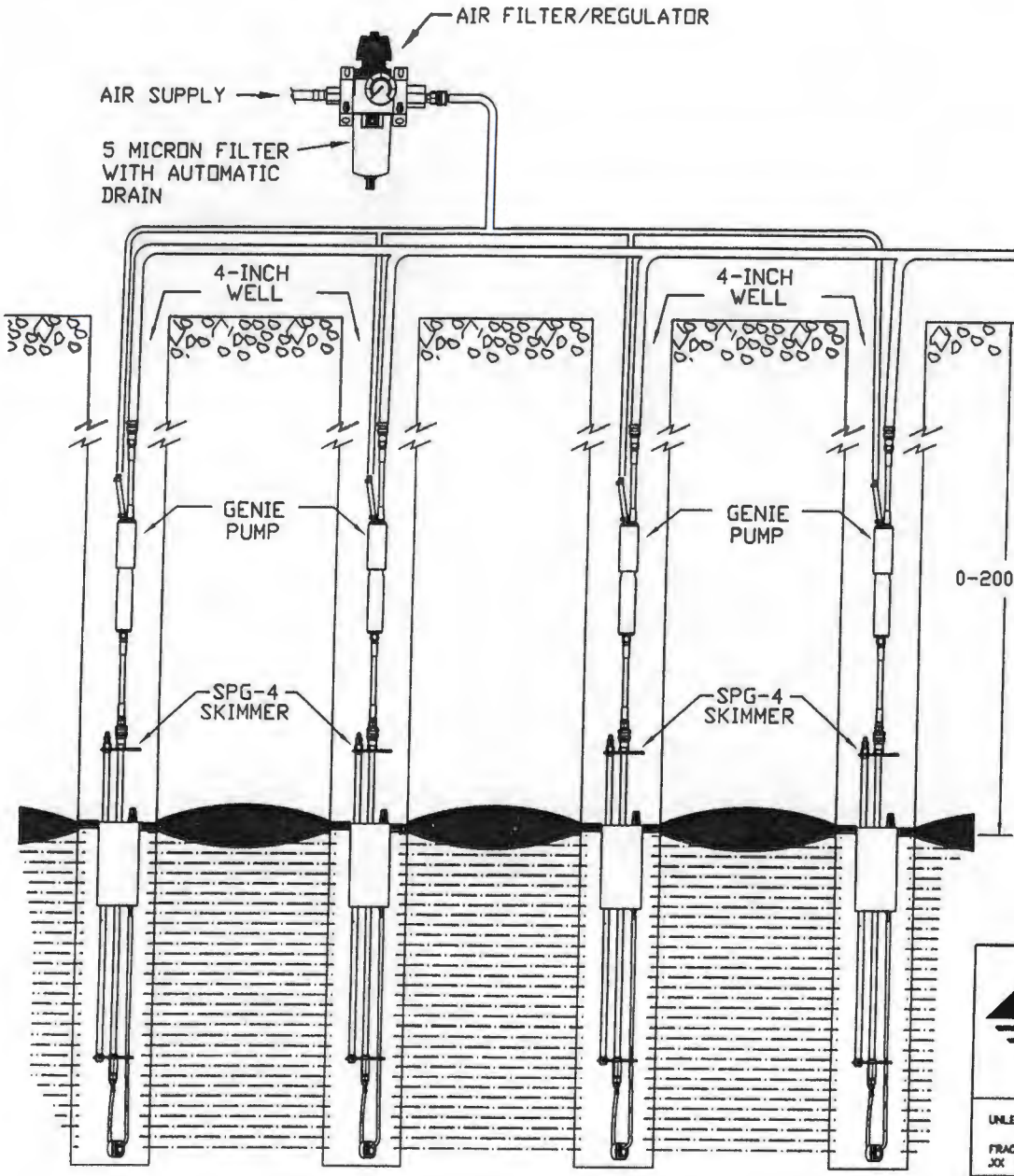


GNE
GENIE® CONTROLLERLESS PUMP

Clean Environment Equipment
EQUIPMENT FOR GROUNDWATER REMEDIATION
AND LEACHATE EXTRACTION
1133 7th ST.
OAKLAND, CA 94607
(510) 891-0880 (800) 537-1767 FAX (510) 444-6789

TOLERANCES UNLESS OTHERVISE SPECIFIED	APPROVALS	DATE	TITLE
ANGULAR : .30'	DRAWN RILEY ENGLISH	6-17-94	GENIE
FRAC : .XXX : .005 .XX : .01 .XXXX : .0005	DESIGNER MIKE K, BRESLIN	11-8-95	DWG NO. 60001502 REV 10-17-95
MATERIAL	CHECKED MIKE K, BRESLIN	11-8-95	SCALE NONE SHT 1 OF 1
FINISH	APPROVED MIKE K, BRESLIN	11-8-95	

MULTI-WELL GNE/200/SPG-4
CONTROLLERLESS PRODUCT ONLY RECOVERY SYSTEM



FEATURES & BENEFITS

- ONLY ONE (1) 5 MICRON FILTER/REGULATOR IS REQUIRED FOR THE MULTI-WELL SYSTEM.
- ANY OF THE CEE FAMILY OF SKIMMERS CAN BE UTILIZED WITH THIS SYSTEM.
- A TANK FULL SHUT-OFF MODULE CAN BE EASILY ADDED AT A LATER DATE.
- THE SYSTEM WILL NOT DEPRESSURIZE THE AIR SUPPLY HOSE AT THE END OF EACH CYCLE.
- THE SYSTEM WILL ACHIEVE MAXIMUM FLOW RATE WITH MINIMUM AIR CONSUMPTION.

Clean Environment Equipment
EQUIPMENT FOR GROUNDWATER REMEDIATION AND LEACHATE EXTRACTION
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OAKLAND, CA 94607
(510) 891-0880 (800) 537-1767 FAX (510) 444-6789

TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR : .30° FRAC : .XX : .01 .XXX : .005 .XXXX : .0005	APPROVALS	DATE	TITLE: MULTI-WELL GNE/200/SPG-4
	DRAWN: RILEY ENGLISH	6-17-94	
	DESIGNER		MODEL No.: 600025 REV:
MATERIAL	CHECKED		
FINISH	APPROVED		SCALE: NONE SHT 1 OF 1

C E E

Hoses and Fittings

S P E C I F I C A T I O N S

CEE Hoses and Fittings are designed to handle performance levels well above system maximum operating limits. All Product Only Recovery Systems come with specialized hose sets for air and product. The air supply and level control hoses equal or surpass the specifications noted below. And all hoses are color coded and equipped with non-interchangeable, brass quick-connect fittings.

HOSE	WORKING PRESSURE	BURST PRESSURE	FITTINGS	SIZE	MATERIALS OF CONSTRUCTION
AIR HOSE					
• *Main Air*	200 psi	800 psi	Brass quick-connects with one-way shut-off on the pressurized end.	3/8" to 3/4"	Seamless, oil & heat resistant synthetic rubber tube that is reinforced with a high strength synthetic cord & rubber.
• *Pump Air*	200 psi	800 psi	Brass quick-connects with one-way shut-off on the pressurized end.	1/4" to 1/2"	Seamless, oil & heat resistant synthetic rubber tube that is reinforced with a high strength synthetic cord and a synthetic rubber.
• *Sensor Air*	60-250 psi	100-1000 psi	Brass quick-connects.	1/8" to 3/8"	Various hoses including PVC and synthetic rubber.
FUEL HOSE					
	3500-4500 psi	6500-18,000 psi	Brass quick-connect hydraulic-design with double shut-off to prevent accidental discharge under pressure.	1/4" to 3/8"	Steel-reinforced Nylon core with a Urethane cover. Steel reinforcing is electrically grounded to the end fitting to reduce static electricity build-up. See Illustration.

OPTIONS

- Stainless steel fittings
- Plastic tubing vs. industrial grade hose
- Barbs vs. locking sleeve quick-connects
- Nylon tubing

Shipping and Component Weights

All shipping and component weights vary on hose length and type of fittings.

C E E

SECTION 7

Tank-Full Shut-Off System (TFSO)

S P E C I F I C A T I O N S

The CEE Tank-Full Shut-Off System is a self-contained safety system which can be used to turn off other pneumatic systems in the event of a liquid level rise or a pressure increase in a container (e.g., product recovery tank, oil/water separator, and/or surge tank). This system, which incorporates a dual-sensor safety mechanism, can be "T-ed" to monitor many tanks or containers without the need of adding more TFSO systems. This system consists of a TFSO Tank Unit with a fume/product overflow return, an air-operated control panel, a filter/pressure regulator, and a hose package.

METHOD OF OPERATION

The TFSO System is mounted first in a given series of pneumatic systems and passes compressed air to other "downstream" pneumatic systems as long as a "trip condition" does not exist. A TFSO Tank Unit is attached to each tank where shut-off protection is desired. The TFSO System monitors all TFSO-equipped tanks and if any one of the following conditions exists, the system closes the valve supplying compressed air and exhausts the air, shutting down all "downstream" systems:

- *Liquid Level Rise in the Tank.* If the liquid rises 4 inches above the float guide tube or pushes the float up against the trip button, the system trips.
- *Hoses Are Not Properly Connected or a Hose Leak Exists.* If an improper hose connection is made or there is a cut in one of the sensor hoses, the system will trip.
- *Tube Sensor or Fitting Blockage.* If any of the hoses or fittings become clogged by debris or condensate build-up, causing back pressure of up to 3 to 4 inches of water pressure, the system will trip.
- *Tank Vent or Control Exhaust Blockage.* Dangerous pressure build-up in a container is sensed by the TFSO Tank Unit and causes the system to trip.
- *Tank-Full Reset Button Has Not Been Pushed.* The TFSO System requires the manual pushing of the reset button before continuing operation.
- *Oil/Moisture Enters Controls.* If oil or water from the compressor clogs the sensors, the controls will shut down.

TFSO TANK UNIT

The TFSO Tank Unit has two sensors (a bubbler sensor and a float sensor) and a fume/product overflow return.

The bubbler sensor:

- Is fed a small amount of air which bleeds into the atmosphere or bubbles into the fluid.
- Is the guide tube that the float sensor slides up and down.
- Trips when 3 to 4 inches of water pressure is sensed.

The float sensor:

- Utilizes a 2-piece, hydrocarbon resistant float.
- Is triggered as the float rises with the fluid level coming in contact with a button located on the TFSO Tank Unit. This contact releases the air pressure built up behind the button, tripping the system.

The fume/product overflow return:

- Directs fumes back into the well (or other tanks if desired) under normal conditions to avoid potential hazardous accumulations of explosive fumes.
- Allows fluid to return to the well (or atmosphere or other tanks if desired) should both the bubbler and float sensors fail.

CONTROL PANEL

The Control Panel consists of TFSO circuitry, a pump air valve, air filters, and a pressure regulator; all housed within a NEMA 12 wall-mountable, aluminum enclosure.

The Tank-Full Shut-Off (TFSO) Circuitry:

- Has an overriding safety circuit that stops air flow to downstream pumps (Product, Total Fluids, and/or Water Pumps, etc.) when activated by the TFSO Tank Units.
- Includes a control panel-mounted Status Indicator and Reset Button that allows the operator to assess the condition and to re-start the system.

The air filter/pressure regulator unit:

- Is typically mounted on the Control Panel.
- Consists of a two-stage, 5 micron (first stage) and 0.01 micron (second stage), particulate filter contained in a metal bowl.
- Includes a float-operated condensate drain.
- Includes a pressure regulator that is adjustable from 0-125 psi and is rated for 250 psi.
- Allows for the adjustment of supply air pressure to the value necessary to operate the system.
- Is typically provided with locking-sleeve, hydraulic grade brass quick-connect fittings.

HOSE AND HARDWARE PACKAGE

The hoses supplied with the system are of industrial grade.

- The main air supply hoses equal or surpass Parker 801 specifications.
- The TFSO Sensor Hose consists of a low pressure single-wall PVC tubing.
- All hoses are color coded and equipped with non-interchangeable, brass quick-connect fittings.

SYSTEM REQUIREMENTS/PARAMETERS

The TFSO System:

- Has varying air usage, however, less than 0.7 scfm @ 80 psi is considered appropriate for most applications.
- Requires a 2-inch Female NPT fitting on tank for the TFSO Float (2-inch Male NPT).

SYSTEM OPTION

- Single Sensor TFSO Tank Unit.

