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FINAL WORK PLAN

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

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Prepared for:

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

Prepared by:

Foster Wheeler Environmental Corporation
8 Peach Tree Hill Road
Livingston, New Jersey 07039

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1	1/27/98	R. DeGiorgio W. DeMaio	M. Lindhardt	

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LIST OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIH	Certified Industrial Hygienist
CLEAN	Comprehensive Long Term Environmental Action Navy
CMP	Complete Manifest Package
CPM	Critical Path Method
CSV	Carbon Tetrachloride Number
CTO	Contract Task Order
DO	Delivery Order
EHS	Extremely Hazardous Substance
EPCRA	Emergency Planning and Community Right-to-Know Act
GAS	Granular Activated Carbon
HVAC	Heating, Ventilation and Air Conditioning
LEL	Lower Explosion Limit
LEPC	Local Emergency Planning Committee
MS	Matrix spike
MSD	Matrix spike duplicate
NRC	National Response Center
NWIRP	Naval Weapons Industrial Reserve Plant
NYSDEC	New York State Department of Environmental Conservation
O&M	Operation and Maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
PCE	tetrachloroethene
PRGs	Preliminary Remediation Goals
PPE	Personal Protective Equipment
PQCM	Program QC Manager
PLCs	Programmable Logic Controllers
QC	Quality Control
QCPM	Quality Control Program Manager
RAC	Remedial Action Contract
SAP	Sampling and Analyses Program
SHSO	Site Health and Safety Officer
SHSP	Site Health and Safety Plan
SPEM	Senior Project Engineer/Manager
SQCM	Site QC Manager
SQCP	Site Quality Control Plan
SVE/AS	Soil Vapor Extraction/Air Sparging
SVOCs	Semi-Volatile Organic Compounds
T&D	Transportation and Disposal
TAL	Target Analyte List

LIST OF ACRONYMS (Cont'd)

TBCs	To Be Considered
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TOX	Total Organic Halogens
USEPA	United States Environmental Protection Agency
VOC	volatile organic compounds
USCS	Unified Soil Classification System

1. WORK DESCRIPTION

Foster Wheeler Environmental Corporation (Foster Wheeler) has prepared this Work Plan for remediation of volatile organic compounds (VOC) in soil at the project site, located at the Naval Weapons Industrial Reserve Plant (NWIRP) in Bethpage, NY. The Work Plan has been prepared for Delivery Order (DO) No. 0004 under Remedial Action Contract (RAC) # N62472-94-D-0398.

1.1 Narrative

1.1.1 Site Introduction

NWIRP-Bethpage is a 108-acre site located in Nassau County on Long Island, New York, approximately 30 miles east of New York City. The site is bordered on the north, west, and south by the Grumman Aerospace complex, which covers approximately 605 acres, and on the east by a residential neighborhood. NWIRP-Bethpage is currently listed by the New York State Department of Environmental Conservation (NYSDEC) as an "inactive hazardous waste site" (#1-30-003B), as is the Northrop Grumman Corporation (#1-30-300A) and the Hooker/Ruco site (#1-30-004), located less than 1/2 mile west of NWIRP-Bethpage.

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

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

The remediation to be performed under DO 0004 involves contaminated soil at Site 1, which is the entire former drum marshaling area. Site 1- Former Drum Marshaling Area occupies approximately four acres. It contains a concrete storage pad and an abandoned cesspool leach field. It is surrounded on three sides by a fence and on the fourth side by Plant No. 3. The site is relatively flat, with the eastern portion covered with bare sandy soils, gravel, grass and one concrete pad. The western portion of the site is predominantly covered with concrete. A vegetated wind row (pine) and fence are present along the eastern edge of the site to reduce community visibility.

Haliburton NUS conducted a remedial investigation in 1992 and 1993 for the Navy to investigate potential sources of VOC contamination. Based upon this investigation, a source of the groundwater contamination at Site 1 was determined to originate near the former drum marshaling pads. All shallow groundwater samples collected south of the Former Cinder Drum Marshaling Pad, and a few shallow groundwater samples collected north of the pad, exhibited VOC contamination. However, this area of groundwater contamination also coincides with the location of cesspools at the site. The cesspools could also be a source of VOC contamination.

Soil testing during the remedial investigation determined that Site 1 soils contained VOC, polychlorinated biphenyls (PCB) and arsenic contamination. Subsequent soil testing by Foster Wheeler in 1995 at the site confirmed the presence of PCB and VOC contamination; however, the arsenic contamination could not be confirmed. In addition, testing of the cesspool contents resulted in higher concentrations of VOCs and PCBs in the cesspools than in the surrounding soil, and revealed the presence of cadmium. Additionally, occurrences of various polycyclic aromatic hydrocarbon (PAH) compounds, phenolic compounds and pesticides were present at Site 1 at relatively low concentrations.

Table 1-1 summarizes the maximum VOC contamination identified at the project site. PCBs, pesticides, semi-volatile organics and metals were also detected at the site, but will not be addressed by this phase of remedial action. See Section 1.2 for site maps and figures.

The concentration levels for soil are based on pre-excavation samples collected by Foster Wheeler which were analyzed by Toxicity Characteristic Leaching Procedure (TCLP). Due to the excessive depths of contamination, excavation was not completed. The TCLP value is multiplied by 20 to approximate maximum concentrations. The exception is tetrachlorothene (PCE) which was provided by CF Braun sampling at the conclusion of the soil vapor extraction/air sparging (SVE/AS) pilot study. All groundwater data are provided by CF Braun.

Table 1-1 Summary of Maximum VOC Contamination

Media	Maximum Levels of VOCs	Extent
Soil	TCE = 158 mg/kg PCE = 660 mg/kg 1,2-DCA = 1.4 mg/kg 1,2-DCE = 9 mg/kg 1,1-DCE = 0.016 mg/kg 1,1,1-TCA = 13 mg/kg	• Area approximately 4 acres • Maximum depth of soil samples was 40 feet bgs • Depth of contamination varies throughout the site
Groundwater	TCE = 1,500 ug/l PCE = 11,000 ug/l 1,2-DCA = 880 ug/l 1,2-DCE = 3,600 ug/l 1,1-DCE = 250 ug/l 1,1,1-TCA = 10,000 ug/l	• Water table is at 55 feet bgs. • Groundwater contamination extends throughout the entire project site.

Site characteristics based on previous investigations are summarized in Table 1-2.

Table 1-2 Site Characteristics

Topography	Relatively flat, with ground surface elevations ranging from 124 to 132 mean sea level (msl)
Geology	Medium to coarse sand and gravel Clay lens exists approximately 5 feet above water table
Hydrogeology	Water table is 55 ft or more bgs
Permeability Data (from pilot test)	Radius of Vacuum Influence = ~50 ft Radius of Injection Influence = ~30 ft Flow = 10 scfm Vacuum = 0.05 inches water

1.1.2 Project Basis

The basis for this project is the SVE/AS pilot study conducted by CF Braun Engineering Corporation under the CLEAN contract from April to September, 1997. The system design analysis and testing results are summarized in:

- Design Analysis Report for Air Sparging/Soil Vapor Extraction System at Site 1 - Former Drum Marshaling area, CF Braun, September, 1997; and
- Draft Results Letter Report for Air Sparging/Soil Vapor Extraction System at Site 1 - Former Drum Marshaling Area, CF Braun, October, 1997.

1.1.3 Project Objectives

The objective of this project is to reduce the VOC contamination in the soil at Site 1 to acceptable levels in the most cost-effective manner. Specific objectives include the remediation of the soil to the Preliminary Remediation Goals (PRGs) for the site (from CF Braun Design Analysis Report, above). The soil will be remediated by in-situ soil vapor extraction and air sparging. During the soil remediation, it is expected that the air sparging will also remediate groundwater contamination under the site.

1.1.4 Action Levels

The preliminary remediaton goals are provided in the Design Analysis Report, October 1997. The PRGs are presented in Table 1-3.

Table 1-3 Site Cleanup Levels

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

[1]No standard has yet been developed

[2]Groundwater PRG's have not been finalized

1.1.5 Summary of Activities

Subsequent to approval of the Work Plan, the Project Superintendent, assisted by a purchasing specialist, will begin the procurement process. He will identify materials, equipment, and subcontracts, provide specifications for the procurement packages, review bids and proposals, and recommend awards to the Project Manager.

Upon plan approval, the Project Manager and Project Superintendent will attend the preconstruction meeting to discuss schedule, quality control (QC) issues and coordinate site activities with NWIRP-Bethpage personnel.

For this project, the electrical and telephone distribution work will begin prior to full mobilization. As this task nears completion, the Project Superintendent/Site Health and Safety Officer (SHSO) and Field Geologist will mobilize to the site. Local field labor includes the equipment operator and two laborers. As needed, additional labor including the Field Engineer/Site QC Manager (SQCM) will be mobilized for specific tasks.

As the temporary support facilities are being set up, the Field Geologist will locate the proposed well locations and mark each location with a wooden stake.

The air inlet and extraction wells will be installed, developed and sampled. The treatment equipment will be installed in the existing building, piping completed and start-up performed over a one-month period. Based on groundwater sample results from the soil vapor extraction wells and the one existing monitoring well, up to four monitoring wells will be located and installed.

The system is expected to run for two years. Operation and maintenance (O&M) will be performed by a Field Engineer or Field Technician who will visit the site weekly.

Subsequent to receipt of the verification sample results, all temporary support facilities will be demobilized. Final submittals, including the Project Close-Out Report, will be provided to the Navy.

1.1.5.1 Task 1 - Mobilization and Site Preparation

Premobilization activities include preparation of preconstruction submittals. This Work Plan is the primary component of this subtask. Other preconstruction submittals include a site health and safety plan (SHSP) addendum, site quality control plan (SQCP), air permit application ("review purposes only") and draft operation and maintenance (O&M) manual. The SHSP and the SQCP are being prepared concurrently with this Work Plan. The air permit application will be prepared subsequent to approval of the Work Plan and will be prepared to assure that substantive permitting requirements will be met. It has been assumed that an actual air discharge permit is not required.

This phase includes mobilizing all personnel and equipment to the site, as well as setting up temporary support facilities and utilities.

As part of this task, we will coordinate a preconstruction meeting with the Navy ROICC, Project Manager, Project Superintendent, the Navy RPM, the Navy Design NTR, and any other activity or NORTHDIV personnel. The purpose of this meeting is to develop a mutual understanding of the construction activities, the SQCP details including forms to be used, site security requirements, administration of on-site work, coordination of the construction management and production, and finalizing construction schedules. The submittal register will be reviewed. Any subcontracts and subcontractors will be identified. The Project Superintendent and Field Geologist will mobilize initially. The Field Engineer will mobilize to support pipe installation and treatment system construction. Local union labor will be hired as needed.

No trailers are intended to be brought onto the site. Two offices in the treatment building will be furnished and used for this purpose. A small building adjacent to the treatment building will be designated for laydown and storage of equipment and materials. The construction field office

furniture/equipment will be mobilized to support the beginning of field activities. The office will utilize the existing electrical service at this building. Temporary telephone services will be connected and energized using cellular phones. Temporary sanitary facilities will be subcontracted after the Northrup Grumman facility has shut down and permanent sanitary facilities are no longer available. This is expected to occur during the O&M phase of the project. Office machines, if necessary, will be mobilized at this time. Construction equipment, services, and materials will be mobilized in a timely manner to support the construction program.

Based on Foster Wheeler conversations with Navy personnel, the existence of underground utilities is limited to a water main that runs along the northern perimeter of the site. Since the exact location of this pipe can not be verified, a utility locator will be utilized to perform a mark out. As an added precaution, the One Call Service will be contacted.

A personnel decontamination area and an equipment decontamination area will be set up adjacent to the area near the potable water source of the building. Since the majority of this project involves clean construction, decontamination is anticipated only during drilling and sampling activities. A series of 55-gallon drums will be used to store decontamination water prior to disposal. The decontamination area will be set up on a relatively flat area adjacent to the work area. It will be constructed with polyethylene liner installed over an earthen berm or hay bales. The bottom will be sloped to one end to function as a sump. If necessary, a small sump pump will be provided to pump the collected water to 55-gallon drums placed on pallets. The contents of the drums will be pumped for disposal. Traffic control, consisting of barricades and safety tape, will be erected around the work areas in accordance with traffic control requirements.

1.1.5.2 Task 2 - Monitoring, Sampling, Testing, and Analysis

In order to verify the effectiveness of the remedial activities, a sampling and analysis program will be implemented. A detailed sampling and analysis plan is provided in Section 2.

Sampling and analysis of the target compounds will be according to Table 1-5. The methodology employed to measure TCL VOCs will be EPA 8260A for the soil and water matrices. The gas samples will employ T01 and T02 sampling and analytical methodology using adsorption tubes and air sampling pumps. The laboratory reporting protocol will be NYS "Category B", as applicable. The turn around time is three weeks.

Trip and Field Blanks are included as estimated below. Matrix spike (MS) and matrix spike duplicate (MSD) estimates are also included in the table below.

Table 1-5 Sampling and Analysis Schedule Summary

Matrix	Baseline	M1	M2	Q1	M4	M5	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q10	Total
Soil Borings	11						11		11		11		11		55
Trip Blank	5						5		5		5		5		25
Field Blank	1						1		1		1		1		5
MS, MSDs	1						1		1		1		1		5
TOTAL															90
Groundwater	15			6			6	6	6	6	6	6	6	20	83
Trip Blank	3			2			2	2	2	2	2	2	2	5	24
Field Blank	1			1			1	1	1	1	1	1	1	1	10
MS, MSDs	1			1			1	1	1	1	1	1	1	1	10
TOTAL															127
Vapor (Gas)	16	16	16	4	4	4	4	4	4	4	4	4	16		100
Trip Blank	-	-	-	-	-	-	-	-	-	-	-	-	-		0
Field Blank	-	-	-	-	-	-	-	-	-	-	-	-	-		0
MS, MSDs	-	-	-	-	-	-	-	-	-	-	-	-	-		0
TOTAL															100

M = Month
Q = Quarter

1.1.5.2.1 Monitoring Wells

Four new monitoring wells may be installed at the southern edge of the site to monitor the groundwater leaving the site. The necessity for, and locations of, these monitoring wells will be determined based on the results of the groundwater samples collected, prior to the start of the remediation, from the soil vapor extraction wells and the one existing monitoring well. The groundwater sample results obtained from these new monitoring wells will be used to monitor the effectiveness of the air sparging component of the system.

The groundwater monitoring wells will be drilled to a depth of approximately 65 feet below ground surface (bgs) by a licensed New York State driller using 4.25- to 6.25-inch hollow-stem augers. Split-spoon samples will be collected every five feet from the ground surface to the water table, which corresponds to approximately 55 feet bgs. The split-spoon samples will be collected to identify the possible presence of significant clay lenses which would impact the capture of injected air. Drill cuttings will be containerized in drums and staged on-site for characterization prior to disposal. In order to reduce the amount of waste material requiring disposal, the drill cuttings will be segregated based on the location of the well from which they were derived. The drill cuttings will be segregated into potential RCRA-hazardous, potential TSC-hazardous, and potential non-hazardous, and will be characterized for disposal accordingly.

Each groundwater monitoring well will be constructed of 2-inch diameter Schedule 40 PVC casing with 15 feet of 0.020-inch screen extending from five feet above the water table to ten feet below the water table. A sand pack of No. 2 silica sand will be installed from the bottom of the well screen to one foot above the top of the screen, followed by a two-foot thick bentonite seal. The

remainder of the borehole will be filled with a cement/bentonite grout. The top of the casing will extend to approximately two feet above the ground surface and will be capped with a threaded PVC cap.

Each monitoring well will have a vented cap and a protective steel casing with a hinged, locking cap placed over the monitoring well. The protective casing will extend at least two feet below ground surface and will be cemented in place. A concrete pad, approximately two feet square will be constructed around each monitoring well, sloped to channel water away from the well, and installed deep enough to remain stable during freezing and thawing of the ground. A drain hole will be drilled at the base of the protective casing to allow water between the inner and outer casings to drain.

1.1.5.2.2 Well Development

The soil vapor extraction wells, air injection wells, and groundwater monitoring wells will be developed a minimum of 24 hours after completion of each well installation. The wells will be developed using a disposable polyethylene bailer, centrifugal pump with dedicated polyethylene tubing, or positive displacement foot-valve pump with dedicated polyethylene tubing. Development water will be monitored for organic vapors with a photoionization detector (PID). The development water will be containerized in drums and staged on-site for characterization prior to disposal. In order to reduce the amount of waste material requiring disposal, the development water will be segregated based on the location of the well from which it was derived. The development water will be segregated into potential RCRA-hazardous, potential TSCA-hazardous, and potential non-hazardous, and will be characterized for disposal accordingly.

Well development will proceed by repeatedly removing volumes of water from the well until the discharged water is relatively sediment free. Development effectiveness will be monitored at regular intervals (after each well volume is removed) using a portable turbidity meter. In addition, pH, temperature, and conductivity measurements will be obtained during development and recorded in the field logbook. Well development will be discontinued either when the turbidity of the discharged water reaches the development goal of 50 NTUs or when the turbidity level stabilizes indicating that additional development will be ineffective.

Following development, the wells will be allowed to recover for at least one week before groundwater is purged and sampled. Monitoring well development will be performed by the licensed driller and will be supervised by the Field Geologist. All measurements and well information collected during the development will be recorded in the field logbook and on well development forms.

1.1.5.2.3 Air Monitoring and Testing

Headspace analysis, using a photoionization detector, will be performed during all drilling activities. Extracted vapor sampling will be conducted on a weekly basis to estimate the efficiency of the extraction process.

1.1.5.2.4 Wastewater Sampling

All decontamination water generated during the remedial activities will be containerized in 55-gallon drums. Development water generated during well development and purge water generated during groundwater sampling also will be containerized in 55-gallon drums. Condensate generated by the SVE system will be transferred from the 500-gallon moisture separator to 55-gallon drums. Samples of the decontamination, purge and development water and condensate will be collected and analyzed prior to disposal.

1.1.5.2.5 Soil Sampling

Soil sampling for lithologic purposes will be conducted during well installation to assist with the horizontal and vertical placement of the wells.

Verification soil sampling using a Geoprobe® drill rig will be performed during O&M and following the completion of the remediation to ensure the cleanup objectives have been achieved.

1.1.5.2.6 Laboratory Chemical Analysis

The samples collected for analysis will be analyzed by Navy-approved and state-certified analytical laboratories as described in Section 2 and in the SQCP.

1.1.5.3 Task 3 - Physical Treatment - SVE/AS

This subtask encompasses all portions of vapor handling including extraction wells, air inlet wells, and associated piping.

1.1.5.3.1 Air Sparge Well Installation

Eleven air injection wells will be installed to induce air flow through the shallow groundwater, as well as through the soils at the groundwater/soil interface. This flow will cause VOCs in these media to volatilize and be collected by the soil vapor extraction system.

The air injection wells will be drilled to a depth of 65 feet bgs by a licensed New York State driller using 4.25- to 6.25-inch hollow stem augers. Split-spoon samples will be collected every five feet from the ground surface to 10 feet above the water table, or approximately 45 feet bgs. Continuous split-spoon samples will be collected from 10 feet above the water table to 10 feet below the water table. This interval represents the critical flow path for air from the air injection wells to the soil vapor extraction well screens. Drill cuttings will be containerized in drums and staged on-site for characterization prior to disposal. In order to reduce the amount of waste material requiring disposal, the drill cuttings will be segregated based on the location of the well from which they were derived. The drill cuttings will be segregated into potential RCRA-hazardous, potential TSCA-hazardous, and potential non-hazardous, and will be characterized for disposal accordingly.

The soil samples will be visually classified by the Field Geologist according to the Unified Soil Classification System (USCS). Detailed lithologic logs for each well will be recorded in the field logbook and on a standardized Boring Log form. All field observations, including blow counts,

PID readings, evidence of contamination, and description of moisture content, will be recorded in the field logbook and on the Boring Log form.

The split-spoon samples will be collected in order to identify the possible presence of significant clay lenses above and below the water table, which is a concern for the successful operation of the air sparging system. If clay is detected in this zone, an air injection well will not be installed at this depth unless the air flow pathway to a soil vapor extraction well can be confirmed. If necessary, the air injection well will be installed at a higher elevation (i.e., just above the clay lens) or a location adjacent to the clay lens.

Each injection well will be constructed of 2-inch diameter Schedule 40 PVC casing with two feet of 0.020-inch screen extending from 8 to 10 feet below the water table. A sand pack of No. 2 silica sand will be installed from the bottom of the well screen to one foot above the top of the screen, followed by a two-foot thick bentonite seal. The remainder of the borehole will be filled with a cement/bentonite grout. Each injection well will be completed with a PVC "T" and a removable cap. The well casing will extend approximately six inches above the ground surface to allow access into the well for cleaning, water level measurements, and groundwater sampling. Each well also will have a sample port to allow for measurements of air velocity and pressure. This port will be located two feet from valves and fittings which could interfere with velocity measurements.

1.1.5.3.2 Extraction Well Installation

Thirteen soil vapor extraction wells will be installed to: (1) induce a flow of air through the unsaturated soils and cesspools in order to volatilize VOCs; (2) collect these VOCs; and (3) collect air from the sparging process which was injected to volatilize the VOCs in the groundwater.

The soil vapor extraction wells will be drilled to a depth of 60 feet bgs by a licensed New York State driller using 4.25- to 6.25-inch hollow stem augers. Split-spoon samples will be collected every five feet from the ground surface to 10 feet above the water table, or approximately 45 feet bgs. Continuous split-spoon samples will be collected from 10 feet above the water table to 5 feet below the water table. This interval represents the screen location for the soil vapor extraction wells. Drill cuttings will be containerized in drums and staged on-site for proper disposal. In order to reduce the amount of waste material requiring disposal, the drill cuttings will be segregated based on the location of the well from which they were derived. The drill cuttings will be segregated into potential RCRA-hazardous, potential TSCA-hazardous, and potential non-hazardous, and will be characterized for disposal accordingly.

The soil samples will be visually classified by the Field Geologist according to the USCS. Detailed lithologic (geologic) logs for each well will be recorded in the field logbook and on a standardized Boring Log form. All field observations, including blow counts, PID readings, evidence of contamination, and description of moisture content, will be recorded in the field logbook and on the Boring Log form.

The split-spoon samples will be collected in order to identify the possible presence of significant clay lenses, which may impact the effectiveness of the soil vapor extraction system. The presence

of a clay lens near the water table could inhibit the capture of injected air from nearby air injection wells.

If clay is detected within the screened interval of the soil vapor extraction well, the screen length or location will be modified according to the following considerations:

- The length of the well screen will be increased to allow vapor extraction from both above and below the clay layer.
- If the well screen above the water table exceeds 20 feet in length, then an additional soil vapor extraction well will be installed. The resulting well cluster at this location would have one well with a screened interval above the clay layer and one well with a screened interval below the clay layer.
- If the clay layer is less than one foot above the water table and extends to an air injection well, then this well may not be suitable to capture injected air.

Each extraction well will be constructed of 2-inch diameter Schedule 40 PVC casing with 15 feet of 0.020-inch screen extending from 10 feet above the water table to five feet below the water table. A sand pack of No. 2 silica sand will be installed from the bottom of the well screen to one foot above the top of the screen, followed by a two-foot thick bentonite seal. The remainder of the borehole will be filled with a cement/bentonite grout. Each extraction well will be completed with a PVC "T" and a removable cap. The well casing will extend approximately six inches above the ground surface to allow access into the well for cleaning, water level measurements, and groundwater sampling. Each well also will have a sample port to allow collection of soil gas samples, and for measurements of gas velocity and vapor pressure. This port will be located two feet from valves and fittings which could interfere with velocity measurements.

1.1.5.3.3 Soil Vapor Pressure Monitors

Six clusters of soil vapor pressure monitors will be installed to confirm that all injected air is being captured by the soil vapor extraction system. A negative pressure (vacuum) at each of these locations will be considered confirmation of capture. Each cluster will consist of two wells, one near the middle of the unsaturated zone, approximately 25 feet bgs, and one near the water table approximately 52 feet bgs.

The soil vapor pressure monitors will be drilled by a licensed New York State driller using 4.25- to 6.25-inch hollow stem augers. One boring per cluster will be evaluated for lithology. Split-spoon samples will be collected every five feet from the ground surface to the water table, or approximately 55 feet bgs. Drill cuttings will be containerized in drums and staged on-site for proper disposal. In order to reduce the amount of waste material requiring disposal, the drill cuttings will be segregated based on the location of the well from which they were derived. The drill cuttings will be segregated into potential RCRA-hazardous, potential TSCA-hazardous, and potential non-hazardous, and will be characterized for disposal accordingly.

The soil samples will be visually classified by the Field Geologist according to the USCS. Detailed lithologic (geologic) logs for one pressure monitor within each cluster will be recorded in

the field logbook and on a standardized Boring Log form. Each sample collected will be transferred directly from the stainless steel split-spoon to a pre-cleaned, screw-top, air-tight glass jar using a clean stainless steel spoon. The sample jar will be identified, using permanent waterproof marker, with the location and depth of the sample and project number. After the sample jar has been prepared, the probe tip of the photoionization detector will be inserted into the container and a head-space reading will be collected. All field observations, including blow counts, head-space analysis results, evidence of contamination, and description of moisture content, will be recorded in the field logbook and on the Boring Log form.

The split-spoon samples will be collected in order to identify the possible presence of significant clay lenses, which may impact the effectiveness of the soil vapor extraction system. The presence of a clay lens near the water table could inhibit the capture of injected air from nearby air injection wells.

Each soil vapor pressure monitor will be constructed of 2-inch diameter Schedule 40 PVC casing. One pressure monitor within each cluster will be installed to a depth of 25 feet bgs, with a two-foot length of 0.020-inch well screen extending from 23 to 25 feet bgs. The second pressure monitor within each cluster will be installed to a depth of 52 feet bgs, with a two-foot length of 0.020-inch screen extending from 50 to 52 feet bgs. A sand pack of No. 2 silica sand will be installed from the bottom of the well screen to one foot above the top of the screen, followed by a two-foot thick bentonite seal. The remainder of the borehole will be filled with a cement/bentonite grout. Each pressure monitor will be completed with a removable cap. The well casing will extend approximately six inches above the ground surface to allow access into the well for soil vapor pressure readings, water level measurements, and/or groundwater sampling.

1.1.5.3.4 Well Development

The air sparge and soil vapor extraction wells will be developed a minimum of 24 hours after completion of each well installation. The wells will be developed using a disposable polyethylene bailer, centrifugal pump with dedicated polyethylene tubing, or positive displacement foot-valve pump with dedicated polyethylene tubing. Development water will be monitored for organic vapors with a PID. The development water will be containerized in drums and staged on-site for characterization prior to disposal. In order to reduce the amount of waste material requiring disposal, the development water will be segregated based on the location of the well from which it was derived. The development water will be segregated into potential RCRA-hazardous, potential TSCA-hazardous, and potential non-hazardous, and will be characterized for disposal accordingly.

Well development will proceed by repeatedly removing volumes of water from the well until the discharged water is relatively sediment-free. Development effectiveness will be monitored at regular intervals (after each well volume is removed) using a portable turbidity meter. In addition, pH, temperature, and conductivity measurements will be obtained during development and recorded in the field logbook. Well development will be discontinued either when the turbidity of the discharged water reaches the development goal of 50 NTUs or when the turbidity level stabilizes indicating that additional development will be ineffective.

Following development, the soil vapor extraction wells will be allowed to recover for at least one week before groundwater is purged and sampled. Well development will be performed by the licensed driller and will be supervised by the Field Geologist. All measurements and well information collected during the development will be recorded in the field logbook and on well development forms.

1.1.5.3.5 SVE/AS Piping

The air inlet wells will be piped above grade as shown on the drawings. All above-grade piping will be supported on temporary sleepers as shown on the drawings.

We will install approximately 1,400 lineal feet (lf) of two-inch, four-inch and six-inch Schedule 40 PVC piping and fittings for the SVE system and likewise, 900 lf of 1 1/2-inch, two-inch and four-inch for the AS injection system network. The layout of the piping will follow CF Braun DWG No 2. The system will include allowance for physical extraction and contraction and sloped to facilitate condensate transport. Pipe insulation is not required because the system will be shut down during winter months. Piping joints will be sealed with cement.

1.1.5.3.6 Mobilization/Setup of Treatment Equipment

This task includes all elements to construct the treatment system.

1.1.5.3.6.1 Equipment Area Fence

A permanent, six-foot high chain link fence will be constructed along the western side of Site 1. The fence will incorporate a gate large enough to permit a truck in the area. Chain link fence posts, fabric, and gates will meet applicable portions of Navy Specification 02821. Utility terminations will be located inside the fence. The fence will be constructed during well installation.

1.1.5.3.6.2 Equipment Installation

New equipment required for installation include: 1) 500-gallon Primary Moisture Separator with level indicator; 2) replacement vacuum switch on injection blower; 3) alarm and telemetry system to monitor system operation on a continuous basis; 4) three (3) 1800 lb. activated carbon units and stack; 5) miscellaneous instrumental valves. Installation will be performed by Foster Wheeler personnel with support provided by manufacturer's representative(s), as required.

Existing equipment to be modified includes the injection air Roots blower used in the CF Braun pilot study. In addition to relocation of the blower skid assembly to the treatment building, the speed of the injection air blower will be increased to accommodate full scale treatment. This modification will be performed by a manufacturer's representative. The extraction blower will be replaced with one sized accordingly.

Interconnecting piping, valve and sample ports will be installed per drawings. Electrical wiring, conduits, etc. will be installed by a local electrician familiar with both local and Navy site codes.

The treatment building will be flashed for piping and stack penetrations with similar materials. Other general construction work inside the building will be subcontracted to local contractors.

The telemetry system or auto-dialer will not include provisions for pager service. The local telephone company will provide a line service which can accommodate tie-in to the central control alarm system as one of its auto-dial phone numbers.

1.1.5.3.7 Startup

Upon completion of equipment installation and hookup, the system will be started up in accordance with manufacturer's instructions and our O&M manual. If appropriate, the O&M manual will be revised to reflect operating data obtained during the startup.

The following is a preliminary list of measures to be executed prior to system start-up.

- Pneumatic testing of the piping system
- Motor rotation and alignment
- Electrical circuits check
- Calibration adjustments
- Control logic controls check
- "Hot" start-up procedure

Once the prestart-up tests have been completed, "hot" startup of the extraction and injection systems will be conducted in accordance with O&M procedures. Both pressure and air/gas velocity measurements will be made at each well system port to assure design flows and to balance the system. Off-gas readings will be made at the carbon units, before, in between and after these units to monitor VOC capture and breakthrough.

System start-up and prove-out will consist of the following:

- Air flow rates and pressure checks
- Control logic checks
- Off-gas sampling
- Telemetry system check

The overall system will be monitored during this period to ensure proper operation

1.1.5.4 Task 4 - Operation and Maintenance

The O&M of the remediation system will be performed for a total period of 24 months by a Field Technician, managed by the Field Engineer. During this period the system will be shut down during harsh weather months (roughly three months per year) in the winter.

The Field Technician will visit the site weekly. Operating system data such as extraction flow rate, extraction vacuums, and individual well vacuums will be recorded. The Field Engineer will accompany the Field Technician monthly to check the system and collect additional operating data.

System operating data will be entered into a site-specific database to track remediation system effectiveness. This critical step will enable us to optimize remediation system effectiveness. The database will track VOC removals by the system, VOC concentrations in individual wells, and exerted vacuums at individual wells.

The Field Technician will perform all routine periodic maintenance items, such as lubrication of equipment, belt wear, air filter inspections/replacements, vibration checks, instrument checks, PID readings, condensate draining and scheduling and assisting with carbon change-outs. Both weekly and monthly inspection logs will be required to be completed by the Field Technician, as well as, any non-routine incidents such as telemetry system call-ins.

Engineering support is provided to; 1) interpret system data; 2) monitor system performance; 3) recommend system adjustments; 4) recommend pulsing frequency and schedule; 5) provide monthly reporting to the Navy.

1.1.5.5 Task 5 - Disposal

Transportation and disposal (T&D) of waste material will be subcontracted as described in Section 4. Five waste streams were identified which will require off-site transportation and disposal. These are: 1) Drill cuttings and mud; 2) Spent personal protective equipment (PPE); 3) Condensate from moisture separators; 4) Spent activated carbon, 5) Decontamination and well purge water from well drilling.

1.1.5.6 Task 6 - Demobilization

Upon completion of construction activities, construction equipment and personnel will be demobilized. Upon completion of O&M, all temporary office and storage facilities, decontamination facilities and portable toilets will be removed. Power and phone connections will be disconnected.

No equipment other than sampling tools will require final decontamination. Final PPE, decontamination pad liners, and other potentially contaminated supplies will be labeled and properly disposed. Clean drums used for the collection of decontamination water will be returned to the supplier for recycling. The treatment building office will be emptied of contractor office equipment. Construction equipment will be returned to the respective supplier when it is no longer needed.

1.1.5.6.1 Submittals

A Project Close-Out Report will be prepared confirming the activities performed and the results obtained. Certifications as required will be provided. Material tracking information, including manifests and bills of lading, will be included in the final report. As-builts and final surveys will also be included as appropriate.

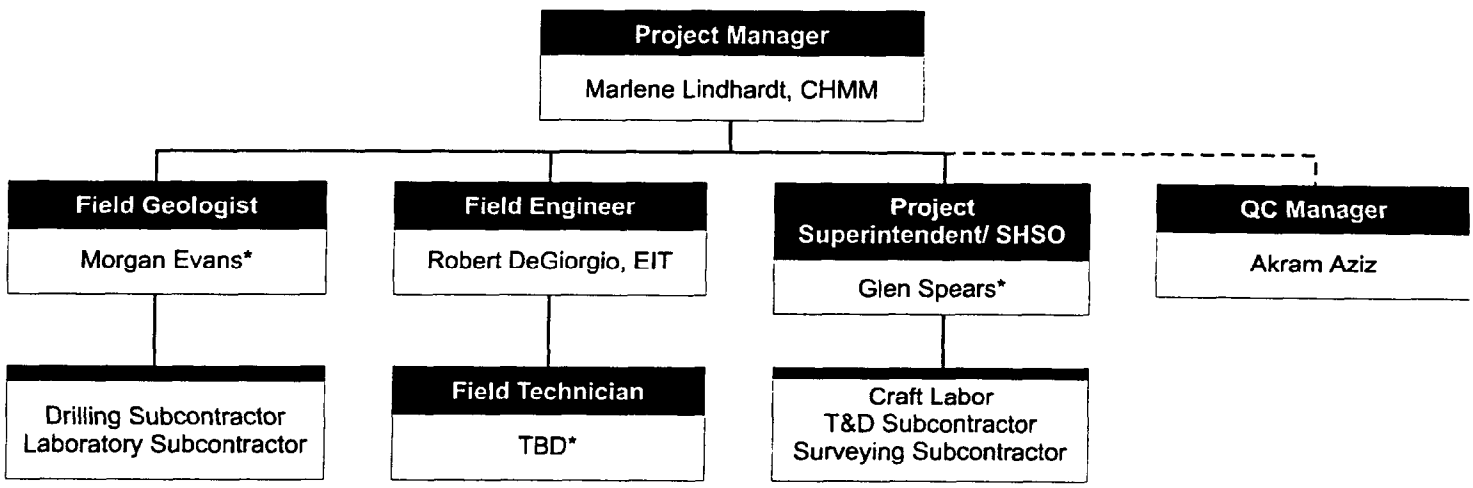
1.1.6 Management Approach

This section presents key aspects of Foster Wheeler's project organization and management including key personnel and their responsibilities, project management methods and project control methods.

1.1.6.1 Organization

The organization chart for this DO is provided in Figure 1-1. Ms. Marlene Lindhardt CHMM, is the responsible Senior Project Engineer/Manager (SPEM) for this DO. Table 1-6 describes the other staff resources assigned to this project, along with responsibilities and primary reporting chain of command.

Figure 1-1 Project Organization



Notes: Dashed lines indicate project reporting. The QC Manager and SHSO have independent reporting lines to the Corporate QAO and H&S Manager, respectively.

*Positions subject to staff availability at mobilization

Table 1-6 Personnel Responsibilities and Authorities

Position	Responsibilities	Reports to
SPEM	• DO negotiation assistance • Commit project resources • Obtain staffing • Approval - Work Plan, budgets, schedules	• Program Manager
Project Superintendent/ Site Health and Safety Officer (SHSO)	• Coordinate daily activities • Communicate with ROICC • Schedule personnel, equipment • Supervise field labor and subcontractors • Implement SHSP • Ensure site staff have adequate medical training • Issue "Stop-Work"	• SPEM/Program Health & Safety Manager
Field Engineer/ Site QC Manager (SQCM)	• Assist Project Superintendent with system construction • Implement SQCP • O&M oversight	• SPEM/ Program QC Manager (PQCM)
Project Control Engineer	• Track budgets, schedule	• SPEM
Field Geologist	• Driller supervision • Log soil cuttings • Sampling and field analysis	• Project Superintendent
Regulatory Specialist	• Waste characterization and waste profile preparation • Prepare manifests and bills of lading • Waste tracking	• SPEM
Field Technician	• Perform O&M duties	• Field Engineer

Based on the requirements of the DO, Foster Wheeler will hire locally available field labor for portions of the project. We anticipate using one equipment operator and two laborers for construction.

We have defined services to be subcontracted for portions of the project and identified potential subcontractors as summarized in Table 1-7. The subcontractors will be finalized after completion of the procurement process. When possible, SB/SDB subcontractors will be used for these services.

Table 1-7 Subcontract Services

Service	
• Project Control	• T&D of soil and PPE
• Utility hookups	• Carbon regeneration
• Well installation	• T&D of VOC condensate and well purge water
• Vapor analysis	• Surveyor
• Soil and water analysis	• Confirmatory soil borings
• Security fence and gate	

1.1.6.1.1 Key Personnel

Project staff include the SPEM, Project Superintendent/SHSO, Field Engineer/SQCM, Field Geologist, Regulatory Specialist, and field labor. Resumes for key DO staff are included in Attachment A.

Senior Project Engineer/Manager — Ms. Marlene Lindhardt, CHMM is the SPEM for the DO. She is responsible for the overall direction and management of the project including technical quality, schedule, cost control, reports/submittals, and NORTHDIV contact.

Reporting to Ms. Lindhardt will be the technical staff required to implement the in-situ volatilization system. This includes the engineers, scientists, and regulatory compliance personnel shown on the organization chart. The Project Superintendent/SHSO and the field staff will report to the SPEM while assigned to the project. Also reporting to Ms. Lindhardt will be the support services which control cost and schedule and procure material, equipment, and subcontracts.

Project Superintendent/SHSO — The Project Superintendent, Mr. Glen Spears, is responsible for all construction activities and will coordinate field activities with technical staff. He will interact with NORTHDIV and NWIRP construction personnel and will oversee subcontractor activities. He will coordinate site activities and is responsible for implementation of the SHSP. As the cross-trained Site Health and Safety Officer (SHSO), he enforces the SHSP, air monitoring, sampling, training and coordination of medical surveillance for all site personnel. He has "stop work" authority for all safety-related issues. The SHSO will receive project guidance from the SPEM while maintaining an independent reporting relationship to the contract Certified Industrial Hygienist (CIH).

Field Engineer/SQCM — Mr. Robert DeGiorgio, EIT is the Field Engineer for the DO. He will monitor activities to ensure conformance with approved work plans, design documents, corporate procedures, and Program policies. He will oversee the operation and maintenance of the system and is responsible for monthly data reports.

As the Site Quality Control Manager (SQCM), he will inspect the activities of field labor, subcontractors, and vendors and will monitor the performance of off site laboratories, prepare construction submittals and maintain the submittal register. He has "stop work" authority. In this role, he reports directly to the contract Quality Control Program Manager (QCPM). The QCPM prepares the SQCP as a pre-construction submittal for review and approval by the Navy.

Field Geologist — Mr. Morgan Evans is the Field Geologist and will oversee well installation. He will be responsible for final location of the wells, log soil cuttings and supervise well development and sampling.

1.1.6.2.2 Communications

Weekly Meetings — Weekly telephone conferences or site meetings between the Project Manager and NTR/ROICC will address short-term issues such as site personnel, activities schedule, and other issues relevant to the status and forecast of site activities. When necessary, key team

members and/or subcontractors will participate in action plans. Assignments will be identified and documented in these meetings.

Monthly Progress Meetings — The first weekly meeting after issuance of a monthly progress report will also be used to discuss long range issues. Attending the meeting will be the COTR, Foster Wheeler SPEM, and DO staff. Action plans and assignments will be documented.

Verbal Updates — The occurrence of new developments in the project, particularly those that may result in changes to the contract, will be verbally communicated to the NTR/ROICC as information is available. This will allow quicker and better field decision-making consistent with project objectives.

Emergency Notification — In the event of a site emergency, the NTR/ROICC and COTR will be notified immediately following notification of any emergency response teams or organizations.

1.1.6.2.3 Cost and Schedule Control

The contract procedures will be followed to prepare, monitor and control cost and schedule. On-site support will be provided to maintain the cost reports and schedule during construction.

A target schedule will be created from the original detailed project schedule. Actual project progress will be measured against the target schedule so that variances to the original plan can be easily identified and evaluated. The detailed schedule will be used by the Project Superintendent to plan upcoming manpower and resource requirements on the project. The Project Superintendent will also use the schedule to coordinate material deliveries with construction activities.

Contract changes are those increases or decreases in the project that require an increase or decrease in resources. If changes are identified, a Change Request Form will be prepared and submitted for Navy approvals.

1.1.6.2.4 Delivery Order Close-Out

As construction completion approaches, the Project Superintendent will notify the Navy to schedule the prefinal and then final inspections. During each inspection a close-out punch list will be prepared to document unfinished work. Rework Item Lists and In-Process Deficiency Punch Lists will be reviewed to insure that all deficiencies have been corrected.

Following completion of the project, Foster Wheeler will submit a Project Close-Out Report. The SPEM will routinely collect, consolidate, and audit the project files and make certain that all documentation is retained and properly filed in accordance with the standard operating procedure for document control. The Project Close-Out Report will include material tracking and manifests, test results, record drawings, O&M manual, equipment cut sheets and warranties, and photographs.

1.2 Site Maps

Site maps and engineering drawings are listed below and provided in Attachment B:

BTH-01	Cover Page
BTH-02	Site Plan
BTH-03	Piping Instrumentation Diagram
BTH-04	Well Installation Diagram
BTH-05	Electrical Details
BTH-06	Construction Details

1.3 Permanent Installations

The purpose of the section is to identify the basis of the system design and to specify the installed equipment, instruments, materials of construction and all utility tie-ins. This section presents the objectives of and approach to the remedial design, a summary of the pre-design investigations which have been performed, the requirements of the vapor treatment system; the design criteria and data; and the selection of equipment. This section also includes references to various guidelines, criteria and data available through the referenced sources.

1.3.1 Description

1.3.1.1 Building Construction

The system will be housed within an existing metal pre-fabricated building located as shown on the Site Plan drawings. The building is approximately 40 feet by 30 feet wide and is located on a concrete slab. The roof height at the eaves of the building is approximately 25 feet with a roof slope of about 12 to 1. The facility includes a partitioned area which will be used for office space and storage. The building is in excellent condition and offers ideal accommodations for the permanent system. Sufficient floor space exists within the building which will facilitate the installation of the equipment, process piping and electrical conduits.

1.3.1.2 Heating, Ventilation and Air Conditioning (HVAC)

The building is equipped with functional unit heaters and louvers which provide heating and ventilation. Since the facility will not be manned 24 hours per day and will not be operated during the winter months, the current HVAC system should be sufficient in protecting the process equipment.

1.3.1.3 Facility Lighting

The facility is equipped with sufficient fluorescent lighting with a dedicated service box and circuit breaker. No additional interior lighting requirements are anticipated to be required at this time.

1.3.1.4 Potable Water Service

The facility is equipped with potable water service at an adequate pressure and flow rate. Potable water usage is anticipated to be minimal for this system.

1.3.1.5 Sanitary Facilities

The existing building does not include sanitary facilities. Sanitary facilities are available in Plant 3, adjacent to the site. Plant 3 facilities will be used until no longer available due to plant decommissioning. Portable sanitary facilities will be rented on a monthly basis, thereafter.

1.3.1.6 Process Drainage

The facility does not include provisions for process water drainage, therefore, process water (condensate, etc.) will be collected in drums, staged on site in a dedicated satellite staging area and disposed of properly.

1.3.1.7 Phone Services

The facility does not currently have phone services. Phone service will be provided by the local phone company. Three phone service lines will be installed, two lines will be used for the facility phone and fax and one line will be required for the autodialer system that will be installed as part of the system design. In addition to the traditional phone service, Grumman facility personnel have expressed a desire to tie-in the new system alarm panel to Grumman's main alarm system. This would require a dedicated line from the Grumman Alarm center to the new system. Installation and design of this new line will be by others. The new alarm panel will include provisions to accommodate this line.

1.3.1.8 Storm Water Control

The design and installation of this system does not include provisions for final grading and storm water control since the impact to the site grade is expected to be minimal. Existing facility storm water provisions will continue to be utilized.

1.3.1.9 Electrical Service

Electrical power will be serviced from an existing distribution panel located within the facility. The nameplate data are presented below in Table 1-8.

Table 1-8 Existing Electrical Service Panel Nameplate Data

Existing Electrical Distribution Panel Nameplate Data	
Manufacturer	Square D
Style No.	168 586
Class	AA
High Voltage (H.V.)	480
H.V. Amps	180
Low Voltage (L.V.)	208/120
L.V. Amps	417

1.3.2 Remedial Design Approach

The design approach for this project is the preparation of a construction level design providing enough detail to facilitate direct construction of system in conjunction with the support of the

design engineers. This approach includes the development of basic drawings and performance type technical specifications for the treatment processes and support systems.

1.3.2.1 Remedial Design Assumptions

1. Remedial design was developed based on the *"Design Analysis Report for Air Sparging/Soil Vapor Extraction (AS/SVE) System at Site 1- Former Drum Marshaling Area; Naval Weapons Industrial Reserve Plant; Bethpage New York; September 1997"* (herein Reference 1) submitted by C F Braun Engineering Corporation and *"Results Letter Report for Air Sparging/Soil Vapor Extraction System at Site 1 - Former Drum Marshaling Area ; Naval Weapons Industrial Reserve Plant; Bethpage New York; October 1997"* (herein Reference 2) submitted by C F Braun Engineering Corporation. The conclusions and data presented in these documents are assumed to be correct and appropriate QA has been exercised.

2. No new source of contamination will be added to increase the present levels of contamination in the aquifer or in the site soils.

3. The design guidelines presented herein are intended to treat the VOCs found in the site soils and, to a lesser extent, the VOCs found in the site groundwater.

4. The radius of influence developed by C F Braun for the air sparging and soil vapor extraction systems is accurate and representative throughout the site.

5. The initial VOC concentrations in the gas stream from soil vapor extraction by vacuum extraction will be elevated, but will rapidly decay to much lower values and asymptotically approach a final stable value. During the pilot study evidence of this trend was observed (Reference 2).

6. The system will operate 24 hours per day, 7 days per week during spring, fall and summer months. The system will not be operated in winter months (estimated to be December through February).

7. The process treatment train for this design will generate two effluent streams, an air stream and low volume water stream resulting from entrained water present in the gas stream. The treatment system equipment will be designed to produce an air effluent that will meet criteria in the New York State Air Guide-1, 1991 (6 NYCRR Parts 200 though 257). The condensate will be tested and disposed of as either a RCRA hazardous waste or a non-hazardous waste.

8. The air stream was classified by C F Braun to be non-explosive based on Lower Explosion Limit (LEL) testing conducted during the pilot study.

1.3.2.2 Summary of the Pre Design Investigations

The Northern Division of the Naval Facilities Engineering Command issued Contract Task Order (CTO) 0213 to C F Braun Engineering Corporation under a master agreement with Brown & Root Environmental Under the Comprehensive Long Term Environmental Action Navy (CLEAN) Contract N62472-90-D-1298. As a part of CTO 213, C F Braun collected and tested soil samples to better define the extent of VOC contamination, installed and operated a Pilot Scale SVE/AS

from March 1997 to July 1997, and prepared a Design Analysis Report for implementation of a full-scale SVE/AS system. The SVE/AS design specifically addresses the VOC-contaminated soils and the associated shallow groundwater contamination at Site 1. Following is a summary of the conclusions of that pilot study.

1. Stratification testing results indicate that dense vapor phase VOCs do not preferentially accumulate near the bottom of an extraction well.

2. Testing of the soil vapor extraction radius of influence showed that the site soils are highly permeable, with extraction rates of 80 cubic feet per minute (cfm) achievable, although the design extraction rate will be 20 to 30 cfm per well. Measured radius of influence ranged from 50 feet at 5 cfm to approximately 100 feet at 80 cfm. A reasonable correlation was developed between flow rate and radius of influence.

3. Soil vapor extraction at the water table resulted in flow through both the upper and lower unsaturated soil zones. Soil vapor extraction at the middle of the unsaturated zone resulted in flow through the middle of the unsaturated zone, but may have created stagnant flow conditions near the water table.

4. The cesspool structures do not appear to restrict air flow through them.

5. Air injection rates of as high as 60 cfm were achieved. However, rates greater than 20 cfm were difficult to consistently achieve and maintain. The design air injection flow rate shall be about 10 cfm per well.

6. The air sparging results were partially successful. An estimated radius of influence of 10 to 40 feet was obtained. Based on the testing data, the radius of influence for air sparging is not a strong function of air flow rate.

7. The presence of clay lens within approximately five feet above the water table at one site location requires special attention for the design of air injection wells. To ensure capture of the injected air, soil vapor extraction must be implemented between the clay lens and the point of air injection. Soil boring samples will be required during installation to confirm the location of clay lenses.

8. Based on the testing, soil vapor extraction rates need to be at least 2 to 3 times higher than air injection rates to ensure capture of injected air.

1.3.2.3 Soil Vapor Extraction System Design

The soil vapor extraction system design includes approximately 13 soil vapor extraction wells designated EW-01 through 13. The purpose of these extraction wells is to:

- Induce a flow of air through the unsaturated soils and cesspools (vadose zone) and thereby volatilize VOCs;
- Collect these VOCs for further treatment; and

- Collect air from the air sparging process which will be injected to volatilize VOCs in the groundwater.

As previously discussed, the target flow rate for each extraction well is 20 to 30 cfm. Based on pilot scale results, a vapor extraction rate of 30 cfm will result in a radius of influence of approximately 75 feet. To provide 50% overlap between wells, an extraction well spacing of 100 feet will be used. The soil vapor wells will be connected to a common point through a series of laterals and headers. Condensate is expected to form in the soil vapor extraction wells, therefore, the piping will be sloped to the extraction wells to address potential condensate formation.

The proposed location of soil vapor extraction wells is based on the area of known VOC-contaminated soils, including cesspool contents and the location of air injection wells to address groundwater contamination.

1.3.2.4 Air Sparging System Design

The air injection system includes approximately 11 air injection wells designated IW-10 through IW-11. The purpose of the injection wells is to induce an air flow through the shallow groundwater, as well as the soils at the groundwater interface. This flow will cause VOCs in these media to volatilize. The VOCs will then be collected by the soil vapor extraction system.

As previously discussed, the target flow rate for each injection well is 10 cfm. The wells will be installed in three lines oriented perpendicular to natural groundwater flow. Based on the pilot scale results, an air injection flow rate of 10 cfm resulted in a measured radius of influence of between 10 to 40 feet.

Because groundwater cleanup is a secondary objective for this project, the average measured radius of influence (25 feet) without overlap will be used for design purposes. Therefore, the air injection wells will be installed on 50-foot centers. This layout also ensures that the injected air is effectively captured by the soil vapor extraction system. The air injection wells will be connected to a common point through a series of laterals and headers. Condensate is not expected to form in the air injection well, however, the piping will be sloped to the air injection wells to address potential condensate formation.

1.3.2.5 Vapor Phase Treatment System

Details associated with the vapor phase treatment system are presented in Section 1.5 of this report. Major process equipment is presented in Attachment D.

1.3.2.6 Operation and Controls

Except during the winter and maintenance periods, the system is intended to run continuously for the duration of the project. The soil vapor extraction system and the air sparging system are two separate skid mounted units, each with their own control panel. Each blower includes a manual start and stop button and reset switches for when the blower shuts down automatically. These two control panels will be linked to a new, main control panel which will house the autodialer system, run indicating lights and alarm lights. The main control system will be comprised of mechanical interlocks and relays, no Programmable Logic Controllers (PLCs) will be used.

The two systems will be interlocked through the use of a vacuum switch that will be used to send a run permissive signal to the air sparging system as long as a vacuum is detected in the soil vapor extraction system. This interlock ensures that the air sparging system will remain inoperative if the soil vapor extraction system is not running. Each blower will also be equipped with a high temperature and high pressure (or vacuum) switch which will automatically shutdown the system in case one of those limits is met.

Soil vapor extraction rates and air injection rates for each well will be controlled by local manual valves. A portable velocity meter will be used to measure air flow while adjusting the control valves. Extraction wells with higher contaminant concentrations (based on PID readings) shall be operated at a higher flow rate. Extraction well flow rates and injection air flow rates will be pulsed periodically (i.e. cycled on/off or adjusted high/low) to prevent stagnant conditions from developing between adjacent extraction/injection wells.

The autodialer system will be programmed to dial pre-set emergency numbers in particular sequence if an alarm condition is encountered. The alarms that will signal an autodialer response are listed below:

- Loss of power, if there is an electrical loss of power the autodialer will activate (the autodialer will be supplied with battery back-up power);
- High temperature or high vacuum from either blower;
- Blower shutdown;
- A temperature switch will be used to alarm the operator if the outlet temperature from the extraction blower is greater than 100°F (set point may vary).

The extraction and air sparging wells may periodically be cycled to promote a more efficient extraction and overall remediation. This technique is typically employed to prevent extraction "dead zones", plugging and short circuiting in the site soils. As the remediation progresses, the use of this application will be further evaluated based on field conditions. The general criteria for its use includes long term flow rate fluctuations, pressure variances, mass loading rates and moisture build-up.

1.4 Engineering Calculations

The purpose of this section is to present the project specific calculations developed for the full scale system. Details of the calculations are presented in Attachment C and the results and highlights are presented below.

1.4.1 Design Criteria Outline

In accordance with applicable procedures this design criteria outline provides relevant project information reviewed and approved by the SPEM. The references for these calculations include:

"Design Analysis Report for Air Sparging/Soil Vapor Extraction (AS/SVE) System at Site 1-Former Drum Marshaling Area; Naval Weapons Industrial Reserve Plant; Bethpage New York;

September 1997" (herein Reference 1) submitted by C F Braun Engineering Corporation and *"Results Letter Report for Air Sparging/Soil Vapor Extraction System at Site 1 - Former Drum Marshaling Area ; Naval Weapons Industrial Reserve Plant; Bethpage New York; October 1997"* (herein Reference 2) submitted by C F Braun Engineering Corporation.

1.4.2 Mass Balance/Loading

Purpose: Calculate the mass loading expected from the soil vapor extraction system.

Assumptions: Data presented in references is accurate and representative of actual site conditions encountered at the 13 extraction points.

Table 1-9 Summary of Mass Loading Calculation

Parameter	Extracted Mass Loading Rate (lb./day)max	Extracted Mass Loading Rate (lb./day)avg
Freon 113	6.006	1.859
1,1- DCA	0.751	0.3887
1,1-DCE	0.579	0.0429
1,2-DCE	2.828	0.8905
1,1,1,-TCA	14.58	7.0018
TCE	9.761	3.0043
PCE	140.14	40.85
Total	174.65	54.03

1.4.3 Process Line Sizing

Purpose: Determine the optimum line size required to attain an air flow velocity of about 1,000 to 1,500 ft/min. The target velocity guideline serves a range based on industry standards, deviations from this range are acceptable especially if there is a desire to minimize noise attenuation. For this application, the yard piping to the vapor wells will be sized to accommodate the sizes presented in the referenced documents and to minimize noise to the maximum extent practical.

Assumptions: None

Table 1-10 Process Line Sizing Summary

Flow Rate (scfm)	Nominal Diameter (Inches)	Velocity (Ft/sec)	Application
10	1 ½	707	Air Injection to Well
20	2	858	Air Injection lateral
25	2	1,072	Air Extraction from Well
40	3	779	Air Injection lateral
50	3	974	Air Extraction/Injection lateral
75	3	1,461	Air Extraction lateral
100	4	1,131	Air Extraction lateral
110	4	1,244	Air Injection Header
325-	6	1,619	Air Extraction Header

Notes: The process piping will be Schedule 40 PVC, sections of carbon steel pipe will be used at the blower outlets which will allow for heat dissipation prior to the air entering the plastic pipe. These sections of pipe may be hot, therefore, the operators should exercise caution.

1.4.4 Pressure Drop in Vapor Lines

Purpose: Establish the maximum friction loss in the extraction and air injection systems.

Assumptions: None

Table 1-11 Friction Loss Summary

Extraction System Maximum Friction Loss (" W.C.)	8.5 " W.C.
Injection Air Maximum Friction Loss (" W.C.)	5.08 " W.C.

1.4.5 Blower Sizing

Purpose: Establish the required extraction and injection blower pressure at the desired flow rate.

Assumptions: None

Table 1-12 Blower Sizing Summary

Parameter	Extraction Blower Pressure Drop (Inches W.C.)	Injection Blower Pressure Drop (Inches W.C.)
Desired Vacuum extraction or air injection pressure	9.0	119.2 (4.3 psi)
Friction and Minor Losses	8.05	5.18
Moisture Separator Pressure Drop	5	5
Air Filter Pressure drop (dirty)	10	-
Discharge Carbon System Pressure Drop	10	-
Discharge Stack Losses	1.4	-
Factor of Safety	15%	15%
Total System Pressure	50 (3.7 in Hg vacuum)	152.47 (5.5 psi pressure)

1.4.6 VOC Decay Coefficient

Purpose: Estimate the loading rate decay coefficient over time based on pilot study results

Assumptions: None

The decay coefficient is estimated to be -0.063 until a constant loading rate is readily attained (estimated to be in 27 - 45 days).

1.4.7 Thermal Expansion

Purpose: Determine the total thermal expansion expected in the yard piping and determine the number of expansion loops or joints required.

References: see Attachment C

Assumptions: none

The yard piping (Schedule 40 PVC) experiences a change in length of about one inch per 22 degree temperature change per 100 feet of pipe. Therefore, it is estimated that the temperature differential in the Bethpage area during the non-winter months may be about 55 degrees, therefore, a 2.5-inch length change can be excepted per 100 feet of pipe. The maximum pipe run is about 1400 feet, therefore about 35" of expansion and contraction can be expected. This is easily accommodated through expansion loops and joints, approximately three per system.

1.5 Treatment System

The process selection for the soil gas treatment system was based on the influent characteristics developed in Section 1.4 of this report. CF Braun concluded that vapor phase carbon adsorption would serve as the optimum treatment technology for this waste stream. Upon review of the data, Foster Wheeler concurs with this recommendation.

Vapor phase carbon adsorption treatment systems consist of containerized beds of adsorbent typically granular activated carbon (GAC). Large and highly permeable void spaces between relatively large GAC particles or pellets allow the contaminated air to flow through the bed, contacting the particles and allowing adsorption to take place. The treated air leaves the bed with reduced concentrations of adsorbate until the carbon has reached capacity (i.e. has become saturated). Once the carbon has reached capacity, no further adsorption takes place.

Saturated vapor phase carbon can either be disposed, regenerated on-site within the adsorption unit or sent off site for regeneration. For this application, the carbon system will be regenerated off site. The entire vapor phase carbon module will be removed from service placed on a truck and replaced with a new unit. The units will be DOT approved and will be regenerated at an approved facility.

The carbon usage rate is estimated in Engineering Calculation B-02RO. A reputable carbon adsorption company was consulted regarding the carbon usage rate for this project. The results indicate that the carbon usage will vary between 190 lb./day to 504 lb./day. In order to

accommodate the high end loading rate, which is expected to be prevalent during the early stages of the design, it may be prudent to rent a 10,000 pound carbon vessel during the first quarter of operation or until the carbon usage rates decrease as required to facilitate the use of portable 1,800 pound carbon vessels. The system design includes the appropriate by pass connections to meet these requirements. Vapor Phase carbon will be regenerated in accordance with industry standards such as ASTM D3467 - Carbon Tetrachloride Test. The reactivated carbon shall have a Carbon Tetrachloride Number (CSV) of 70 (typical).

A heater is typically employed prior to vapor phase carbon units to reduce the relative humidity of the incoming vapor stream to 50% or less and thereby to optimize the use of carbon. To accomplish this a temperature increase of 30 to 40°F is required. However, the extraction blower is expected to heat the soil vapor by 20 to 40°F. As a result, additional heating of the soil vapor cannot be justified. The maximum temperature and pressure drop for the carbon units is anticipated to be 100°F and one pound per square inch (psi), respectively.

1.5.1 Material Specifications

The purpose of this section is to identify the material specification for the major ancillary equipment such as piping and wiring. In all cases, the materials specified will conform with the applicable standards and Navy standards as required.

All PVC piping shall conform to 1, Type 1, Grade 1 in accordance with ASTM D1784/5, ASTM D2466 and ASTM 12454-B.

Copper pipe for instrumentation or other service shall be Type L hard drawn conforming to ASTM B88, ASME B16.18 and ASME B16.22 with grade 95TA welded joints. Stainless steel tubing for instrumentation connection (as necessary) shall be Type 316 3/8 inch OD, tube wall thickness of 0.035 inches conforming to ASTM A213.

Ball valves ¼ inch to 3 inch shall be Type 1 Grade A PVC construction with true union connections and socket connections. Seals shall be viton with either viton or Teflon seats. Valves shall be full port design for low pressure loss and have a fine pitched threaded seal retainer for precise seat adjustments. All valve seats shall be reversible and self lubricating for bubble tight seal. Valves shall be rated for 225 psi.

Butterfly Valves 3 inch to 6 inch shall be Type 1 Grade A PVC single piece wafer type body. They shall be design rated at 150 psi bubble tight shut off. Valve bodies shall be molded of PVC with discs molded of Polypropylene. The shaft shall be 416 stainless steel and blow off proof. Liners and o-rings shall be Viton. The liner shall have a V-notch retention design and an integrally molded flanged face seal. Flange hardware shall be 304 stainless steel.

Electrical conduit shall be rigid steel conduit , low carbon, hot dipped galvanized both inside and outside, with threaded joints. All conduit shall be UL approved. Flexible galvanized conduit shall be steel core with continuous copper ground in the convolutions covered with extruded PVC. Connectors shall be nylon-insulated screw-in ground core type connectors constructed of malleable iron.

Wire installed in conduit for services 600 volt and below, shall be 600 volt, stranded copper, single conductor, heat and moisture resistant thermoplastic insulation 70 (C type THHN/THWN). Cables installed for services 600 volt and below shall be 600 volt multi-conductor type 'TC' cable with stranded copper conductors, heat and moisture resistant thermoplastic insulation, 75 C type THNN/TWHN and an overall black PVC jacket. Power cable shall have a grounding conductor which is either green insulated or re-identified with green tape. Minimal size for power wire shall be No. 12 AWG, except that No. 14 AWG shall be used for control. Instrument signal cable shall be single pair No. 16, stranded copper, 3000V PVC insulation with overall aluminum mylar shield, UL listed as PLTC and include an overall PVC jacket.

2. SAMPLING AND ANALYSIS

A sampling and analysis program (SAP) will be implemented to verify the effectiveness of the remedial activities conducted at the NWIRP site in Bethpage, New York. Tables 2-1 and 2-2 summarize the field sampling program and the waste characterization sampling program, respectively. Sampling locations are provided on Drawing BTH-02 in Attachment B.

2.1 Air Monitoring and Testing

The following sections describe the air monitoring and testing activities which will be conducted during this remedial action.

2.1.1 Ambient Air Monitoring

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

- Photoionization Detector 11.7 (HNu with 11.7eV lamp or equivalent)
- Combustible Gas Indicator

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

2.1.2 Headspace Analysis during Drilling

Thirteen soil vapor extraction and eleven air injection wells will be installed as part of the SVE/AS system. Details regarding the installation of these wells are provided in Sections 1.1.5.3.1 and 1.1.5.3.2. As the borings for these wells are drilled, borehole screening using a PID will be performed on a continuous basis. The readings collected will be used both for health and safety purposes and to identify "hot spots" which may exist on-site. All screening readings, and the approximate depth within each boring at which the reading was collected, will be recorded in the field logbook and on the Boring Log.

Table 2-1 Summary of Field Sampling Program

MATRIX	SAMPLE LOCATION	HEADSPACE ANALYSIS	WATER LEVEL MEASUREMENTS	LABORATORY ANALYSIS				
				NUMBER OF QA/QC SAMPLES				
				VOCs	DUPLICATE SAMPLES	TRIP BLANKS	FIELD BLANKS	MS/ MSD
Air/Vapor	Borings for air sparge and vapor extraction wells, soil vapor pressure monitors, groundwater monitoring wells, and soil sampling	Continuous during drilling activities	N/A	N/A	N/A	N/A	N/A	N/A
	Extracted Vapor	N/A	N/A	2 per week for first 3 months, 2 per month thereafter	N/A	N/A	N/A	N/A
	Carbon Units	Weekly for one month, then monthly	N/A	2 per week for first 3 months, 2 per month thereafter	N/A	N/A	N/A	N/A
Soil	SVE System Area	Continuous during drilling activities	N/A	10 per drilling event	1 per drilling event	5 per drilling event	1 per drilling event	1 per drilling event
Groundwater	Monitoring Wells/Extraction Wells	Each well head screened prior to sampling	Prior to each sampling round	14 - 1st round, 5 - subsequent rounds, 19 - confirmation round	1 per sampling round	3 - 1st round, 2 - subsequent rounds, 5 - confirmation round	1 per sampling round	1 per sampling round

NOTES:

VOCs indicates Volatile Organic Compounds

Table 2-2 Summary of Waste Characterization Sampling Program

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

NOTES:

TCL indicates Target Compound List

TCLP indicates Toxicity Characteristic Leaching Procedure

VOCs indicates Volatile Organic Compounds

SVOCs indicates Semi-Volatile Organic Compounds

Pest/Herb indicates Pesticides/Herbicides

TAL indicates Target Analyte List

PCBs indicates Polychlorinated Biphenyls

In addition, soil headspace analysis will be performed on each split-spoon sample collected from each borehole. It is anticipated that 17 headspace analysis samples will be collected from each soil vapor extraction well, and 19 headspace analysis samples will be collected from each air injection well boring. Each sample collected will be transferred directly from the stainless steel split spoon to a pre-cleaned, screw-top, air-tight glass jar using a clean stainless steel spoon. The sample jar will be identified, using permanent waterproof marker, with the location and depth of the sample and project number. After the sample jar has been prepared, the probe tip of the photoionization detector will be inserted into the container and a head-space reading will be collected. All field observations, including blow counts, head-space analysis results, evidence of contamination, and description of moisture content, will be recorded in the field logbook and on the Boring Log form.

2.1.3 Extracted Vapor Sampling

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

2.1.4 Soil Vapor Pressure Monitors

Six clusters of soil vapor pressure monitors will be installed on the eastern and western edges of the site. These monitors will be used to confirm that all injected air is being captured by the soil vapor extraction system. Each cluster will consist of two wells, one near the water table and one near the middle of the unsaturated zone. Only one soil boring per cluster will be evaluated for lithology. Soil vapor pressure readings will be collected periodically to monitor the effectiveness of the remediation system. Locations and lateral distances between probes will be evaluated further in the field during system installation/operation.

2.1.5 Carbon Unit Sampling

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

2.2 Sampling Groundwater/Wastewater

The following describes the sampling activities which will be conducted for groundwater sampling and disposal of the condensate, decontamination, well development, and purge water.

2.2.1 Groundwater Sampling

Approximately 14 groundwater samples will be collected prior to the start of the remediation to establish baseline conditions. Groundwater from each of the 13 new extraction wells and the existing groundwater monitoring well (CFBMW01) will be sampled and analyzed for VOCs.

These data will be used to confirm the areal extent of groundwater contamination. Based on these results, four new monitoring wells will be installed at the southern edge of the site, to monitor the groundwater leaving the site.

Analytical results from the four perimeter and one center-of-site shallow monitoring wells will be used to monitor the effectiveness of the air sparging component of the system. It is anticipated that groundwater monitoring will be performed monthly for the first six months and quarterly for the balance of the remediation.

In addition, one round of groundwater samples will be collected approximately six months after the remediation is complete to document the final groundwater conditions at the site.