MATERIALS OF CONSTRUCTION

The TFSO Tank Unit:

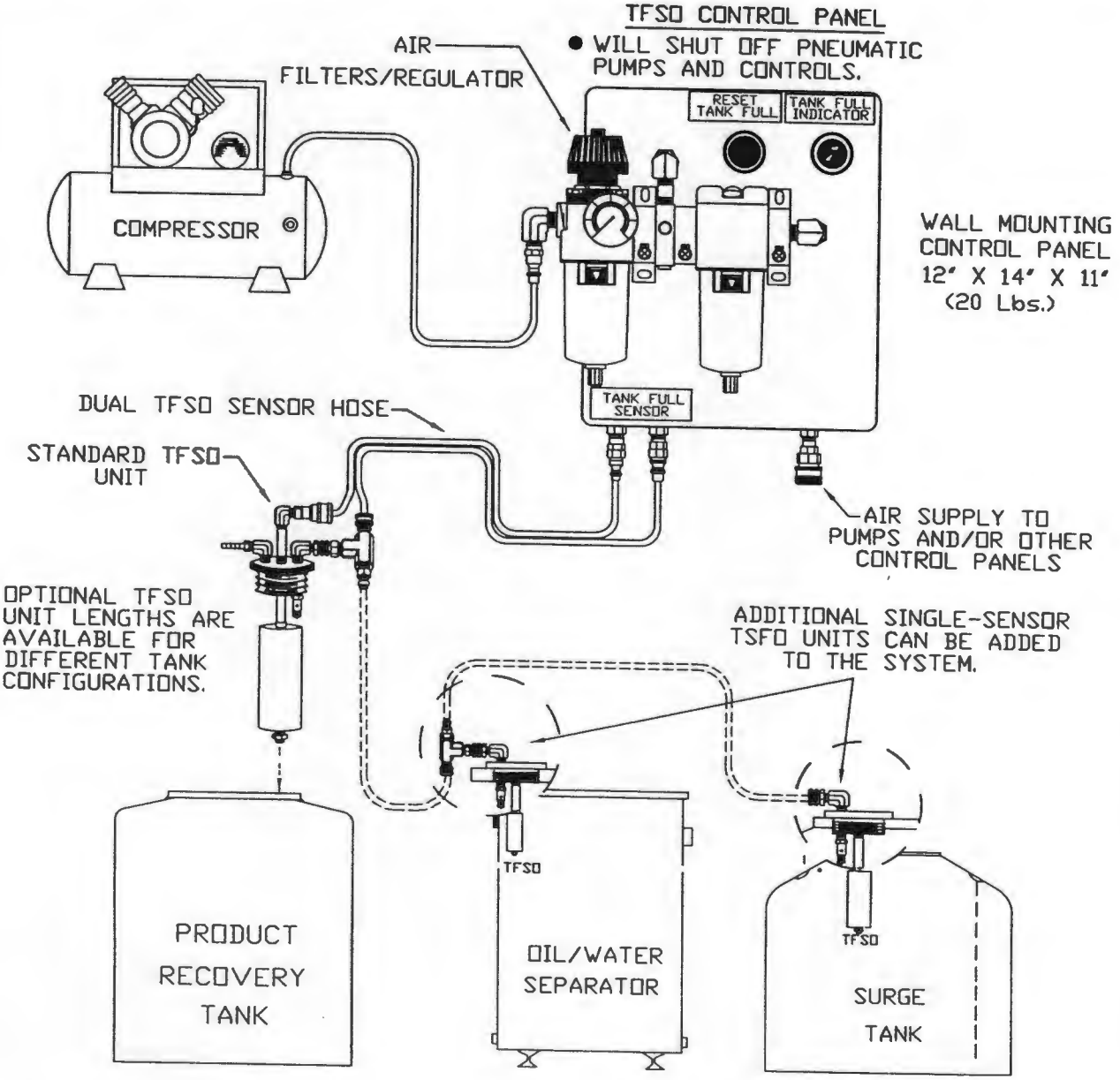
- Hydrocarbon resistant float material
- Stainless Steel
- Brass
- Aluminum

COMPONENT AND SHIPPING WEIGHTS

ITEM	COMPONENT (lb./kg.)	SHIPPING (lb./kg.)
Control Panel	20 / 9.1	23 / 10.4
Tank Unit	2 / 0.9	4 / 1.8
Hose Package	Varies	Varies

DUAL-SENSOR TANK-FULL SHUT-OFF (TFSO) SYSTEM

THE CEE TFSO SYSTEM PROTECTION EXTENDS BEYOND THE CLASSIC PRODUCT TANK-FULL CONDITION. IT ALSO INCLUDES A UNIQUE DUAL SENSOR HOSE FOR ADDED SAFETY. IN ADDITION, ALL EQUIPMENT RECEIVING AIR THAT IS FED BY, AND DOWNSTREAM OF, THE TFSO CONTROL PANEL, INCLUDING FLUID EXTRACTION PUMPS AND SKIMMERS, ARE TURNED OFF DURING 'SHUT-DOWN' CYCLES.

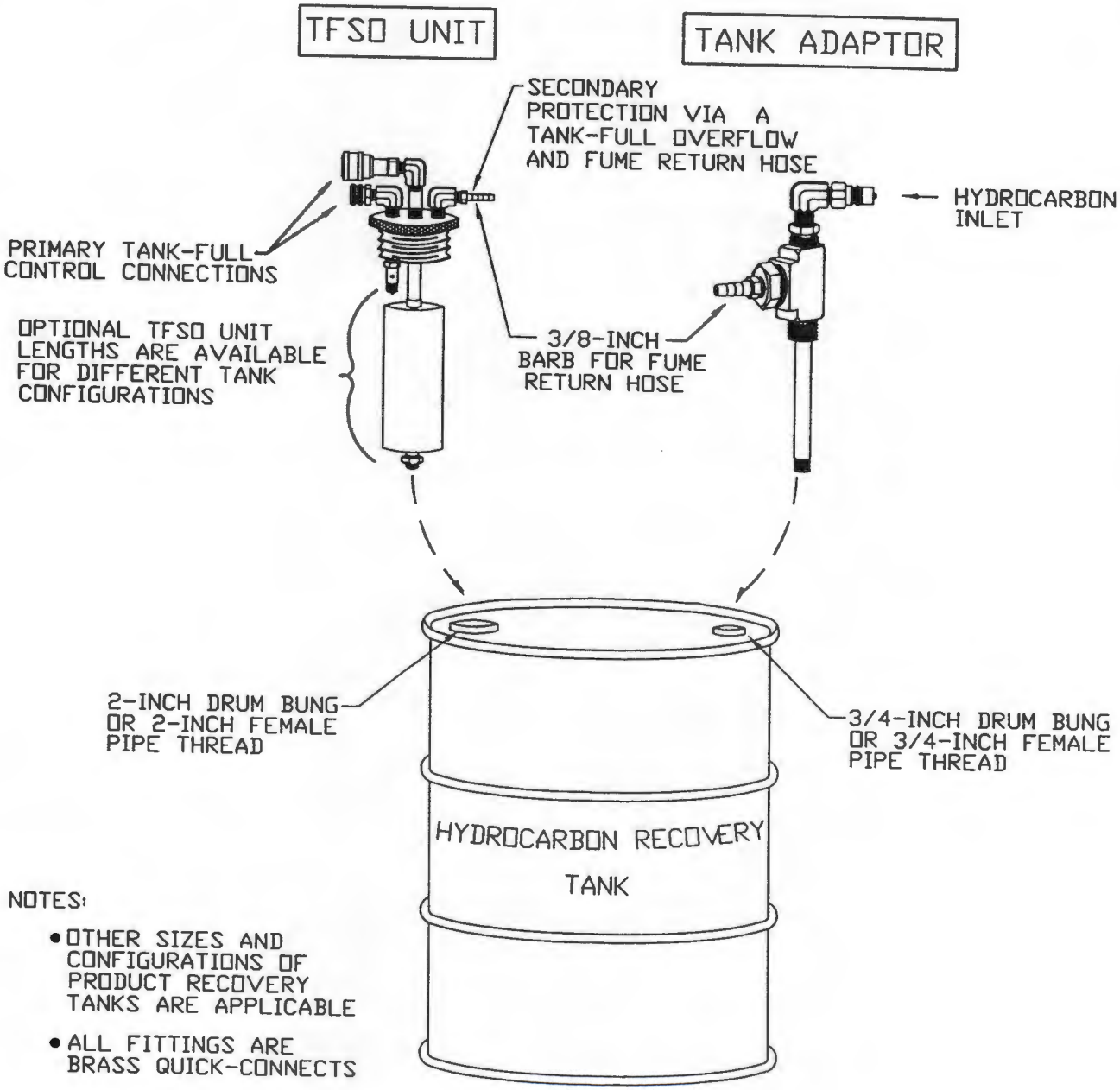


- IF ANY SENSOR HOSE IS DISCONNECTED, THE SYSTEM WILL SHUT DOWN.
- IF THE DUAL SENSOR HOSE IS PINCHED OR CUT, THE SYSTEM WILL SHUT DOWN.
- IF ANY SINGLE TANK ARMED WITH A TFSO UNIT SHOULD FILL, THE SYSTEM WILL SHUT DOWN.

Clean Environment Equipment
EQUIPMENT FOR GROUNDWATER REMEDIATION AND LEACHATE EXTRACTION
1133 7th ST.
OAKLAND, CA 94607
(510) 891-0880 (800) 537-1767 FAX (510) 444-6789

TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR : .30° FRAC : .XX : .01 .XXX : .005 .XXXX : .0005	APPROVALS	DATE	TITLE: DUAL-SENSOR TANK-FULL SHUT-OFF (TFSO) SYSTEM
	DRAWN TONY RAMIREZ	8-1-94	
	DESIGNER		DWG No. 600197 REV
MATERIAL	CHECKED		
FINISH	APPROVED		SCALE NONE SHT 1 OF 1

TFSO UNIT AND TANK ADAPTOR



NOTES:

- OTHER SIZES AND CONFIGURATIONS OF PRODUCT RECOVERY TANKS ARE APPLICABLE
- ALL FITTINGS ARE BRASS QUICK-CONNECTS

Clean Environment Equipment

EQUIPMENT FOR GROUNDWATER REMEDIATION AND LEACHATE EXTRACTION

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OAKLAND, CA 94607

(510) 891-0880 (800) 537-1767 FAX (510) 444-6789

TOLERANCES UNLESS OTHERWISE SPECIFIED	APPROVALS	DATE	TITLE	TFSO UNIT AND TANK ADAPTOR	
ANGULAR : .30° FRAC : .XXX : .005 .XX : .01 .XXXX : .0005	DRAWN TONY RAMIREZ	8-1-94			
	DESIGNER		DWG No.	600198	REV
MATERIAL	CHECKED				
FINISH	APPROVED		SCALE	NONE	SHT 1 OF 1

PUMP/SKIMMER MAXIMUM FLOW RATES

PRODUCT PUMP	STANDARD SKIMMERS			
	SOS-2	SOS-4	SPG-2	SPG-4
Shallow-Well:				
1-inch Double Diaphragm Pump (DDP-1)	360 GPD 1363 LPD	1000 GPD 3785 LPD	700 GPD 2650 LPD	2160 GPD 8176 LPD
Deep-Well:				
24-inch Bladder Pump (PP2-24)	100 GPD 379 LPD	160 GPD 606 LPD	160 GPD 606 LPD	160 GPD 606 LPD
48-inch Bladder Pump (PP2-48)	200 GPD 757 LPD	320 GPD 1211 LPD	320 GPD 1211 LPD	320 GPD 1211 LPD
Genie:				
24-inch Controllerless Pump (GNE-24)	100 GPD 379 LPD	160 GPD 606 LPD	160 GPD 606 LPD	160 GPD 606 LPD
48-inch Controllerless Pump(GNE-48)	200 GPD 757 LPD	320 GPD 1211 LPD	320 GPD 1211 LPD	320 GPD 1211 LPD

Note:
- The deep-well Bladder Pump rates are based on 4 cycles/minute, which typically would be reduced with multiple wells and a single controller.
- Rates will be reduced as well depth increases.
- Larger Double Diaphragm Pumps are available to accommodate higher recovery rates.

HOSE AND HARDWARE PACKAGE

Hoses supplied with all Product Only Recovery Systems are of industrial grade and come in diameters and lengths made to meet site specifications.

- Main air supply and HWSO hoses equal or surpass specifications noted in their respective sections.
- Product hoses are urethane covered, braided-steel reinforced, nylon-core hose, 18,000 pounds per square inch burst pressure with swaged-on connectors and double shut-off quick-connects.
- Product hoses provide static ground running its entire length through the steel-braided reinforcing and the brass (non-sparking) double-shut-off quick connects.
- TFSO Sensor Hoses consist of a low pressure single-wall vinyl tubing.
- All hoses are color coded and have non-interchangeable, brass quick-connect fittings.

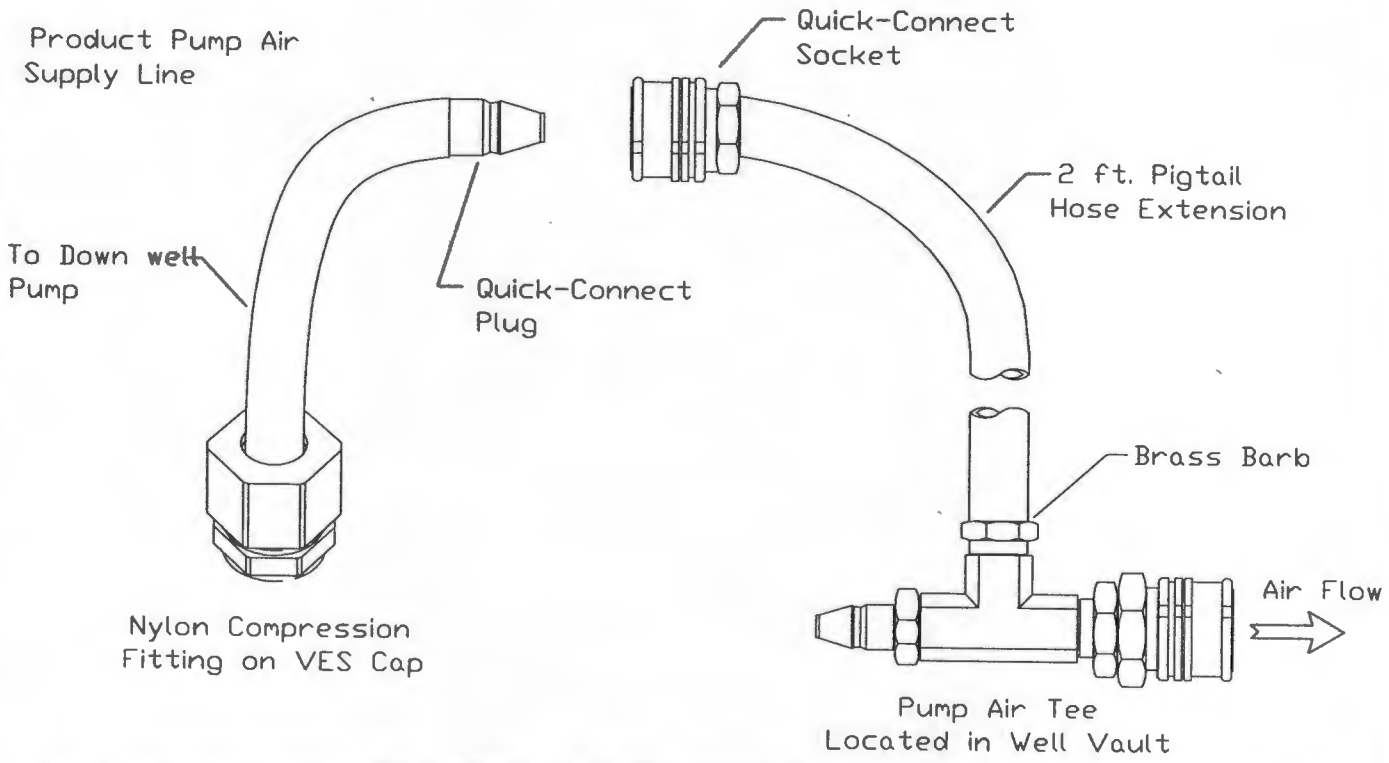
CEE PRODUCT ONLY RECOVERY SYSTEMS MODEL NUMBER EXPLANATION

Model Numbers completely describe the type of control, product pump, and skimmer. This particular section describes twelve different standard systems. Throughout the section, reference is made to various model numbers, for example, FRH/22/SOS-2.

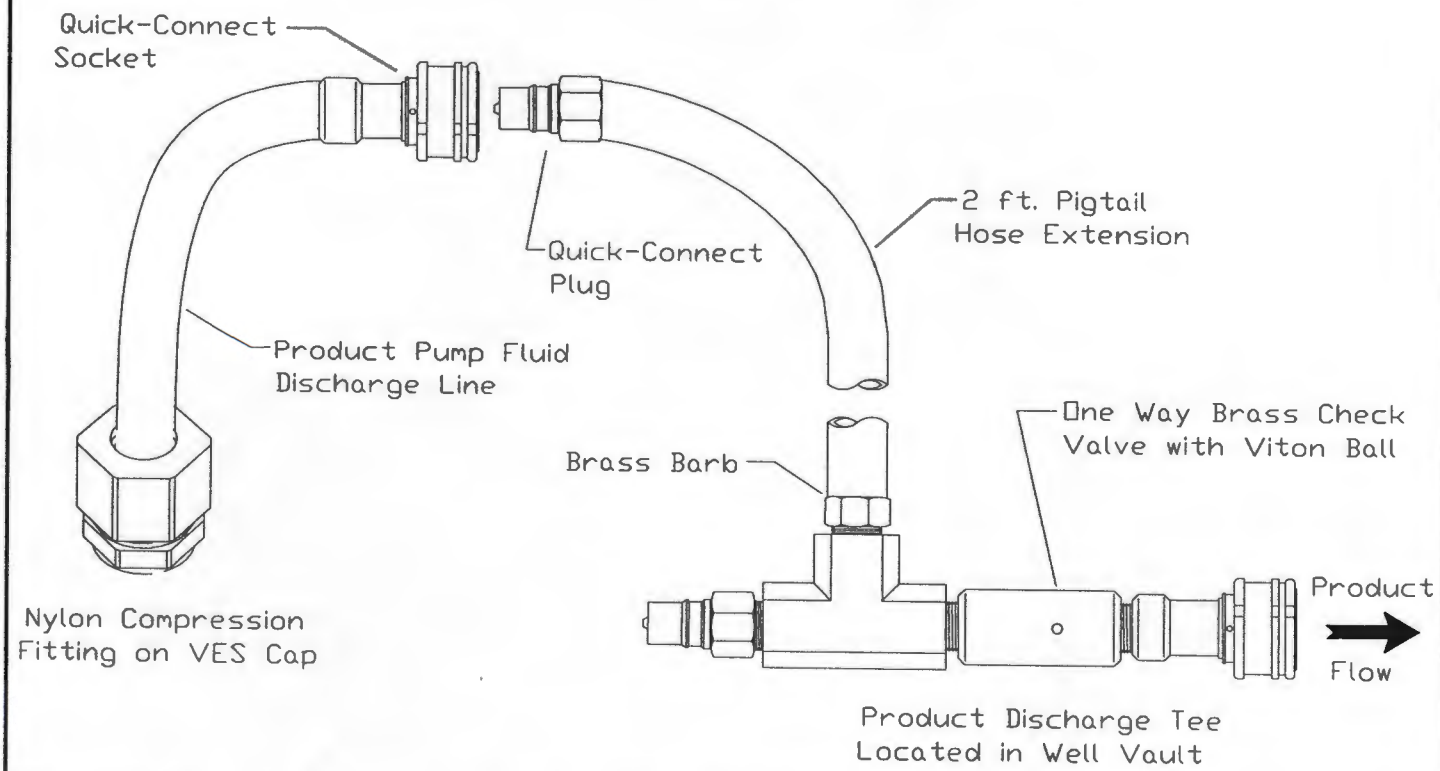
The first series of letters describe the type of control.

The next set of numbers defines the type of product pump. For example, the number "22" (for 22 feet) is used to denote the use of a surface mounted suction lift Double Diaphragm Pump. And the number "250" (for 250 feet) is used to denote the use of a down-well resilient Bladder Pump.

AIR SUPPLY CONNECTIONS DETAIL



FLUID DISCHARGE CONNECTIONS DETAIL



Clean Environment Equipment

Equipment for groundwater remediation and leachate extraction

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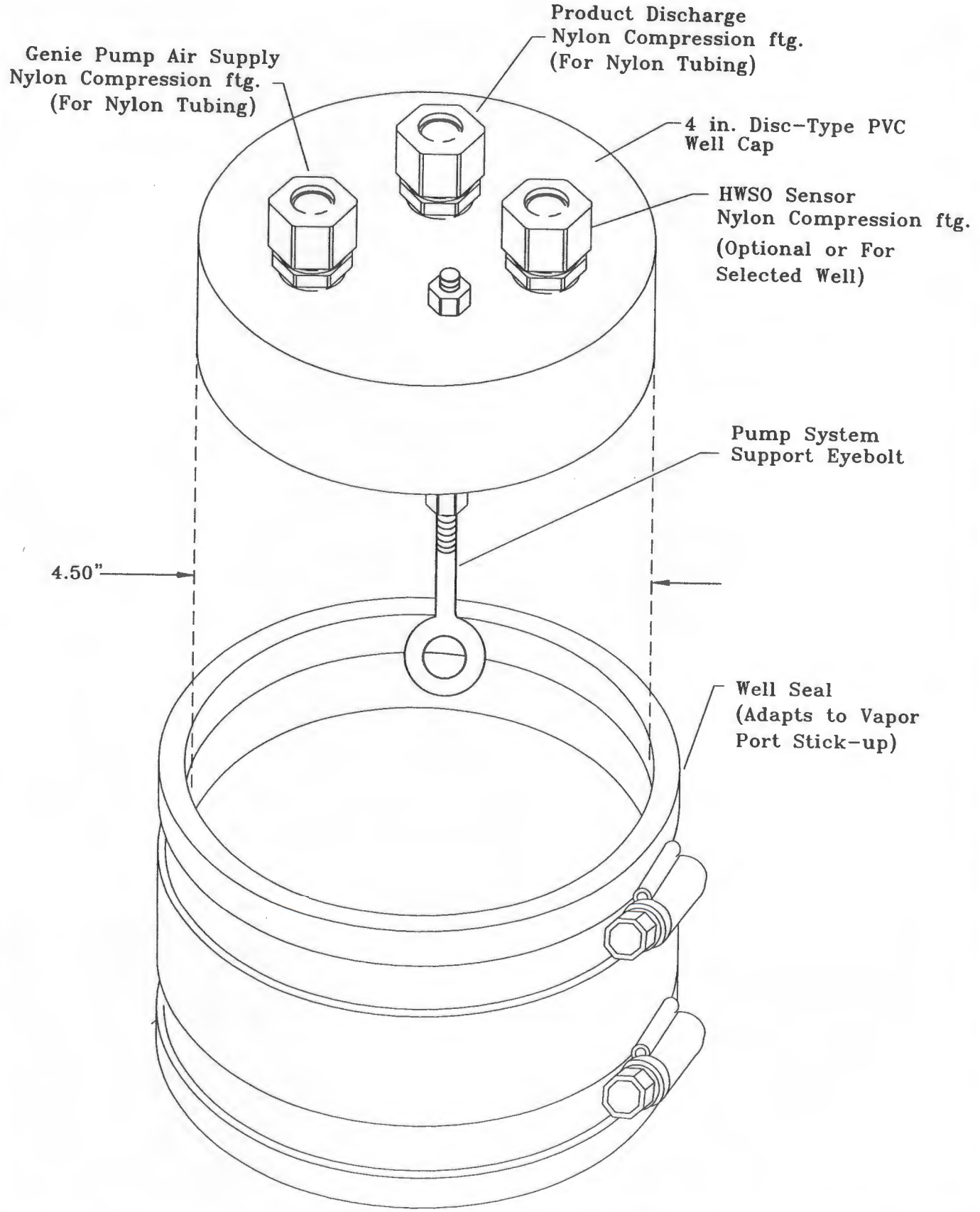
(800) 537-1767 • (510) 891-0880 • FAX (510) 444-6789
Website: www.cee.com

TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR : .5° FRAC : .XXX : .005 .XX : .01 .XXXX : .0005	APPROVALS	DATE	TITLE: AIR SUPPLY AND FLUID DISCHARGE TEE FITTING DETAIL
	DRAWN: TONY RAMIREZ	11-19-99	
	DESIGNER: MIKE K. BRESLIN	11-19-99	DWG No. 601376 REV
MATERIAL	CHECKED: MKB/RW/TH/SF	11-22-99	
FINISH	APPROVED: MIKE K. BRESLIN	11-22-99	SCALE: NONE SHT OF

COMPRESSION FITTINGS



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Website: www.cee.com

TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR : .5° FRAC : .XXX : .005 .XX : .01 .XXXX : .0005	APPROVALS	DATE	TITLE: 4-INCH VAPOR TIGHT WELL CAP WITH COMPRESSION FITTING
	DRAWN Riley English	11-18-99	
	DESIGNER MIKE K. BRESLIN	11-18-99	
MATERIAL	CHECKED MKB/RW/TH/SF	11-22-99	DWG No. 601374 REV
FINISH	APPROVED MIKE K. BRESLIN	11-22-99	SCALE NONE SHT OF

Series DS-200 and DS-300 Flow Sensors

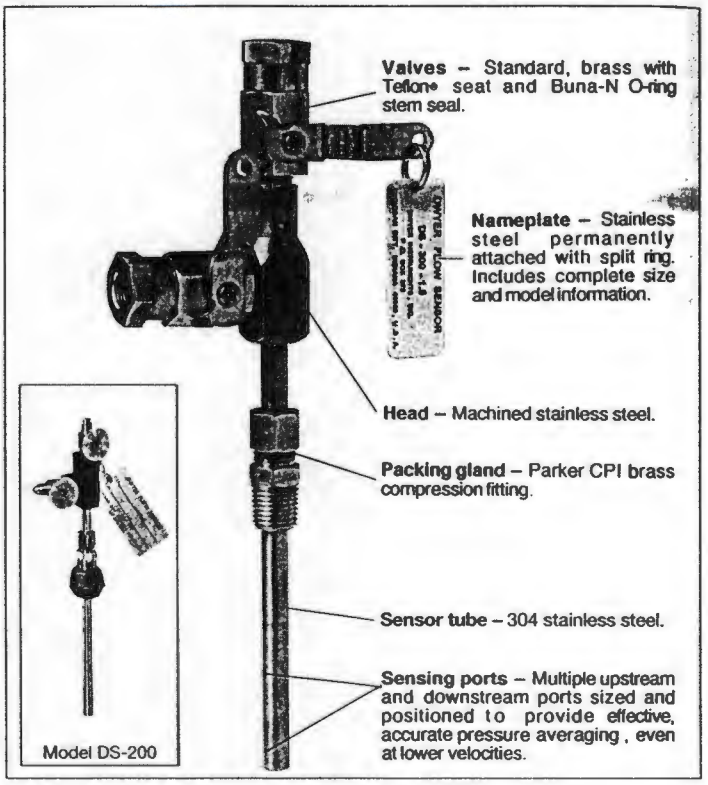
For use with the Dwyer Capsuhelic® differential pressure gage to measure high flow rates of air or water in pipes.

The Dwyer flow sensor is an averaging pitot tube providing accurate and convenient flow rate sensing. 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" NPT female 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". If replacing a DS-200 flow sensor or using an A-160 thredolet with a DS-300, an optional ¼"×⅜" bushing, P/N A-161 is required.

DS-200 models are also available in ten insertion lengths from 1" - 10". Operation is similar to DS-300 units. Basic differences are the multi-turn shut-off valves, ⅜" NPT mounting and installed ¼" SAE 45° flared pressure connections.



Prices – Select model with suffix which matches pipe size

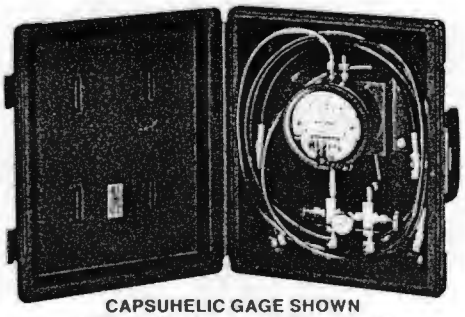
DS-200-1"	$136.75Ⓑ	DS-300-1"	$95.00
DS-200-1¼"	139.25Ⓑ	DS-300-1¼"	95.00
DS-200-1½"	139.25Ⓑ	DS-300-1½"	95.00
DS-200-2"	139.25Ⓑ	DS-300-2"	95.00
DS-200-2½"	149.25Ⓑ	DS-300-2½"	95.00
DS-200-3"	170.50Ⓑ	DS-300-3"	109.00
DS-200-4"	184.00Ⓑ	DS-300-4"	129.00
DS-200-6"	290.25Ⓑ	DS-300-6"	165.00
DS-200-8"	323.50Ⓑ	DS-300-8"	209.00
DS-200-10"	342.25Ⓑ	DS-300-10"	249.00

A-160 Thredolet, ¾"NPT, forged steel, 3000 psi 6.60
A-161 Brass Bushing, ¼"×⅜" 1.00
Less Valves (DS-300) To order, add suffix –LV ..... deduct 15.00
Ⓑ Items subject to Schedule B discounts

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°F to 200°F. 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.



CAPSUHELIC GAGE SHOWN
INSTALLED IN A-471 PORTABLE KIT

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 Bulletin A-30 for complete information on the Capsuhelic gage.