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

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

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

2.2.2 Water Level Measurements

Prior to each round of groundwater sampling, water level measurements will be collected in each well using an electronic water level indicator. This unit has a tape divided into incremental measurements of 0.01 feet and two conductors forming a probe. When groundwater is encountered, the circuit is complete and a light meter, or audible buzzer is activated. The depth to groundwater is then measured from this point to the reference mark of the inner casing of the well. Each reading will be made three to four times, and the readings will be recorded in the field logbook. The water level indicator will be decontaminated between wells to avoid cross contamination and incorrect readings. The water level measurements will be collected in

ascending order of contamination, i.e., the water level in the most contaminated well will be measured last.

2.2.3 Condensate Sampling

The condensate generated by the SVE system will be placed in 55-gallon DOT-approved steel drums for on-site storage. Due to the RCRA Hazardous Waste Generator 90 day storage limits, it will be necessary to ship condensate waste off-site for disposal once every 90 days. Approximately six to seven drums will be generated and disposed every 90 days. A representative sample must be analyzed in order to classify the waste for disposal. After the treatment system's performance has been stabilized, a composite waste classification sample will be prepared by combining grab samples collected from the drums of condensate waste in storage. Per disposal facility requirements, the water sample will be analyzed for TCLP VOCs, TCLP semi-volatile organic compounds (SVOCs), TCLP metals, total organic halogens (TOX), PCBs, ignitability, corrosivity, and reactivity. If the analyses determine that the condensate waste is RCRA hazardous, then it will be necessary to resample the waste and perform a Total Constituent Analysis for the constituents regulated under the RCRA Land Disposal Restrictions for all waste codes which are found to be present in the condensate waste. If the waste generation process does not change substantially, the TSDF facility will only require one characterization analysis for approval to accept this waste stream.

2.2.4 Decontamination and Well Development Water Sampling

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

2.2.5 Activated Carbon Sampling

Prior to off-site disposal, it will be necessary to sample and analyze the spent activated carbon to characterize the carbon. A grab sample will be collected from the carbon vessel and will be analyzed for TCLP VOCs, TCLP SVOCs, TCLP Pesticides/Herbicides, TCLP Metals, PCBs, ignitability, reactivity, and corrosivity. Only one sample will be required to characterize the carbon and fulfill the carbon regeneration facility's pre-acceptance requirements.

2.3 Sampling Soil

2.3.1 Soil Borings

Approximately 10 subsurface soil samples will be collected prior to the start of the remediation activities to establish baseline conditions. Environmental samples will be collected from

throughout the area of VOC contaminated soils. A minimum of one soil sample location will be selected from within a cesspool of known VOC contamination.

Soil samples will be collected from locations exhibiting moderate (three to ten times the PRGs) and high (greater than ten times the PRGs) VOC concentrations. Soil sample locations and depths will be determined based on lithology and elevated PID screening results obtained during the installation of the injection and extraction wells.

Once a soil sample location is selected, the same immediate vicinity will be used for the duration of the project to monitor the effectiveness of the remediation and determine when the soil remediation is complete. Each soil sample will be analyzed for TCL VOCs.

2.3.2 Waste Characterization Soil Sampling

Waste characterization soil sampling will be conducted upon completion of the drilling activities. As discussed previously, the drill cuttings will be segregated based on the location of the well from which they were derived. The drill cuttings will be segregated into potential RCRA-hazardous, potential TSCA-hazardous, and potential non-hazardous. Three composite soil samples, one composite sample from drums within each category, will be prepared and submitted for analysis. Each composite sample will be analyzed for TCLP, TOX, PCBs, ignitability, corrosivity, reactivity, and the paint filter test for free liquids.

2.3.3 Laboratory Analysis

Analytical testing will be performed by a NYSDEC approved laboratory, following either NYSDEC ASP-CLP and/or SW-846 protocols. All of the soil and groundwater samples will be analyzed for TCL VOCs. Tables 2-1 and 2-2 summarize the analytical sampling program. Sample collection and analytical protocol information, including sample type, number of samples and duplicates, matrix, sampling device, analytical parameter, sample container requirements, sample preservation, laboratory analysis, method detection limits, and holding times, is presented in Table 2-3.

Table 2-3 Summary of Analytical Parameters, Test Methods, Containers, Preservation, and Holding Times for Samples

Matrix	Parameter	Proposed Test Method	Container	Preservation	Holding Time
Air/Vapor	VOCs	8015M	(1) 1-liter Tedlar bag	N/A	N/A
Water (Decontamination Water, Well Development/ Purge Water and Condensate)	TCL VOCs	8260A	(2) 40 ml glass vials w/ Teflon-lined septum; No headspace	Ice to 4°C	7 Days
	TCL SVOCs	8270B	(2) 1-liter amber glass w/ Teflon-lined cap	Ice to 4°C	7 Days to Extract 40 Days to Analyze
	TCLP VOCs	1311/8260A	(2) 40-ml glass vials w/ Teflon-lined septum; No headspace	HCL to pH <2 Ice to 4°C	14 Days
	TCLP SVOCs	1311/8270B	(1) 1-liter glass w/ Teflon-lined cap	Ice to 4°C	7 Days to Extract 40 Days to Analyze
	TAL Metals	200 Series	(1) 1-liter polyethylene	Nitric Acid to pH<2; Ice to 4°C	6 Months (Hg - 28 Days)
	TCLP Metals	1311/6010A/ 7471A	(1) 1-liter glass or polyethylene	Nitric Acid to pH<2; Ice to 4°C	6 Months (Hg - 28 Days)
	TOX	9020A	(2) 1-liter amber glass w/ Teflon-lined cap; no headspace	H2SO4 to pH<2; Ice to 4°C	28 Days
	PCBs	8081	(2) 1-L amber glass w/ Teflon-lined cap	Ice to 4°C	7 Days to Extract 40 Days to Analyze
	Specific Gravity	ASTM 213E	(1) 100 ml glass or plastic	N/A	28 Days
	Ignitability	Method 1020	(2) 40-ml glass vials w/ Teflon-lined cap	N/A	N/A
	Reactivity	SW-846 Chp. 7.3	(1) 1-liter amber glass w/ Teflon-lined cap; no headspace	Ice to 4°C	Analyze Immediately
	Corrosivity	Method 1110	(1) 500-ml polyethylene	N/A	N/A
Soil	PCBs	8081	(1) 8 oz. glass w/Teflon-lined cap	Ice to 4°C	7 Days to Extract 40 Days to Analyze
	TCL VOCs	8260A	(2) 40 ml glass vials w/Teflon-lined septum	Ice to 4°C	7 Days
	TCLP VOCs	1311/8260A	(2) 40 ml glass vials w/Teflon-lined septum	Ice to 4°C	14 Days
	TCLP SVOCs	1311/8270B	(1) 8 oz. glass w/Teflon-lined cap	Ice to 4°C	14 Days to Extract 40 Days to Analyze
	TCLP Pest/Herb	1311/8080A/ 8150B	(1) 8-oz. glass w/Teflon-lined cap	Ice to 4°C	14 Days to Extract 40 Days to Analyze
	TCLP Metals	1311/6010A/ 7471A	(1) 8-oz. glass w/Teflon-lined cap	Ice to 4°C	180 Days (Hg - 28 Days)
	TOX	9020A	(1) 8-oz. glass w/Teflon-lined cap	Ice to 4°C	28 Days
	Ignitability	1020	(1) 8-oz. glass w/Teflon-lined cap	N/A	N/A
	Reactivity	SW-846 Chapter 7.3	(1) 8-oz. glass w/Teflon-lined cap	Ice to 4°C	Analyze
	Corrosivity	1110	(1) 8-oz. glass w/Teflon-lined cap	N/A	N/A
	Paint Filter Test	9095	(1) 100 ml glass w/Teflon-lined cap	N/A	N/A

NOTES:
VOCs indicates Volatile Organic Compounds
TCL indicates Target Compound List
SVOCs indicates Semi-Volatile Organic Compounds
TCLP indicates Toxicity Characteristic Leaching Procedure
PCBs indicates polychlorinated biphenyls
TOX indicates total organic halogens
TAL indicates Target Analyte List
Pest/Herb indicates pesticides/herbicides

3. ENVIRONMENTAL PROTECTION

The Environmental Protection Plan has been designed to protect sensitive environmental and natural resources while ensuring compliance with all applicable Federal, state and local regulations.

3.1 Applicable or Relevant and Appropriate Requirements (ARARs)

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

Remedial actions conducted entirely on site need only comply with the substantive aspects of the ARARs/TBCs and not the administrative aspects such as permitting (specifically exempted under CERCLA Section 121(e)) or administrative reviews. Activities off site must comply with all necessary Federal, state, and local laws; regulations; and ordinances (e.g., transportation of remedial action wastes must comply with local, state, and Federal transportation standards, both substantive and administrative). A list of project-specific ARARs/TBCs is presented in Table 3-1.

Table 3-1 List of Applicable or Relevant and Appropriate Requirements (ARARs) and Requirements to be Considered (TBCs)

Requirement	Citation	Description
Federal		
USDOT Hazardous Materials Transportation Regulations	49 CFR 172	Defines DOT Hazard Classes , Proper Shipping Names and labeling , marking and shipping paper requirements for transportation of DOT Hazardous Materials.
	49 CFR 172.700-704	Requirements for DOT training for hazardous materials employees.
	49 CFR 173	Packaging requirements for DOT regulated hazardous materials.
Hazardous Waste Classification	40 CFR 261	Requirements for the identification of hazardous waste.
Hazardous Waste Generation	40 CFR 262, 40 CFR 265 Subparts C, D	Requirements for generators of hazardous waste including storage limits, inspections , marking, record keeping and Contingency Plan.
Transportation of Hazardous Waste	40 CFR 263	Requirements applicable to the off site transportation of hazardous waste.
Storage of Hazardous Waste	40 CFR 265, Subpart I, CC	Requirements for the use and management of containers at generator location.
Employee Training	40 CFR 265.16	Specifies training requirements for all generator employees involved in hazardous waste management activities.
RCRA Land Disposal Restrictions	40 CFR 268.7	Establishes Specifies Universal Treatment Standards for RCRA wastes, and Generator notification requirements.

Requirement	Citation	Description
CERCLA Release Reporting	40 CFR 302	Reporting requirements for releases of CERCLA Hazardous Substances.
EPCRA Release Reporting	40 CFR 372	Reporting Requirements for releases of Extremely Hazardous Substances.
Clean Water Act Release Reporting	40 CFR 110 and 117	Reporting Requirements for releases of petroleum and hazardous substances into surface waters.
New York		
Air Pollution Control Regulations	Air Guide 1 6NYCRR 200-257	Specifies requirements and standards for new source controls for VOCs from point sources.
Hazardous Waste Management	6NYCRR 371;371;& 373	Specifies standards for identification and classification of hazardous wastes; generator management requirements and requirements for hazardous waste transportation.
Hazardous Materials Transportation	17NYC RR 507	NYS Department of Transportation regulations for transportation of DOT hazardous materials.
NY State Release Reporting	6NYCRR613.8 & 6NYCRR595.2	Specifies NY State Requirements for petroleum and hazardous materials releases.

3.2 Environmental Conditions Report

During site mobilization, Foster Wheeler will survey the site with the ROICC and take photographs of the site and prepare an Environmental Conditions Report documenting existing conditions and environmental features onsite.

3.3 Permitting Activities

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

3.4 Hazardous and Solid Waste Management

Any hazardous wastes generated during construction or operation and maintenance phases will be managed in accordance with Section 4, Waste Management, of this Work Plan.

3.5 Air Pollution Control

The New York State Department of Environmental Protection (NYSDEC) is authorized by the United States Environmental Protection Agency (USEPA) for enforcement of the Clean Air Act within New York State. The operation of the SVE system will result in VOCs emissions which will require the use of activated carbon to control VOC emissions. An air emissions permit application will be prepared and submitted to NYSDEC as a courtesy notification even though it is not required for site activities conducted under CERCLA. Fugitive dust emissions may result from project operations, and will be controlled using the best available technology. This may include keeping surfaces adequately wet to prevent fugitive dust emissions.

3.6 Endangered Species Act

The Endangered Species Act is not applicable to this project. No threatened or endangered species are known or suspected to exist in the area of the remedial action.

3.7 Protection of Trees and Shrubs

Foster Wheeler will not remove, cut, deface, injure, or destroy any trees or shrubs without the Navy's approval, and will protect existing trees that are to remain. Foster Wheeler will not attach ropes or cables or chains to existing trees for anchorage without Navy approval. Trees and other landscape features damaged by equipment operations will be replaced with equivalent undamaged trees and landscape features.

3.8 Spill Prevention

Foster Wheeler will take all the necessary precautions to prevent petroleum, hazardous wastes, and other hazardous substances from entering the ground surface, groundwater, or surface waters. All petroleum fuel, PCB and hazardous waste containers and tanks will be equipped with secondary containment in accordance with 40 CFR 112 , 40 CFR 761.65 and 40 CFR 264.

3.9 Excursion and Release Reporting

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

3.10 Training and Certification Requirements for Project Personnel

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

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

3.11 Inspections by Regulatory Agencies

Site personnel will contact the Northdiv RPM if contacted by a regulatory agency for a site inspection. The Foster Wheeler Project Superintendent will contact the Project Manager, who will notify the Northdiv RPM and the Foster Wheeler Director of Regulatory Compliance. Foster Wheeler personnel will follow the Foster Wheeler Regulatory Compliance Program Manual Procedure RC 8 "Environmental Inspections by Regulatory Agencies," revised August 18, 1995. In the event of an unannounced inspection, the Foster Wheeler Director of Regulatory Compliance will be contacted immediately.

3.12 Inspections by Third Parties

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

3.13 CERCLA Release Reporting

CERCLA requires the immediate reporting of any release of a "reportable quantity" of a hazardous substance onto land, surface or ground water, or air in any 24 hour period. Releases permitted under state or federal permits (i.e. NPDES) are not subject to reporting. The materials regulated are hazardous substances and hazardous wastes listed in 40 CFR 302.4. Petroleum products are not regulated under CERCLA. Immediately upon recognition that a reportable release has occurred, the person(s) in charge of the facility must notify by phone the National Response Center (NRC), the State Emergency Response Center (SERC) and the Local Emergency Planning Committee (LEPC) established under the Emergency Planning and Community Right-to-Know Act (EPCRA). Ideally, Foster Wheeler would immediately report all releases to the Navy Representative who would in turn notify the NRC, the SERC, and the LEPC, but in the absence of the Navy Representative, we would assume reporting responsibilities. A follow up written report must be submitted to the EPA Region II Office, the SERC, and the LEPC within 30 days of the event.

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

In addition, CERCLA contains a provision Section 111(g) that requires the facility operator to provide reasonable notice about a release of a hazardous substance to potentially injured parties by publication in local newspapers serving the affected area. Foster Wheeler assumes that the Navy will assume responsibility for all public notices.

3.14 EPCRA Release Reporting

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

3.15 Clean Water Act Reporting

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

3.16 NYS Release Reporting

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

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

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

4. WASTE MANAGEMENT

4.1 Introduction

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

4.2 Waste Classification

The following is an overview of the classification requirements for wastes generated during the remedial action. Refer to Table 4-1, Summary of Waste Material, for a summary listing of classification and disposition requirements by individual waste stream.

Table 4-1 Summary of Waste Material

Waste Stream	Volume	Assumed Classification	Assumed Disposition
Drilling soils/slurries	60 drums	RCRA Hazardous/Non Hazardous	Off-site disposal RCRA/On-site disposal
	60 drums	TSCA Regulated	Off-site disposal TSCA Landfill
PPE	20 drums	RCRA Hazardous / TSCA Regulated	Off-site disposal - RCRA/ TSCA landfill
SVE condensate water	500-750 gallons per year	RCRA Hazardous	Off-site disposal - RCRA Subtitle C Incinerator TSDF
Well development water	150-250 gallons per year	TSCA Regulated	Off-site disposal TSCA Incinerator TSDF
	150-250 gallons per year	Non-hazardous	On-site disposal
Spent Activated Carbon	31,500 lbs	RCRA Hazardous	Off-site recycling/regeneration-Subtitle C

4.3 Hazardous Wastes

Pursuant to 40 CFR 262.11 and 6NYSRR371, generators are required to classify their wastes prior to disposal. Based on the SOW, listed hazardous wastes are not expected to be present on site. We anticipate that any SVE condensate water and activated carbon generated from the remediation of Site 1 would be classified as hazardous waste based on the maximum concentrations of VOC contamination in the soil. The drill cuttings and well development water generated will be segregated, i.e., RCRA-hazardous, TSCA-hazardous, and non-hazardous, based on the location of the well from which they were derived and then classified for appropriate disposal. Likely classifications would include D019 (carbon tetrachloride), D028 (1,2-DCA), D029 (1,2-DCE), and D040 (TCE).

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

4.4 PCB Wastes

Soil cuttings generated from wells suspected to be located within the area of PCB contamination will be segregated. These soil cuttings may contain greater than 50 ppm of PCBs, as stated in the SOW, and will be disposed of off-site as TSCA wastes at a TSCA permitted disposal facility. Any decontamination water derived from soils containing PCBs will be disposed as TSCA wastes in accordance with the anti-dilution provisions of TSCA. SVE condensate and well development and purge waste will be disposed of as TSCA wastes only if they are determined to contain greater than or equal to 50 ppm of PCBs in accordance with USEPA Guidance Memorandum "PCB Contamination at Superfund Site - Relationship of TSCA Anti-Dilution Provision to Superfund Response Action" dated 7/31/1990. PCB wastes will be managed in accordance with requirements under TSCA 40 CFR 761 and New York State Hazardous Waste Regulations under 6 NYCRR 370-375 because PCBs are regulated as a New York State Hazardous Waste.

4.5 Waste Minimization

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

4.6 Screening/Segregation

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

4.7 Containerization

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

4.8 Accumulation/Storage

All containers storing hazardous wastes will remain on site for no more than 90 days from its accumulation start date unless specific approval has been received from NYSDEC. Foster Wheeler will obtain Base specific storage requirements from the ROICC prior to mobilization and will incorporate these requirements into the project plan. All on-site storage will comply with generator requirements listed in 40 CFR 262 and 6NYCRR372. All on-site storage of PCB wastes will be conducted in accordance with PCB container storage requirements under 40 CFR 761.65. All waste container storage areas will be equipped with secondary containment.

4.9 Container Inspections

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

4.10 Container Labeling and Marking

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

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

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

4.11 Permitting/Notification Requirements

If Navy Base personnel have not already done so, Foster Wheeler will assist the Navy in notifying USEPA and NYSDEC of RCRA hazardous waste and PCB waste activities associated with this remedial action. If the Navy has already provided these notifications, no additional notifications are required for on-site waste management activities.

4.12 Selection and Identification of TSDFs

TSDFs to be used for this project have not yet been selected and will be selected via competitive bid in accordance with the FAR requirements. A formal RFP will be prepared after project mobilization. Facilities will be selected in accordance with the requirements of the RFP, the CERCLA Off-site Rule for wastes from CERCLA sites and Foster Wheeler Corporate Regulatory Compliance Procedures. Each of these facilities are subject to final approval by the Navy. CERCLA Off-site approval status of each facility will be verified within 60 days of the anticipated disposal date.

4.13 USEPA Hazardous Waste Generator Identification Numbers

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

4.14 Complete Manifest Packages

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

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

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

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

4.15 Recordkeeping and Reporting Requirements

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

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

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

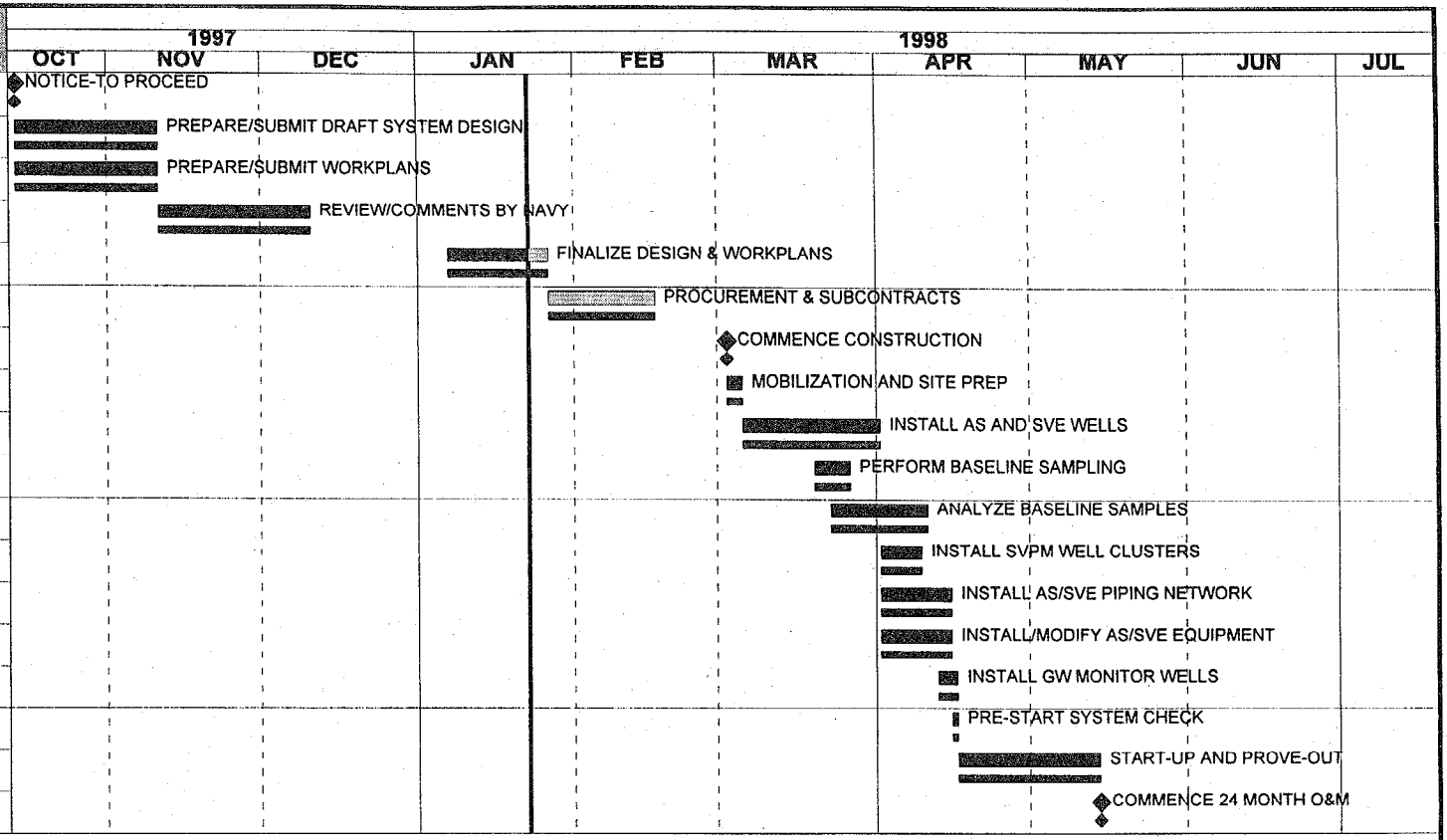
Manifest Exception Reports are required if a generator does not receive a TSDF signed manifest within 45 days of the shipment date. If we do not receive a manifest by the 35th day, we will contact the TSDF and verify the shipment status and prepare an Exception Report, which will be

submitted to the Navy Representative for signature by the 40th day. We will document all calls to locate the shipment and include the documentation in the Exception Report.

5. CPM Project Schedule

We have prepared Critical Path Method (CPM) type construction schedules for the installation of the in-situ volatilization system in a Gantt chart format. The schedule is shown in Figure 5-1. A normal 8-hour, 5-day work week is assumed. Start-up is scheduled for March, 1998.

Early start	Early finish	Percent Complete
	13OCT97A	100
14OCT97A	10NOV97A	100
14OCT97A	10NOV97A	100
11NOV97A	10DEC97A	100
07JAN98A	26JAN98	86
27JAN98	16FEB98	0
	02MAR98*	0
03MAR98	05MAR98	0
06MAR98	01APR98	0
20MAR98	26MAR98	0
23MAR98	10APR98	0
02APR98	09APR98	0
02APR98	15APR98	0
02APR98	15APR98	0
13APR98	16APR98	0
16APR98	16APR98	0
17APR98	14MAY98	0
	14MAY98	0



Project Start	13OCT97
Project Finish	14MAY98
Data Date	23JAN98
Run Date	23JAN98

Early Bar
TARGET BAR
Progress Bar
Critical Activity

BETH

Sheet 1 of 1

AS/SVE SYSTEM

DO 4 - BETHPAGE, NY

ATTACHMENT A
RESUMES

Marlene B. Lindhardt, CHMM
Project Manager

EXPERIENCE SUMMARY

Over 16 years extensive experience gained through work with environmental services, engineering firms and governmental agencies. She is familiar with all aspects of contract management and development of cost estimates, client relations, interfacing with governmental agencies, and regulatory compliance in accordance with RCRA, ECRA, ISRA, CERCLA, and TSCA regulations. She has also been actively involved in the development of feasibility studies and design, installation, startup, and operation of groundwater recovery-and-treatment systems and soil vapor extraction systems.

As program manager for $20 M remedial action contract at Aberdeen Proving Ground for the USACE - Baltimore District, she directed contract startup, development of procedures and site activities for five delivery orders at 14 sites. She developed work plans for remediation of unexploded ordnance (UXO), chemical warfare material (CWM), low-level radioactive waste, as well as the full range of RCRA hazardous compounds.

As a previous employee of USATHAMA, she has experience handling Army projects through all phases from initial investigation through final remediation. She has an in-depth understanding of military practices and procedures including contract management. She has authored the cleanup plans for several sites at APG/EA under the LRAP contract and at subsidiary annex under TEPS for USATHAMA.

As program manager for the USEPA Technical Assistance Team (TAT) $10 MM contract, she was responsible for managing a multidisciplinary team of field and technical personnel for planned and emergency responses throughout the eastern United States. Technical operations include site investigations, risk assessment, health and safety, data collection/management, remediation design and oversight.

As Lead Project Manager for real estate transaction-related projects under the New Jersey ECRA and Massachusetts 21E laws, she has completed more than 20 such projects through various phases including sampling-plan preparation and implementation, cleanup plan preparation and implementation, and negative declaration applications. She has extensive experience negotiating with state agencies on behalf of clients.

She was responsible for the management and production of one of the first national operating permit applications for mobile incineration of PCBs under stringent TSCA regulations.

REGISTRATIONS/CERTIFICATIONS

Certified Hazardous Materials Manager, 12/1/85, No. 838
Engineer in Training - MO, 1/1/87
Registered Environmental Professional, 9/30/91, No. 2406

EDUCATION

BS / Environmental Engineering / Pennsylvania State University / 1981
AA / Liberal Arts / Brookdale Community College / 1976

TRAINING

40-Hour OSHA Hazardous Waste Health and Safety Training
8-Hour OSHA Hazardous Waste Health and Safety Supervisor Training
Chemical Warfare Agent Response Training
Unexploded Ordnance Recognition Training
Emergency Response (Spill Training)
ERCS Contract Training, Regions I and II
Project Management Training
Advanced Hydrogeology Seminar
Communication and Presentation Skills Training

DISCIPLINE(S) (Y = Primary Indicator; N = Secondary Indicator)

Environmental Engineers	N
Hazardous Waste Specialists	N
Management Scientists	N
Project Managers	Y

LOCATION

Company: Foster Wheeler Environmental Corporation; 6/23/93 - Present
Present Location: Livingston, NJ
Daytime Phone: 973-597-7413

REPRESENTATIVE PROJECT EXPERIENCE

Senior Project Manager – Involved in the development of feasibility studies and designs, and installation, startup, and operation of groundwater recovery and treatment systems. Also familiar with all aspects of contract management, development of cost estimates, client relations, interfacing with government agencies, and regulatory compliance in accordance with RCRA, ECRA, CERCLA, and TSCA. Representative projects include:

Aberdeen Proving Ground, Aberdeen, MD, Program Manager – Providing overall direction for a $20 million multi-task delivery order contract for remediation of unexploded ordnance, chemical agents, and radioactive and chemical waste sites. Remediation technologies used include excavation, demolition, building decontamination, and water and soil treatment. Responsible for structuring project including plan preparation, assignment of project team, monthly technical and cost reports, communication with clients, and final site-specific technical report.

U.S. Environmental Protection Agency, Technical Assistance Team (TAT), Program Manager – Responsible for managing a multidisciplinary team of field and technical personnel for planned and emergency responses throughout the eastern United States. Technical operations include site investigations, risk assessments, health and safety, data collection/management, and remediation design and oversight, within USEPA Regions I, II, and III under CPAF $10 million LOE contract. Supervised over 50 geologists, engineers, safety

officers, chemists, and field technicians. Provided client interface and maintained relations. Reviewed and approved contract deliverables.

NJ Real Estate Services Remediation, Program Manager – Directed and managed assessments and cleanup of various real estate projects in NJ, MA, and DE under T&M contracts totaling over $5 million. Developed and negotiated scopes of services. Provided client and regulatory interface. Supervised geologists, engineers, and chemists. Managed UST removals, building decontaminations, groundwater pumping/treatment, soil-vapor extraction, soil excavation, permitting, asbestos removal, and PCB cleanup.

Paterson Gear Motor Manufacturing Facility, Project Manager – Managed the ECRA facility decontamination of a gear-manufacturing facility located in Paterson, New Jersey. Other tasks included the removal of five tanks, soil and groundwater investigation, and regulatory negotiations. Approximately 200 cubic yards of metal, Priority Pollutant (VOA and BN), and petroleum hydrocarbon-contaminated soil were excavated and disposed. This project required more than 30 personnel (hydrogeologists, engineers, site supervisors, foremen, recovery technicians, site safety managers, field chemists, drillers, and surveyors).

Dupont Pompton Lakes Facility, Project Manager – Directed multiple field crews during the installation of approximately 100 bedrock wells in Pompton Lakes, New Jersey. Supervised a crew consisting of four hydrogeologists, two drillers, laborers, and a field clerk. The wells are located throughout the community surrounding the plant. Work was coordinated and performed in a manner to provide minimal disturbance to public streets and private properties.

W.L. Gore Industries Site, Project Manger – Managed the recovery of a release of volatile organics at a site in Delaware. Responsibilities included installation of groundwater recovery and treatment system consisting of one recovery well and an air stripper. Directed field personnel in the installation and operation of the system. Project personnel included a chemical engineer, a driller, a hydrogeologist, and a number of laborers.

Economy Color Card, Inc. Site, Project Manager – Managed an ECRA site investigation in Elizabeth, New Jersey, and groundwater recovery of a spill of gasoline and solvents that were at thicknesses up to nine feet on top of the water table, along with six tons of contaminated soil. Directed a project crew of one driller, one hydrogeologist, an engineer, cleanup technicians, and T&D personnel.

Petroleum Hydrocarbon Contaminated Soil Remediation, Project Manager – Managed the excavation of 500 tons of soil contaminated with petroleum hydrocarbons at a site in Flemington, New Jersey. Other responsibilities included installing eight monitoring wells and designing a soil and groundwater treatment system. Directed a crew of two hydrogeologists, one sample technician, one equipment operator, and one laborer.

South Plainfield Laboratory Site, Project Manager – Managed the cleanup and excavation in South Plainfield, New Jersey of 20 tons of soil contaminated with petroleum hydrocarbons and solvents. Other tasks included tank excavation, backfilling, sampling, monitoring well

installation, and regulatory compliance under ECRA. Supervised a crew of a hydrogeologist, a driller, an equipment operator, and a site supervisor.

Monsanto-St. Peters TCE & Freon Spill, Senior Engineer – Designed and monitored the operation of a groundwater recovery system for a spill of TCE, FREON, and solvents in St. Peters, Missouri. Tasks included the installation of eight recovery wells and an air stripper, preparation of an O&M manual, and optimization of system performance as needed. Worked with a project crew of two hydrogeologists and a sample technician.

Conrail Train Derailment Emergency Response, Senior Engineer – Managed the groundwater pumping and recovery and bioremediation treatment system installation and operation in response to a spill of approximately 5,000 gallons of diethylene glycol and mineral oil from a train derailment accident in Harrisburg, Pennsylvania. Directed a crew of two hydrogeologists, two chemists, one driller, and several cleanup technicians.

PRIOR EXPERIENCE

OH Materials

Manager of Technical Services, 1987-1993

U.S. Environmental Protection Agency

Region I Emergency Response Cleanup Services Contract, ERCS Region I, Program Manager – Managed $80 MM contract for 2-hour remediation removal actions at Superfund sites throughout New England. Supervised the mobilization and performance of site response managers for 8 sites. Site operations included drum excavation, removal and disposal, water line installation, and multi-site soil and groundwater contamination delineation. Served as the primary point of contact for all emergencies and was on call 24 hours per day to arrange for spill response crews. Other duties included negotiating basic ordering agreement terms and conditions; providing USEPA interface and relations at the CO level; and administering the financial aspects of the contract.

Aberdeen Proving Ground/Edgewood Arsenal, Maryland

Remedial Action Plan Development – Managed the preparation of three cleanup plans including health and safety for three sites containing unknown buried drums.

CDAP Development
Sudbury Annex, Fort Devins, MA

Oversaw the development and preparation of the CDAP for USATHAMA under the LRAP contract. Included coordination of laboratory and data management functions of the work plan.

ECRA Decontamination – Managed "at peril" cleanup operations, sampling plan preparation, and negotiations with NJDEPE. Project resulted in two negative declarations for these gear manufacturing facilities.

ECRA Decontamination – Directed efforts to expedite ECRA process at pharmaceutical laboratory. Project included "at peril" excavation and well installation resulting in negative declaration.

21E Investigation – Directed investigation to assess site conditions at former dry cleaning facility. Activities included soil sampling, well installation, sampling, and analysis.

Soil Venting – Directed design, installation, and operation of soil venting cleanup project of solvent spill at an underground storage tank farm. An air emissions permit was obtained for treatment of contaminated vapors by carbon adsorption. A well network for air injection/venting was installed and monitored for the life of the project.

Riedel Environmental Services

Operations and Technical Services Manager, 1986-1987 – Managed daily operations of a multimillion dollar regional office. Responsibilities included scheduling and coordinating personnel and equipment for planned remedial and emergency response actions in states east of the Rocky Mountains. Supervised over 40 administrative and field-oriented personnel in the successful completion of the following projects:

Remedial Action Alternatives Analysis – Directed efforts to identify and select cost effective alternatives for disposal of lead contaminated sludge. Recommended option was subsequently implemented.

Soil Contamination – Directed efforts to define organic contamination at construction site. Oversaw immediate response effort to analyze, excavate, transport, and dispose of 600 cubic yards of soil. Remedial actions were designed to allow ongoing construction at the site to continue uninterrupted.

Decontamination of Dioxin-Contaminated Warehouse – Provided turnkey response including site assessment, contamination definition, remedial action plan, and cleanup. Action included decontamination of warehouse interior using techniques to minimize waste accumulation. Supervised the decontamination of a St. Louis, Missouri warehouse. Cleanup involved the cleansing of walls and floors in the factory that became contaminated by windblown dioxin (contaminated dust). Worked with a crew of a site safety managers, laborers, and a sample technician.

Alternatives Analysis for Dioxin Site – Provided analysis of various alternatives for dioxin cleanup of truck terminal site. Developed remedial action plan for submittal to regulatory agencies.

Building Salvage – Managed the identification of salvageable buildings at dioxin contaminated site. Responsible for specifying sampling requirements, salvage techniques, and waste disposal requirements.

Environmental Science and Engineering, Inc.

Senior Engineer, 1984-1985 – Managed environmental contamination study teams for remedial investigation feasibility studies. Also prepared proposals for major industrial and governmental clients. Project experience is demonstrated by the following:

Site Assessment and Alternatives Review – Evaluated various incineration techniques applicable to solvent contamination at a Superfund site. Provided cost estimates and feasibility analysis of existing, applicable technologies.

Remedial Investigation/Feasibility Study of Wood Treating Plant – Responsible for supervision of soil sampling activities including sampling procedures, equipment decontamination and chain-of-custody. Assisted in data interpretation and report preparation.

Remedial Investigation – Directed the planning for the site investigation including well installation and sampling, health and safety, and QA/QC documentation.

Records Search and Site Investigation – Provided initial contamination assessment for military base in Iowa.

Groundwater Dewatering/Treatment Design and System Implementation – Assisted in detailed design of groundwater pumping system. Responsible for system startup and performance monitoring. Developed and implemented computerized data base for collation and interpretation of resulting data.

Site Investigation and Regulatory Review – Evaluated Superfund site contamination and applicable environmental regulations.

US Army Toxic and Hazardous Materials Agency
(Now Army Environmental Center)

Environmental Engineer, 1981-1984 – Responsible for various site assessments, remedial investigation/feasibility studies and surveys. Project experience which includes extensive experience at a major waste site is outlined as follows:

Woodbridge Research Facility

Remedial Investigation/Feasibility Study at PCB Burial Site – Directed the planning, site investigation, and assessment of groundwater, surface water, soil, and sediment for a capacitor/transformer burial site. Managed remedial action alternatives analysis and provided the implementation plan for the excavation and disposal of contaminated material.

Camp Simms

Site Investigation – Directed effort to locate buried chemical agent using magnetometers and electromagnetic induction.

Fort Belvoir

Site Investigation – Managed sampling/analysis program to quantify migration of organic contaminants from leaking underground storage tanks and select appropriate remedial actions.

Rocky Mountain Arsenal

Off-Post Contamination Assessment Plan – Directed the development of a plan to collect and evaluate data on the off-post environment and provide for a health risk assessment. Coordinated cooperative efforts between Army, USEPA, state, and county agencies.

Rocky Mountain Arsenal

Decontamination Assessment/Feasibility Study for Lands and Facilities – Directed efforts to provide a comprehensive alternatives analysis for the arsenal's decontamination for "unrestricted use." Developed four regulatory acceptable versions of the selected remedial action, associated cost estimates, and concept designs.

Vint Hill Farm Station

Site Investigation – Managed sampling/analysis of groundwater and surface water sampling program for various sites at the installation including photographic laboratory effluent, leaking underground fuel oil tanks, and multiple dump sites.

Litigation Package Rocky Mountain Arsenal – Provided a technical data package used by the Department of Justice in litigation efforts.

Rocky Mountain Arsenal

Groundwater Dewatering, Treatment, and Recharge System – Advisory role on COE review board for design of combination slurry wall/hydrological barrier system installed to prevent contamination from crossing the arsenal boundary.

Rocky Mountain Arsenal

Nemagon (DBCP) Remedial Action Study – Prepared remedial action alternatives analysis and provided the implementation plan for the excavation and disposal of contaminated material.

Rocky Mountain Arsenal

Surface Water Study – Managed a 2-year program which included the installation of flow measuring devices and analysis of data to provide overall water balance.

Rocky Mountain Arsenal

Hazardous Waste, Landfill Design Study – Provided initial plan and requirements for the design of a RCRA landfill to be situated at the arsenal.

Rocky Mountain Arsenal

Selection of a Contamination Control Strategy – Participated in a study which included definition of contaminant sources, regulatory review, geohydrological assessment, remedial action alternatives analysis, and conceptual design/cost estimates for selected actions.

Rocky Mountain Arsenal

Potential Source Study – Directed a site investigation which identified all potential contamination sources and provided confirmation via soil, groundwater, and surface water sampling and analysis. Specific sites included chemical agent storage and treatment facilities, abandoned wastewater lagoons, and recreational lakes.

Rocky Mountain Arsenal

Data Management – Directed the preparation which provided government and contract personnel a single process for data collection, storage, and retrieval. Coordinated effort to merge two incompatible computer system data bases. Developed and implemented the center as the clearinghouse for all computer stored and hard copy data. Managed personnel at the center during the initial two years of operation.

PUBLICATIONS

Campbell, D.L. and M.B. Lindhardt, 1982, "Installation/Restoration Program at Rocky Mountain Arsenal: A Case Study," proceedings of the Twelfth Annual Environmental Systems Symposium, American Defense Preparedness Association.

Robert J. DeGiorgio
Mechanical Engineer

EXPERIENCE SUMMARY

A degreed mechanical engineer with over four years experience in environmental and mechanical designs for industrial and hazardous waste remediation projects. In addition to project management support, responsible for design and start up of environmental treatment and pharmaceutical process systems, environmental compliance review, preparation of technical/environmental reports, technical specifications and drawings, detailed engineering calculations and water- and air-permit applications. Extensive experience in equipment procurement, treatability studies, technical and economical equipment optimization, field sampling activities, feasibility studies and subcontractor supervision and oversight. Served as a lead design engineer/project engineer on a variety of different projects.

PROFESSIONAL AFFILIATIONS

American Society of Mechanical Engineers, Associate Member
Society of Automotive Engineers, Associate Member

EDUCATION

ME / Environmental Engineering / Manhattan College / 1996
BS / Mechanical Engineering / Manhattan College / 1992

TRAINING

ASTM Standard E-1527 Phase I Environmental Site Assessment Training - 1997
DOT/HM-126F Hazmat Training 49 CFR 172, Subpart H - 1996
New York City Community Right to Know Regulations Local Law 92 41-01-12 - 1996
Regulatory Auditing/Protocol Training - 1996
8-Hour OSHA Hazardous Waste Health and Safety Supervisor Training - 1995
AIChE - Air Toxics and VOC Abatement Technical Seminar - 1995
40-Hour OSHA Hazardous Waste Health and Safety Training - 1993

DISCIPLINE(S) (Y = Primary Indicator; N = Secondary Indicator)

Mechanical Engineers Y

LOCATION

Company: Foster Wheeler Environmental Corporation; 11/23/92 - Present
Present Location: Livingston, NJ
Daytime Phone: 201-597-7134

REPRESENTATIVE PROJECT EXPERIENCE

Chevron Chemical Company, Berkeley Heights Remediation Project, Berkeley Heights, NJ, Engineer, 1992-Present – Responsible for the mechanical and process design of an in-situ bioremediation groundwater treatment system. Responsibilities included preparation of complete operation and maintenance manuals and start-up plans, and starting up all mechanical and electrical devices, detailed engineering design calculations and drawings for

extraction/reinjection system (system was started up under budget and on schedule), pump and pipe sizing, carbon adsorption, chemical feed systems and filtration systems. Preparation of all mechanical and equipment specifications for the 100% design package. In addition, coordinated interdisciplinary review during all phases of design.

Engineer responsible for assuring treatment system discharge is in compliance with local and state discharge criteria and regulations. Prepared NJDEPE Discharge to Groundwater (DGW) permit application as well as the Treatment Works Approval (TWA) permit application. Assisted in the preparation of other required permits such as the Site Plan and the Stream Encroachment NJDEPE permit applications. Prepared Pollution Prevention Report tracking all hazardous waste generated during field sampling activities.

The Company was awarded the contract for the construction of the state-approved 100% remedial design. Responsibilities as mechanical engineer included equipment procurement coordination, technical evaluation of bids, preparation of construction drawings and all other final mechanical engineering details. Assisted in the coordination of other engineering disciplines during construction phase including electrical, instrumentation & control and civil. Also the resident process/mechanical engineer during the construction phases of this $14 million remediation project.

Consolidated Edison Company of New York, Risk Management Development, Project Engineer and Assistant Program Coordinator, 1996 – Responsible for the preparation and coordination of Risk Management Plans (15-25 Plans) for numerous Con Edison facilities throughout New York City. Plans were prepared in conformance with New York State requirements and typically cover common plant activities such as storage and handling of lead/acid batteries, chemical storage, etc. Plans were completed on an aggressive schedule and within budget.

Consolidated Edison Company of New York, Indian Point Facility, Buchanan, NY, Project Manager – Responsible for the implementation of a field sampling program as part of a NYS RCRA Part B permit application for mixed waste storage. Confirmatory field sampling encompasses soil boring sampling to depths of 36 inches.

Consolidated Edison Company of New York, Astoria Site Project, Queens, NY, Project Engineer, 1993-1994 – Responsible for the engineering, coordination, planning and report preparation of a storm sewer investigation in light of a corrective action program. The investigation is to determine the source(s) of dry weather flow as well as an oily product discharging into the East River. Responsibilities include work plan preparation, field activities coordination and supervision, and recommendation of viable remedial alternatives. Field activities include smoke/dye testing, water quality sampling, 7 - day flow monitoring, geophysical surveys and video inspections. Project was completed within budget and the recommended remedial alternative was successfully implemented.

Consolidated Edison Company of New York, Long Island City Project, Project Engineer, 1994 – Responsible for the management of a video inspection investigating a 12" combined city sewer susceptible to infiltrating oil. Investigated various sewer rehabilitation techniques such as In-situ form sewer relining and chemical grouting and recommended corrective action.

Project Engineer responsible for the implementation of the recommended sewer rehabilitation (sewer relining). Responsibilities include contractor procurement, specification preparation, construction management, construction oversight, and report preparation. Job completed on schedule and within budget.

Sidmak Laboratories, East Hanover, NJ, Mechanical Engineer, 1993 – Assisted in the preparation of a conceptual design report investigating various treatment systems for the reduction of solvent emissions from a pharmaceutical process. Thereafter, Engineer responsible for the preparation of the final design specification for this turn-key emissions control system featuring thermal oxidation and regenerative carbon adsorption. Specifications included fire protection, heating, ventilation and air conditioning, dampers, ductwork, and all other basic mechanical materials and methods. Involved in the selection of Contractor performing system construction. Mechanical engineer responsible for Contractor specifications and drawing review and approvals.

AlliedSignal Aerospace Company, Montrose Facility, Montrose, PA, 1992 – Prepared and coordinated limited treatability study for the removal of zinc from process water and assisted in the design and permitting for the process water treatment system upgrade. Responsible for drawing review and equipment assessment for all phases of upgrade.

AlliedSignal Aerospace Company, Teterboro Site, Teterboro, NJ, Engineer, 1992 – Responsible for the preliminary design of a groundwater extraction system. Responsibilities included investigating various pump configurations and technologies, performing detailed calculations and preparation of drawings and specifications. In addition, coordinated effort with electrical and instrumentation and control engineers.

Lead Field Engineer for a limited groundwater sampling effort investigating inorganic compounds in the groundwater. Prepared chemical characterization report summarizing results.

Mechanical Engineer responsible for the engineering and design of a groundwater/soils treatment system utilizing air-stripping UV oxidation, heavy metals removal and carbon adsorbtion. Responsibilities include preparation of Basis of Design Report and technical specifications and drawings.

Engineer responsible for the preparation of the NJDEP Discharge to Groundwater Permit Application for above mentioned treatment system.

U.S. Army Corps of Engineers, Silresim Superfund Site, Lowell, MA, Engineering Lead, 1995 – Prepared and provided design and construction drawings for Vapor Phase Treatment System as part of a groundwater treatment system. Responsibilities included equipment procurement, submittals review and approval, system design, preparation of construction drawing and equipment inspections.

Served as Lead Start-up Engineer for entire groundwater treatment system. System was brought on line within budget and on schedule. Responsibilities included the start-up and testing of all mechanical and electrical devices, instrumentation, system integration and control. This 10 million dollar plant was started-up on time and within budget. Thereafter served as lead

operation and maintenance engineer, recommended process changes, reviewed data and provided engineered design modifications to enhance system performance.

AlliedSignal Aerospace Company, Sumitomo Site, Teterboro, NJ, Engineer, 1993 – Responsible for the design of an interim stormwater management system for an outdoor soil treatment system pad. Design included stormwater assessment and flow rate calculation, pump and pipe sizing, material selection and equipment layout.

Lead Engineer responsible for the investigation and comparison (feasibility study) of various vapor phase treatment systems. Treatment alternatives included thermal and catalytic oxidation, regenerative carbon adsorption and reactivated carbon adsorption. Analysis was performed passed upon technical and economical viability over a ten year treatment period.

Engineer responsible for Phase I design of groundwater and soil vapor extraction system and on-site thermal desorption of low-level radioactive site soils.

Schering Corporation, Elizabeth River Project, Elizabeth, NJ, Engineer, 1992 – Responsible for the design of a pumping station upgrade (2000 GPM) and storm sewer basin pump rerouting stormwater to an on-site treatment system. Design included detailed calculations, pump specifications, force main sizing and material selection. Assisted in the design of pipe supports, aboveground piping route and installation procedures. Completed specifications for all mechanical methods and equipment. Assisted in the preparation of SPCC plans in accordance with New Jersey requirements.

New York U.S. Environmental Protection Agency, ARCS II Contract, Mattiace Property, Glen Cove, NY, 1992-Present – Supervised on-site soil gas sampling and assisted in coordinating all data compilation and complied extensive chemical characterization database/library.

Assisted in the review of pump test results and made recommendations based upon hydrogeological models.

Engineer responsible for the mechanical and process design of a vapor phase treatment system as part of a groundwater remediation design. Unit operations included air stripping thermal oxidation, and wet scrubbing. Coordinated all aspects of design including instrumentation and control design. Also responsible for the preparation of technical specifications and drawings.

New York U.S. Environmental Protection Agency, ARCS II Contract, Superfund Site, NY, Project Engineer, 1996 – Project Engineer responsible for the overall design of an in-situ vacuum extraction soil treatment system. Responsible for process calculations, mass balance, specifications and construction drawings.

Chevron Chemical Company, South Plainfield Site, South Plainfield, NJ, Engineer, 1993-Present – Responsible for determining a theoretical carbon adsorption usage rate and prepared report outlining carbon adsorption technology and its advantages and disadvantages in relation to the South Plainfield application. The report was used as a basis of design for an interim carbon adsorption treatment system. Engineer responsible for preparation of engineers

report as part of the state certification of groundwater treatment plant. Assisted in the preparation of SPCC plans in accordance with New Jersey requirements.

Vineland Chemical Company, Vineland, NJ, 1992-1993 – Assisted in the preliminary design of an interim groundwater treatment plant, prepared equipment specifications and assessments for all types of unit operations such as ion exchange, ultrafiltration, reverse osmosis, carbon adsorbtion and air stripping. Field Engineer for an extensive groundwater sampling effort obtaining data on arsenic concentrations in the groundwater. Assisted in the preparation of the analytical results report analyzing various filtration systems employed during field activities. Responsibilities included filtration field activities work plan, design and equipment procurement.

Assisted in the preparation of a Discharge to Surface Water (DSW) permit application.

New Jersey Natural Gas Company, Atlantic Highlands Site, Atlantic Highlands, NJ, 1993 – Assisted in the preparation of feasibility study analyzing alternative soil and groundwater treatment technologies. Responsibilities included capital and operational cost estimating, preliminary design, equipment assessments and report organization.

New Jersey Power and Light/Electrical Power Institute, Toms River, NJ, 1996-Present, Engineer – Responsible for the design of a groundwater treatment utilizing dissolved air flotation and air stripping for the removal of organic compounds at this former MGP site. Responsible for all aspects of design including project engineering interdisciplinary review, preparation of technical specifications and drawings.

Engelhard Corporation, Plainville, Massachusetts, 1995 – Engineer responsible for the preparation of a Basis of Design report for a groundwater pump and treat system. Responsible for the technical and economic assessment of all process operations including air stripping and UV oxidation.

Circuitron Superfund Site EPA Region 2, Long Island, New York, 1996 – Mechanical engineer responsible for the design of the heating, ventilation and air conditioning system for 2000 square foot facility. Prepared Heating and cooling load calculations (ASHRAE standards) and developed technical specifications and drawings for HVAC systems.

Operating Industries Incorporated (OII) Landfill, Monterey Park, California, 1997 – Conducted on-site review of existing Leachate Treatment System in order to assess effectiveness, recommended process enhancements and establish process constraints and throughput capacity. System unit operations included Biological Sequencing Batch reactors, sand filtration, carbon adsorption, metals removal and sludge handling.

NASA, John F. Kennedy Space Center, Kennedy Space Center, Florida, Engineer – Responsible for the preparation of a technical specification for a low temperature condensation prototype system for the application of nitrogen tetroxide vapor recovery and emission control during loading and transfer operations.

PRIOR EXPERIENCE

IBM Corporation
Yorktown Heights, NY

Research Laboratory Engineer, 1991-1992 – Performed extensive thermal experiments on various heat sensitive computer devices, interfaces and systems. Design, modified and implemented various personal and mainframe computer cooling systems. Install all experimental equipment such as wind tunnels, thermocouple data loggers and flow meters and configured a large PC-based data acquisition system to automatically conduct all experiments and generate results. Assisted in preparing project management schedule and project equipment charts. Prepared detailed drawings of various computer components and systems.

Morgan I. Evans
Hydrogeologist

EXPERIENCE SUMMARY

More than five years in the environmental field. Responsible for performing a broad range of hydrogeological tasks. Areas of expertise include surface/groundwater investigations, design and implementation of soil boring and monitoring well programs, managing underground storage tank remedial actions, performing Phase I and II Environmental Assessments, soil and groundwater sampling, geophysical support in seismic refraction and magnetometry surveys, and compliance with EPA and NJDEPE regulatory programs.

REGISTRATIONS/CERTIFICATIONS

UST Subsurface Evaluator Certification, New Jersey - 1994

EDUCATION

BS / Geology / Thomas Edison State University / 1993
BA / English / Kean College / 1988
AA / Liberal Arts / Somerset County College / 1983

TRAINING

40-Hour OSHA Hazardous Waste Health and Safety Training - 1989
8-Hour OSHA Hazardous Waste Health and Safety Supervisor Training - 1995
8-Hour OSHA Hazardous Waste Health and Safety Refresher Course - Current
Red Cross First Aid and CPR Training - 1995
USEPA Lead Inspector Training - 1994
Radiological Worker Level II Certification - 1993

REPRESENTATIVE PROJECT EXPERIENCE

Foster Wheeler Environmental Corporation; Livingston, NJ; 10/1/91 - Present

Site Soil Remediation Project; Project Geologist - Responsible for remediation of over 40,000 cubic yards of soil contaminated with polynuclear aromatic hydrocarbons. Work was conducted in preparation for the construction of a waste-to-energy facility in Robbins, IL.

1991-Present; Hydrogeologist - Environmental technician on a Technology Demonstration Site Program utilizing an in-situ groundwater treatment system for the purpose of remediating MMAcontaminated groundwater at an NPL site in Millville, New Jersey.

Environmental Technician - Served as environmental technician and conducted soil sample collection as well as assisted in a subsurface geophysical investigation during a four week field effort for the purpose of creating a Remedial Action Workplan for an industrial facility in Perth Amboy, New Jersey.

Site Geologist - Served as Site Geologist at a mixed waste remediation project in Teterboro, New Jersey. Conducted field screening of soil samples for levels of radium-226 and thorium-232 using

a gamma-ray spectrometer. Also conducted sampling of unprocessed and processed soil, and waste water.

U.S. Department of Energy; Project Geologist - Responsible for the construction of a groundwater extraction system for the collection of groundwater contaminated with radioactive waste and volatile organic compounds.

Field Geologist - Responsible for the collection and evaluation of groundwater data from a monitoring well network of more than 300 wells.

Field Supervisor - Responsible of an extensive program consisting of soil borings, groundwater monitoring well installation,surface water sampling, sediment sampling, subsurface and surface soil sampling, groundwater sampling, hydraulic conductivity tests, continuous and synoptic water level measurements, geophysical investigations, and report preparation in support ofthe Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, a 10-year program supporting naval installation restoration.

Field Hydrogeologist - Responsible for the groundwater monitoring well installation and 7-day pump tests in support of a Hydrocarbon Recovery System Evaluation and Conceptual Design for an oil refinery in Texas.

Field Geologist - Responsible for an extensive remedial program consisting of soil borings, groundwater monitoring well installation, and groundwater sampling in support of an RCRA Facility Investigation (RFI) for an active oil refinery in Texas.

Environmental Technician - Prepared closure plan and necessary NJDEPE permit applications for decommissioning Underground Storage Tanks (USTs), and performed lead paint sand surface soil sampling at 22 buildings in support of building demolition program at a military installation in New Jersey.

Field Geologist - Associated with a geophysical survey using electromagnetic subsurface exploration in order to provide an accurate interpretation of subsurface conditions at a private industrial facility in Edison, New Jersey.

Field Geologist - Responsible for a sampling effort in support of a Waste Characterization and Treatability Study in order to characterize sludge and determine treatability options at a private industrial/ chemical facility in Delaware.

Project Geologist - Responsible for a hydrogeological investigation in support of a Remedial Action Work Plan for a Cranbury, New Jersey facility. Responsibilities included installation and sampling of groundwater monitoring wells and soil borings in support of a bioremediation project.

Field Geologist - Responsible for an extensive soil sampling investigation in support of a Remedial Design program for a Perth Amboy facility. Responsibilities included installation and sampling of soil borings in support of a Remedial Action Work Plan.

Hydrogeologist - Associated with a NJDEPE DICAR investigation at a Jersey City facility. Responsibilities included installation of groundwater monitoring wells and meeting wetlands permitting requirements.

Performed Phase I Environmental Site assessments throughout the U.S.

PRIOR EXPERIENCE

Staff II Scientist; 1989-1991 - Environmental scientist associated with over 60 clean-ups for various clients in New Jersey and Connecticut. Responsibilities included groundwater investigation and remediation, drilling programs, installation and sampling of soil borings and monitoring wells, field investigations, waste management, and disposal. Involved in bioremediation programs and environmental site audits and remediation. Actively involved in NJDEPE report preparation and client-state interface.

Field Supervisor - Responsible for a 60-acre site in Wharton, New Jersey undergoing remediation for volatile organics in soils and groundwater. Responsible for installing and sampling groundwater monitoring well network, performing pump and hydraulic conductivity tests, and overseeing excavation and disposal of contaminated materials.

Site Geologist - Responsible for an ECRA investigation at an industrial facility in Linden, New Jersey with high levels of PCBs, volatile organics, and metals in soils and groundwater. Responsible for soil sampling and removal from both exterior and interior excavations, installation of groundwater monitoring wells, soil disposal, and coordination of an historical investigation and large-scale soil boring program in an effort to attribute PCBs emitted from a neighboring facility as the primary source of contamination.

Project Geologist - Associated with a BUST project at a gasoline station in Brick Township, New Jersey. Responsibilities included removal of USTs, post-excavation confirmation sampling and installation of soil venting system at the facility in compliance with DICAR investigation.

Morgan I. Evans
Hydrogeologist

GEOSCIENCES SPECIALTIES:

__6__ Years Geosciences Experience
Borings and Wells - Geotechnical Borings
Borings and Wells - Monitoring Well Installation
Borings and Wells - Recovery Well / Production Well Installation
Borings and Wells - Soil Classification / Logging
Dense Non Aqueous Phase Liquids (DNAPL)
Geophysics - Electromagnetics
Geophysics - Ground Penetrating Radar
Geophysics - Other
Geophysics - Resistivity
Geostatistics
Hydraulics / Design - Product Recovery Well Design
Hydraulics / Design - Slurry Walls / Cut Off Trenches
Hydrogeology - Groundwater Hydraulics
Hydrogeology - Pump Test Analysis- Pump Test Performance
Hydrogeology - Slug Test Analysis
Hydrogeology - Slug Test Performance
Hydrogeology - Water Quality
Hydrology - Water Quality
In Situ Remediation - Air Sparging
In Situ Remediation - Bioremediation
In Situ Remediation - Soil Vapor Extraction
Light Non Aqueous Phase Liquids (LNAPL)
Manufacturing Facilities / Property Transfer
Modeling - Contaminant Transport
Modeling - Groundwater Flow
Radioactive Waste / Mixed Waste
RCRA / CERCLA
Sampling - EPA / CLP Paperwork
Sampling - Groundwater
Sampling - Sediment
Sampling - Soil
Sampling - Water Level Measurements
Underground Storage Tanks / Refineries

Glendon J. Spears
Construction Superintendent

EXPERIENCE SUMMARY

Over 25 years of experience as a Superintendent and Operations Manager for incineration projects and plants operations and maintenance. Responsibilities have included overseeing maintenance and operations, directing shift supervisors and operations employees, monitoring incineration process, operating equipment, and arranging production schedules and excavation projects.

REGISTRATIONS/ CERTIFICATIONS (complete registration data in rfpdata/registra/corpdata)

Standard First Aid and CPR - 9/17/96

EDUCATION

Technical Courses - ICS - Electrical Wiring
Certified Stack Reader / Cook College, Rutgers University
Blue Seal Boiler Operation / Salem County College
Hazardous Waste Disposal Via Incineration / Self-Educated

TRAINING

40-Hour OSHA Initial Hazardous Waste Training in Accordance with 29 CFR 1910.120 - 8/25/89
8-Hour OSHA Supervisor Training in Accordance with 1910.120(e)(4) - 10/18/94
8-Hour OSHA Annual Hazardous Waste Site Refresher as Required by 29 CFR 1910.120(e)(8) - Current
RCRA Waste Management Training Program in Accordance with 40 CFR 265.16 - 7/97
Practical Loss Control Leadership Course - 2/96
DOT Training Program in Accordance with DOT/HM-126F Hazmat Training 49 CFR 172, Subpart H - 03/08/95
Project Management Training - 2/95
Hazardous Waste Training in Accordance with 40 CFR 265.16 - 12/94
First Aid/CPR Training

Company: Foster Wheeler Environmental Corporation; 5/1/93 - Present
Present Location: BROS, NJ
Daytime Phone: 609-241-9238

REPRESENTATIVE PROJECT EXPERIENCE

Union Pacific Railroad Company, DM&E Huron Roundhouse Site Remediation, Huron, SD, Site Superintendent, 8 Months - Supervised at this site where remedial actions involve excavation of contaminated sediment and soil from the adjacent ditch and creek, pond water diversion and treatment, oil soil disposal, and site restoration. Developed remediation work plans/submittals based on the specifications for remedial actions of this site which is being cleaned up under CERCLA. The Roundhouse, which is still in operation discharged oil wastewater from the repair and maintenance of locomotives into two on-site settling ponds. Responsible for the productivity of a labor force of 15 craft operators. Directed daily workplace and insure compliance within project guidelines.

U.S. Army Corps of Engineers, BROS Superfund Site, NJ, Site Superintendent and Operations Manager, 3.5 Years - Responsible for the oversight and maintenance of the Thermal Destruction Facility (TDF) at the Bridgeport Rental and Oil Services (BROS) site. Responsibilities included assigning shifts, coordinating staff activities, and overseeing the maintenance and operator of the TDF. Also, responsible for runloading acid trailers, bulk transfer of lime, operating acid neutralization vessels, and insuring reactions were completed by sampling and analysis. Operated biological trickle filter system in pre-aeration activated sludge basin.

Performed various maintenance functions such as rebuilding pumps, welding/burning, pipe threading, pipe and metal fabricating, and electrical maintenance.

Monitored complete incinerator process, selected solid materials to feed into rotary kiln, provided directions to two other shift operators, and operated all equipment while maintaining environmentally sound and safe conditions.

Directed six operators and four helpers in the Chemical Process Area. Ensured proper chemical reacting in a timely manner, performed various inventory functions, and interfaced with transportation to complete scheduling of equipment. Directed one incinerator operator and two helpers, completed daily shift inspectors and reports for production, and made certain transportation equipment was unloaded and washed. Worked at the Houston, TX facility and performed the above job duties.

Worked for the Engineering Department performing field follow-up on projects, directed contractors on various projects, verified work completed and inventory control, and directed refractory installation. Worked at various field service remediation projects.

Directed special projects for plant operations, performed administrative support, and reported daily revenues and production levels.

Directed four shift supervisors and the maintenance supervisor. Arranged production schedules which included burnables, liquids, ash, and sludge manifesting. Oversaw 12 maintenance mechanics for 12-month period. Interfaced with the Sales Department for receipt of materials for incineration.

Responsible for overall plant operations and maintenance functions since 1978 after appointment from the supervisory staff. Provided direction to seven shift supervisors, coordinated overall plant operations and maintenance and supervised the productivity of 41 operation employees and 16 maintenance mechanics at a $45 million incineration process and a $60,000 maintenance budget facility. Capital improvements amounted to $50,000 annually for improvements to incineration process, equipment and labor selection, and refractory materials. Handled labor union grievances. Interfaced with New Jersey Department of Environmental Protection Agency and Energy and U.S. Environmental Protection Agency Region II regarding incineration operations.

Interfaced with Corporate Engineering on operational problems and equipment upgrades. Worked in Engineering Department with responsibility for contract projects. Directed off-site remedial clean-ups. Performed Supervisory and Consulting functions at other Rollins Environmental Services facilities. Hands-on experience in all departments.

PRIOR EXPERIENCE

Rollins Environmental Services, Inc.
New Jersey

Debt Market Agent, 1970-1993 - Worked in insurance sales and as an auto/truck mechanic. Managed an electrical supply business for five years.

ATTACHMENT B
ENGINEERING DRAWINGS

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

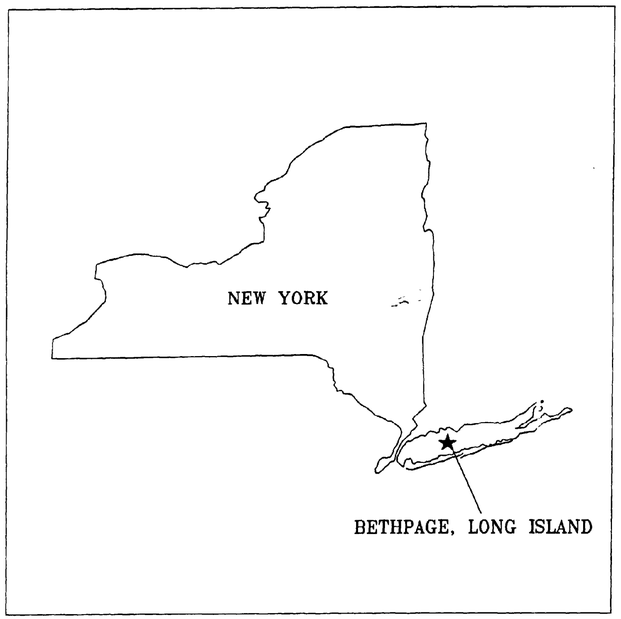
Prepared for:

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

Prepared by:

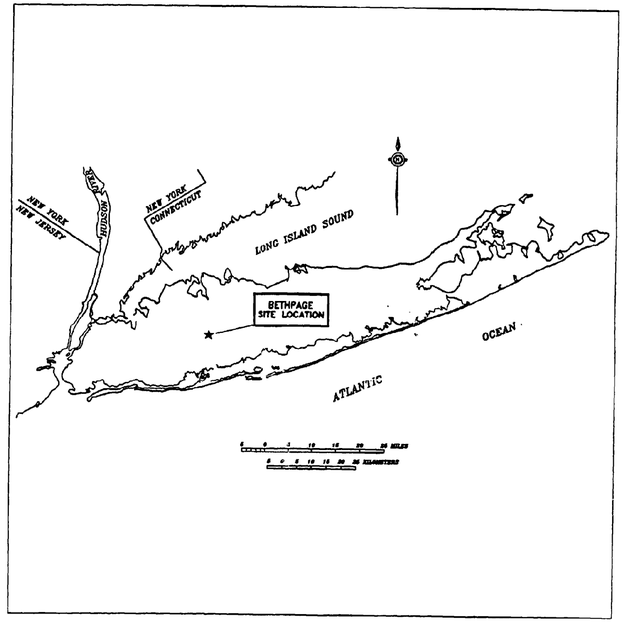
Foster Wheeler Environmental Corporation
8 Peach Tree Hill Road
Livingston, New Jersey 07039

Contract. No. N62472-94-D-0398
Delivery Order 0004
December 1997



STATE LOCATION MAP

DRAWING NUMBER	DESCRIPTION
BTH-01	COVER PAGE
BTH-02	SITE PLAN
BTH-03	PIPING INSTRUMENTATION DIAGRAM
BTH-04	WELL INSTALLATION DETAILS
BTH-05	ELECTRICAL DETAILS
BTH-06	CONSTRUCTION DETAILS



LOCATION MAP

FOSTER WHEELER ENVIRONMENTAL CORPORATION
PREP BY DATE APPRVD
REV. DESCRIPTION

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NORTHERN DIVISION
PHILADELPHIA, PA.
NAVAL BASE
WWRP
BETHPAGE, NEW YORK

COVER SHEET
SITE 1 - FORMER DRUM MARSHALLING AREA
AIR SPARGING/SOIL VAPOR EXTRACTION SYSTEM

APPROVED
DATE
NORTHERN DIV. FACILITIES ENGINEERING COMMAND
APPROVED
DATE

SEAL AREA

SAT TO DATE
CODE I.D. NO.
SCALE :
SPEC. NO. 04-
CONSTRN. CONTR. NO.
NAVFAC DRAWING NO.
SHEET 1 OF 6
SIZE: D
DIS. SH. NO. BTH-01

CAD FILE NAME: NDBTH-1.DWG DATE: 12/08/97
PLOT SCALE: 1=1 TIME: 10:52 AM

Map Notes:

1.) Coordinate Datum for this project is based on the New York State Plane Coordinate System, Long Island Zone (3104) established on the North American Datum of 1983 (NAD83) through the use of differential GPS techniques from Nassau County D.P.W. Stations 18E13NAZ, 18E12N and 11E11N.