Dwyer Instruments, Inc. P.O. Box 373/Michigan City, Indiana 46361/Phone 219 879-8000/Fax 219 872-9057 • U.K. Phone (01494)-461707 • Australia Phone (02) 9708-4799

How To Order

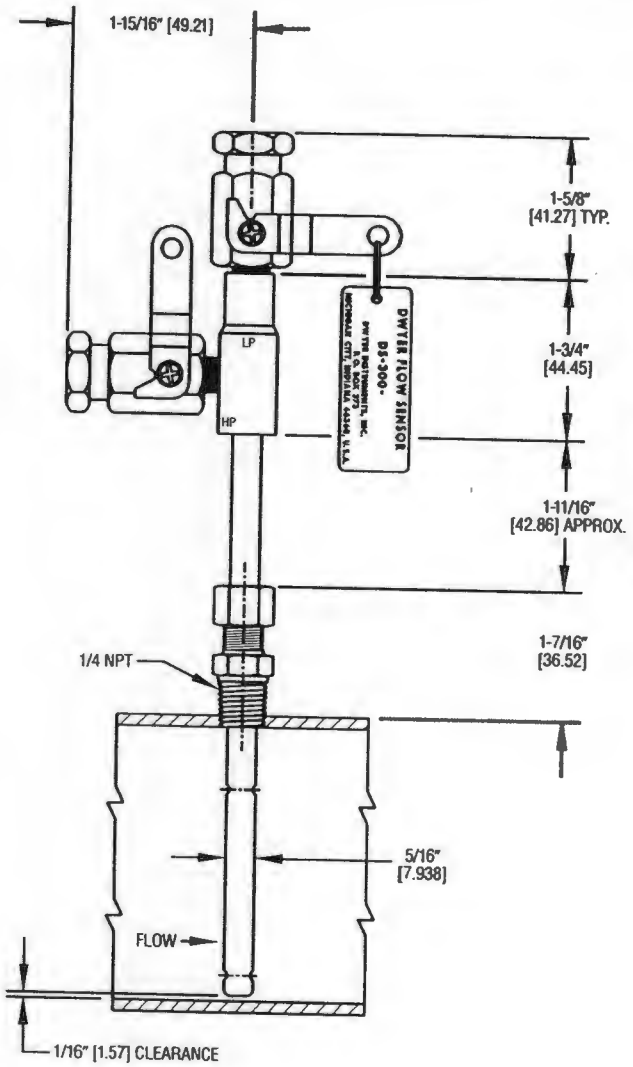
Merely determine the pipe size into which the flow sensor will be mounted and designate the size as a suffix to Model DS-300. For example, a flow sensor to be mounted in a 2" pipe would be a Model No. DS-300-2".

Options and Accessories

Less Valves (DS-300) – To order, add suffix -LV. Example: DS-300-2"-LV
A-160 Thredolet – ¾" NPT, forged steel, 3000 psi
A-161 Bushing – ¼"×⅜" brass bushing

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 charts 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.

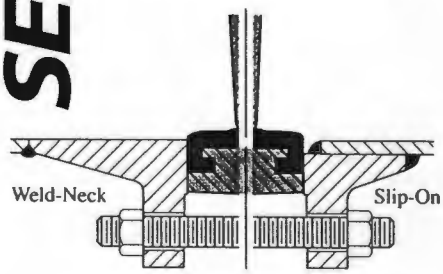


GAGE RANGE (in. W.C.)	MEDIA @ 70°F	FULL RANGE FLOWS BY PIPE SIZE (APPROXIMATE)									
		1"	1½"	1½"	2"	2½"	3"	4"	6"	8"	10"
2	WATER (GPM) AIR @ 14.7 PSIA (SCFM) AIR @ 100 PSIG (SCFM)	4.8 19.0 50.0	8.3 33.0 90.5	11.5 42.0 120.0	20.5 65.0 210.0	30 113 325	49 183 510	86 330 920	205 760 2050	350 1340 3600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

SELECTION DATA

FLANGE REQUIREMENTS

Bray valves are designed for installation between ANSI Class 125/150 lb. weld-neck or slip-on flanges, BS 10 Tables D & E, BS 4504 NP 10/16. DIN ND 10/16, AS 2129 and JIS 10, either flat faced or raised faced. While weld-neck flanges are recommended, Bray has specifically designed its valve seat to work with slip-on flanges, thus eliminating common failures of other butterfly valve designs. When using raised face flanges be sure to properly align valve and flange. Type C stub-end flanges are not recommended.



PRESSURE RATINGS*

For bi-directional bubble-tight shut off, disc in closed position:

Inches	mm	psig	bar
2-12	50-300	175	12
14-20	350-500	150	10

For Dead-end Service Applications:
With *downstream flanges installed* or with *vulcanized seats*, the dead-end pressure ratings are equal to valve bi-directional ratings as stated above.
With no downstream flanges or with seats that are not vulcanized, the dead-end pressure rating for 2"-20" valves is 75 psi (5 bar).

*Pressure Ratings are based on standard disc diameters. For low pressure application, Bray offers a standard reduced disc diameter to decrease seating torques and to extend seat life, thus increasing the valve's performance and reducing actuator costs for the customer.

VELOCITY LIMITS

For On/Off Services:
Fluids – 30 ft / sec (9m/s)
Gases – 175 ft / sec (54m/s)

C_V VALUES–VALVE SIZING COEFFICIENT

Valve Size		Disc Position (degrees)								
ins	mm	90°	80°	70°	60°	50°	40°	30°	20°	10°
2	50	144	114	84	61	43	27	16	7	1
2½	65	282	223	163	107	67	43	24	11	1.5
3	80	461	364	267	154	96	61	35	15	2
4	100	841	701	496	274	171	109	62	27	3
5	125	1376	1146	775	428	268	170	98	43	5
6	150	1850	1542	1025	567	354	225	129	56	6
8	200	3316	2842	1862	1081	680	421	241	102	12
10	250	5430	4525	2948	1710	1076	667	382	162	19
12	300	8077	6731	4393	2563	1594	1005	555	235	27
14	350	10538	8874	5939	3384	2149	1320	756	299	34
16	400	13966	11761	7867	4483	2847	1749	1001	397	45
18	450	17214	14496	10065	5736	3643	2237	1281	507	58
20	500	22339	18812	12535	7144	4536	2786	1595	632	72

C_V is defined as the volume of water in U.S.G.P.M. that will flow through a given restriction or valve opening with a pressure drop of one (1) p.s.i. at room temperature. Recommended control angles are between 25°–70° open. Preferred angle for control valve sizing is 60°–65° open.

EXPECTED SEATING/UNSEATING TORQUES (Lb.-Ins.)

Valve Size		Full-Rated Pressure Valves				Reduced Disc Diameter
		ΔP (PSI)				ΔP (PSI)
ins	mm	50	100	150	175	50
2	50	125	130	135	140	125
2½	65	195	205	215	220	195
3	80	260	275	290	297	260
4	100	400	425	450	462	267
5	125	615	670	725	755	410
6	150	783	871	953	1003	537
8	200	1475	1650	1825	1915	983
10	250	2240	2520	2800	2940	1493
12	300	3420	3870	4320	4545	2280
14	350	4950	5700	6450	—	3300
16	400	6400	7700	9000	—	4267
18	450	7850	9850	11850	—	5267
20	500	10300	12900	15500	—	6867

Valve Torque Rating – Bray has classified valve torque ratings according to 3 types: non-corrosive lubricating service, general service, and severe service. Consult Bray for torque information corresponding to specific applications.

TO USE TORQUE CHART, NOTE THE FOLLOWING:
1) For Bray valves, Series 20, 21, 30, 31 and 34 service Class 'B' torques.
2) Review Technical Bulletin No. 1001, Expected Seating/Unseating Torques, for explanation of the 3 service classes and their related seating/unseating torque values for given pressure differentials of Full-Rated and Reduced Disc Diameter valves.
3) Dynamic Torque values are not considered. See Technical Bulletin No. 1002 for evaluation of Dynamic Torque values vs. Seating/Unseating Torque values.
4) Do not apply a safety factor to above torque values when determining actuator output torque requirement.
5) For 3 way assemblies where one valve is opening and other is closing, multiply torque by 1.5 factor.

SPECIFICATIONS

RECOMMENDED SPECIFICATIONS FOR BRAY SERIES 30/31 SHALL BE:

- Epoxy coated, cast iron, wafer or lug bodies.
- With flange locating holes that meet ANSI Class 125/150 (or BS 10 Tables D & E, BS 4504 NP 10/16, DIN ND 10/16, AS 2129 and JIS 10) drillings.
- Through-stem direct drive double "D" design requiring no disc screws or pins to connect stem to disc with no possible leak paths in disc/stem connection.
- Stem mechanically retained in body neck and no part of stem or body exposed to line media.
- Tongue-and-groove seat design with primary hub seal and a molded O-ring suitable for weld-neck and slip-on flanges. Seat totally encapsulates the body with no flange gaskets required.
- Spherically machined, hand polished disc edge and hub for minimum torque and maximum sealing capability.
- Equipped with non-corrosive bushing and self-adjusting stem seal.
- Bi-directional and tested to 110% of full rating.
- Bi-directional pressure ratings of
  2"–12" valves: 175 psi
  14"–20" valves: 150 psi
  Lug bodies for dead end service
  With downstream flanges or vulcanized seats, pressure ratings are equal to bi-directional ratings as stated above.
  With no downstream flanges or not vulcanized seats: 2"-20" valves: 75 psi
- No field adjustment necessary to maintain optimum field performance.
- The valve shall be Bray Series 30 wafer / 31 lug or equal.

WEIGHTS

Valve Size ins	Valve Size mm	Series 30	Series 31
2	50	5.5	7.0
2½	65	7.0	8.0
3	80	7.5	9.0
4	100	11.5	15.0
5	125	14.0	20.0
6	150	17.0	23.0
8	200	34.0	42.0
10	250	49.0	66.0
12	300	67.0	88.0
14	350	95.0	114.0
16	400	135.0	166.0
18	450	200.0	226.0
20	500	260.0	305.0

Weights are in lbs.

MATERIALS SELECTION

2"–20" (50mm-500mm)

BODY:
- Cast Iron ASTM A126 Class B
- Ductile Iron ASTM A536
- Cast Steel ASTM A216 WCB
- Aluminum ASTM B26

SEAT:
- Buna-N – Food Grade
- EPDM – Food Grade
- FKM*
- White Buna-N – Food Grade

STEM:
- Coated Carbon Steel
- 416 Stainless Steel ASTM A582 Type 416
- 304 Stainless Steel ASTM A276 Type 304
- 316 Stainless Steel ASTM A276 Type 316
- Monel

DISC:
- Aluminum Bronze ASTM B148-954
- Coated Ductile Iron ASTM A536 Gr. 65-45-12
- Ductile Iron, Nylon 11 Coated, ASTM A536 Gr. 65-45-12
- Ductile Iron, Halar® Coated, ASTM A536 Gr. 65-45-12
- 316 Stainless Steel ASTM A351 CF8M
- Hastelloy® C-276 ASTM B575 Alloy N10276

TEMPERATURE RANGE OF SEATS

Type	Maximum	Minimum
EPDM	+250°F(121°C)	-40°F(-40°C)
Buna-N	+212°F(100°C)	0°F(-18°C)
FKM*	+400°F(204°C)	0°F(-18°C)

COMPONENTS

No.	Qty.	Description
1	1	Body
2	1	Seat
3	1	Disc
4	1	Stem
5	1	Stem Seal
6	1	Stem Bushing
7	2	Stem Retainer
8	1	Thrust Washer
9	1	Retaining Ring

*FKM is the ASTM D1418 designation for Fluorinated Hydrocarbon Elastomers (also called Fluoroelastomers) such as Viton® (DuPont) and Fluorel® (3M).

Hastelloy® is a registered trademark of Haynes International, Inc.
Halar® is a registered trademark of Ausimont U.S.A., Inc.

COMMAND CENTER

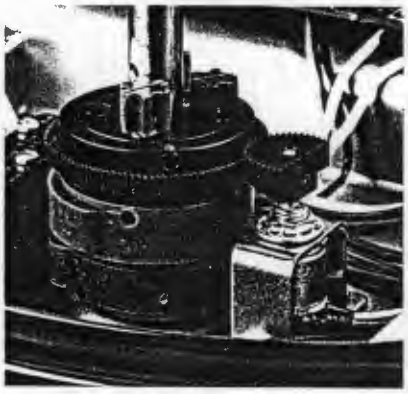
MODULATING ACTUATOR FOR PRECISION CONTROL OF VALVE POSITION

The Bray R4 Electric Actuator can be equipped with a Servo for precise control of valve position. The Servo consists of a circuit board and a feedback potentiometer assembly, which both fit entirely within the standard R4 actuator housing. The circuit board has a single terminal block for customer field wiring, and other terminals for internal connections to the actuator components. The feedback potentiometer is driven by a gearset connected to the actuator output drive.

COMMAND CENTER OPTIONS

SERVO OPERATION

The Servo can be easily configured by the factory or the customer to accept several types of input signals, such as 4-20 mADC, 0-10 VDC, 2-10 VDC or potentiometer control. The input signal electronically represents the *desired* actuator position, and the feedback potentiometer signal electronically represents the *actual* actuator position. The circuit board constantly compares the two signals, and if a difference is detected, drives the actuator in the proper direction until the signals are equal. When a balance is reached, the circuit board turns off the actuator motor. The worm gear then mechanically holds the valve in the desired position until the input signal is changed again.



Feedback Potentiometer Gear

SPEED CONTROL

Adjustments are provided for both open and closed speed control of the actuator motor. In addition, an approach control circuit senses when the actuator is about to reach the desired valve position, and pulses the motor to avoid overshooting the setpoint.

POTENTIOMETER CALIBRATION

Calibration of the feedback potentiometer is done through a unique gear arrangement that is easily accessible and eliminates the need of any special tools to make required adjustments. A simple adjustment of Bray's patented cam drive aligns the

SERVO SPECIFICATIONS

Note: Servo is available for modulating service – continuous duty actuators only.

Note: "Standard" is the way the Servo is set at the factory
"Configurable" means the customer, or the factory, can modify the Servo simply by moving switches, jumpers, etc.