2.) Elevation Datum for this project is the National Geodetic Vertical Datum of 1929 (NGVD29). Differential GPS Observations in conjunction with standard leveling techniques were employed to establish and verify elevations shown hereon.

3.) The limited underground structures shown hereon have been scaled from record plans provided to C.T. Male by Foster-Wheeler. C.T. Male does not guarentee that all underground structures or utilities have been shown as this was not part of the scope of work. Prior to any excavation or digging, the appropriate officals should be contacted to verify the existence of such facilities.

4.) All information shown hereon is the result of an actual "on-the-ground" field survey conducted by C.T. Male Associates, P.C. during the week of November 6, 1995, and on April 25, 1996.

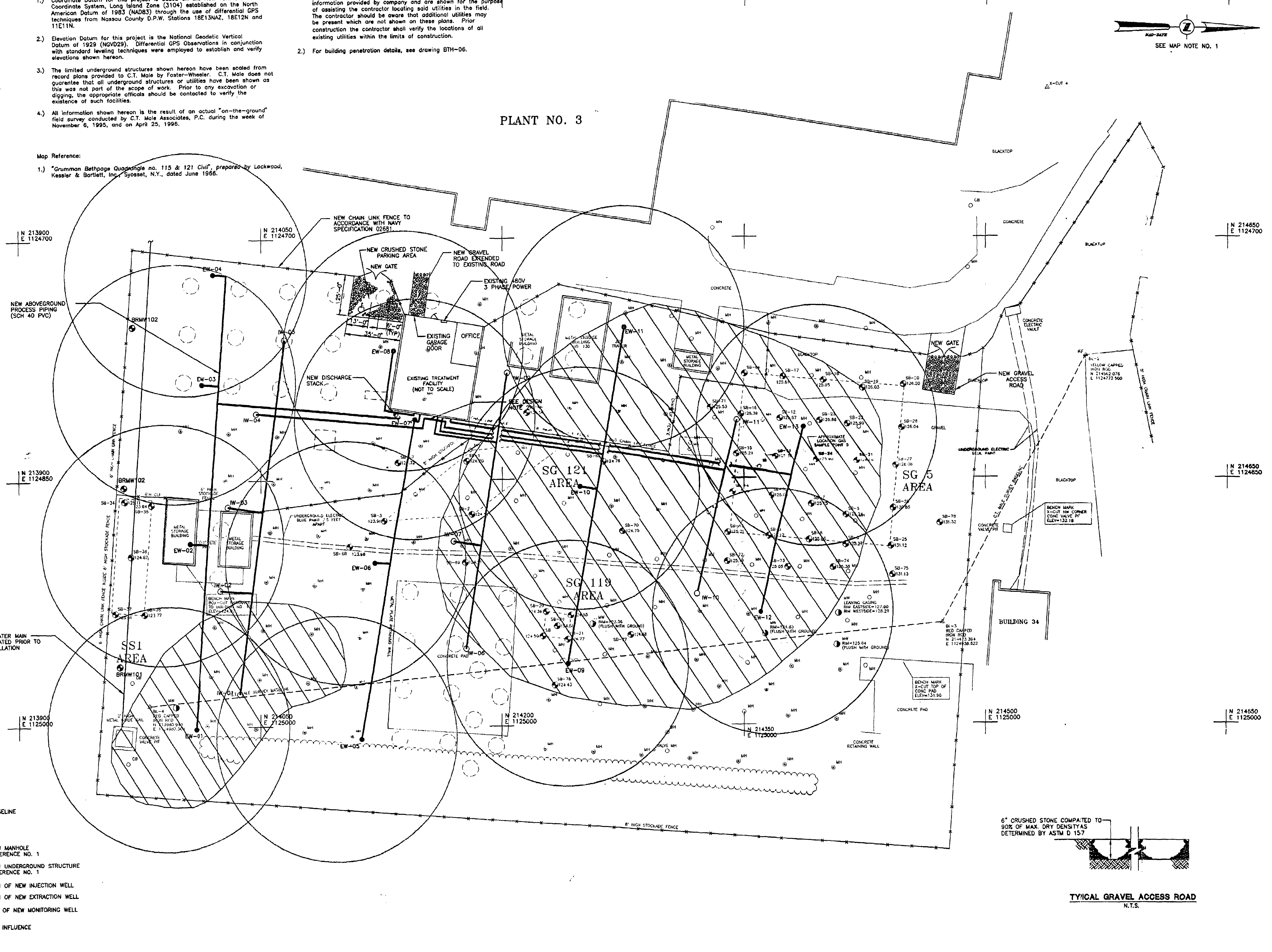
Map Reference:

1.) *"Grumman Bethpage Quadrangle no. 115 & 121 Civil"*, prepared by Lockwood, Kessler & Bartlett, Inc., Syosset, N.Y., dated June 1966.

Design Notes:

1.) Some existing underground utilities have been locate using information provided by company and are shown for the purpose of assisting the contractor locating said utilities in the field. The contractor should be aware that additional utilities may be present which are not shown on these plans. Prior construction the contractor shall verify the locations of all existing utilities within the limits of construction.

2.) For building penetration details, see drawing BTH-06.



FOSTER WHEELER ENVIRONMENTAL CORPORATION

REV.	DESCRIPTION	PREP BY	DATE	APPRVD

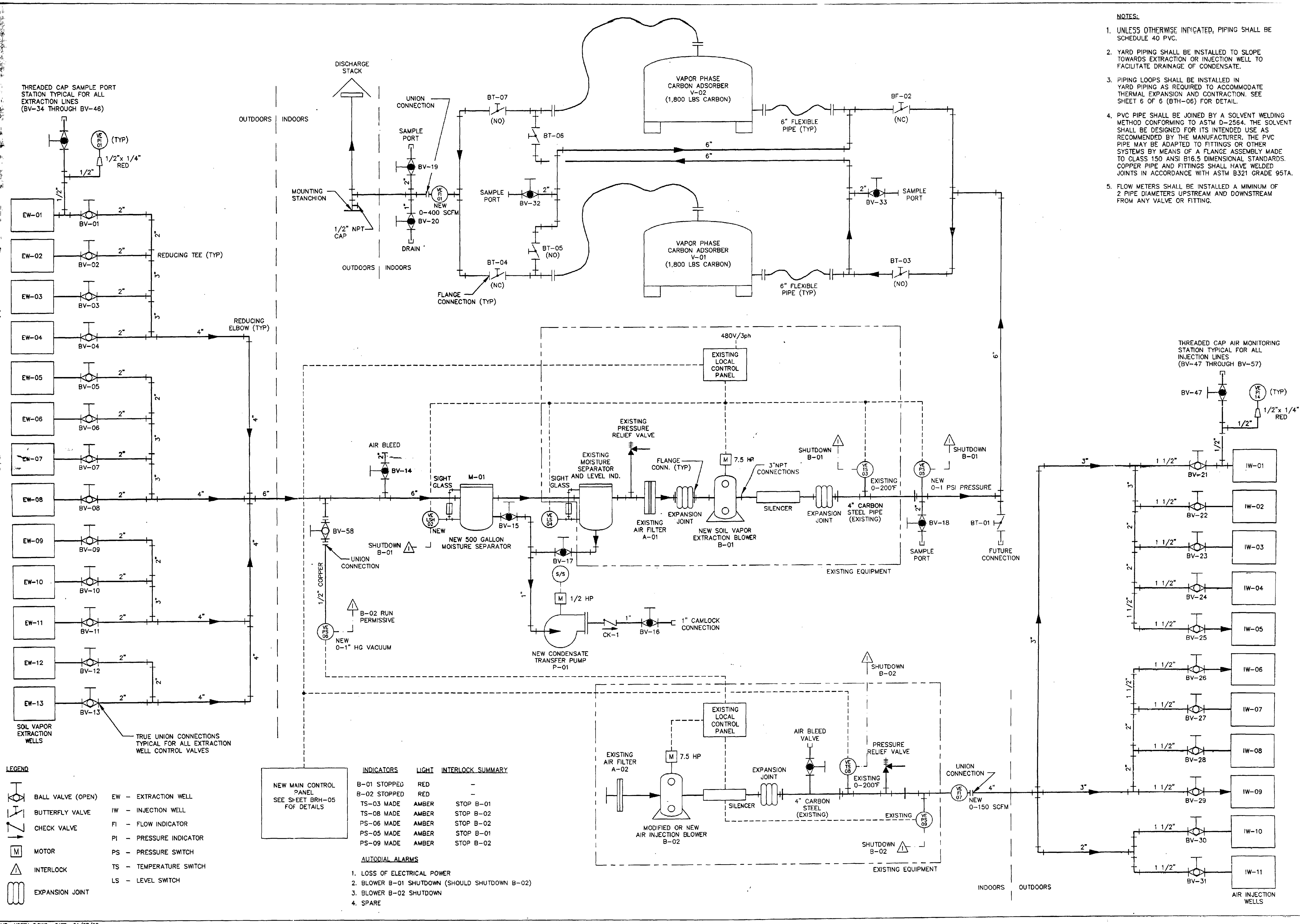
DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND — NORTHERN DIVISION — PHILADELPHIA, PA.

NAVAL BASE — NWIRP — BETHPAGE, NEW YORK

SITE PLAN
SITE 1 – FORMER DRUM MARSHALLING AREA
AIR SPARGING/SOIL VAPOR EXTRACTION SYSTEM

SAT TO
CODE I.D. NO.
SCALE : 1"=30'-0"
SPEC. NO. 04-
CONSTRN. CONTR. NO.
NAVFAC DRAWING NO.
SHEET 2 OF 6
SIZE: D
DIS. SH. NO. BTH-02

CAD FILE NAME: NDBTH-2.DWG DATE: 01/06/98
PLOT SCALE: 1=30 TIME: 2:37 PM


THREADED CAP SAMPLE PORT STATION TYPICAL FOR ALL EXTRACTION LINES (BV-34 THROUGH BV-46)
VE PI 01 (TYP)
1/2"x 1/4" RED
EW-01
EW-02
EW-03
EW-04
EW-05
EW-06
EW-07
EW-08
EW-09
EW-10
EW-11
EW-12
EW-13
SOIL VAPOR EXTRACTION WELLS
REDUCING TEE (TYP)
REDUCING ELBOW (TYP)
TRUE UNION CONNECTIONS TYPICAL FOR ALL EXTRACTION WELL CONTROL VALVES
OUTDOORS | INDOORS
DISCHARGE STACK
UNION CONNECTION
SAMPLE PORT
MOUNTING STANCHION
1/2" NPT CAP
NEW 0-400 SCFM
DRAIN
VAPOR PHASE CARBON ADSORBER V-02 (1,800 LBS CARBON)
VAPOR PHASE CARBON ADSORBER V-01 (1,800 LBS CARBON)
6" FLEXIBLE PIPE (TYP)
FLANGE CONNECTION (TYP)
480V/3ph
EXISTING LOCAL CONTROL PANEL
AIR BLEED
SIGHT GLASS
M-01
NEW 500 GALLON MOISTURE SEPARATOR
EXISTING PRESSURE RELIEF VALVE
EXISTING MOISTURE SEPARATOR AND LEVEL IND.
FLANGE CONN. (TYP)
3"NPT CONNECTIONS
EXISTING AIR FILTER A-01
EXPANSION JOINT
NEW SOIL VAPOR EXTRACTION BLOWER B-01
SILENCER
4" CARBON STEEL PIPE (EXISTING)
EXISTING 0-200°F
NEW 0-1 PSI PRESSURE
SHUTDOWN B-01
FUTURE CONNECTION
EXISTING EQUIPMENT
NEW CONDENSATE TRANSFER PUMP P-01
1" CAMLOCK CONNECTION
B-02 RUN PERMISSIVE
NEW 0-1" HG VACUUM
1/2" COPPER
SHUTDOWN B-02
EXISTING AIR FILTER A-02
MODIFIED OR NEW AIR INJECTION BLOWER B-02
AIR BLEED VALVE
PRESSURE RELIEF VALVE
UNION CONNECTION
NEW 0-150 SCFM
INDOORS | OUTDOORS
THREADED CAP AIR MONITORING STATION TYPICAL FOR ALL INJECTION LINES (BV-47 THROUGH BV-57)
IW-01
IW-02
IW-03
IW-04
IW-05
IW-06
IW-07
IW-08
IW-09
IW-10
IW-11
AIR INJECTION WELLS
NEW MAIN CONTROL PANEL SEE SHEET BRH-05 FOR DETAILS

LEGEND

- BALL VALVE (OPEN)
- BUTTERFLY VALVE
- CHECK VALVE
- M — MOTOR
- INTERLOCK
- EXPANSION JOINT

EW	-	EXTRACTION WELL
IW	-	INJECTION WELL
FI	-	FLOW INDICATOR
PI	-	PRESSURE INDICATOR
PS	-	PRESSURE SWITCH
TS	-	TEMPERATURE SWITCH
LS	-	LEVEL SWITCH

INDICATORS	LIGHT	INTERLOCK SUMMARY
B-01 STOPPED	RED	-
B-02 STOPPED	RED	-
TS-03 MADE	AMBER	STOP B-01
TS-08 MADE	AMBER	STOP B-02
PS-06 MADE	AMBER	STOP B-02
PS-05 MADE	AMBER	STOP B-01
PS-09 MADE	AMBER	STOP B-02

AUTODIAL ALARMS

1. LOSS OF ELECTRICAL POWER
2. BLOWER B-01 SHUTDOWN (SHOULD SHUTDOWN B-02)
3. BLOWER B-02 SHUTDOWN
4. SPARE

NOTES:

1. UNLESS OTHERWISE INDICATED, PIPING SHALL BE SCHEDULE 40 PVC.
2. YARD PIPING SHALL BE INSTALLED TO SLOPE TOWARDS EXTRACTION OR INJECTION WELL TO FACILITATE DRAINAGE OF CONDENSATE.
3. PIPING LOOPS SHALL BE INSTALLED IN YARD PIPING AS REQUIRED TO ACCOMMODATE THERMAL EXPANSION AND CONTRACTION. SEE SHEET 6 OF 6 (BTH-06) FOR DETAIL.
4. PVC PIPE SHALL BE JOINED BY A SOLVENT WELDING METHOD CONFORMING TO ASTM D-2564. THE SOLVENT SHALL BE DESIGNED FOR ITS INTENDED USE AS RECOMMENDED BY THE MANUFACTURER. THE PVC PIPE MAY BE ADAPTED TO FITTINGS OR OTHER SYSTEMS BY MEANS OF A FLANGE ASSEMBLY MADE TO CLASS 150 ANSI B16.5 DIMENSIONAL STANDARDS. COPPER PIPE AND FITTINGS SHALL HAVE WELDED JOINTS IN ACCORDANCE WITH ASTM B321 GRADE 95TA.
5. FLOW METERS SHALL BE INSTALLED A MIMINUM OF 2 PIPE DIAMETERS UPSTREAM AND DOWNSTREAM FROM ANY VALVE OR FITTING.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

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NAVAL FACILITIES ENGINEERING COMMAND — PHILADELPHIA, PA

NORTHERN DIVISION

PIPING AND INSTRUMENTATION DIAGRAM
SITE 1 - FORMER DRUM MARSHALLING AREA
AIR SPARGING/SOIL VAPOR EXTRACTION SYSTEM

SHEET 3 OF 6 — SIZE: D — DIS. SH. NO. BTH-03

CAD FILE NAME: NDBTH-3.DWG DATE: 01/07/98
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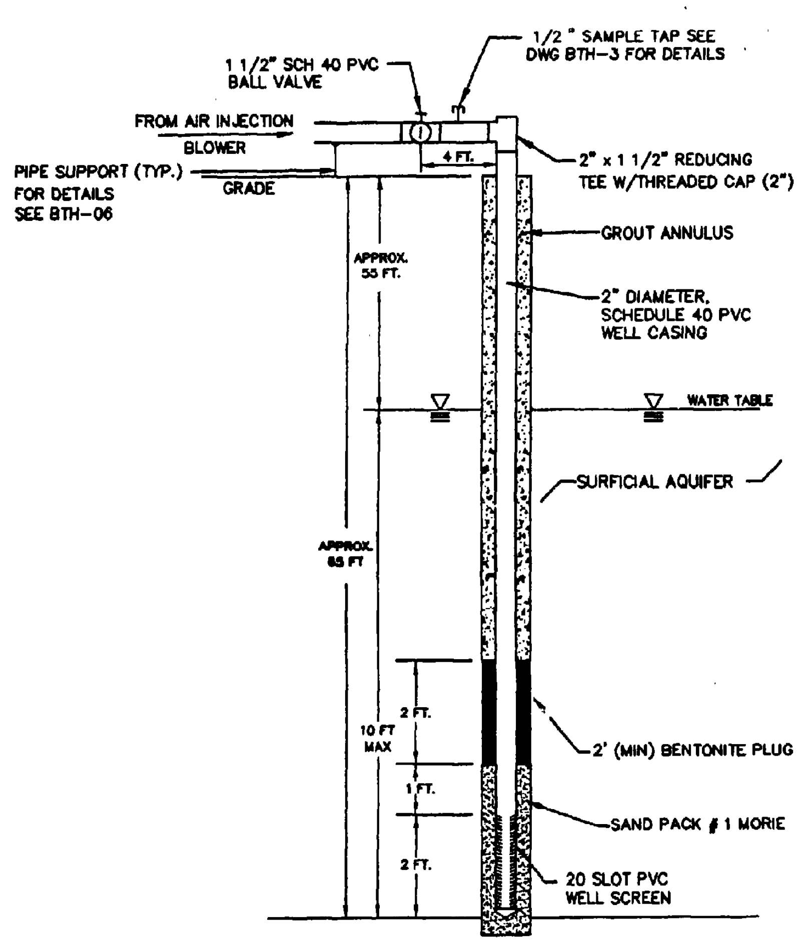
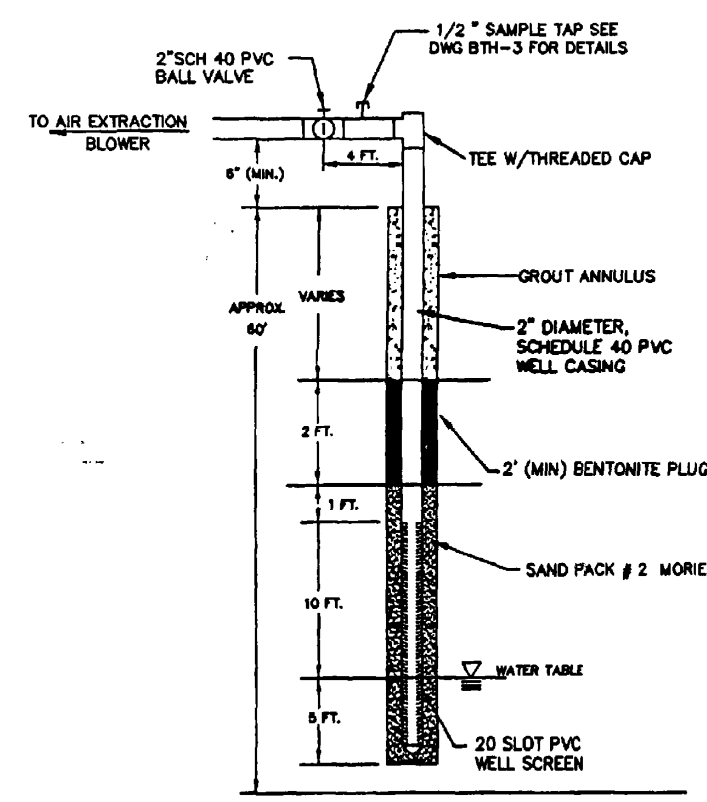


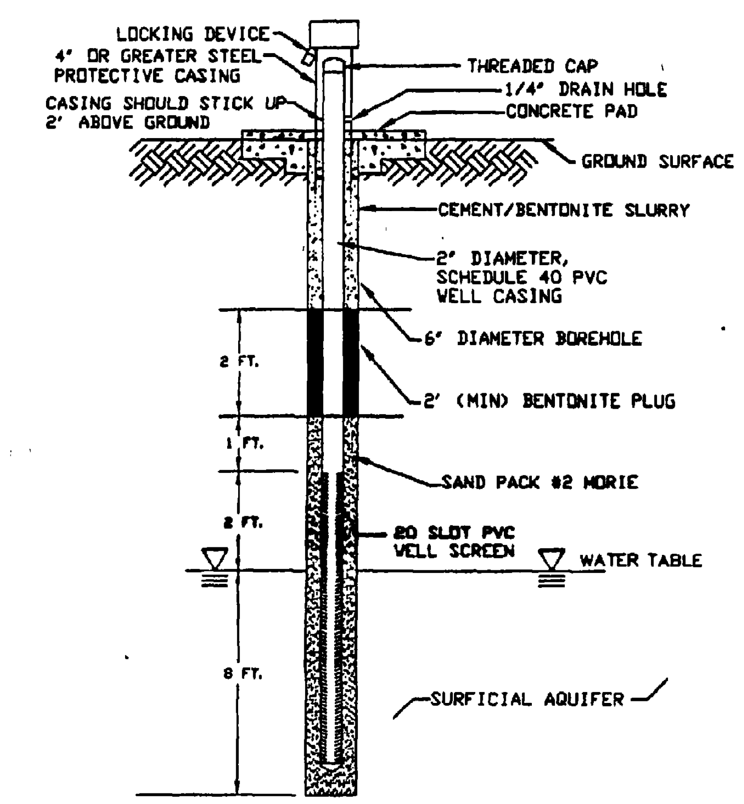
INJECTION WELL DETAIL (TYPICAL)

NOT TO SCALE



EXTRACTION WELL DETAIL (TYPICAL)

NOT TO SCALE



GROUNDWATER MONITORING WELL
WELL INSTALLATION DETAIL (TYPICAL)

NOT TO SCALE

REV.	DESCRIPTION	PREP BY	DATE	APPRVD

FOSTER WHEELER ENVIRONMENTAL CORPORATION

DEPARTMENT OF THE NAVY

NAVAL FACILITIES ENGINEERING COMMAND PHILADELPHIA, PA.

NORTHERN DIVISION

WELL INSERTION DETAILS
SITE 1 - FORMER DRUM MARSHALLING AREA
AIR SPARGING/SOIL VAPOR EXTRACTION SYSTEM

SEAL AREA

SAT TO / DATE

CODE I.D. NO.

SCALE :

SPEC. NO. 04-

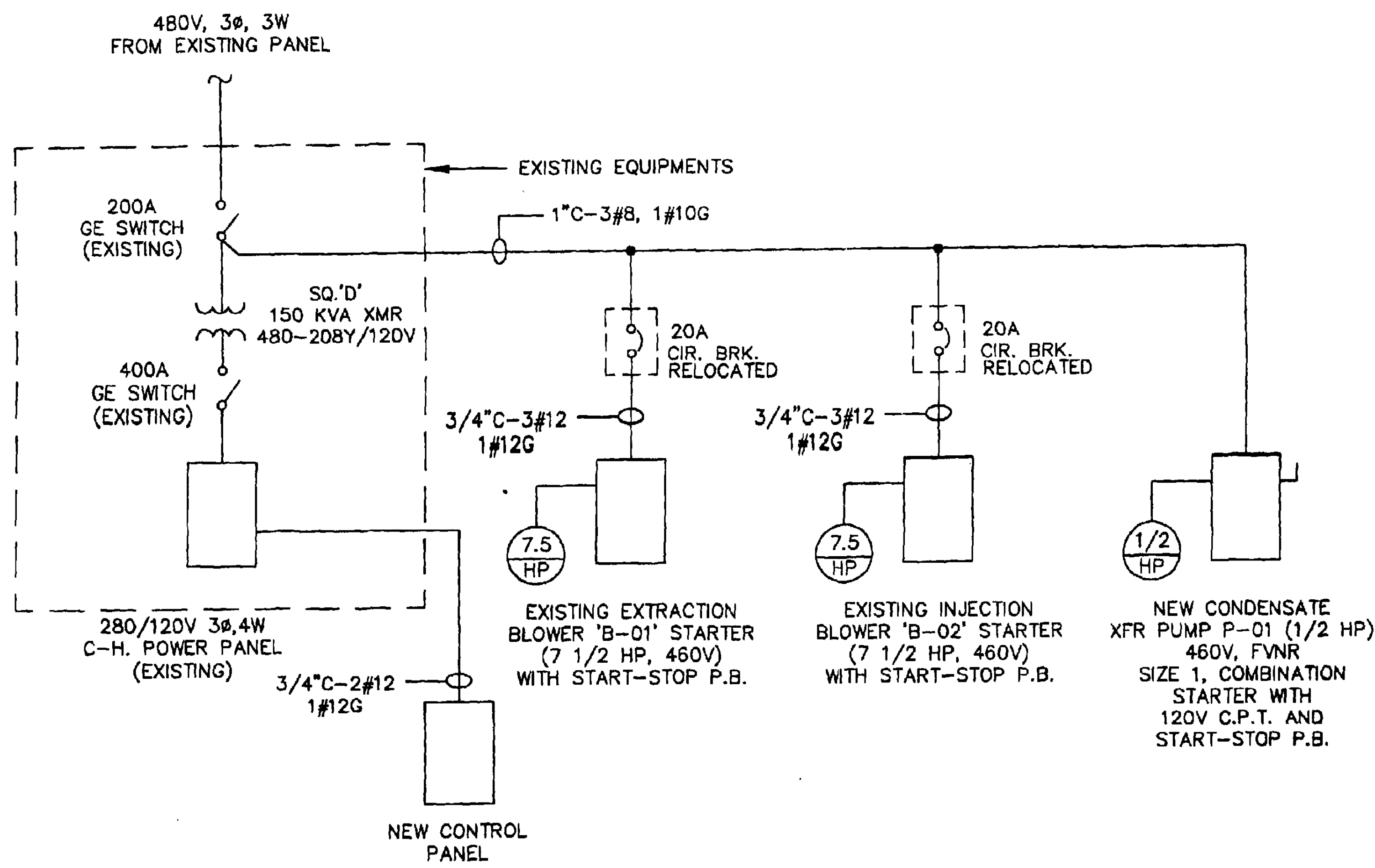
CONSTR. CONTR. NO.

NAVFAC DRAWING NO.

SHEET 4 OF 6

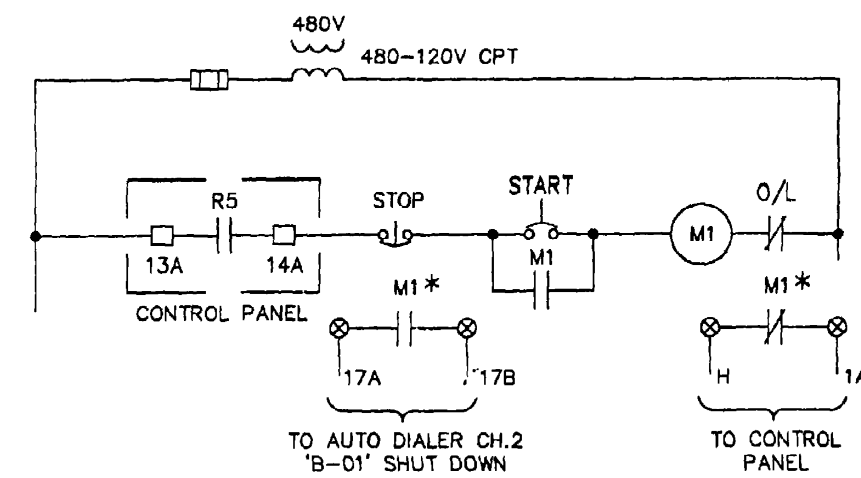
SIZE: D / DIS. SH. NO. BTH-04

CAD FILE NAME: BTH4.DWG DATE: 12/09/97
PLOT SCALE: 1=1 TIME: 12:08 PM



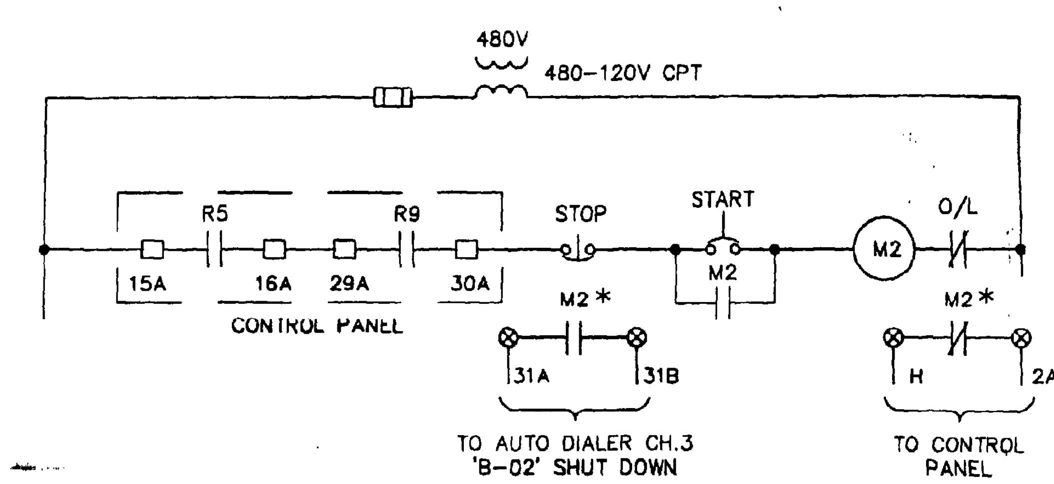
ELECTRICAL ONE LINE DIAGRAM

N.T.S.



BLOWER 'B-01' STARTER W.D.

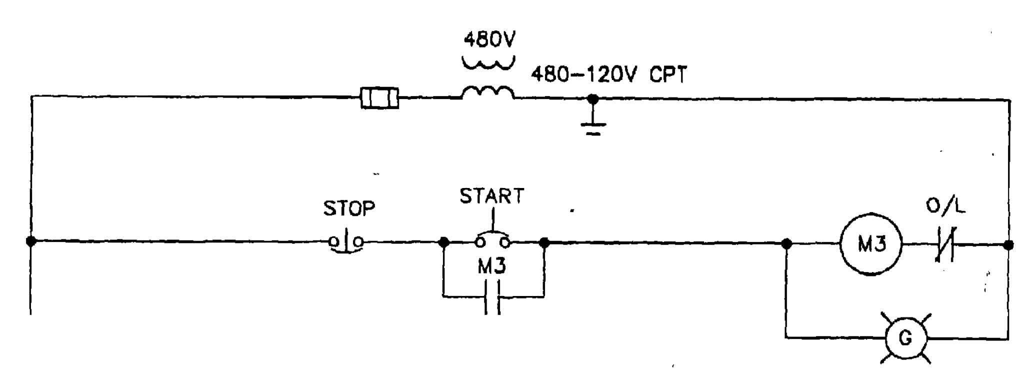
(CONTRACTOR TO REWIRE THE STARTER)



BLOWER 'B-02' STARTER W.D.

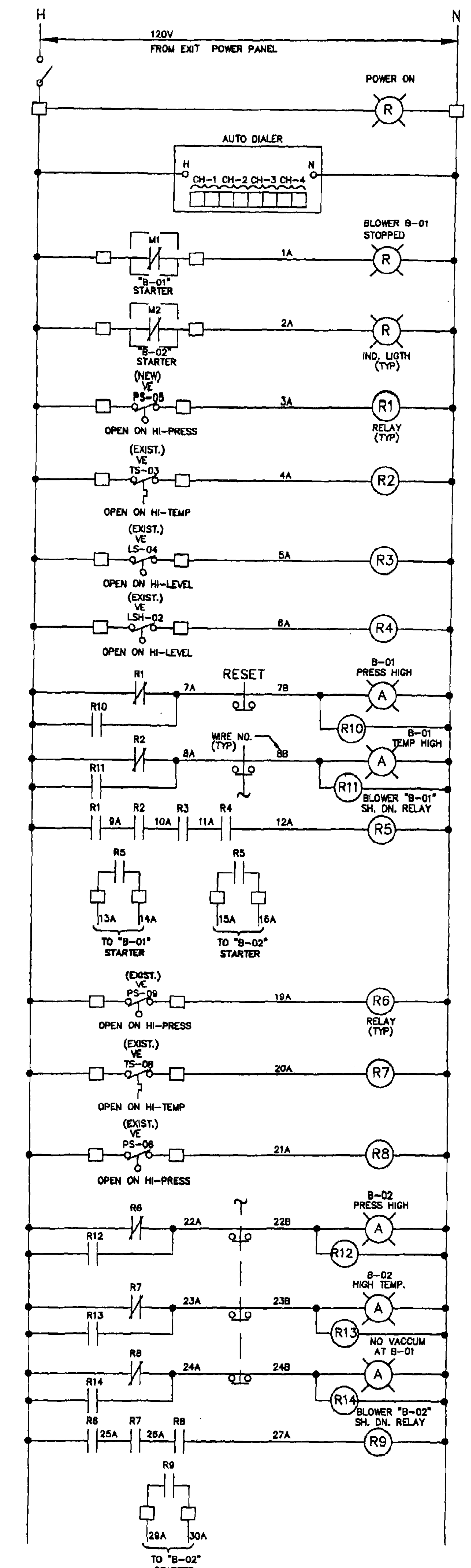
(CONTRACTOR TO REWIRE THE STARTER)

* ADD AUX 'M' CONTACT IN THE STARTER



CONDENSTE PUMP P-01 W.D.