POWER INPUT:	115 VAC. 60 Hz	(standard)
	230 VAC, 50 Hz	(configurable)
POWER CONSUMPTION:	2 Watts (not including actuator power)	
INPUT SIGNAL:	4-20 mADC into 250 Ohm	(standard)
	0-10 VDC	(configurable)
	2-10 VDC	(configurable)
	135 Ohm or greater potentiometer	(configurable)
CALIBRATION:	Circuit board: Zero, Span, Deadband	
	Open Speed, Close Speed	
	Feedback: Potentiometer Drive Gear	
TEMPERATURE RATING:	-40°F (-40°C) TO 160°F (70°C)	
INDICATORS:	Power (Yellow LED)	
	Open Drive (Green LED)	
	Close Drive (Red LED)	
CONTROL CHARACTERISTIC:	Linear	
DUTY CYCLE:	100%	
INTERNAL FEEDBACK:	5 kOhm Potentiometer, gear driven	

R4™ Red Round Rotary Reliable

potentiometer gear as easily as a travel cam.

Also, the feedback potentiometer gear is specially shaped to disengage when the limits of the active region of the potentiometer are exceeded. This situation can occur when the manual override handwheel is turned past 90° or below 0° travel. The special gear prevents damage to the potentiometer from over rotation, and provides an easy reference for recalibration. Returning the actuator to the fully open or closed position and remeshing the potentiometer gears restores the proper alignment.

SERVO VOLTAGE SPIKE PROTECTION

Voltage spikes that can damage electrical equipment are very common in industrial locations. Large voltage spikes can be caused by interrupting the current to the actuator motor when the travel limit is reached. The output stage TRIACs of the Servo are protected against damage from voltage spikes by a special combination of

- limit switch circuitry
- zero crossing detection
- metal oxide varistor (mov) for transient voltage suppression.

CONTROL STATION (Optional)

Bray has designed a manual local electrical control station that flush mounts directly to the R4.

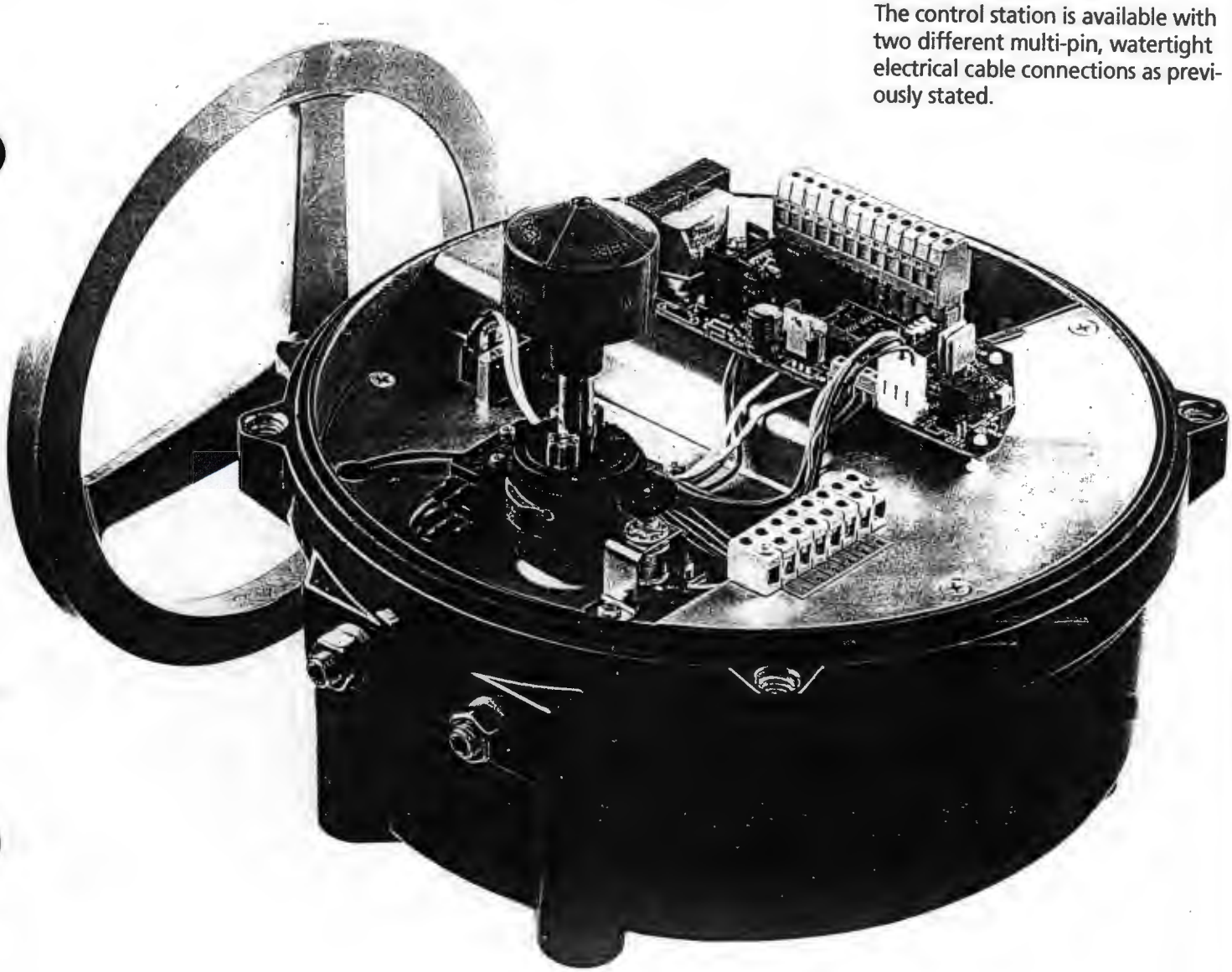
The control station features:

- a local and remote control switch
- an open–stop–close switch
- two lights which locally indicate open and closed valve position.

Control Station

The cover plate can be rotated in any 90° increment, allowing the customer to operate and view the station with ease. The enclosure is aluminum and weatherproof (NEMA 4, 4X, IP 65). Additionally, the control station has captive cover bolts and two input connections available in the following thread connections: 3/4" NPT, M25 or PG16.

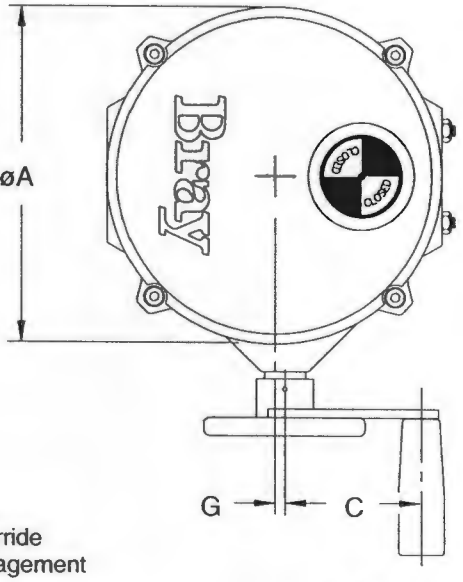
The control station is available with two different multi-pin, watertight electrical cable connections as previously stated.

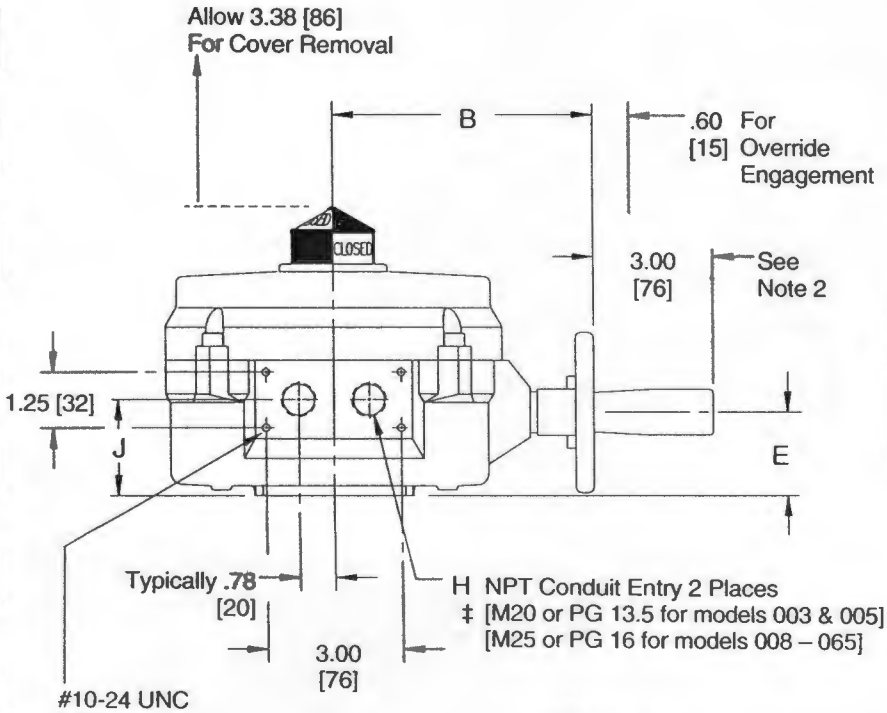


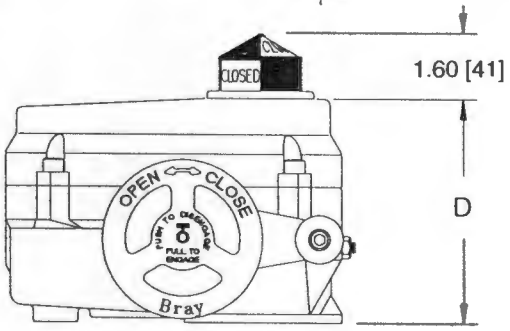
DIMENSIONS

Actuator Series	A	B	C	D	E	F	G	H	J	K(UNC) x B.C.	M(UNC) x B.C.	N	P	Q
S70-003 S70-005	7.5 [191]	5.6 [142]	3.0 [76]	5.1 [130]	1.9 [48]	1.94 [49.3]	.19 [4.8]	1/2 ‡	2.0 [51]	5/16-18 x ø2.76	—	.75 [19]	.51 [13]	1.47 [37]
S70-008 S70-012 S70-020	10.1 [257]	7.8 [198]	3.7 [94]	6.5 [165]	2.5 [64]	2.69 [68.3]	.56 [14.2]	3/4 ‡	2.6 [66]	5/16-18 x ø2.76	1/2-13 x ø4.92	1.18 [30]	.87 [22]	1.82 [46]
S70-030 S70-050 S70-065	12.1 [307]	9.5 [241]	5.6 [142]	7.2 [183]	2.9 [74]	3.19 [81]	.56 [14.2]	3/4 ‡	3.1 [79]	1/2-13 x ø4.92	5/8-11 x ø6.50	See Detail A		

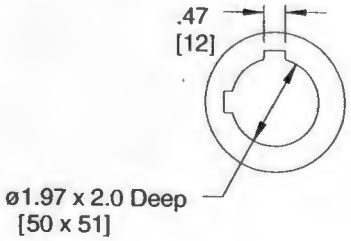
NOTE:
1) Dimensions are in Inches, [Millimeters in brackets].
2) Handwheel Spinner shown in drawing is available as an option.

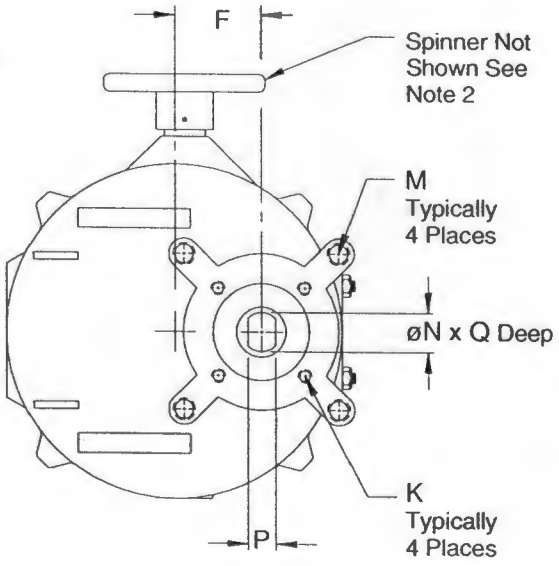






DETAIL A
(Series 70-030, 050 & 065 Only)





Actuator Series	Torque Output lb/in [Nm]	Single Phase Motors Current Rating (Amps) At All Speeds (locked rotor)			Speed For 90° Operation In Seconds / Total Gear Ratio						Rim Pull lbs [kgs]	Bray Valve Sizes For Direct Mounting	Weight lbs [kgs]
					On-Off Intermittent‡			Modulating Continuous‡		Manual Override			
		VAC	Hz	Amps	Optional Speeds		Standard Speeds	Optional Speeds					
S70-003	300	120	50/60	2.0		8 sec.	15 sec.	30 sec.	60 sec.		11.4	2" through 6"	12
	[34]	220	50/60	1.0		1,392:1	2,413:1	5,070:1	11,200:1	30:1	[5]		[6]
S70-005	500	120	50/60	2.0			15 sec.	30 sec.	60 sec.		19.0	2" through 6"	12
	[57]	220	50/60	1.0			2,413:1	5,070:1	11,200:1	30:1	[9]		[6]
S70-008	800	120	50/60	2.3	6 sec.	10 sec.	15 sec.	30 sec.			13.0	2" through 12"	28
	[90]	220	50/60	1.4	681:1	1,080:1	1,640:1	3,340:1		30:1	[6]		[13]
S70-012	1200	120	50/60	2.3		10 sec.	15 sec.	30 sec.			20.0	2" through 12"	28
	[136]	220	50/60	1.4		1,080:1	1,640:1	3,340:1		30:1	[9]		[13]
S70-020	2000	120	50/60	2.3			15 sec.	30 sec.			33.0	2" through 12"	28
	[226]	220	50/60	1.4			1,640:1	3,340:1		30:1	[15]		[13]
S70-030	3000	120	50/60	3.1			18 sec.	30 sec.			33.0	8" through 20"	48
	[339]	220	50/60	1.7			2,080:1	3,340:1		30:1	[15]		[22]
S70-050	5000	120	50/60	3.1			18 sec.	30 sec.			55.0	8" through 20"	48
	[565]	220	50/60	1.7			2,080:1	3,340:1		30:1	[25]		[22]
S70-065	6500	120	50/60	3.1				30 sec.			72.0	8" through 20"	48
	[734]	220	50/60	1.7				3,340:1		30:1	[33]		[22]

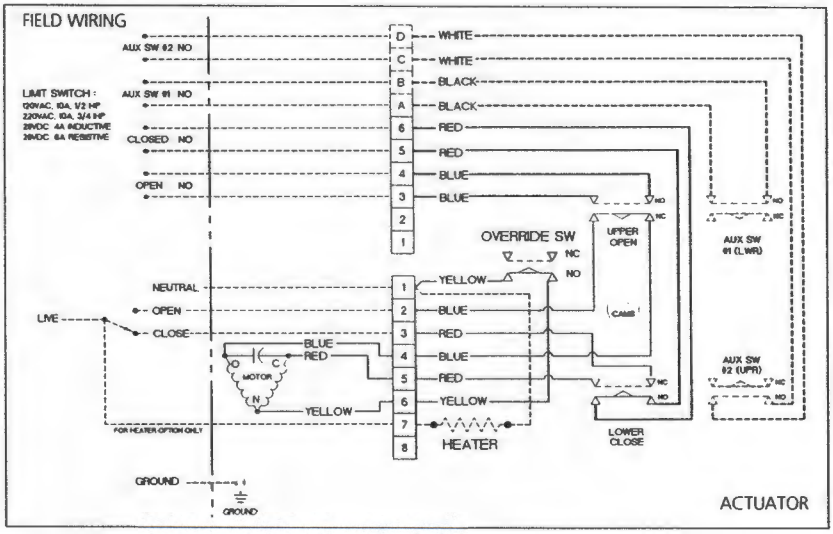
24 VDC available as an option, please consult your Bray representative or the factory.