(CONTRACTOR TO REWIRE THE STARTER)



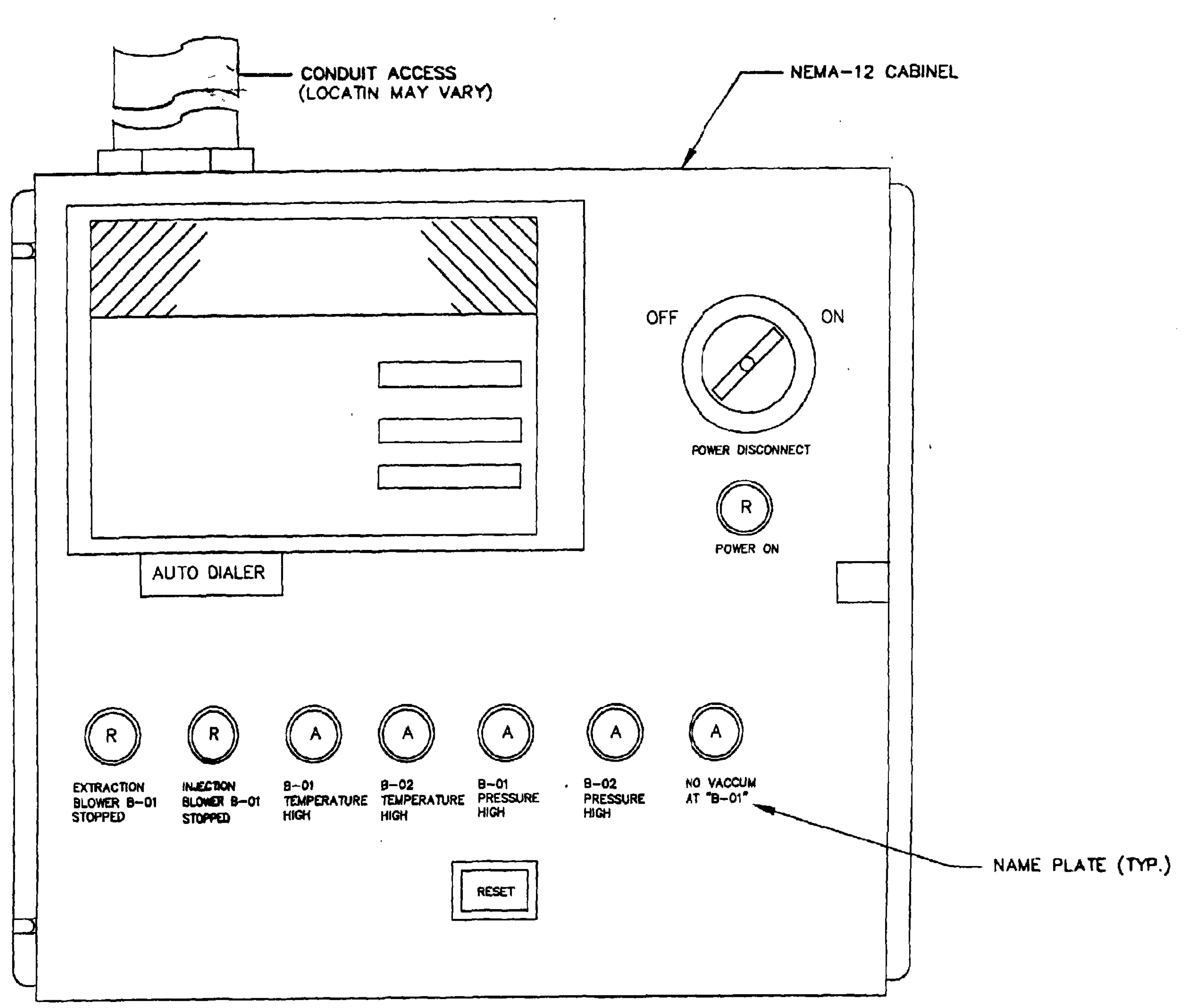
CONTROL PANEL W.D.

NOTES:

1. ALL RELAY CONTACTS ARE SHOWN IN DE-ENERGIZED POSITION.
2. ALL RELAYS SHALL HAVE 120V. COIL AND TWO (2) DPDT CONTACTS.
3. INDICATING LIGHTS SHALL BE LOW VOLTAGE TRANSFORMER TYPE.
4. TAG EACH WIRE WITH WIRE NUMBER AS SHOWN ON WIRING DIAGRAM.
5. COLOR CODING OF WIRES SHALL BE AS FOLLOWS:
   HOT – BLACK
   NEUTRAL – WHITE
   CONTROL – RED

INSTRUMENT WIRING AND RELAYS

N.T.S.



NEW CONTROL PANEL LAYOUT

N.T.S.

(PANEL MANUFACTURER TO SIZE THE PANEL)

NOTES:

1. ALL ELECTRICAL INSTALLATION SHALL MEET THE REQUIREMENTS OF THE "NATIONAL ELECTRICAL CODE" (NEC).
2. ALL WIRING SHALL BE STRANDED COPPER CONDUCTOR,#14 AWG MINIMUM, 600V THHN/THWN INSULATION.
3. ABOVE GROUND CONDUITS SHALL BE RIGID GALVANIZED STEEL (RGS), 3/4" MINIMUM.
4. IN TREATMENT BUILDING, LIGHTING, EHXHAUST FANS AND HEATERS ARE EXISTING. COORDINATE NEW WIRING WITH THE EXISTING WIRING.
5. VERIFY ALL EXISTING CONDITIONS AT THE SITE AND COORDINATE SHUT-DOWN OF POWER TO THE TRANSFORMER WITH THE OWNER.
6. CONTRACTOR TO SUPPLY CONTROL PANEL, CIRCUIT BREAKERS, FVNR COMBINATION STARTER AND ALL CONDUITS AND WIRES ASSOCIATED WITH THEM.
7. FOR ELECTRICAL EQUIPMENT LAYOUT SEE DWG. #BTH-06

FOSTER WHEELER ENVIRONMENTAL CORPORATION

REV.	DESCRIPTION	PREP BY	DATE	APPRVD

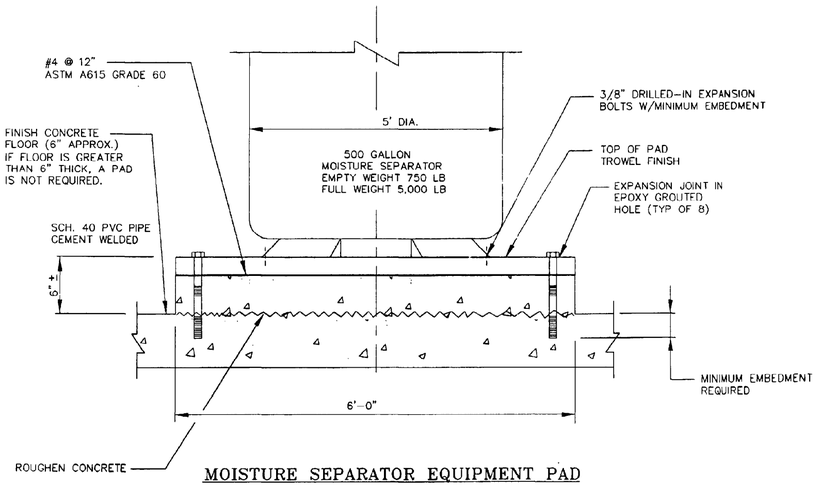
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NORTHERN DIVISION
PHILADELPHIA, PA.
NAVAL BASE
NWIRP BETHPAGE, NEW YORK

ELECTRICAL DETAILS
SITE 1 – FORMER DRUM MARSHALLING AREA
AIR SPARGING/SOIL VAPOR EXTRACTION SYSTEM

SEAL AREA

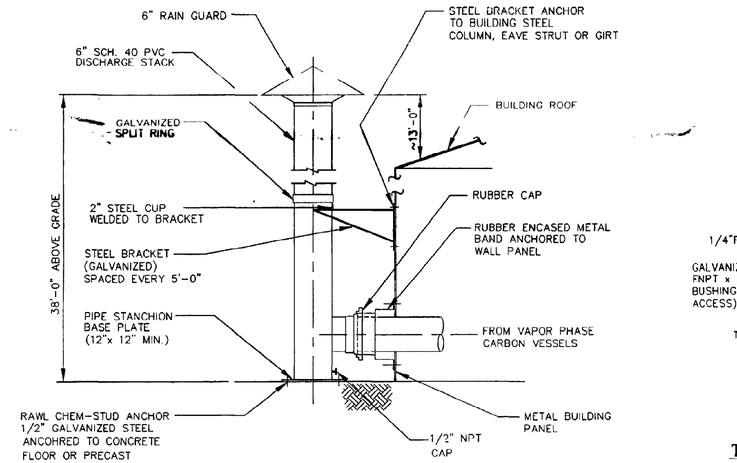
SAT TO / DATE
CODE I.D. NO.
SCALE :
SPEC. NO. 04-
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET 5 OF 6
SIZE: D
DRG. SH. NO. BTH-05

CAD FILE NAME: NDBTH-5.DWG DATE: 1/7/98
PLOT SCALE: 1=1 TIME: 3:35 pm



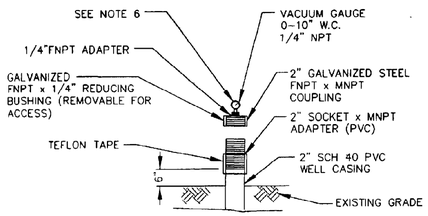
MOISTURE SEPARATOR EQUIPMENT PAD

NOT TO SCALE



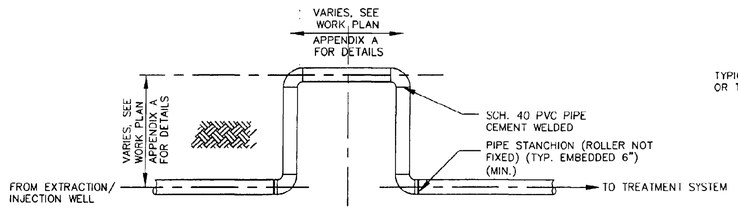
DISCHARGE STACK DETAILS

NOT TO SCALE



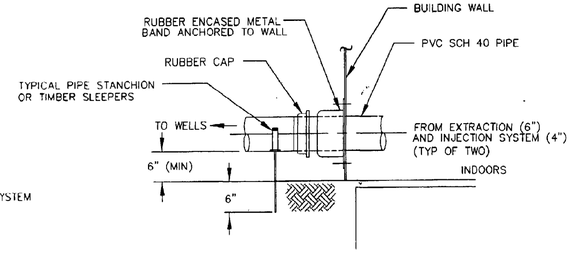
TYPICAL SOIL VAPOR PRESSURE MONITOR WELL HEAD COMPLETION

NOT TO SCALE



TYPICAL PIPE LOOP SUPPORT PLAN VIEW

NOT TO SCALE

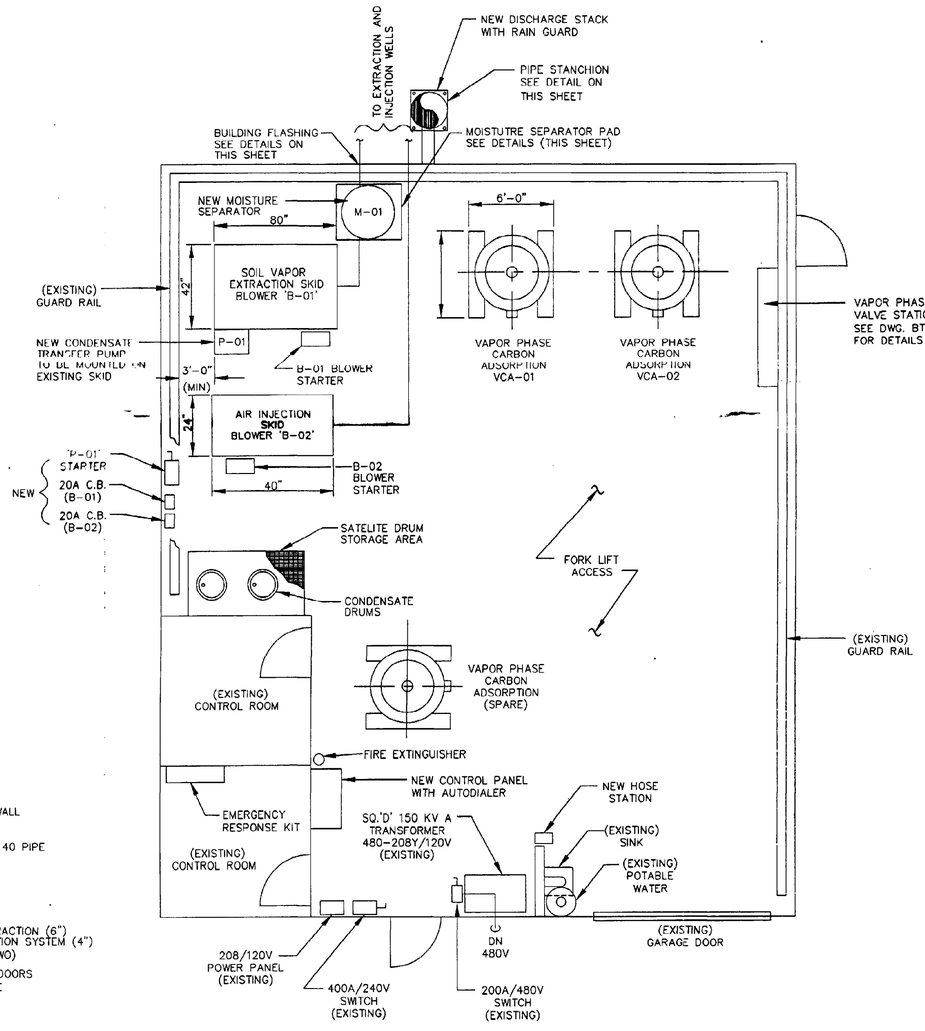


TYPICAL BUILDING PENETRATION PLAN

NOT TO SCALE

NOTES:

1. PIPING AND CONDUIT SHALL BE FIELD ROUTED. MATERIALS SHALL BE IN ACCORDANCE WITH APPLICABLE STANDARDS PRESENTED IN WORK PLAN.
2. FOR ELECTRICAL DETAILS SEE DWG. # BTH-05.
3. BUILDING DIMENSIONS ARE APPROXIMATE AND EQUIPMENT LOCATIONS SHALL BE FIELD VERIFIED.
4. CONCRETE SHALL BE A MINIMUM OF 4000 PSI COMPRESSED STRENGTH AND PLACEMENT SHALL BE IN ACCORDANCE WITH NAVY SPECIFICATION 03300. CONCRETE REINFORCEMENT STEEL SHALL BE ASTM A615-GRADE 60 AND SHALL BE FABRICATED AND PLACED IN ACCORDANCE WITH SPECIFICATION SECTION 03200.
5. STACK SUPPORT HARDWARE (SPUT RING, CLIPS, BRACKETS, ETC.) SHALL BE ARRANGED TO PROVIDE RESISTANCE TO BOTH LATERAL DIRECTIONS, ONE PERPENDICULAR AND THE OTHER PARALLEL TO BUILDING.
6. TYPICAL OF THREE ASSEMBLIES. WELL HEADS SHALL BE COMPLETED WITH A GALVANIZED CAPS (2") WHEN NOT IN SERVICE.



TREATMENT FACILITY LAYOUT

NOT TO SCALE

FOSTER WHEELER ENVIRONMENTAL CORPORATION

REV.	DESCRIPTION	PREP BY	DATE	APPR'D

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL BASE PHILADELPHIA, PA
NNPP BETHPAGE, NEW YORK

NORTHERN DIVISION

CONSTRUCTION DETAILS
SITE 1 - FORMER DRUM MARSHALLING AREA
AIR SPARGING/SOIL VAPOR EXTRACTION SYSTEM

SEAL AREA

NORTHDIV FOR COMMANDER, NAVFAC

APPROVED

SAT TO DATE

CODE I.D. NO.

SCALE :

SPEC. NO. 04-

CONSTRN. CONTR. NO.

NAVFAC DRAWING NO.

SHEET 6 OF 6

SIZE: D

DWG. SH. NO. BTH-06

CAD FILE NAME: NDBTH-6.DWG DATE: 01/06/98
PLOT SCALE: 1=1 TIME: 2:49 PM

ATTACHMENT C
ENGINEERING CALCULATIONS

NORTHDIV RAC D#O04
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
CALCULATIONS
TABLE OF CONTENTS

FOSTER WHEELER ENVIRONMENTAL CORPORATION

REVISION NO. NEW
DATED: JUL 7, 1995

CALCULATION COVER SHEET

PROJECT Naval Weapons Industrial Research Plant
BethPage, New York, AS/SVE System Design

SUBJECT DESIGN CRITERIA OUTLINE

CLIENT NorthDiv RAC DO#004

CALCULATION NO. B-01RO

PROJECT NO. _____

NO OF SHEETS _____

DESIGN LEVEL Final

CALCULATION BY OTHERS _____YES _____NO PREPARER _____

REVIEWED BY _____ DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____YES _____NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE, INITIAL

Rev No	Affect Sheets	Prepared by Date	Checked by Date	Verified by Date
0	All	DeGiorgio	Reino Starks 11/3/97	

NORTHDIV RAC DO#004
NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT (NWIRP)
BETHPAGE, NEW YORK

DESIGN CRITERIA OUTLINE - 10/7/97

1.0 Design Purpose and Life
- PURPOSE - PROVIDE LONG TERM REMEDY AND CLEAN-UP SOILS AND
- SHALLOW UNDERLYING GROUNDWATER AT THE NWIRP BETHPAGE-SITE.
- DESIGN LIFE ≈ 24 - 48 MONTHS

2.0 Codes, Standard and Specifications
- GENERAL QUALITY ASSURANCE CODES: ASME, ANSI, NEC, BOCA
- H/S CODES - 40 CFR
- NO DWGS OR SPECIFICATIONS WILL BE P.E. SEALED

3.0 External Loads/Environmental Considerations
- ENVIRONMENTAL CONSIDERATIONS - SYSTEM WILL NOT OPERATE
- DURING WINTER MONTHS
- WASTE STREAM IS NOT EXPLOSIVE - CF BRAUN ENGINEERING CORP

4.0 Health and Safety Considerations
- WELL INSTALLATION AND YARD PIPING REQUIRES HAZARDOUS
- WORK CLASSIFICATIONS - WORK INSIDE BUILDING CONSIDERED
- "CLEAN WORK"

5.0 Equipment Data and Vendor Information
- EXISTING AIR SPARGING BLOWER TO BE USED - ROOTS FRAME 32
- UNIVERSAL RAI BLOWER (MAX PRES RISE = 15 PSI) 7.5 HP 3φ480
- EXISTING SVE BLOWER PROPOSED FOR USE - ROOTS FRAME 36 UNIVERSAL RAI BLOWER (MAX VAC PRESSURE) 7.5HP 3φ480V

6.0 Other Information
- DESIGN BASIS - DESIGN ANALYSIS REPORT FOR AIR SPARGING/
- SOIL VAPOR EXTRACTION SYSTEM AT SITE I - FORMER DRUM
- MARSHALING AREA - NAVAL WEAPONS INDUSTRIAL RESERVE PLANT - BETHPAGE NEW YORK - SEPT 1997 - CF BRAUN ENGINEERING CORP.

REVIEW AND APPROVAL

Prepared by: R DEGIORGIO
(Lead Discipline Engineer)

Approved by: Robert [illegible]
(Project Engineer)

Approved by: [illegible]
(Project Manager)

FOSTER WHEELER ENVIRONMENTAL CORPORATION

REVISION NO. NEW
DATED: JUL 7, 1995

CALCULATION COVER SHEET

PROJECT Naval Weapons Industrial Research Plant
BethPage, New York, AS/SVE System Design

SUBJECT MASS BALANCE/LOADING

CLIENT NorthDiv RAC DO#004

CALCULATION NO. B-02RO

PROJECT NO. _____

NO OF SHEETS _____

DESIGN LEVEL Final

CALCULATION BY OTHERS _____YES _____NO PREPARER _____

REVIEWED BY _____ DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____YES _____NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE, INITIAL

Rev No	Affect Sheets	Prepared by Date	Checked by Date	Verified by Date
0	All	DeGiorgio	Reino Starks RS 11/3/97	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DEGiorGio DATE 10/7/97 SHEET 1 OF ____

CHKD. BY [illegible] DATE 11/3/97 OFS NO. ____ DEPT. NO. EC

CLIENT NORTHDIV RAC DO #004

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT BETHPAGE NY

SUBJECT AS/SVE SYSTEM DESIGN - MASS LOADING CALCULATIONS

PURPOSE: CALCULATE MASS LOADING EXPECTED FROM NEW SVE TREATMENT SYSTEM.

DESIGN PARAMETERS

1. NUMBER OF EXTRACTION POINTS ≈ 13 (PAGE 9; SECTION 2.2)

REFERENCE:
"DESIGN ANALYSIS REPORT FOR AIR SPARGING/SOIL VAPOR EXTRACTION SYSTEM AT SITE 1 - FORMER DRUM MARSHALLING AREA"
NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT
BETHPAGE, NEW YORK
CONTRACT NO. N6247-90-D-1296
SEPTEMBER 1997
CF BRAUN ENGINEERING CORP.
(HEREIN REFERRED TO AS REFERENCE 1)

ASSUMPTIONS

1. DATA PRESENTED IN REFERENCE 1 IS ACCURATE AND REPRESENTATIVE OF ACTUAL CONDITIONS TO BE ENCOUNTERED AT THE 13 EXTRACTION POINTS

2. WASTE CLASSIFIED BY CF BRAUN AS NON-EXPLOSION PROOF (REFERENCE LETTER TO MR STEVE LEHMAN DATED SEPT 19, 1997 PAGE 2)

2. DESIGN FLOW RATE FROM EACH WELL (REFERENCE 1; PAGE 8, SECTION 2.2 — 20 - 30 SCFM

3. PRIMARY CONSTITUENTS AND AVERAGE CONCENTRATIONS (REFERENCE 1; PAGE 18, SECTION 2.4)

PARAMETER	MOLECULAR WEIGHT (NIOSH NO. 9416)	AVERAGE CONCENTRATION (PPM-V/V)
FREON 113	187.4	6.8
1,1-DCA	99.0	2.7
1,1-DCE	96.9	0.3
1,2-DCE	97.0	6.3
1,1,1-TCA	133.4	36.0
TCE	131.3	15.7
PCE	165.8	169.0

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DEGIORGIO DATE 10/7/97 SHEET 2 OF ____

CHKD. BY RG DATE 11/3/97 OFS NO. ____ DEPT. NO. CE

CLIENT NORTHDIV RAC DO#0074

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT BETHPAGE NY

SUBJECT AS/SVE SYSTEM DESIGN - MASS LOADING CALCULATIONS

WORST CASE SCENARIO ASSUMES 30 SCFM FROM EACH WELL, THEREFORE THE MASS LOADING CAN BE CALCULATED AS FOLLOWS:
ASSUME ≈ STND PRESSURE AND TEMPERATURE

30 $\frac{scf}{MIN}$ SHALL BE THE MAXIMUM FLOW RATE FROM EACH WELL

$$C_w = \frac{C[ppb_v] \times MW}{24050}$$

C_w = CONCENTRATION OF CONSTITUENT PPB BY MASS
MW = MOLECULAR WEIGHT
24050 = CONVERSION FACTOR

$$W_i = \frac{(C_w)(G_s)(1440\ ^{MIN}/_{DAY})(28.32\ ^{L}/_{FT^3})}{(453.6 \cdot 10^6\ ^{\mu g}/_{lb})} = C_w(0.00269714)$$

W_i = MASS LOADING (lb/day)
G_s = FLOW RATE (SCFM)

PARAMETER	C (ppb v)	Cw	Wi
FREON 113	6800	52.98	0.143
1,1-DCA	2700	11.11	0.0299
1,1-DCE	300	1.208	0.0033
1,2-DCE	6300	25.4	0.0685
1,1,1-TCA	36,000	199.6	0.5383
TCE	15,700	85.7	0.2311
PCE	169,000	1165.08	3.1423

4.156 lbs/day/well

THEREFORE, ABOUT 4.156 x 13 wells = 54.03 lbs/day OF THE TARGET VOCS CAN BE EXPECTED AS THE AVERAGE INFLUENT MASS LOADING

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DeGIORGIO DATE _____ SHEET 3 OF _____

CHKD. BY _____ DATE 11-3-97 OFS NO. _____ DEPT. NO. CE

CLIENT NORTH DIV RAC 007#004

PROJECT NAVAL WEAPONS RESEARCH PLANT BETHPAGE NY

SUBJECT AS/SVE SYSTEM DESIGN - MASS LOADING CALCULATIONS

MAXIMUM VOC LOADING IS CALCULATED ASSUMING THE MAXIMUM CONCENTRATIONS ENCOUNTERED DURING THE PILOT STUDY ARE REPRESENTATIVE OF THE MAXIMUM CONCENTRATIONS ENCOUNTERED DURING STARTUP

PARAMETER	$C\ (ppb\ v)_{MAX}$	Cw	Wi
FREON 113	22,000	171.4	0.462
1,1-DCA	5,200	21.4	0.0577
1,1-DCE	4,100	16.5	0.0445
1,2-DCE	20,000	80.66	0.2176
1,1,1-TCA	75,000	416	1.122
TCE	51,000	278.4	0.75088
PCE	580,000	3998.5	10.78

13.43 lbs/day/well

13.43 x 13 = 174.65 lbs/day (MAXIMUM)

SUMMARY MASS LOADING

PARAMETER	lbs/day MAX	lbs/day AVG	
FREON 113	6.006	1.859	
1,1-DCA	0.751	0.3887	
1,1-DCE	0.5785	0.0429	
1,2-DCE	2.8288	0.8905	
1,1,1-TCA	14.586	7.0018	
TCE	9.76144	3.0043	
PCE	140.14	40.85	
TOTAL	174.65	54.03	lbs/day
TOTAL	7.27	2.25	lbs/hour

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DEGIORGIO DATE 10/7/97 SHEET 4 OF ____

CHKD. BY [illegible] DATE 11/3/97 OFS NO. ____ DEPT. NO. CE

CLIENT NORTHDIV RAC DO#004

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT BETHPAGE NY

SUBJECT AS/SVE SYSTEM DESIGN - MASS LOADING CALCULATIONS

CARBON USAGE RATES

REFERENCE: CALGON CARBON CORPORATION (ATTACHED)

PARAMETERS LISTED IN ORDER OF BREAKTHROUGH

1. 1,1-DCE
2. 1,2-DCE
3. 1,1-DCA
4. FREON 113
5. TCE
6. 1,1,1-TCA
7. PCE

AVERAGE CARBON USAGE RATE $151 \frac{lbs}{DAY} \times 1.25 SF \cong 190 \frac{lbs}{DAY}$

MAXIMUM CARBON USAGE RATE $403 \frac{lbs}{DAY} \times 1.25 SF \cong 504 \frac{lbs}{DAY}$

NOTES:

- SERIES OPERATION OFFERS SOME BENEFIT BY REDUCING FREQ OF CHANGEOUTS.
- IF OPERATED PROPERLY - EFFLUENT VAPOR STREAM WILL CONTAIN NON DETECTABLE LEVELS OF VOC'S.
- PORTABLE/TRANSPORTABLE UNITS ARE PREFERRED OVER ON-SITE REGENERABLE/SLURRY CHANGEOUT TYPE UNITS.

Calgon Carbon Corporation VaporAds Report

Temperature (F): 80.0 Flow Rate (actual ft3/min): 390 10/7/97
Pressure (atm): 1.0

Adsorbate (Listed In Order of Elution)	Concentration (ppmv)	Adsorbent Use Rate (lbs/day) BPL4X6				
11-Dichloroethylene	0.3	151.07				
cis-12-Dichloroethylene	6.3	150.69				
11-Dichloroethane	2.7	147.63				
Freon113	6.8	140.03				
Trichloroethylene	15.8	136.07				
111-Trichloroethane	36.2	130.09				
Tetrachloroethylene	169.75	91.23				
Totals:	2.38E2					

Note: This information has been generated using Calgon Carbon's proprietary predictive model. No safety factors have been incorporated into these results. Appropriate safety factors should be applied as necessary. There is no expressed or implied warranty regarding the suitability or applicability of results.

Average Concentration

$151 \times 1.25 = \frac{189\ lb}{day}$

Calgon Carbon Corporation VaporAds Report

Temperature (F): 80.0 Flow Rate (actual ft3/min): 390 10/7/97

Pressure (atm): 1.0

Adsorbate (Listed In Order of Elution)	Concentration (ppmv)	Adsorbent Use Rate (lbs/day) BPL4X6				
11-Dichloroethylene	4.1	402.97				
cis-12-Dichloroethylene	20.1	400.18				
11-Dichloroethane	5.2	392.45				
Freon113	22.1	375.39				
Trichloroethylene	51.2	363.68				
111-Trichloroethane	75.3	351.19				
Tetrachloroethylene	582.3	266.65				
Totals:	7.60E2					

Note: This information has been generated using Calgon Carbon's proprietary predictive model. No safety factors have been incorporated into these results. Appropriate safety factors should be applied as necessary. There is no expressed or implied warranty regarding the suitability or applicability of results.

Maximum concentration

403 x 1.25 = 504 lb/day

FOSTER WHEELER ENVIRONMENTAL CORPORATION

REVISION NO. NEW
DATED: JUL 7, 1995

CALCULATION COVER SHEET

PROJECT Naval Weapons Industrial Research Plant
BethPage, New York, AS/SVE System Design

SUBJECT LINE Sizing

CLIENT NorthDiv RAC DO#004

CALCULATION NO. B-03RO

PROJECT NO. _____

NO OF SHEETS _____

DESIGN LEVEL Final

CALCULATION BY OTHERS _____YES _____NO PREPARER _____

REVIEWED BY _____ DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____YES _____NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE, INITIAL

Rev No	Affect Sheets	Prepared by Date	Checked by Date	Verified by Date
0	All	DeGiorgio	Reino Stacks 11/3/97	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DEGIORGIO DATE 10/7/97 SHEET 1 OF ____

CHKD. BY [illegible] DATE 11/3/97 OFS NO. ____ DEPT. NO. ____

CLIENT NORTHDIV RAC DO #004

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT BETHPAGE NEW YORK

SUBJECT AS/SVE DESIGN - LINE SIZING

VELOCITY LINE SIZING

SVE FLOW RATE 20 - 30 SCFM/WELL ; 25 SCFM/WELL

AS FLOW RATE 8 - 12 SCFM/WELL ; 10 SCFM/WELL

(REFERENCE 1)

TARGET VELOCITY ≈ 1,500 FT/MIN (REFERENCE : DESIGN STND)

$$Q = VA = V\frac{\pi}{4}d^2$$

Q = FLOW RATE (SCFM)
V = VELOCITY (FT/MIN)
A = AREA (SQ FT)
d = DIAMETER (FT)

$$d = \sqrt{\frac{Q}{V}\frac{4}{\pi}} = \sqrt{\frac{25\ SCFM}{1{,}500\ FT/MIN}\frac{4}{\pi}} = 0.145\ FT = 1.75''$$

USE 2" SCH 40 PVC PIPE I.D. 2.067" AS RECOMMENDED IN REFERENCE 1.

$$d = \sqrt{\frac{10\ SCFM}{1500\ FT/MIN}\frac{4}{\pi}} = 0.092\ FT = 1.10''$$

USE 1 1/4 SCH 40 PVC I.D. = 1.380". REFERENCE 1 RECOMMENDS 2" PVC - WHICH APPEARS TO LARGE FOR THE APPLICATION.

BY DEGIORGIO DATE 10/7/97 SHEET 2 OF ____

CHKD. BY RS DATE 11/3/97 OFS NO. ____ DEPT. NO. ____

CLIENT NORTHDIV RAC DO#004

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT BETHPAGE NY

SUBJECT AS/SVE DESIGN - LINE SIZING

FLOW HEADERS AS SHOWN ON DWG PROCESS FLOW SCHEMATIC REFERENCE 1. (SVE)

WELL CLUSTER	FLOW RATE -	SVE SYSTEM
1	4 X 25	100 SCFM
2	4 X 25	100 SCFM
3	3 X 25	75 SCFM
4	2 X 25	50 SCFM

$$d = \sqrt{\frac{100\ SCFM}{1500\ FT/MIN} \cdot \frac{4}{\pi}} = 0.29\ FT = 3.49"$$

USE 4" SCH 40 PVC I.D. = 4026"

$$d = \sqrt{\frac{75\ SCFM}{1500\ FT/MIN} \cdot \frac{4}{\pi}} = 0.25\ FT = 3.027"$$

USE 3" SCH 40 PVC I.D. = 3.068"

$$d = \sqrt{\frac{50\ SCFM}{1,500\ FT/MIN} \cdot \frac{4}{\pi}} = 0.206\ FT = 2.47"$$

USE 3" SCH 40 PVC I.D. = 3.068"

FLOW HEADERS AS SHOWN ON DWG PROCESS FLOW SCHEMATIC REFERENCE 1 (AS)

WELL CLUSTER	FLOW RATE	AS SYSTEM	REC. DIA
1	5 X 10	50 SCFM	3"
2	4 X 10	40 SCFM	3"
3	2 X 10	20 SCFM	2"
4	—	—	—

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DEGIORGIO DATE 10/7/97 SHEET 3 OF ____

CHKD. BY RG DATE 11/3/97 OFS NO. ____ DEPT. NO. CE

CLIENT NORTHDIV RAC 004004

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT BETHPAGE NEW YORK

SUBJECT AS/SVE DESIGN - LINE SIZING

SUMMARY - VELOCITY LINE SIZING

FLOW RATE (SFCM)		NOMINAL DIAMETER (INCH)	(I.D.)	VELOCITY (FT/MIN)	APPLICATION
10	*	1 1/4	1.38	963	AIR INJECTION
20	*	2	2.067	858	AIR INJECTION HDR (2 WELLS)
25		2		1072	AIR EXTRACTION
40	*	3	3.068	779	AIR INJECTION HEADER (4)
50	*	3		974	AIR EXTRACTION/REINJECTION
75	*	3		1461	AIR EXTRACTION
100		4	4.026	1131	"
110		4		1244	AIR INJECTION HEADER
325		6	6.065	1,619	AIR EXTRACTION HEADER

* INDICATES DEVIATION FROM REFERENCE 1 REPORT

FOR 10 SCFM USE 1 1/2" IN LIEAU OF 1 1/4" TO ACCOMODATE CONCEPTUAL DESIGN

Design Properties of Pipe

The following data can be used by piping designers to calculate working pressures, bending stresses for line expansion, bending stresses by weight loadings, pipe column sizes for axial loads, and other factors.

The weights shown are higher than minimum weights because tooling is designed to produce material at or near the midpoint of the minimum and maximum wall thickness specification dimensions. For certain sizes, the weight of CPVC pipe is not shown because production is not anticipated for CPVC in those sizes and schedules or SDR.

However, CPVC weights can be calculated by multiplying PVC weight x 1.116.

SYMBOLS & UNITS

D = outside diameter of pipe, inches
d = inside diameter of pipe, inches
t = nominal wall thickness of pipe, inches

$A_o = \frac{D\pi}{12}$ = outside pipe surface, sq ft per ft length

$A_i = \frac{d\pi}{12}$ = inside pipe surface, sq ft per ft length

$A = \frac{(D^2 - d^2)\pi}{4}$ = cross-sectional metal area, sq in.

$A_f = \frac{d^2\pi}{4}$ = cross-sectional flow area, sq in.