‡ The duty cycle for intermittent on-off operation is 25%. The continuous duty actuator with Servo is rated for 100% modulating operation at an ambient temperature of 104°F (40°C).

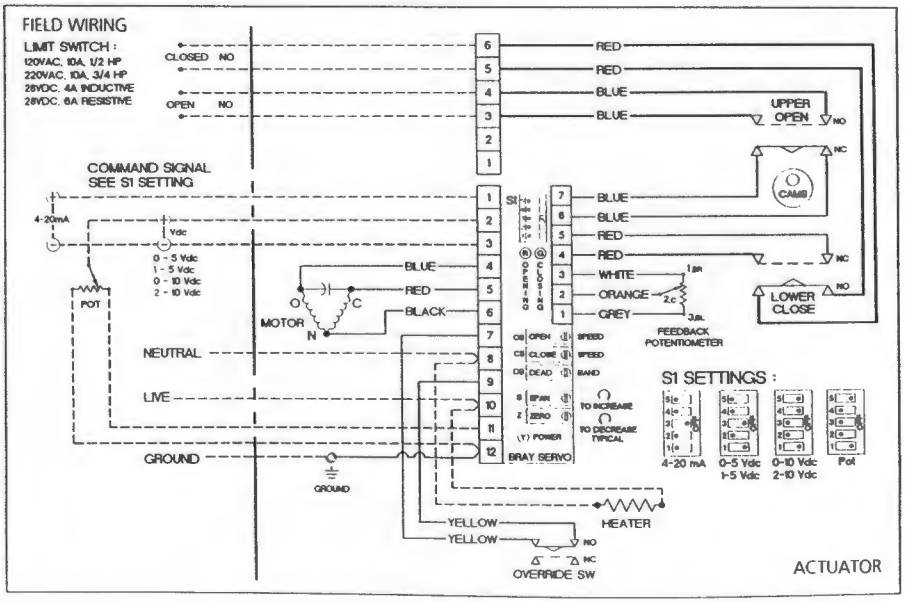
TYPICAL WIRING DIAGRAMS

ON–OFF
With Optional Torque Limit Switches, Heater and Auxillary Switches

Wiring Diagrams are For Reference Only. Do NOT use for field wiring.



MODULATING–Servo
With Optional Torque Limit Switches and Heater



Notes:

1) Actuators are shown in closed position.
2) Manual Override is not engaged.
3) Heater is optional.
4) All switches are Single Pole, Double Throw, Double Break.
5) Terminal block accepts field wiring from 10-22 AWG. 12-22 AWG for Servo.

SPECIFICATIONS

The electric actuator shall be compact and low-profile to greatly reduce space requirements. The actuator shall feature ease of access to field wiring and adjustment. The actuator shall be built to withstand line vibration and shock without failure and shall bolt directly to Bray valve mounting flanges without using brackets.

MOTOR A single phase permanent split-capacitor reversible motor with voltages of 120 and 220 VAC 50/60 Hz shall be standard. Motor insulation shall be Class F or better. The motor shall contain a built-in thermal overload protector of a bi-metallic strip in windings set at 338°F (170°C) with automatic reset. DC motors shall be available upon request.

DUTY CYCLE The duty cycle for intermittent on-off operation shall be 25%. The continuous duty actuator with Servo shall be rated for 100% modulating operation at an ambient temperature of 104°F (40°C).

SPUR GEAR TRAIN SYSTEM The actuator shall have a self-locking gear train consisting of a worm and worm gear output drive mechanism. The spur gear train shall have precision cut multi-staged gears which will withstand locked rotor conditions. The spur gear train shall be permanently lubricated at the factory. The gear train shall drive a chrome-moly steel worm which drives the composite aluminum bronze segment gear / stainless steel output shaft.

WIRING Actuator switches shall be pre-wired to a terminal block for ease of access and all internal wiring shall range from 10-22 AWG.

SWITCHES All travel switches shall be Single Pole, Double Throw, Double Break Form Z type 10A at 125/250 VAC, 4A at 28 VDC inductive load, 6A at 28 VDC resistive load, UL and CSA approved. Travel Limit switches shall limit actuator in both the open and closed position of valve travel.

CAMS Cams for each travel limit switch shall be infinitely adjustable by finger touch or screw driver, as provided by Bray's patented design.

CONDUIT ENTRIES All units shall have 2 conduit entries. Conduit entries for models 003 and 005 shall be either 1/2" NPT, M 20 or PG 13.5. Conduit entries for models 008 – 065 shall be either 3/4" NPT, M 25 or PG 16.

MECHANICAL TRAVEL STOPS Mechanical stainless steel travel stops shall be located outside the actuator for ease of adjustment and contain stainless steel lock nuts with O-ring seals to hold the travel stops in place. The travel stops shall limit the actuator movement to specific degrees of rotation.

MANUAL OVERRIDE All units shall be equipped with an aluminum manual override handwheel to rotate the valve without electrical power. The override assembly shall ensure positive and fast manual operation without the use of extra tools or levers.

EMERGENCY SHUT-OFF An automatic power cutout switch shall be provided to cut power to the motor when actuator handwheel is engaged for manual operation. This switch shall function as a safety emergency shutdown device.

ENCLOSURE The die-cast aluminum enclosure shall be waterproof (NEMA 4, 4X, IP 65) rated and high-quality polyester powder coated for exceptional corrosion, wear, impact and UV resistance. The enclosure cover shall have captive cover bolts therefore preventing time consuming problems due to lost or misplaced bolts.

VALVE STATUS DISPLAY The actuator shall have a highly visible clear polycarbonate display prominently labeled and color coded to indicate valve position throughout the full range of travel.

TEMPERATURE RATING Actuators shall be designed for temperature ranges of -40°F (-40°C) to +150°F (65°C).

OPTIONAL EQUIPMENT

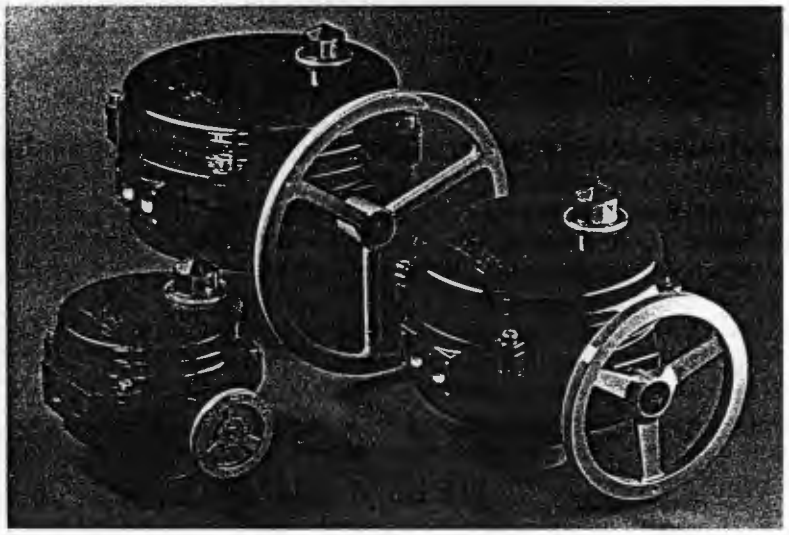
The actuator shall be designed to include any of the following accessories as an option.

TORQUE LIMITING SYSTEM with 2 SPDT-DB mechanical switches and 2 factory calibrated adjusting screws – the green adjusts the limit in the open direction, the red adjusts the limit in the closed direction. The worm shaft is driven against the torque disc springs in response to the output torque. The switches contact the worm shaft groove in response to predetermined loads and interrupt the electrical power to the motor. The switches can operate at any point of actuator travel.

HEATER with thermostat control to prevent condensation buildup. The heater is pre-wired to the terminal block. Rated output is 15 W at 110 or 240 VAC.

SERVO for precise modulating control of valve position. A solid state circuit board compares the input signal with the feedback potentiometer signal and drives the actuator until a balance is reached. The Servo has a specially shaped potentiometer gear which prevents damage due to over rotation and features voltage spike protection. Adjustments are provided for both open and closed Speed Control of the actuator. Input Signals: 4-20 mADC into 250 Ohm, 0-10 VDC, 2-10 VDC and 135 Ohm or greater potentiometer. Adjustments: Zero, Span, Deadband, Open & Close Speed. Internal Feedback: 5 kOhm Potentiometer.

CONTROL STATION for manual local electrical operation of the actuator. The Control Station flush mounts to the actuator and features a local and remote control switch, an open–stop–close switch, and two lights which locally indicate open and closed valve position. The enclosure is aluminum and weatherproof (NEMA 4, 4X, IP 65).



The Bray R4™ Electric Actuator – Series 70-005, 065 and 020.

DISTRIBUTOR

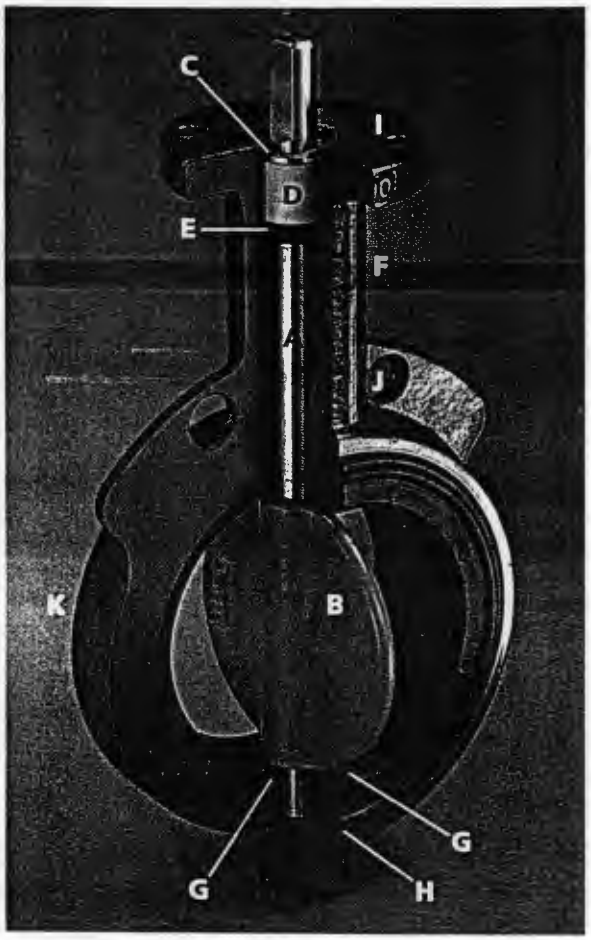
Bray® VALVE & CONTROLS

A Division of BRAY INTERNATIONAL, Inc.
13333 Westland East Blvd. Houston, Texas 77041
281/894-5454 FAX 281/894-9499 http://www.bray.com

 B-1016 11/96

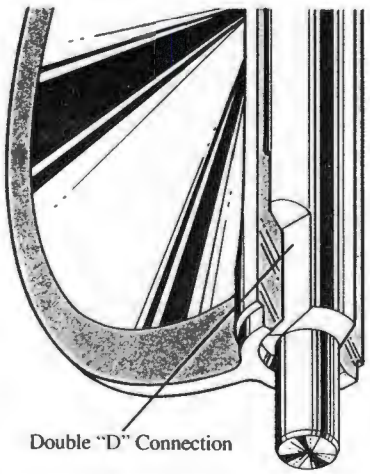
SERIES 30

2"–20" (50mm–500mm)
Bray® Valve & Controls is proud to offer a high quality line of butterfly valves to meet the requirements of today's market. Combining years of field application experience, research and development, Bray has designed many unique features in the Series 30/31 not previously available. The results are longer service life, greater reliability, ease of parts replacement and interchangeability of components.



DISC AND STEM CONNECTION

(A) Features a high-strength through stem design. The close tolerance, double "D" connection that drives the valve disc is an exclusive feature of the Bray valve. It eliminates stem retention components being exposed to the line media, such as disc screws and taper pins, which commonly result in leak paths, corrosion, and vibration failures. Disc screws or taper pins, due to wear and corrosion, often require difficult machining for disassembly. Disassembly of the Bray stem is just a matter of pulling the stem out of the disc. Without fasteners obstructing the line flow, the Series 30/31 C_V values are higher than many other valves, turbulence is reduced, and pressure recovery is increased. The stem ends and top mounting flange are standardized for interchangeability with Bray actuators.


Double "D" Connection

DISC (B) Casting is spherically machined and hand polished to provide a bubble-tight shut off, minimum torque, and longer seat life. The disc O.D. clearance is designed to work with all standard piping.

STEM BUSHING (D)

Non-corrosive, heavy duty acetal bushing absorbs actuator side thrusts.

STEM SEAL (E)

Double "U" cup seal design is self-adjusting and gives positive sealing in both directions. Prevents external substances from entering the stem bore.

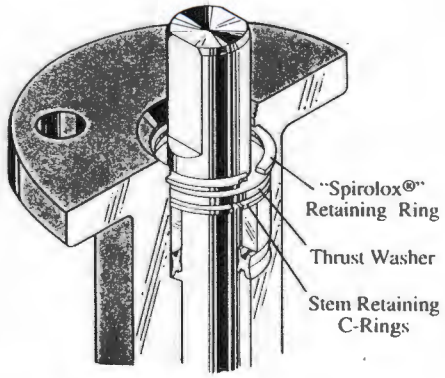
NECK (F) Extended neck length allows for 2" of piping insulation and is easily accessible for mounting actuators.

PRIMARY AND SECONDARY SEALS (G)

The Primary Seal is achieved by an interference fit of the molded seat flat with the disc hub. The Secondary Seal is created because the stem diameter is greater than the diameter of the seat stem hole. These seals prevent line media from coming in contact with the stem or body.

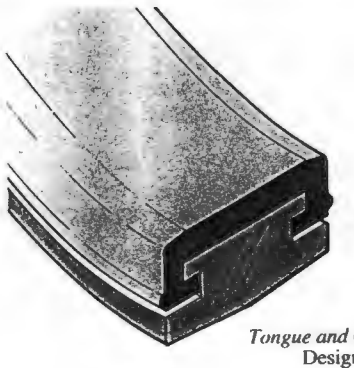
STEM RETAINING ASSEMBLY (C)

The stem is retained in the body by means of a unique Stainless Steel "Spirolox®" retaining ring, a thrust washer and two C-rings, manufactured from brass as standard, stainless steel upon request. The retaining ring may be easily removed with a standard hand tool. The stem retaining assembly prevents unintentional removal of the stem during field service.



BRAY UNIQUE SEAT DESIGN (H)

One of the valve's key elements is Bray's unique *tongue and groove* seat design. This resilient seat features lower torque than many valves on the market today and provides complete isolation of flowing media from the body. The tongue-and-groove seat to body retention method is superior to traditional designs, making field replacement simple and fast. The seat is specifically designed to seal with slip-on or weld-neck flanges. The seat features a molded O-ring which eliminates the use of flange gaskets. An important maintenance feature is


Tongue and Groove Design

*"Spirolox®" designation is a registered trademark of Kaydon Ring and Seal, Inc.

that all resilient seats for Bray butterfly valves Series 20, 21, 30, 31 and 34 are completely interchangeable.

ACTUATOR MOUNTING FLANGE AND STEM CONNECTION (I)
Universally designed to ISO 5211 for direct mounting of Bray® power actuators and manual operators.

FLANGE LOCATING HOLES (J)
Provide quick and proper alignment during installation.

BODY (K) One-piece wafer or lug style. Epoxy coating for excellent corrosion resistance. Bray valve bodies meet ANSI 150 pressure ratings for hydrostatic shell test requirements.

DESIGN FEATURES

Bray's Series 30 valve is a wafer version with flange locating holes, and the Series 31 is the companion lug version for dead-end service and other flange requirements. All Bray valves are tested to 110% of full pressure rating before shipment.

A major design advantage of Bray valve product lines is international compatibility. The same valve is compatible with most world flange standards – ANSI Class 125/150, BS 10 Tables D and E, BS 4504 NP 10/16, DIN ND 10/16, AS 2129 and JIS 10. In addition the valves are designed to comply with ISO 5752 face-to-face and ISO 5211 actuator mounting flanges. Therefore, one valve design can be used in many different world markets.

Due to a modular concept of design, all Bray® handles, manual gear operators and pneumatic and electric actuators mount directly to Bray valves. No brackets or adapters are required.

Bray interchangeability and compatibility offers you the best in uniformity of product line and low-cost performance in the industry today.

EPOXY COATING CORROSION PROTECTION Bray's standard product offers valve bodies with an epoxy coating, providing excellent corrosion and wear resistance to the valve's surface. The Bray epoxy coating is a hard, gloss red finish.

Chemical Resistance – resists a broad range of chemicals including: dilute aqueous acids and alkalies, salts, salt spray, petroleum solvents, alcohols, greases and oils. Offers outstanding resistance to humidity and water.

Weatherability – outdoor tested resistant to ultra-violet radiation.

Abrasion Resistance – excellent resistance to abrasion.

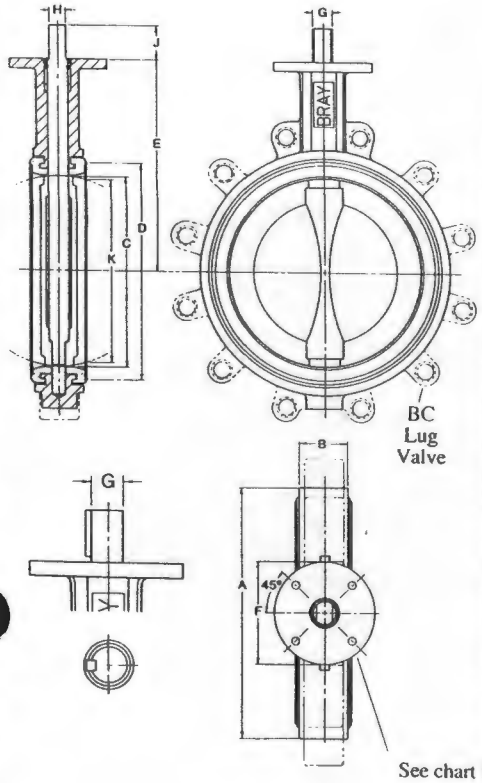
Impact Resistance – withstands impact without chipping or cracking.

NYLON 11 COATING

Optionally available for valve bodies where outstanding protection and performance is needed. A thermoplastic produced from a vegetable base, this coating is inert to fungus growth and molds. Nylon 11 is *USDA Approved*, as well as certified to ANSI/NSF 61 for water service.

Corrosion Resistance – superior resistance to a broad range of chemical environments. Salt spray tested in excess of 2,000 hours and seawater immersion tested for over 10 years without corrosion to metal substrates.

Nylon 11 features a very low coefficient of friction and excellent resistance to impact and ultra-violet radiation.



See chart for Actuator Mounting Flange Drilling.

DIMENSIONS SERIES 30 Wafer

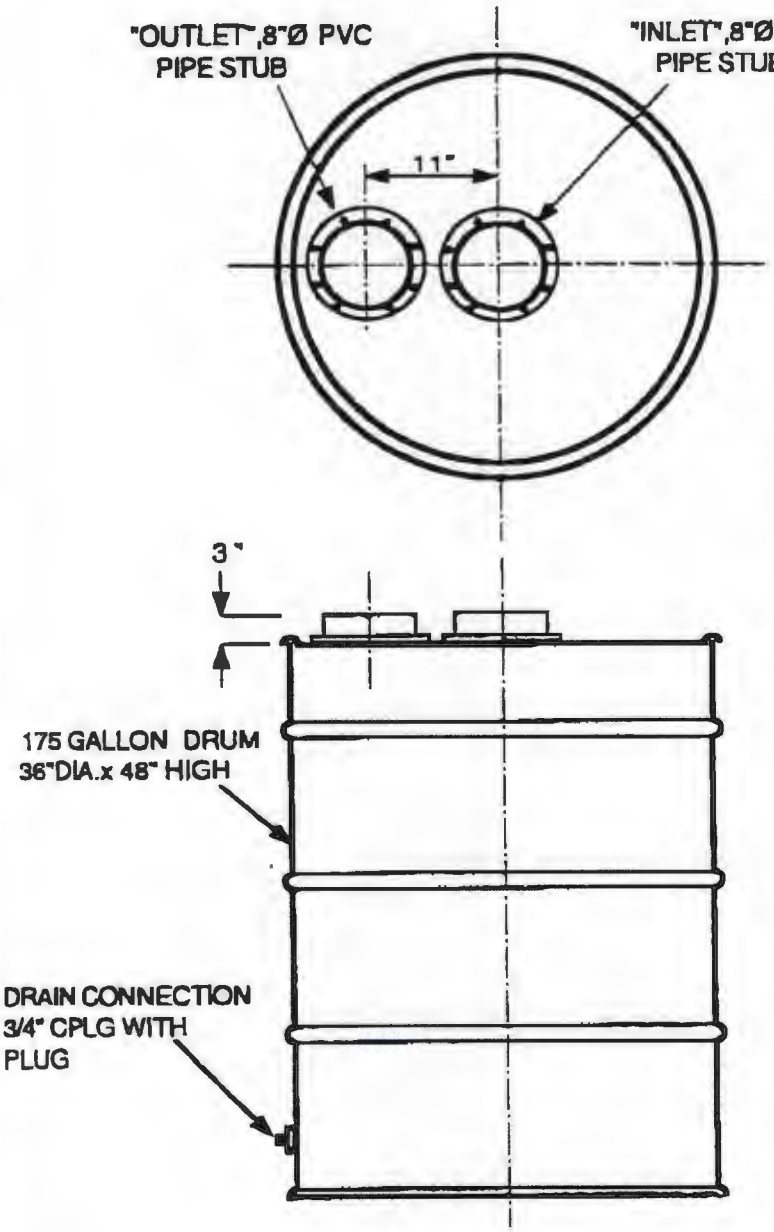
Valve Size ins	Valve Size mm	A	B	C	D	E	F	Mounting Flange Drlg. BC	No. Holes	Hole Dia.	G	H	J	K
2	50	3.69	1.62	2.00	2.84	5.50	3.54	2.76	4	.39	.55	.39	1.25	1.32
2½	65	4.19	1.75	2.50	3.34	6.00	3.54	2.76	4	.39	.55	.39	1.25	1.91
3	80	4.88	1.75	3.00	4.03	6.25	3.54	2.76	4	.39	.55	.39	1.25	2.55
4	100	6.06	2.00	4.00	5.16	7.00	3.54	2.76	4	.39	.63	.43	1.25	3.57
5	125	7.12	2.12	5.00	6.16	7.50	3.54	2.76	4	.39	.75	.51	1.25	4.63
6	150	8.12	2.12	5.75	7.02	8.00	3.54	2.76	4	.39	.75	.51	1.25	5.45
8	200	10.50	2.50	7.75	9.47	9.50	5.91	4.92	4	.57	.87	.63	1.25	7.45
10	250	12.75	2.50	9.75	11.47	10.75	5.91	4.92	4	.57	1.18	.87	2.00	9.53
12	300	14.88	3.00	11.75	13.47	12.25	5.91	4.92	4	.57	1.18	.87	2.00	11.47

Valve Size ins	Valve Size mm	A	B	C	D	E	F	Mounting Flange Drlg. BC	No. Holes	Hole Dia.	G	J	KEY SIZE	K
14	350	17.05	3.00	13.25	15.28	13.62	5.91	4.92	4	.57	1.38	2.00	.39x.39	13.04
16	400	19.21	4.00	15.25	17.41	14.75	5.91	4.92	4	.57	1.38	2.00	.39x.39	14.85
18	450	21.12	4.25	17.25	19.47	16.00	8.27	6.50	4	.81	1.97	2.50	.39x.47	16.85
20	500	23.25	5.00	19.25	21.59	17.25	8.27	6.50	4	.81	1.97	2.50	.39x.47	18.73

SERIES 31 Lug

Lug Bolting Data BC	No. Holes	Threads UNC-2B
4.75	4	5/8-11
5.50	4	5/8-11
6.00	4	5/8-11
7.50	8	5/8-11
8.50	8	3/4-10
9.50	8	3/4-10
11.75	8	3/4-10
14.25	12	7/8-9
17.00	12	7/8-9

Lug Bolting Data BC	No. Holes	Threads UNC-2B
18.75	12	1-8
21.25	16	1-8
22.75	16	1 1/8-7
25.00	20	1 1/8-7



SPECIFICATIONS

Model:	G-11
Design flow - max.:	1500 CFM
Design Features:	
Pressure Drop:	8.5" w.c.@ 1500 CFM
Operating Pressure:	5 psi
Carbon:	500 lbs vapor phase carbon 4 x 8 mesh
Canister:	36" Dia. x 48" steel drum, PVC internals
Connections:	Inlet-8" Ø PVC pipe stub in cover Outlet-8" Ø PVC pipe stub in cover
Shipping Weight:	675 lbs
Availability:	4-6 weeks

CARBTROL®
CORPORATION

51 RIVERSIDE AVENUE
WESTPORT CONN. 06880
(203) 226-5642

SCALE ----		BY WH
DATE 10-8-98		REV 6-14-00

G-11 VAPOR PHASE ADSORBER

RADIAL-500 LBS 4 X 8 GAC

ARRANGEMENT	**S**	DWG **3713/1**

CARBTROL®

AIR PURIFICATION CANISTERS 140-200 LB. ACTIVATED CARBON

G-1
G-2
G-3

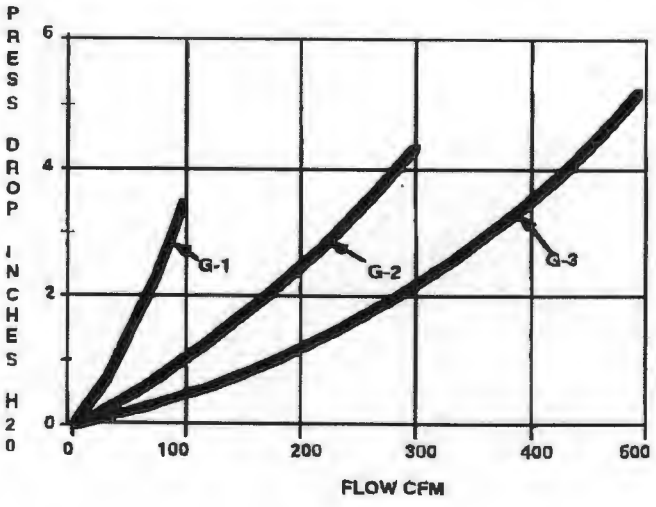
The CARBTROL "G" Canisters handles flows up to 500 CFM.