$W_{pvc} = .632\ A$ = weight of pipe, lb per ft length

$W_{cpvc} = .705\ A$ = weight of pipe, lb per ft length

$W_w = 0.433\ A_i$ = weight of water filling, lb per ft length

$r_g = \sqrt{\frac{I}{A}} = \frac{\sqrt{D^2 + d^2}}{4}$ = radius of gyration, inches

$I = Ar_g^2 = 0.0491\ (D^4 - d^4)$ = moment of inertia, inches fourth

$Z = \frac{2I}{D} = 0.0982\ \frac{D^4 - D^4}{D}$ = section modulus, inches cube

SDR 13.5, SDR 26

Pipe Size Schedule or SDR	Wall Thickness t, Inches	Inside Diameter d, Inches	Fifth Power of I.D. d^5, in.^{5}	Areas and Weights: Surface Area Outside A_o, Sq. Ft Per Ft	Surface Area Inside A_i, Sq. Ft Per Ft	Cross-Sectional Plastic Area A, Sq in.	Cross-Sectional Flow Area A_i, Sq in.	Average Weight of Pipe PVC W_{pvc}, lb. Per Ft.	Average Weight of Pipe CPVC W_{cpvc}, lb. Per Ft.	Weight of Water W_w, lb. Per Ft.	Radius of Gyration r_g, Inches	Moment of Inertia I, in.^{4}	Section Modulus Z, in.^{3}
½" SDR 13.5	.062	.716	.1882	.220	.187	.151	.402	.104		.1741	.276	.0115	.0274
1" SDR 26	.060	1.195	2.437	.344	.313	.236	1.121	.164		.4854	.445	.0467	.0710
1¼" SDR 26	.064	1.532	8.439	.435	.401	.321	1.842	.221		.7976	.565	.1024	.1234
1½" SDR 26	.073	1.754	16.60	.497	.459	.418	2.415	.284		1.046	.647	.1751	.1843
2" SDR 26	.091	2.193	50.72	.622	.574	.653	3.775	.432		1.635	.808	.4265	.3592
2½" SDR 26	.110	2.655	132.	.753	.695	.955	5.533	.622		2.396	.979	.9148	.6364
3" SDR 26	.135	3.230	357.	.916	.845	1.426	8.190	.915		3.546	1.191	2.024	1.157
4" SDR 26	.173	4.154	1237	1.178	1.087	2.350	13.546	1.494		5.865	1.532	5.514	2.451
5" SDR 26	.214	5.135	3570	1.456	1.344	3.595	20.699	2.288		8.963	1.894	12.89	4.634
6" SDR 26	.255	6.115	8550	1.734	1.600	5.110	29.354	3.228		12.71	2.253	25.93	7.620
NOTE: For pipe sizes 8" and larger, the value of Fifth Power of ID listed is .001 of the actual value and should be multiplied x 1000.													
8" SDR 26	.332	7.961	32	2.258	2.083	8.644	49.751	5.468		21.54	2.936	74.50	17.28
10" SDR 26	.413	9.924	96.3	2.814	2.597	13.405	77.311	8.492		33.48	3.659	179.50	33.40
12" SDR 26	.490	11.770	226	3.338	3.080	18.864	108.748	11.956		47.09	4.339	355.20	55.72
14" SDR 26	.538	12.924	361	3.665	3.382	22.741	131.118	14.430		56.77	4.765	516.4	73.77
16" SDR 26	.615	14.770	703	4.189	3.865	29.710	171.250	18.810		74.15	5.446	881.1	110.1
18" SDR 26	.692	16.616	1267	4.712	4.348	37.609	216.732	23.860		93.84	6.127	1412.	156.9
20" SDR 26	.769	18.462	2145	5.236	4.831	46.437	267.564	29.470		115.9	6.808	2152.	215.2
24" SDR 26	.923	22.154	5337	6.283	5.797	66.882	385.278	42.520		166.8	8.169	4463.	371.9

SDR 21, SDR 41

Pipe Size Schedule or SDR	Wall Thickness t, Inches	Inside Diameter d, Inches	Fifth Power of I.D. d^5, in.^{5}	Areas and Weights: Surface Area Outside A_o, Sq. Ft Per Ft	Surface Area Inside A_i, Sq. Ft Per Ft	Cross-Sectional Plastic Area A, Sq in.	Cross-Sectional Flow Area A_i, Sq in.	Average Weight of Pipe PVC W_{pvc}, lb. Per Ft.	Average Weight of Pipe CPVC W_{cpvc}, lb. Per Ft.	Weight of Water W_w, lb. Per Ft.	Radius of Gyration r_g, Inches	Moment of Inertia I, in.^{4}	Section Modulus Z, in.^{3}
¾" SDR 21	.060	.930	.6957	.275	.243	.187	.679	.129		.2940	.351	.0230	.0438
1" SDR 21	.063	1.189	2.376	.344	.311	.247	1.110	.170		.4806	.424	.0444	.0675
1¼" SDR 21	.079	1.502	7.645	.435	.393	.392	1.771	.263		.7668	.559	.1229	.1481
1½" SDR 21	.090	1.720	15.05	.497	.450	.512	2.322	.339		1.005	.641	.2101	.2212
2" SDR 21	.113	2.149	45.8	.622	.562	.803	3.625	.521		1.570	.801	.5150	.4337
2½" SDR 21	.137	2.601	119.0	.753	.681	1.178	5.311	.754		2.300	.969	1.107	.7701
3" SDR 21	.167	3.166	318.0	.916	.828	1.747	7.868	1.106		3.407	1.181	2.435	1.391
4" SDR 21	.214	4.072	1120	1.178	1.066	2.880	13.016	1.825		5.636	1.518	6.635	2.949
5" SDR 21	.265	5.033	3230	1.456	1.317	4.409	19.885	2.792		8.610	1.876	15.52	5.580
6" SDR 21	.316	5.993	7731	1.734	1.568	6.260	28.194	3.964		12.21	2.234	31.25	9.434
NOTE: For pipe sizes 8" and larger, the value of Fifth Power of ID listed is .001 of the actual value and should be multiplied x 1000.													
8" SDR 21	.411	7.803	29	2.258	2.042	10.601	47.796	6.679		20.70	2.909	89.69	20.80
18" SDR 41	.439	17.122	1472	4.712	4.480	24.207	230.133	15.370		99.65	6.213	934.4	173.8
20" SDR 41	.487	19.026	2493	5.236	4.976	29.839	284.161	18.920		123.0	6.903	1422.0	158.0
24" SDR 41	.585	22.830	6202	6.283	5.974	43.011	409.149	27.320		177.2	8.285	2952.0	246.0

Design Properties of Pipe (continued)

Schedule 40, 80, 120

Pipe Size Schedule or SDR	Wall Thickness t Inches	Inside Diameter d Inches	Fifth Power of I.D. d^5 In.^{5}	Areas and Weights: Surface Area Outside A_o Sq. Ft Per Ft	Surface Area Inside A_i Sq. Ft Per Ft	Cross-Sectional Area Plastic A Sq In.	Cross-Sectional Area Flow A_i Sq In.	Average Weight of Pipe PVC W_{pvc} lb. Per Ft	Average Weight of Pipe CPVC W_{cpvc} lb. Per Ft	Average Weight of Water W_w lb. Per Ft	Radius of Gyration r_g Inches	Moment of Inertia I In.^{4}	Section Modulus Z In.^{3}
⅛" Sch. 40	.068	.269	.00141	.106	.070	.072	.057	.045	.050	.025	.1215	.0011	.0052
⅛" Sch. 80	.095	.215	.00046	.106	.056	.092	.036	.058	.065	.016	.1146	.0012	.0060
¼" Sch. 40	.088	.364	.00639	.141	.095	.125	.104	.081	.090	.045	.1628	.0033	.0123
¼" Sch. 80	.119	.302	.00251	.141	.079	.157	.072	.100	.112	.031	.1547	.0038	.0140
⅜" Sch. 40	.091	.493	.02912	.177	.129	.167	.191	.109	.122	.083	.2090	.0073	.0216
⅜" Sch. 80	.126	.423	.01354	.177	.111	.217	.140	.138	.154	.061	.1991	.0086	.0255
½" Sch. 40	.109	.622	.09310	.220	.163	.250	.304	.161	.180	.132	.261	.0171	.0407
½" Sch. 80	.147	.546	.04352	.220	.143	.320	.234	.202	.225	.101	.250	.0201	.0478
½" Sch. 120	.170	.500	.03125	.220	.131	.358	.196	.223	.249	.085	.244	.0213	.0486
¾" Sch. 40	.113	.824	.3799	.275	.216	.333	.533	.214	.239	.231	.334	.0370	.0706
¾" Sch. 80	.154	.742	.2249	.275	.194	.434	.432	.273	.305	.187	.321	.0448	.0853
¾" Sch. 120	.170	.710	.1869	.275	.166	.470	.396	.295	.329	.172	.317	.0472	.0899
1" Sch. 40	.133	1.049	1.270	.344	.275	.494	.864	.315	.352	.374	.420	.0874	.1329
1" Sch. 80	.179	.957	.803	.344	.250	.639	.719	.402	.449	.311	.407	.1056	.1606
1" Sch. 120	.200	.915	.641	.344	.240	.892	.658	.440	.491	.285	.401	.1124	.1710
1¼" Sch. 40	.140	1.380	5.005	.434	.361	668	1.496	.426	.475	.648	.540	.1948	.2346
1¼" Sch. 80	.191	1.278	3.409	.434	.334	.881	1.283	.554	.618	.555	.524	.2418	.291
1¼" Sch. 120	.215	1.230	2.815	.434	.322	1.184	1.188	.614	.680	.514	.517	.2578	.311
1½" Sch. 40	.145	1.610	10.82	.497	.421	.799	2.036	.509	.568	.882	.623	.310	.326
1½" Sch. 80	.200	1.500	7.59	.497	.393	1.068	1.767	.673	.751	.765	.605	.391	.412
1½" Sch. 120	.225	1.450	6.41	.497	.380	1.184	1.656	.744	.830	.717	.598	.423	.445
2" Sch. 40	.154	2.067	37.73	.622	.541	1.074	3.356	.682	.761	1.453	.787	.666	.561
2" Sch. 80	.218	1.939	27.41	.622	.508	1.477	2.953	.932	1.040	1.278	.766	.868	.731
2" Sch. 120	.250	1.875	23.17	.622	.491	1.669	2.761	1.052	1.174	1.196	.757	.955	.804
2½" Sch. 40	.203	2.469	91.8	.753	.646	1.704	4.79	1.076	1.201	2.073	.947	1.530	1.064
2½" Sch. 80	.276	2.323	67.6	.753	.608	2.254	4.24	1.419	1.584	1.835	.924	1.925	1.339
2½" Sch. 120	.300	2.275	60.94	.753	.596	2.427	4.07	1.529	1.706	1.762	.917	2.039	1.418
3" Sch. 40	.216	3.068	271.8	.916	.803	2.228	7.39	1.409	1.572	3.20	1.164	3.02	1.724
3" Sch. 80	.300	2.900	205.0	.916	.759	3.016	6.60	1.903	2.124	2.86	1.136	3.90	2.226
3" Sch. 120	.350	2.800	172.1	.916	.733	3.464	6.15	2.184	2.437	2.66	1.121	4.35	2.486
4" Sch. 40	.237	4.026	1058.	1.178	1.054	3.17	12.73	2.006	2.239	5.51	1.510	7.23	3.22
4" Sch. 80	.337	3.826	820.	1.178	1.002	4.41	11.50	2.782	3.105	4.98	1.477	9.61	4.27
4" Sch. 120	.438	3.624	625.	1.178	.949	5.59	10.32	3.516	3.924	4.47	1.444	11.67	5.19
5" Sch. 40	.258	5.047	3275.	1.456	1.321	4.30	20.01	2.726	3.062	8.66	1.878	15.17	5.45
5" Sch. 80	.375	4.813	2583.	1.456	1.260	6.11	18.19	3.867	4.343	7.88	1.839	20.68	7.43
NOTE: For pipe sizes 6" and larger, the value of Fifth Power of ID listed is .001 of the actual value and should be multiplied x 1000.													
6" Sch. 40	.280	6.065	8.21	1.734	1.588	5.58	28.90	3.535	3.945	12.51	2.246	28.10	8.50
6" Sch. 80	.432	5.761	6.35	1.734	1.508	8.40	26.10	5.313	5.929	11.29	2.195	40.50	12.23
6" Sch. 120	.562	5.501	5.04	1.734	1.440	10.70	23.80	6.759	7.543	10.29	2.153	49.62	14.98
8" Sch. 40	.322	7.981	32.4	2.258	2.089	8.40	50.0	5.305	5.920	21.68	2.94	72.50	16.81
8" Sch. 80	.500	7.625	25.8	2.258	1.996	12.76	45.7	8.058	8.993	19.80	2.88	105.70	24.52
10" Sch. 40	.365	10.020	101.	2.81	2.62	11.91	78.9	7.532	8.406	34.1	3.67	160.8	29.9
10" Sch. 80	.593	9.564	80.	2.81	2.50	18.92	71.8	11.956	13.343	31.1	3.60	244.8	45.5
12" Sch. 40	.406	11.938	242.	3.34	3.13	15.74	111.9	9.929		48.5	4.37	300.0	47.1
12" Sch. 80	.687	11.376	191.	3.34	2.98	26.04	101.6	16.437		44.0	4.27	475.0	74.5
14" Sch. 40	.438	13.124	389.	3.67	3.44	18.66	135.3	11.810		58.6	4.80	429.0	61.4
14" Sch. 80	.750	12.500	305.	3.67	3.27	31.22	122.7	19.790		53.1	4.69	687.0	98.2
16" Sch. 40	.500	15.000	759.	4.19	3.93	24.35	176.7	15.416		76.5	5.48	732.0	91.5
16" Sch. 80	.843	14.314	601.	4.19	3.75	40.14	160.9	25.430		69.7	5.37	1157.0	144.6
18" Sch. 80	.937	16.126	1091.	4.71	4.22	50.23	204.2	31.83		88.4	6.04	1634.0	203.8

FOSTER WHEELER ENVIRONMENTAL CORPORATION

REVISION NO. NEW
DATED: JUL 7, 1995

CALCULATION COVER SHEET

PROJECT Naval Weapons Industrial Research Plant
BethPage, New York, AS/SVE System Design

SUBJECT PRESSURE DROP IN AIR LINES

CLIENT NorthDiv RAC DO#004

CALCULATION NO. B-04R0

PROJECT NO. _____

NO OF SHEETS _____

DESIGN LEVEL Final

CALCULATION BY OTHERS _____YES _____NO PREPARER _____

REVIEWED BY _____ DATE _____

ASSUMPTIONS THAT REQUIRE CONFIRMATION _____YES _____NO

ASSUMPTIONS CONFIRMED BY _____ DATE _____

PRINT NAME, DATE, INITIAL

Rev No	Affect Sheets	Prepared by Date	Checked by Date	Verified by Date
0	All	DeGiorgio	Reino Stocks 11/3/97	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DEGIORGIO DATE 10/8/97 SHEET 1 OF 10

CHKD. BY [illegible] DATE 11/3/97 OFS NO. _____ DEPT. NO. EC

CLIENT NORTHDIV RAC DO#004

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT BETHPAGE NEW YORK

SUBJECT AS/SVE SYSTEM DESIGN

PURPOSE: ESTABLISH HIGHEST FRICTION AND MINOR LOSS IN SYSTEM (EXTRACTION AND INJECTION)

EXTRACTION SYSTEM

LINE DESCRIPTION	DIAMETER INCH	FLOW RATE SCFM	FITTINGS -	LENGTH FT	ΔP "WC
MAIN MANIFOLD	6"	325	6 ELBOWS 4 TEES (6/4 6/4, 6/3 6/3) 1 VALVE	~60	2.3
HEADER TO EW-1,2,3,4	4"	~100	3 ELBOW 4 TEES (4/2)	~170	1.7
HEADER TO EW 1,2,3	3"	~75	2 ELBOWS 3 TEES 3/2 3/2 3/2	~100	2.5
HEADER TO EW 4	2"	~25	2 ELBOWS 1 TEE (4/2)	~90	0.05
TOTAL					6.55

EW 5,6,7,8 - LESS DISTANCE THAN 1,2,3,4 ∴ LESS DROP (ALSO 9,10,11)

MAIN MANIFOLD	6"	325	SAME AS ABOVE	~60	2.3
HEADER TO EW 12,13	3"	~50	2 TEES (4/2 4/2)	~290	0.03
LINE TO EW-12	2"	~25'	2 ELBOWS 1 ELBOW 1 TEE	~80	0.06
TOTAL					2.38

HIGHEST FRICTION LOSS IS ≈ 6.55 SAY 7.0" W.C. ≈ 0.25 psi

DUCTWORK SIZING SUMMARY

Main Extraction Header

VALUES OF DUCTWORK SEGMENT		FITTINGS	NO.	EQ FT
STANDARD CFM	325	90 DEG SHORT RAD	6	93.4
POUNDS/HR	1492.0	90 DEG LONG RAD	0	0.0
DENSITY, LB/CU.FT	0.08	45 DEG ELBOW	0	0.0
VISCOSITY, CP	0.018	180 DEG ELBOW	0	0.0
TEMP, DEG.F.	70.0	TEE THRU	4	171.8
PRESSURE, PSIG	1.0	TEE BRANCH	0	0.0
INTERNAL DIA.,IN.	6.065	DUCT ENTRANCE	1	13.4
VELOCITY, FT/MIN	1549.5	DUCT EXIT	1	26.8
DUCT EPSILON,IN	0.00006	45 DEG TAKEOFF	0	0.0
REYNOLDS NUMBER	85384	60 DEG TAKEOFF	0	0.0
FRICTION FACTOR	0.018833	90 DEG MITRE	0	0.0
DUCT LENGTH, FT.	60.0	90 DEG VANE MITRE	0	0.0
EQUIVALENT FT	380.5	HOOD, DEG.OPEN	0	0.0
TOTAL FITTING K	0.0	REDUCTN DIA, IN.	3.0	10.1
TOTAL SEGMENT K	14.18	ENLARGE DIA,IN.	0.0	0.0
IN.H20 DROP/100 FT	0.596	MISC EQUIV.FT.		5.0
TOTAL IN.H20 DROP	2.266	MISC K FACTOR		0.0

DUCTWORK SIZING SUMMARY

Main Extraction Header

VALUES OF DUCTWORK SEGMENT		FITTINGS	NO.	EQ FT
STANDARD CFM	100	90 DEG SHORT RAD	3	26.2
POUNDS/HR	459.1	90 DEG LONG RAD	0	0.0
DENSITY, LB/CU.FT	0.08	45 DEG ELBOW	0	0.0
VISCOSITY, CP	0.018	180 DEG ELBOW	0	0.0
TEMP, DEG.F.	70.0	TEE THRU	4	96.3
PRESSURE, PSIG	1.0	TEE BRANCH	0	0.0
INTERNAL DIA.,IN.	4.026	DUCT ENTRANCE	1	7.5
VELOCITY, FT/MIN	1082.0	DUCT EXIT	1	15.0
DUCT EPSILON,IN	0.00006	45 DEG TAKEOFF	0	0.0
REYNOLDS NUMBER	39578	60 DEG TAKEOFF	0	0.0
FRICTION FACTOR	0.022304	90 DEG MITRE	0	0.0
DUCT LENGTH, FT	170.0	90 DEG VANE MITRE	0	0.0
EQUIVALENT FT	325.7	HOOD, DEG.OPEN	0	0.0
TOTAL FITTING K	0.0	REDUCTN DIA, IN.	2.0	5.7
TOTAL SEGMENT K	21.65	ENLARGE DIA,IN.	0.0	0.0
IN.H20 DROP/100 FT	0.518	MISC EQUIV.FT.		5.0
TOTAL IN.H20 DROP	1.687	MISC K FACTOR		0.0

DUCTWORK SIZING SUMMARY

Main Extraction Header

VALUES OF DUCTWORK SEGMENT		FITTINGS	NO.	EQ FT
STANDARD CFM	75	90 DEG SHORT RAD	3	20.1
POUNDS/HR	344.3	90 DEG LONG RAD	0	0.0
DENSITY, LB/CU.FT	0.08	45 DEG ELBOW	0	0.0
VISCOSITY, CP	0.018	180 DEG ELBOW	0	0.0
TEMP, DEG.F.	70.0	TEE THRU	4	73.8
PRESSURE, PSIG	1.0	TEE BRANCH	0	0.0
INTERNAL DIA.,IN.	3.068	DUCT ENTRANCE	1	5.8
VELOCITY, FT/MIN	1397.4	DUCT EXIT	1	11.5
DUCT EPSILON,IN	0.00006	45 DEG TAKEOFF	0	0.0
REYNOLDS NUMBER	38952	60 DEG TAKEOFF	0	0.0
FRICTION FACTOR	0.022181	90 DEG MITRE	0	0.0
DUCT LENGTH, FT	100.0	90 DEG VANE MITRE	0	0.0
EQUIVALENT FT	219.4	HOOD, DEG.OPEN	0	0.0
TOTAL FITTING K	0.0	REDUCTN DIA, IN.	2.0	3.3
TOTAL SEGMENT K	19.04	ENLARGE DIA,IN.	0.0	0.0
IN.H20 DROP/100 FT	1.128	MISC EQUIV.FT.		5.0
TOTAL IN.H20 DROP	2.474	MISC K FACTOR		0.0

GAS PIPELINE SIZING SUMMARY

Main Extraction Header

VALUES OF PIPELINE SEGMENT		FITTINGS	NO.	EQ FT
STANDARD CFM	25	90 DEG SHORT RAD	2	6.9
POUNDS/HR	115	90 DEG LONG RAD	0	0.0
DENSITY, LB/CU.FT	0.08	45 DEG ELBOW	0	0.0
VISCOSITY, CP	0.018	180 DEG ELBOW	0	0.0
TEMP, DEG.F.	70.0	TEE THRU	1	3.4
PRESSURE,PSIG	1.0	TEE BRANCH	0	0.0
INTERNAL DIA.,IN.	2.067	PIPE ENTRANCE	1	4.5
VELOCITY, FT/MIN	1026.2	PIPE EXIT	1	9.1
PIPE EPSILON,IN	0.0018	GATE VALVES	0	0.0
REYNOLDS NUMBER	19272	BALL VALVES	0	0.0
FRICTION FACTOR	0.027936	BUTTERFLY VALVES	0	0.0
PIPE LENGTH, FT	90.0	GLOBE VALVES	0	0.0
EQUIVALENT FT	118.9	CHECK VALVES	0.0	0.0
TOTAL FITTING K	0.0	REDUCTN DIA,IN.	0.0	0.0
TOTAL SEGMENT K	19.29	ENLARGE DIA,IN.	0.0	0.0
PSI DROP/100 FT	0.0409	MISC EQUIV.FT.		5.0
TOTAL PSI DROP	0.05	MISC K FACTOR		0.0

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DEGIORGIO DATE 10/8/97 SHEET 6 OF 10

CHKD. BY [illegible] DATE 11/3/97 OFS NO. _____ DEPT. NO. EC

CLIENT NORTHDIV RAC DO#004

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PARK BETHPAGE NEW YORK

SUBJECT _____

Injection System

LINE	DIAMETER	FLOW	FITTINGS	LENGTH	ΔP
MAIN HEADER	4"	110 SCFM	6 ELBOWS 3 TEES 4/3 4/3 3/2	60'	1.5
HEADER TO 1,2,3,4,5	3"	~40 SCFM	3 ELBOWS 5 TEES 3/1 1/4	180'	1.[illegible]
IW-01	1 1/4"	10 SCFM	2 ELBOWS	100'	1.6
TOTAL					4.1"

HIGHEST FRICTION LOSS IN INJECTION SYSTEM IS 4.1" SAY 4.5" WC

(0.16 PSI)

REFERENCES:
DWG - PROCESS FLOW SCHEMATIC - FOR PIPING LAYOUT

SUMMARY

EXTRACTION SYSTEM FRICTION LOSS ("W.C) 7.0 x 1.15SF = 8.05"

INJECTION AIR FRICTION LOSS ("WC) 4.5 x 1.15 SF = 5.18"

DUCTWORK SIZING SUMMARY

Injection Header

VALUES OF DUCTWORK SEGMENT		FITTINGS	NO.	EQ FT
STANDARD CFM	110	90 DEG SHORT RAD	6	53.6
POUNDS/HR	505.0	90 DEG LONG RAD	0	0.0
DENSITY, LB/CU.FT	0.11	45 DEG ELBOW	0	0.0
VISCOSITY, CP	0.018	180 DEG ELBOW	0	0.0
TEMP, DEG.F.	70.0	TEE THRU	4	98.6
PRESSURE, PSIG	6.0	TEE BRANCH	0	0.0
INTERNAL DIA.,IN.	4.026	DUCT ENTRANCE	1	7.7
VELOCITY, FT/MIN	902.7	DUCT EXIT	1	15.4
DUCT EPSILON,IN	0.00006	45 DEG TAKEOFF	0	0.0
REYNOLDS NUMBER	43536	60 DEG TAKEOFF	0	0.0
FRICTION FACTOR	0.021767	90 DEG MITRE	0	0.0
DUCT LENGTH, FT	60.0	90 DEG VANE MITRE	0	0.0
EQUIVALENT FT	315.9	HOOD, DEG.OPEN	0	0.0
TOTAL FITTING K	0.0	REDUCTN DIA, IN.	3.0	3.4
TOTAL SEGMENT K	20.5	ENLARGE DIA,IN.	0.0	0.0
IN.H20 DROP/100 FT	0.464	MISC EQUIV.FT.		0.0
TOTAL IN.H20 DROP	1.466	MISC K FACTOR		77.1

DUCTWORK SIZING SUMMARY

Injection Header

VALUES OF DUCTWORK SEGMENT		FITTINGS	NO.	EQ FT
STANDARD CFM	40	90 DEG SHORT RAD	3	17.1
POUNDS/HR	183.6	90 DEG LONG RAD	0	0.0
DENSITY, LB/CU.FT	0.11	45 DEG ELBOW	0	0.0
VISCOSITY, CP	0.018	180 DEG ELBOW	0	0.0
TEMP, DEG.F.	70.0	TEE THRU	5	78.8
PRESSURE, PSIG	6.0	TEE BRANCH	0	0.0
INTERNAL DIA.,IN.	3.068	DUCT ENTRANCE	1	4.9
VELOCITY, FT/MIN	565.3	DUCT EXIT	1	9.8
DUCT EPSILON,IN	0.00006	45 DEG TAKEOFF	0	0.0
REYNOLDS NUMBER	20774	60 DEG TAKEOFF	0	0.0
FRICTION FACTOR	0.025959	90 DEG MITRE	0	0.0
DUCT LENGTH, FT	180.0	90 DEG VANE MITRE	0	0.0
EQUIVALENT FT	342.8	HOOD, DEG.OPEN	0	0.0
TOTAL FITTING K	0.0	REDUCTN DIA, IN.	2.0	2.8
TOTAL SEGMENT K	34.8	ENLARGE DIA,IN.	0.0	0.0
IN.H20 DROP/100 FT	0.285	MISC EQUIV.FT.		0.0
TOTAL IN.H20 DROP	0.976	MISC K FACTOR		49.2

DUCTWORK SIZING SUMMARY

Injection Header

VALUES OF DUCTWORK SEGMENT		FITTINGS	NO.	EQ FT
STANDARD CFM	10	90 DEG SHORT RAD	2	4.5
POUNDS/HR	45.9	90 DEG LONG RAD	0	0.0
DENSITY, LB/CU.FT	0.11	45 DEG ELBOW	0	0.0
VISCOSITY, CP	0.018	180 DEG ELBOW	0	0.0
TEMP, DEG.F.	70.0	TEE THRU	1	6.2
PRESSURE, PSIG	6.0	TEE BRANCH	0	0.0
INTERNAL DIA.,IN.	1.38	DUCT ENTRANCE	1	1.9
VELOCITY, FT/MIN	698.5	DUCT EXIT	1	3.9
DUCT EPSILON,IN	0.00006	45 DEG TAKEOFF	0	0.0
REYNOLDS NUMBER	11546	60 DEG TAKEOFF	0	0.0
FRICTION FACTOR	0.02985	90 DEG MITRE	0	0.0
DUCT LENGTH, FT	100.0	90 DEG VANE MITRE	0	0.0
EQUIVALENT FT	137.8	HOOD, DEG.OPEN	0	0.0
TOTAL FITTING K	0.0	REDUCTN DIA, IN.	2.0	2.1
TOTAL SEGMENT K	35.77	ENLARGE DIA,IN.	0.0	0.0
IN.H20 DROP/100 FT	1.111	MISC EQUIV.FT.		0.0
TOTAL IN.H20 DROP	1.531	MISC K FACTOR		19.3

FOSTER WHEELER ENVIRONMENTAL CORPORATION

REVISION NO. NEW
DATED: JUL 7, 1995

CALCULATION COVER SHEET

PROJECT Naval Weapons Industrial Research Plant
BethPage, New York, AS/SVE System Design

SUBJECT Blower Sizing

CLIENT NorthDiv RAC DO#004

CALCULATION NO. B-05RO

PROJECT NO. _____

NO OF SHEETS _____

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CALCULATION BY OTHERS _____YES _____NO PREPARER _____

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0	All	DeGiorgio	Reino Starks RS 11/3/97	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DEGIORGIO DATE 10/14/97

CHKD. BY [illegible] DATE 11/3/97

SHEET 1 OF

OFS NO. DEPT. NO. EC

CLIENT NORTHDIV RAC 007#004

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT BETHPAGE NY

SUBJECT AS/SVE DESIGN - BLOWER SIZING

EXTRACTION BLOWER VACUUM REQUIRMENTS

DESIRED VACUUM EXTRACTION RATE (REFERENCE: I; PAGE A-16 SECTION 1.2.)	8.4" W.C SAY	9.0" W.C.
FRICTION LOSS IN PIPING (REFERENCE: B-04RO)		8.05" W.C.
MOISTURE SEPARATOR PRESSURE DROP (REFERENCE I; PAGE A-22)		5" W.C.
AIR FILTER PRESSURE DROP (ASSUMPTION)		~ 10" W.C.
DISCHARGE CARBON SYSTEM - CALGON VAPOR PAC (STAINLESS STEEL) NO. I		5" W.C.
CALGON VAPOR PAC (S.S.) NO. 2		5" W.C.
DISCHARGE STACK 6" SCH 40 PVC APPROX LENGTH ≈ 55'		1.4" W.C.
TOTAL SYSTEM LOSS		43.45" W.C.
		1.15 SF
		50" W.C

BLOWER TOBE RATED @ ≈ 325 - 390 SFCM @ 50" W.C.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY DEGIORGIO DATE 10/14/97 SHEET 2 OF ____

CHKD. BY [illegible] DATE 11/3/97 OFS NO. ____ DEPT. NO. EC

CLIENT NORTHDIV RAC DO#004

PROJECT NAVAL WEAPONS INDUSTRIAL RESEARCH PLANT BETHPAGE NY

SUBJECT AS/SVE DESIGN - BLOWER SIZING

INJECTION AIR BLOWER PRESSURE REQUIREMENTS

FRICTION LOSS IN PIPING (REFERENCE B-04RO)	5.18" W.C.
STATIC HEAD LOSS (REFERENCE I PAGE A-42)	4.3 PSI (119.2" W.C)
AIR FILTER PRESSURE DROP (ASSUMPTION)	~10" W.C.
TOTAL SYSTEM LOSS	134.38". W.C. ~4.8 PSI 1.15 SF = 5.5PSI

INJECTION BLOWER TO BE RATED FOR ~110 SCFM @ 5.5 PSI

CALGON

CALGON CARBON CORPORATION

SERVICE BULLETIN

VAPOR PAC

Calgon Carbon's Vapor Pac Service meets industrial needs for cost-effective removal of volatile organic compounds (VOCs) at air emission sources.

The Vapor Pac Service features a small, easily transportable adsorber which contains 1,800 pounds of activated carbon. The adsorber can handle air flows up to 1,000 cfm.

Designed to remove both toxic and non-toxic VOCs, the adsorption system is especially useful for short-term projects and for treatment of low volume flows that contain low to moderate VOC concentrations. Common applications include VOC removal from process vents, soil remediation vents, and air stripper off-gases.

To accommodate a wide variety of process conditions, Vapor Pac adsorbers are available in two basic designs: a polyethylene model that offers excellent corrosion-resistance, and a stainless steel model than can withstand higher temperatures, and slight pressure or vacuum conditions.

Calgon Carbon provides the adsorber, carbon, spent carbon handling and carbon reactivation (after the carbon meets the company's acceptance criteria) as part of the Vapor Pac Service. Ductwork and fans are the only equipment requiring a capital expenditure by the user.

When carbon becomes saturated with VOCs, the system is replaced with another adsorber containing fresh carbon.

By utilizing this unique service, users can generally achieve VOC removal and regulatory compliance objectives, minimize operating costs, and eliminate maintenance costs* (as the equipment is owned and maintained by Calgon Carbon). Furthermore, because organic compounds are safely destroyed through the carbon reactivation process, costs and regulations typically associated with waste disposal can be eliminated.

Please contact a Calgon Carbon Technical Sales Representative to learn more about the advantages of the Vapor Pac Service for your specific VOC control needs.

**Damage to Vapor Pac Unit caused by negligence or misapplication is the responsibility of the user.*

FEATURES AND BENEFITS OF VAPOR PAC SERVICE

- Adsorbers are specifically designed for ease of installation and operation.
- Adsorbers are available in plastic (polyethylene) and metal (stainless steel) construction to accommodate a wide variety of applications.
- System can be operated in series or parallel mode or a combination of both modes to handle a variety of flows and concentrations.
- System exchange eliminates on-site carbon handling.
- Recycling of spent carbon eliminates disposal problems.
- Capital expenditure is eliminated since Calgon Carbon Corporation owns and maintains equipment.