FEATURES

- High activity carbon.
- Epoxy lined steel or polyethylene construction.
- Acceptable for transport of hazardous spent carbon.
- Side drain for removal of accumulated condensate.
- Low pressure drop.
- PVC internal piping.
- High temperature (180°F) steel units available.

APPLICATIONS

- Soil vapor remediation
- Air stripper exhausts
- Tank vents
- Exhaust hoods
- Work area purification
- Sewage plant odor control



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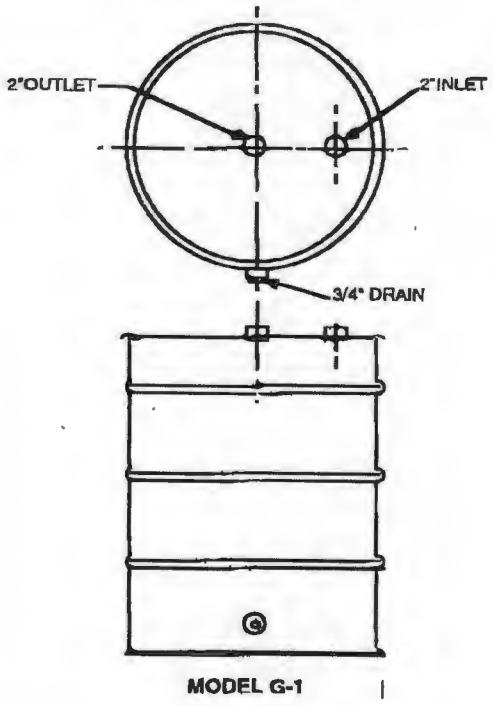
CARBTROL® CORPORATION
51 Riverside Avenue
Westport, CT 06880
1-800-242-1150 • Fax # (203) 226-5322
Web Address: http://www.carbtrol.com

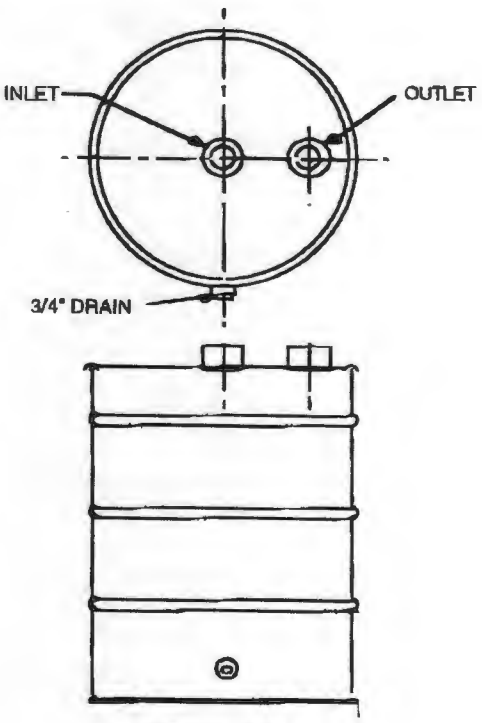
CARBTROL®

AIR PURIFICATION CANISTERS
140-200 LB. ACTIVATED CARBON

G-1
G-2
G-3



MODEL G-1



MODEL G-2,G-3

SPECIFICATIONS

MODEL	DIAMETER/HEIGHT	CARBON WEIGHT	INLET/OUTLET	MAXIMUM RATED FLOW	APPROXIMATE SHIP WEIGHT
G-1*	24"/36"	200 lbs.	2"/2"	100 CFM	240 lbs.
G-2*	24"/36"	170 lbs.	4"/4"	300 CFM	210 lbs.
G-3P	24"/36"	140 lbs.	6"/6"	500 CFM	180 lbs.
G-3S	24"/34"	140 lbs.	4"/4"	500 CFM	180 lbs.

* Specify: Polyethylene (P) or Epoxy Lined Steel (S)

SAFETY

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

CARBTROL® CORPORATION
51 Riverside Avenue
Westport, CT 06880
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APPENDIX D

Citizen Participation Fact Sheet

SITE LOCATION AND HISTORY

The Harmon Railroad Yard Wastewater Lagoon Inactive Hazardous Waste Disposal Site (NYSDEC No. 360010) is located in Croton-on-Hudson, Westchester County, New York, as shown on Figure 1. The Harmon Railroad Yard is an approximately 100-acre maintenance and repair yard. The wastewater lagoon site, as shown on Figure 2, consists of less than 8 acres and is located within the boundaries of Harmon Yard. The facility has been operated since 1983 by Metro-North Commuter Railroad (Metro-North). Harmon Railroad Yard was operated by Consolidated Rail Corporation (Conrail) between 1976 and 1982.

In 1980, polychlorinated biphenyls (PCBs) were discovered in the effluent discharge from the Old Wastewater Treatment Plant. The source of PCBs was identified as the maintenance areas in the Harmon Shop where transformers were then being serviced. Since the treatment process at that time was not capable of removing PCBs, portions of the Old Wastewater Treatment Plant, its appurtenances, and the lagoon and pond became contaminated with PCBs.

In September 1992, the New York State Department of Environmental Conservation (NYSDEC) issued a Record of Decision (ROD) which specified the remedy to be implemented in remediating the Old Wastewater Treatment Plant and the wastewater lagoon. That remedy called for the removal and incineration of the sludge at an off-site treatment facility and the removal and off-site disposal of soil containing PCBs above the specified cleanup level. The remediation of the Old Wastewater Treatment Plant components and the lagoon was designated as Operable Unit I (OU-I). Construction of the OU-I remedy was completed in 1996. As part of the remedy, the area of the former lagoon was filled and paved.

The ROD for OU-I stated that following completion of the remedy for OU-I, an investigation and, if necessary, remediation of Operable Unit II (OU-II) would be performed. The OU-I ROD called for an investigation of possible past releases from the Old Wastewater Treatment Plant and the lagoon on ground water, surface water and Hudson River sediment. The components of the OU-II investigation are shown on Figure 3. The OU-I ROD required that the results of this investigation be used to determine if additional actions were needed. The additional actions considered in the OU-I ROD included preparing a feasibility study, issuing a second operable unit ROD and performing the remedial actions outlined in an OU-II ROD. In response, Metro-North conducted a Remedial Investigation (RI) of the OU-II Site. Based on the results of the RI, the NYSDEC decided that it was appropriate to prepare a Feasibility Study (FS) reviewing remedial measures for OU-II and to issue a ROD for OU-II. Metro-North prepared and submitted a final FS to the NYSDEC in January 1998. The FS developed and evaluated five remedial action alternatives and identified a proposed remedial action alternative to address environmental

conditions at the OU-II Site. The NYSDEC prepared a Proposed Remedial Action Plan (PRAP) based on the information provided in the combined OU-II RI/FS report. A public meeting was held on February 26, 1998, to present the findings of the RI/FS and to discuss the preferred remedial action selected in the PRAP. The OU-II ROD, which identified Vacuum Enhanced NAPL Removal (VENR) as the selected remedy, was issued on March 27, 1998.

RESULTS OF THE RI/FS AND REMEDIAL ACTION OBJECTIVES FOR THE OU-II SITE

The RI characterized the following environmental media:

- Ground water in the vicinity of the former lagoon;
- Soil adjacent to the former discharge line from the Old Wastewater Treatment Plant to Croton Bay, located adjacent to the Hudson River;
- Sediment in Croton Bay; and
- A layer of petroleum that is located above the water table adjacent to the former lagoon. This material is referred to as non-aqueous phase liquid (NAPL).

The findings of the OU-II RI and the subsequent risk assessment were used to conclude that: (1) remediation of the soil along the former discharge line, ground water and OU-II Croton Bay sediment at the OU-II Site was not required; and (2) actions were needed to address OU-II NAPL. Based on a review of the potential risks and the regulatory requirements related to the presence of OU-II NAPL, the following remedial action objectives were established for OU-II NAPL:

- To prevent further off-site migration of OU-II NAPL;
- To remove OU-II NAPL to the extent practicable; and
- To continue to prevent direct contact with subsurface OU-II NAPL in the vicinity of the former lagoon.

The presence of the NAPL layer in the soil above the water table in the vicinity of the former lagoon was monitored at various times as part of the OU-II RI beginning in November 1994. The NAPL that is present at the OU-II Site is not soluble in water and its density is less that that of water. Hence, it is found as a separate liquid layer above the water table. The extensive monitoring conducted as part of the OU-II RI delineated the extent of NAPL at the OU-II Site. As shown on Figure 5, NAPL has been observed in four areas around the lagoon, referred to as NAPL Areas L1 through L4.

The majority of the NAPL is comprised of diesel fuel petroleum-related organic compounds. PCBs and inorganic constituents have been detected in this material at relatively low concentrations. Most of the PCB concentrations are below the NYSDEC recommended soil cleanup objective of 10 parts per million. Only one NAPL sample, collected from NAPL Area L4 during the OU-II investigation,

contained PCBs at a concentration higher than 10 parts per million. This sample contained PCBs at a concentration of 23 parts per million. Analysis of samples collected from all four NAPL areas determined that this material is a severely degraded diesel fuel and that most of this NAPL has been present at the OU-II Site for over 20 years. This pre-dates the creation of Metro-North in 1983.

SELECTED REMEDIAL ACTION

Alternative V, Vacuum Enhanced NAPL Removal (VENR), was selected as the preferred remedial action alternative in the OU-II FS, which was submitted to the NYSDEC on January 14, 1998. Based on an evaluation by the NYSDEC and the positive responses received during the February 26, 1998 public meeting and the comment period, the NYSDEC selected Alternative V, VENR, as the remedial action alternative to be implemented at the OU-II Site. This selection is defined in the NYSDEC ROD for the OU-II Site dated March 27, 1998.

VENR is an innovative NAPL remediation technology that combines physical NAPL recovery, in-situ biodegradation of primarily petroleum-related organic compounds and vapor extraction of volatile compounds. In VENR applications, air, which is supplied to the formation through air inlet wells, is drawn through the subsurface soil using a series of vacuum wells. This induced air flow:

- transports free phase NAPL through subsurface soil to the recovery wells where the organic compounds, in particular the petroleum-related organic compounds that comprise OU-II NAPL, are then removed from the recovery wells;
- promotes the biodegradation of the NAPL in the unsaturated zone above the NAPL layer (i.e., residual saturation) through the introduction of oxygen: and
- promotes the volatilization of volatile organic compounds in the OU-II NAPL.

PILOT STUDIES

As a condition of the OU-II ROD, pilot testing of the VENR technology was required prior to commencement of the Remedial Design. This testing was conducted to confirm the effectiveness of the VENR technology for remediation of the OU-II NAPL and to collect the information needed to prepare the Remedial Design.

The VENR pilot testing was conducted at the Site in the spring and summer of 1999. During this testing, VENR with and without ground water removal was evaluated. Pilot testing of treatment systems for the recovered soil gas, NAPL and ground water was also conducted at this time.

Under either VENR method (i.e., with or without ground water removal), the well is sealed and soil gas is withdrawn from the formation under vacuum conditions. The withdrawal of soil gas promotes the transport of NAPL into the recovery wells. The

difference between the two NAPL removal methods is the manner in which they transfer the NAPL from the well to an aboveground storage vessel. The VENR method that removes ground water utilizes a drop tube placed above the ground water interface within the NAPL layer to simultaneously remove NAPL and soil gas from the recovery well. Due to vacuum control limitations, significant amounts of ground water are generally recovered along with the NAPL and soil gas using this method.

As discussed earlier, ground water at the OU-II Site does not pose any unacceptable risks to human health or the environment. Only very low concentrations of organic compounds or other Site-related constituents have ever been detected in this ground water. Ground water removal was tested as part of a VENR system solely to evaluate its potential to facilitate the removal of NAPL.

The second VENR method tested removes NAPL and soil gas only and does not require the removal, treatment and discharge of ground water. The second VENR method removes soil gas under vacuum conditions from the well through a suction line installed at the top of the well. The NAPL that is induced by the vacuum to accumulate in the well is then removed using a NAPL-only pump installed in the well. This significantly reduces the amount of ground water that is recovered with the NAPL. In some cases, this type of system is able to remove only NAPL and soil gas and no ground water is removed.

The results of the pilot tests were documented in the OU-II Pilot Testing Results Report (PTRR), dated July 1999 and in the Addendum to the PTRR, dated 18 October 1999. In summary, the pilot tests confirmed that VENR would be an effective technology to remove OU-II NAPL. The collective pilot testing results documentation (i.e., the PTRR, Addendum No. 1 to the PTRR and ERM's responses to NYSDEC's comments on the PTRR) and adoption of the VENR as the OU-II remedy were approved by NYSDEC on 10 November 1999.

REMEDIAL DESIGN

Based on the pilot test results, the design criteria and the OU-II remedy components were finalized. These design criteria included: well spacing, extraction rates, VENR techniques, and the number of ground water monitoring wells.

The components of the OU-II remedy are:

- annual ground water monitoring in two OU-II perimeter ground water monitoring wells;
- continued access and use restrictions through existing Metro-North procedures;
- site preparation;
- installation of a vertical sheeting barrier in NAPL Area L1;

- installation of VENR systems in the four OU-II NAPL areas (e.g., NAPL recovery wells equipped with VENR systems and air injection/inlet wells in all four NAPL areas);
- off-Site disposal of construction-related waste materials;
- Site restoration following construction;
- operation and maintenance (O&M) of the VENR systems; and
- off-Site disposal of recovered OU-II NAPL.

The OU-II Engineer's Report was submitted to NYSDEC on 17 February 2000 and the 95% Remedial Design Submittal was submitted to NYSDEC on 28 July 2000. Once the design had been approved by the NYSDEC, the bid documents will be prepared and Metro-North will advertise the project and solicit bids. Metro-North will evaluate the bids received and will select the contractor (bidder) to perform the work. The anticipated date when the construction of the OU-II remedy is expected to begin is 1 March 2001.