VAPOR PAC (PLASTIC) SPECIFICATIONS

Vessel dimensions:	44 1/4" x 44 1/4" x 89 3/8"
Inlet & discharge connections:	6" PS 15-69 duct flanges
Carbon volume:	60 cu. ft. (1800 lbs)
System shipping weight:	New - 2200 lbs Spent - 4000 lbs
Temperature rating:	150°F max
Static pressure rating above carbon level:	20" W.C. max
Vacuum pressure rating above carbon level:	2" W.C. max

All units shipped F.O.B., Pittsburgh, Pennsylvania

MATERIALS OF CONSTRUCTION

Vessel:	Polyethylene
Frame:	Carbon steel coated with Sherwin Williams Tile Clad II
Inlet flanges, elbow, septum:	PVC
Discharge flange:	Polyethylene
Fasteners & bottom valve support plate:	Steel, plated
Sample fittings & sample canister:	PVC

VAPOR PAC (STAINLESS STEEL) SPECIFICATIONS

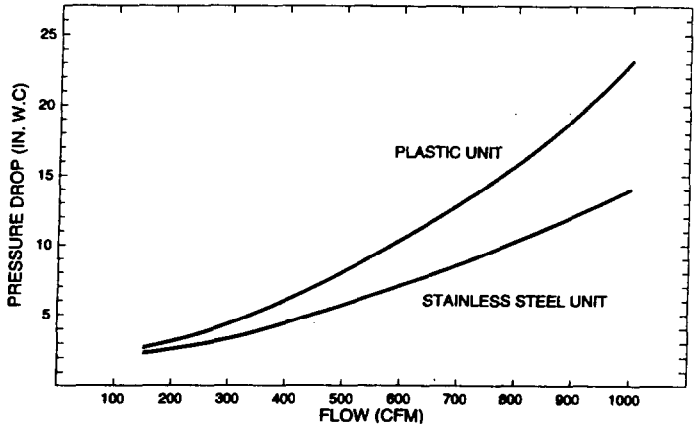
Vessel dimensions, diameter:	5'
height:	7'3"
Inlet & discharge connections:	8" PS 15-69 duct flanges
Carbon volume:	60 cu. ft. approx. (1800 lbs)
System shipping weight:	New - 2840 lbs Spent - 4640 lbs
Static pressure rating above carbon level:	15 psig
Vacuum pressure rating above carbon level:	Full

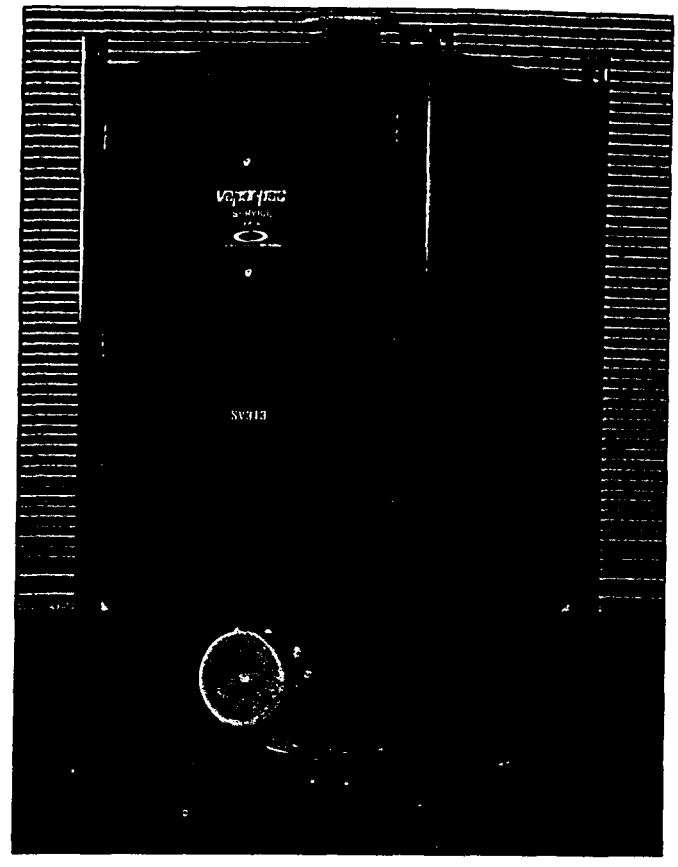
All units shipped F.O.B., Pittsburgh, Pennsylvania

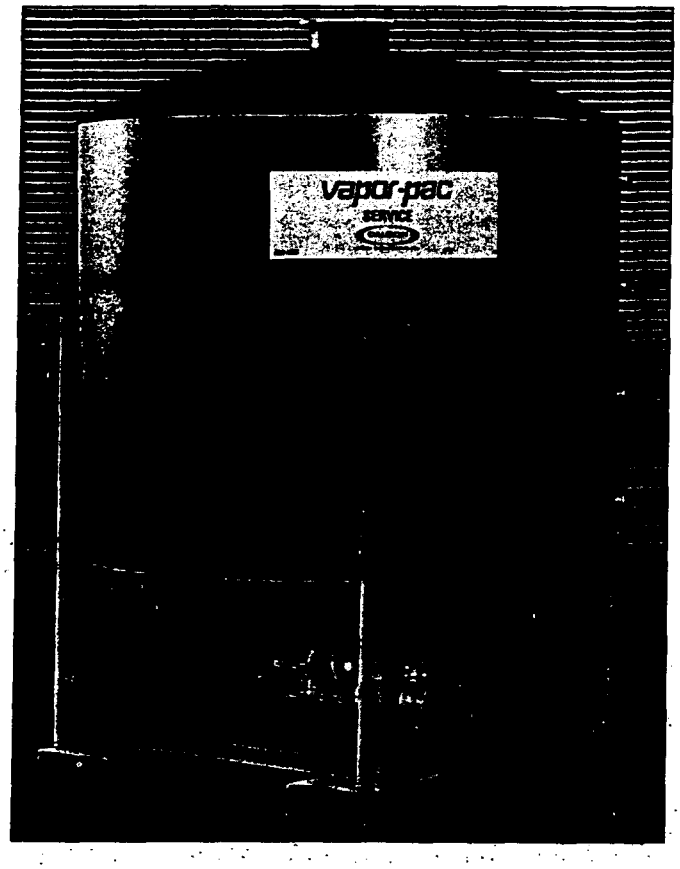
MATERIALS OF CONSTRUCTION

Vessel ..... 316L stainless steel
Skid and support frame: ..... 304 stainless steel
Inlet flanges, elbow, septum: ..... 316L stainless steel
Discharge flange: ..... 316L stainless steel
Fasteners & bottom valve
support plate: ..... Steel, plated
Sample fittings &
sample canister: ..... 316L stainless steel

VAPOR-PAC UNIT PRESSURE DROP
UPFLOW WITH 1800LBS., 4x10 MESH CARBON DENSE PACKED







CAUTION

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing activated carbon, appropriate sampling and work procedures should be followed, including all applicable federal and state requirements.

For information regarding human and environmental exposure, call Calgon Carbon's Regulatory and Trade Affairs personnel at (412) 787-6700.

INSTALLATION INSTRUCTIONS

See Bulletin #27-199 for details on how to install a Vapor-Pac.

SAFETY CONSIDERATIONS

See Safety Bulletin #27-198 for important safety considerations.

OPTIONAL EQUIPMENT

Inlet and outlet flange connectors for ANSI hose connections.

For additional information, contact
Calgon Carbon Corporation,
Box 717, Pittsburgh, PA 15230-0717
Phone (412) 787-6700

+1000 shipp

2500 RCRA

CALGON
CALGON CARBON CORPORATION

INITIAL FEE $4685
MONTHLY $275
FREIGHT

DUCTWORK SIZING SUMMARY

Discharge Stack

VALUES OF DUCTWORK SEGMENT		FITTINGS	NO.	EQ FT
STANDARD CFM	325	90 DEG SHORT RAD	3	48.8
POUNDS/HR	1492.0	90 DEG LONG RAD	0	0.0
DENSITY, LB/CU.FT	0.08	45 DEG ELBOW	0	0.0
VISCOSITY, CP	0.018	180 DEG ELBOW	0	0.0
TEMP, DEG.F.	75.0	TEE THRU	0	0.0
PRESSURE, PSIG	1.0	TEE BRANCH	0	0.0
INTERNAL DIA.,IN.	6.357	DUCT ENTRANCE	1	14.0
VELOCITY, FT/MIN	1423.8	DUCT EXIT	1	28.1
DUCT EPSILON,IN	0.00006	45 DEG TAKEOFF	0	0.0
REYNOLDS NUMBER	80852	60 DEG TAKEOFF	0	0.0
FRICTION FACTOR	0.018879	90 DEG MITRE	0	0.0
DUCT LENGTH, FT	55.0	90 DEG VANE MITRE	0	0.0
EQUIVALENT FT	295.5	HOOD, DEG.OPEN	75	4.2
TOTAL FITTING K	0.0	REDUCTN DIA, IN.	0.0	0.0
TOTAL SEGMENT K	10.53	ENLARGE DIA,IN.	0.0	0.0
IN.H20 DROP/100 FT	0.476	MISC EQUIV.FT.		5.0
TOTAL IN.H20 DROP	1.407	MISC K FACTOR		140.3

FOSTER WHEELER ENVIRONMENTAL CORPORATION

REVISION NO. NEW
DATED: JUL 7, 1995

CALCULATION COVER SHEET

PROJECT Naval Weapons Industrial Research Plant
BethPage, New York, AS/SVE System Design

SUBJECT VOC DECAY COEFFICIENT

CLIENT NorthDiv RAC DO#004

CALCULATION NO. B-06RO

PROJECT NO. _____

NO OF SHEETS _____

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0	All	VERACCO	Reino Starks RS 11/3/97	

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY T. VERACCO DATE 10/28/97 SHEET 1 OF

CHKD. BY [illegible] DATE 11/3/97 OFS NO. DEPT. NO. EC

CLIENT NORTHDIV RAC DO#004

PROJECT NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

SUBJECT AS/SVE DESIGN - VOC DECAY COEFFICIENT CALCULATIONS

PURPOSE: CALCULATE ESTIMATED VOC DECAY COEFFICIENT OVER TIME.

REFERENCE: "RESULTS LETTER REPORT FOR AIR SPARGING / SOIL VAPOR EXTRACTION SYSTEM AT SITE 1 - FORMER DRUM MARSHALLING AREA"
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK
CONTRACT NO. N62472-90-D-1298
OCTOBER 1997
CF BRAUN ENGINEERING CORP.
(HEREIN REFERRED TO AS REFERENCE 2)

ASSUMPTIONS: DATA PRESENTED IN REFERENCE 2, FIGURE 16, IS REPRESENTATIVE OF ACTUAL CONDITIONS TO BE ENCOUNTERED WITH THE AS/SVE SYSTEM.

DESIGN PARAMETERS:

1. INITIAL VOC CONCENTRATION $\approx$ 4,000 mg/M^3
   (PAGE 56; FIGURE 16; REFERENCE 2)

2. VOC CONCENTRATIONS AT VARIOUS TIMES
   (PAGE 56; FIGURE 16; REFERENCE 2)

TIME		CONCENTRATION
0	$\approx$	4,000
27	$\approx$	500
57	$\approx$	250
83	$\approx$	320
142	$\approx$	335

EQUATION TO BE USED:

$$ER = ER_0 e^{-kt}$$

ER = VOC CONCENTRATION IN MG/M³ AT TIME t
ER_0 = INITIAL VOC CONCENTRATION IN MG/M³
t = TIME IN DAYS FROM STARTUP
k = DECAY COEFFICIENT OF VOC CONCENTRATION OVER TIME

FOR TIME, t = 27 DAYS:

$500 = 4{,}000e^{(-k)(27)}$
$0.125 = e^{-27k}$
$\ln(0.125) = -27k$
$-2.079 = -27k$
$k = 0.077$

FOR TIME, t = 142 DAYS:

$335 = 4{,}000e^{-k(142)}$
$0.084 = e^{-142k}$
$\ln(0.084) = -142k$
$k = 0.017$

FOR TIME, t = 57 DAYS:

$250 = 4{,}000e^{-k(57)}$
$0.0625 = e^{-57k}$
$\ln(0.0625) = -57k$
$-2.77 = -57k$
$k = 0.049$

FOR TIME, t = 83 DAYS:

$320 = 4{,}000e^{-k(83)}$
$0.08 = e^{-83k}$
$\ln(0.08) = -83k$
$k = 0.030$

BASED ON THESE CALCULATIONS, THE VOC CONCENTRATION ESTIMATED DECAY COEFFICIENT OVER TIME RANGES FROM 0.017 TO 0.077.

FOR CONSERVATIVE PURPOSES, AN AVERAGE OF THE 1ST TWO DECAY COEFFICIENTS (FOR t=27 DAYS & t=57 DAYS) WILL BE USED BECAUSE THEY BEST REPRESENT THE DECAY.

$$\frac{0.077+0.049}{2} = 0.063$$

FOR DESIGN PURPOSES,

$$\boxed{K=0.063}$$

WILL BE USED.

BASED ON THIS ESTIMATE IT IS ESTIMATED THAT THE SYSTEM WILL ACHIEVE STEADY STATE OPERATION IN <30 DAYS UNDER CONTINUOUS FLOW

FOSTER WHEELER ENVIRONMENTAL CORPORATION

REVISION NO. NEW
DATED: JUL 7, 1995

CALCULATION COVER SHEET

PROJECT Naval Weapons Industrial Research Plant
BethPage, New York, AS/SVE System Design

SUBJECT Thermal Expansion of PVC Pipe

CLIENT NorthDiv RAC DO#004

CALCULATION NO. B-07RO

PROJECT NO. _____

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FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY R. Starks DATE 11/12/97

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SHEET 1 OF _____

OFS NO. _____ DEPT. NO. CE

CLIENT Northern Division RAC DO# 0074

PROJECT Naval Weapons Industrial Research Plant Bethpage NY

SUBJECT Thermal Expansion of PVC Pipe

Purpose: Calculate the thermal expansion expected in PVC pipes to see if loops or expansion joints are needed.

Assumptions: 1. The design stress is assumed to be 1500 psi.

Reference: -Thermal Effects on Plastic Pipe, Valves and Fittings (Hayward).
-Site 2 - Former Drum Marshalling Area AS/SVE System Site Plan and Piping and Instrumentation Diagram.

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY R. Starks DATE 11/12/97

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SHEET _____ OF _____

OFS NO. _____ DEPT. NO. CE

CLIENT Northern Division RAC Do#0074

PROJECT Naval Weapons Industrial Research Plant Bethpage NY

SUBJECT Thermal Expansion of PVC Pipe

Sample Calculation for Run #1

Length $= 6\frac{3}{4}$ in. Diameter (D) = 2 in. $\Delta T = 50°F$

$\alpha = .000031 \frac{\text{in.}}{\text{in.}°\text{F}}$ Design Stress (Sd) = 1500 psi

Modulus of Elasticity (E) = 420,000 psi

Scale of the map is 1 in. = 30 ft.

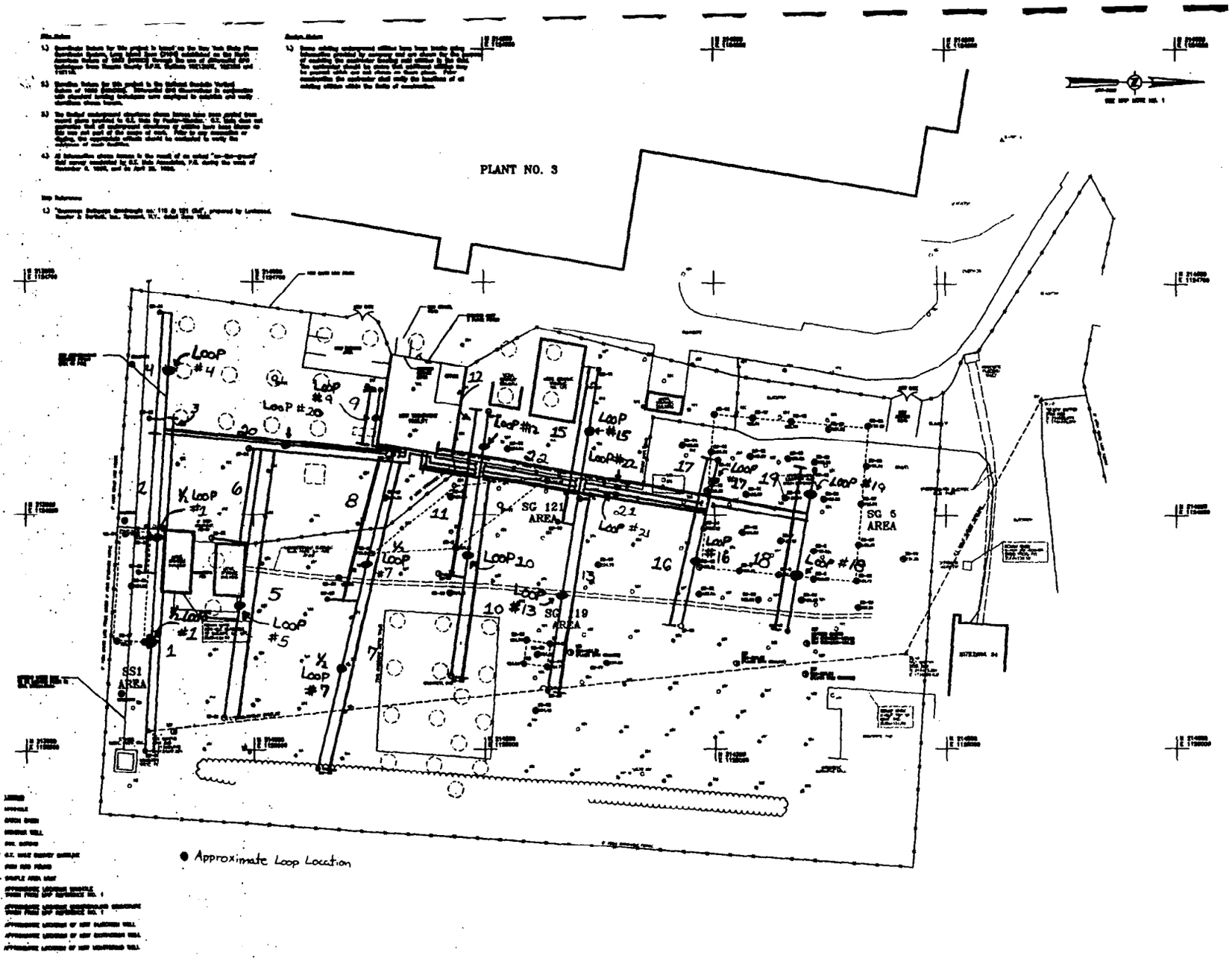
Actual Length (L) $= 6\frac{3}{4}\ \text{in.} \times \frac{30\ \text{ft.}}{1\ \text{in.}} = 202\frac{1}{2}\ \text{ft.}$

$\Delta L = L \times \Delta T \times \alpha \times 12$ $\quad \Delta L = 202\frac{1}{2}\ \text{ft} \times 50°\text{F} \times .000031 \frac{\text{in.}}{\text{in.}°\text{F}} \times 12\frac{\text{in.}}{\text{ft.}} = 3\frac{3}{4}\ \text{in.}$

$$Lo = \frac{\sqrt{\frac{3 \times E}{Sd}} \times D \times \Delta L}{12} \qquad Lo = \frac{\sqrt{\frac{3 \times 420{,}000\ \text{psi}}{1500\ \text{psi}}} \times 2\ \text{in.} \times 3\frac{3}{4}\ \text{in}}{12\frac{\text{in.}}{\text{ft.}}} = 6\frac{5}{8}\ \text{ft.}$$

$$La = \frac{Lo}{2} \qquad La = \frac{6\frac{5}{8}\ \text{ft.}}{2} = 3\frac{1}{3}\ \text{ft.}$$

Conclusion: From the calculations the length of the offset leg and the length of the expansion loop were determined. By calling vendors it was found that expansion joints cost roughly $200 with only a 1 to 2 inch compressive movement. From these results and the information on expansion joints, it would be more cost effective to use loops for the 2" pipe runs since PVC pipe is inexpensive compared to the expansion joints.


PLANT NO. 3
Loop #4
Loop #9
Loop #20
Loop #12
Loop #15
Loop #22
Loop #17
Loop #19
Loop #21
Loop #16
Loop #18
½ Loop #7
Loop 10
Loop #13
Loop #5
½ Loop #1
SS1 AREA
SG 121 AREA
SG 19 AREA
SG 6 AREA
● Approximate Loop Location

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Physical Properties of Harvel Rigid PVC & CPVC Pipe

Properties	ASTM Test Method	PVC 1120 (Normal Impact)	PVC 2110 (Hi Impact)	Harvel CPVC 4120
Mechanical				
Specific Gravity, g/cm³	D792	1.40 ± .02	1.37 ± .02	1.55 ± .02
Tensile Strength at 73° F psi	D638	7,450	6,400	8,000
Modulus Elasticity in Tension, psi at 73° F	D638	420,000	385,000	360,000
Compressive Strength, psi at 73° F	D695	9,600	8,600	9,000
Flexural Strength at 73° F psi	D790	14,450	11,850	15,100
Izod Impact, ft. lb./in. notch at 73° F	D256	.75	10.9	1.5
Hardness Durometer D	D2240	82 ± 3	78 ± 3	–
Hardness Rockwell R	D785	110 - 120	–	119
Thermal				
Coefficient of Thermal Conductivity (Cal.) (cm) / (cm²) (sec.) (°C) x 10⁻⁴	C177	3.5	4.5	0.96
Coefficient of Linear Expansion	D696			
x 10⁻⁵ cm/cm °C		5.2	9.9	6.2
x 10⁻⁵ in/in °F		2.9	5.5	3.4
Heat Distortion Temperature, °F at 264 psi	D648	170	146	217
Specific Heat, Cal./°C/gm	D2766	0.25	0.25	–
Upper Service Temp. Limit °F		140	140	200
Flammability				
Average Time of Burning (sec.)	D635	<5	<5	<5
Average Extent of Burning (mm)		<10	<15	<10
Flame Spread Index	E162	<10	–	<10
Flame Spread	E84	10-25	–	4-18
Flash Ignition		730°F	–	900°F
Smoke Developed*		600-1000	–	9-169
Flammability (.062")	UL-94	V-O	–	V-O, 5VB, 5VA
Softening Starts, approx. °F		250	–	295
Material Become Viscous, °F		350	–	395
Material Carbonizes, °F		425	–	450
Limiting Oxygen Index (LOI)				60
Electrical				
Dielectric Strength, volts/mil	D149	1,413	1,085	1,250
Dielectric Constant	D150			
60 cps at 30°C		3.70	3.90	–
1000 cps at 30°C		3.62	3.31	–
Power Factor %	D150			
60 cps at 30°C		1.25	2.85	–
1000 cps at 30°C		2.82	3.97	–
Volume Resistivity at 95°C, ohms/cm/10¹⁴		1.2	2.4	–
Harvel Rigid Pipe is non-electrolytic.				
Other Properties				
Water Absorption, % Increase– 24hrs. at 25°C	D570	0.05	0.10	0.03
Light Transmission	E308	Opaque	Opaque	–
Light Stability		Excellent	Excellent	–
Effect of Sunlight		Slight Darkening	Slight Darkening	–
Color (Standard)		Dark Grey	Light Grey	Medium Grey
Material Cell Classification				
ASTM D1784		12454-B	16334-D	23447-B
ASTM D3915		12452-4	14341-1	23444-4

ASTM D1784 and D3915 refer to similar compounds. The major difference is that the alphabetical sixth place designation refers to corrosion resistance under ASTM D1784, and the sixth place designation under D3915 refers to the hydrostatic design stress. In addition, D3915 also places upper limits for values in the second through the fifth place designations.

*Tests performed on pipe sizes 3/4" - 4" with a single pipe exposed each test. Some of the CPVC pipes were water filled and these resulted in the lower smoke development values.
NOTE: Harvel CPVC pipe is extruded from TempRite® compounds manufactured by B.F. Goodrich Specialty Polymers and Chemicals Division.

NOTES

8 PEACH TREE HILL ROAD, LIVINGSTON, NJ 07039
TEL: 201 597 7000 FAX: 201 597 7025

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Thermal Effects on Plastic Pipe, Valves and Fittings

Temperature effects on plastic piping systems should always be considered when the system is initially designed. As with all piping systems the pipe changes length with changes in temperature. When a piping system is designed without enough directional changes to compensate for expansion or contraction, the movement can effect the performance of the system valves and in many cases generate external loads that can cause damage. Generally the system design will have many bends in the pipe, minimizing the effects of temperature changes. Plastic piping should be installed in such a way as to minimize the stress induced by temperature changes by hanging the pipe on rollers or pipe hangers rather then fixing it in position. With long lengths of straight pipe with expected large temperature changes, either from time of installation or in operating conditions, expansion loops or expansion joints should be considered. When an expansion loop or expansion joint is installed, the pipe should be anchored in such a way as to direct the axial movement into the compensating configuration. The total pipe length change can be calculated from the following:

$$\Delta L = L * (T_2 - T_1) * \alpha * 12$$

Where:
- ΔL pipe length change (in.)
- α coefficient of the thermal expansion (in./in./°F, from Table I)
- T_1 Ambient Temperature (°F)
- T_2 maximum process temperature (°F)
- L length of pipe run (ft.)

Table I - Coefficient of Thermal Expansion

Material	PVC	CPVC	PPL
α (in./in./°F)	.000031	.000038	.000021

Example 1:

A 200 ft. 4" CPVC, straight pipe run is to be constructed. During installation the ambient temperature is 60°F. The anticipated operating temperature for the system is 100°F. The total change in length of the pipe run is:

$\Delta L = 200 * (100\text{-}60) * .000038 * 12 = 3.6$ in.

The length of the offset leg of an expansion loop can be calculated by:

$$L_0 = \frac{\sqrt{\frac{3 * E}{S_d}} * D * \Delta L}{12}$$

Where:
- L_0 length of offset leg (ft.)
- D nominal outside pipe diameter (in.)
- E modulus of elasticity at the maximum temperature (psi)
- S_d design stress of the pipe at design condition (psi)

Example 2:

The design stress for the system is 1,600 psi and the modulus of elasticity for CPVC is 360,000 psi. The length of the offset leg required to accommodate expansion during operation is given by:

$$L_0 = \frac{\sqrt{\frac{3 * 360{,}000}{1{,}600}} * 4.5 * 3.6}{12} = 8.7 \text{ ft.}$$

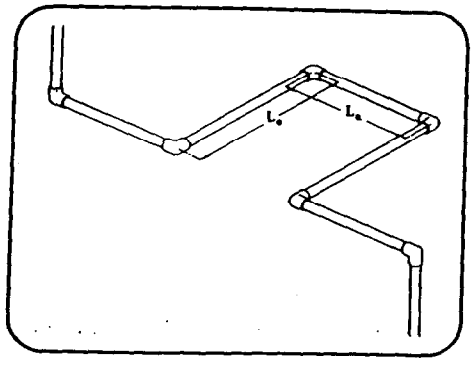
The length of the expansion loop along the run of the pipe is:

$$L_a = \frac{L_0}{2}$$

Example 3:

The length of the expansion loop along the run is:

$$L_a = \frac{8.7}{2} = 4.4 \text{ ft.}$$



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

NOTES

8 Peach Tree Hill Road, Livingston, NJ 07039
Tel: 201-597-7000 Fax: 201-597-7025

Site 1- Former Drum Marshing Area
NWIRP Bethpage, NY
Air Sparging/ Soil Vapor Extraction System

Run #	Lenght (in.)	Lenght (ft.)	Diameter (in.)	ΔT (°F)	ΔL (in.)	Sd (psi)	Lo (ft.)	La (ft.)	Description
1	6 3/4	202 1/2	2	50	3 3/4	1500	6 5/8	3 1/3	EW-01 to header pipe
2	3	90	3	50	1 2/3	1500	5 2/5	2 5/7	EW-02 to header pipe
3	1/4	7 1/2	3	50	1/7	1500	1 5/9	7/9	EW-03 to header pipe
4	2 1/2	75	2	50	1 2/5	1500	4	2	EW-04 to header pipe
5	5 4/5	174 3/8	2	50	3 1/4	1500	6 1/7	3	IW-01 to header pipe
6	2	61 7/8	2	50	1 1/7	1500	3 2/3	1 5/6	IW-03 to header pipe
7	6 3/4	202 1/2	2	50	3 3/4	1500	6 5/8	3 1/3	EW-05 to header pipe
8	3 1/8	93 3/4	3	50	1 3/4	1500	5 1/2	2 3/4	EW-06 to header pipe
9	1 1/4	37 1/2	3	50	2/3	1500	3 1/2	1 3/4	EW-08 to header pipe
10	4 1/3	129 3/8	1 1/2	50	2 2/5	1500	4 3/5	2 2/7	IW-06 to header pipe
11	2 1/4	67 1/2	2	50	1 1/4	1500	3 5/6	2	IW-07 to header pipe
12	1 1/2	45	2	50	5/6	1500	3 1/8	1 5/9	IW-09 to header pipe
13	4 3/8	131 1/4	2	50	2 4/9	1500	5 1/3	2 2/3	EW-09 to header pipe
14	3/4	22 1/2	3	50	3/7	1500	2 5/7	1 1/3	EW-10 to header pipe
15	2 3/4	82 1/2	2	50	1 1/2	1500	4 1/4	2 1/9	EW-11 to header pipe
16	2 5/8	78 3/4	1 1/2	50	1 1/2	1500	3 4/7	1 4/5	IW-10 to header pipe
17	1 1/5	35 5/8	1 1/2	50	2/3	1500	2 2/5	1 1/5	IW-11 to header pipe
18	2 1/2	75	2	50	1 2/5	1500	4	2	EW-12 to header pipe
19	1 1/5	35 5/8	2	50	2/3	1500	2 7/9	1 2/5	EW-13 to header pipe
20	5 1/4	157 1/2	4	50	3	1500	8 1/4	4 1/7	Header pipe for EW-01 to EW-04
21	6 1/8	183 3/4	2	50	3 3/7	1500	6 1/3	3 1/6	Header pipe for IW-10 and IW-11
22	8 1/8	243 3/4	4	50	4 1/2	1500	10 2/7	5 1/7	Header pipe for EW-12 and EW-13

The design stress was assumed to be 1500 psi.

ATTACHMENT D
VENDOR CATALOG SHEETS

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

Condensate Transfer Pump P-01

FOSTER WHEELER ENVIRONMENTAL CORPORATION

DATA SHEET
CENTRIFUGAL PUMP

0575-7/4-81

CLIENT AND LOCATION: NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE
PLANT SECTION NAME AND SECTION NUMBER: SVE/AS TREATMENT FACILITY

PREPARED BY: DeGIORGIO DATE: 11/04/9-
CHECKED BY: DATE:
APPROVED BY: DATE:

DATE / APPROVED BY / ISSUE

1 Service — No. Pumps Required
2 No. Motors Required 1 — Item No. — — Furnished By FW — MTD By —
3 No. Turbines Required — — Item No. — — Furnished By FW — MTD By —
4 Pump Mfr GOULDS — Serial No. —
5 Type CENTRIFUGAL — Model/Size NPE 1X1 1/4 X 6
6 NOTE: Δ Indicates Information to be Completed by Purchaser — ☒ By Manufacturer

DATE / APPROVED BY / ISSUE

Δ OPERATING CONDITIONS (EACH PUMP)
8 Liquid WATER — U.S. Gpm at Pt Nor 25 — Rated —
9 P Discharge ~~psig~~ 60 FT TDH
10 Pt °F Nor 75 Max 95 — P Suct psig Max — — Rated —
11 Sp Gr at Pt 1.0 — Diff Pressure psi —
12 Vap Pressure at Pt psia — — Diff Head Ft —
13 Vis at Pt SSU 1 CP — NPSHA Ft —
14 Corr/Eros Caused By VOCS — Hyd Hz
15 ☐ CONSTRUCTION

16 NOZZLES	SIZE	RATING	FACING	LOCATION
17 Suction	1			VERT
18 Discharge	1 1/4			TOP

19 Case Mt: ☒ Centerline ☐ Foot ☐ Bracket ☐ Vert (Type)
20 Split: ☐ Axial ☐ Rad: Type Volute ☒ SGL ☐ DBL ☐ Diffuser
21 Press: ☒ Max Allow 226 psig 70 °F ☒ Hydro Test 225 psig

DATE / APPROVED BY / ISSUE

22 Connect: ☐ Vent ☒ Drain ☐ Gauge
23 Impeller Dia: 4 1/16 ☒ Rated — ☐ Max — ☐ Type —
24 Mount: ☒ Between Brgs ☐ Overhung
25 Bearings Type: ☐ Radial ☒ Thrust
26 Lube: ☐ Ring Oil ☒ Flood ☐ Oil Mist ☐ Flinger ☐ Pressure
27 Coupling: ☐ Mfr — ☐ Model —
28 Driver Half MTD By ☒ Pump Mfr Δ Driver Mfr Δ Purchaser
29 Packing: ☐ Mfr & Type ☐ Size/No. Rings
30 Mechanical Seal: ☒ Mfr & Model VITON
31 ☐ Mfr Code
32 AUXILIARY PIPING
33 Δ C W Pipe Plan Δ CU Δ SS Δ Tubing Δ Piping PVC
34 ☐ Total Cooling Water Req'd, Gpm — Δ Sight F.I. Req'd —
35 Δ Packing Cool. Injection Req'd ☐ Total Gpm — ☐ psig —
36 Δ Seal Flush Pipe Plan — Δ C S Δ S S Δ Tubing Δ Pipe
37 Δ External Seal Flush Fluid — ☐ Gpm ☐ psig
38 Δ Auxiliary Seal Plan Δ C S — Δ S S Δ Tubing Δ Pipe
39 Δ Auxiliary Seal Quench Fluid — API Class Code

DATE / APPROVED BY / ISSUE

40 MOTOR DRIVER
41 Hp 1/2 — Rpm 3500 — Frame TEFC — V/Phase/Hz 115/3/60
42 Mfr GOULDS — Bearings — — Lube —
43 Type — Insulation THERM — Full Load Amps
44 Enc — — Temperature Rise °C — Locked Rotor Amps —
45 Δ VHS Δ VSS Vert Thrust Cap Lb
46 APPLICABLE SPECIFICATIONS: —
47 Δ API 610 Δ ANSI Standards Δ
48 Remarks:
49
50
51

ISSUE

FURNISH IN ACCORDANCE WITH BUYER'S PURCHASE ORDER AND SPECIFICATION AND AS NOTED HEREON ☐

AUTHORIZATION NO.

DRAWING NO.
SHEET OF

☒ PERFORMANCE
Proposal Curve No.
RPM — NPSHR (Water)
Eff — BHP Rated
Max BHP Rated Imp
Max Heat Rated Imp
Min Continuous Gpm
Rotation (Viewd from CPLG End)

SHOP TESTS
Δ Non-Wit Perf Δ Wit Perf
Δ Non-Wit Hydro ☒ Wit Hydro
Δ Npsh Req'd Δ Wit Npsh
☒ Shop Inspection
Δ Dismant & Insp after Test
Δ Other

MATERIALS
☒ Pump: Case/Trim Class STAINLESS STEEL
Δ Corr. Allowance In
☐ Baseplate NONE

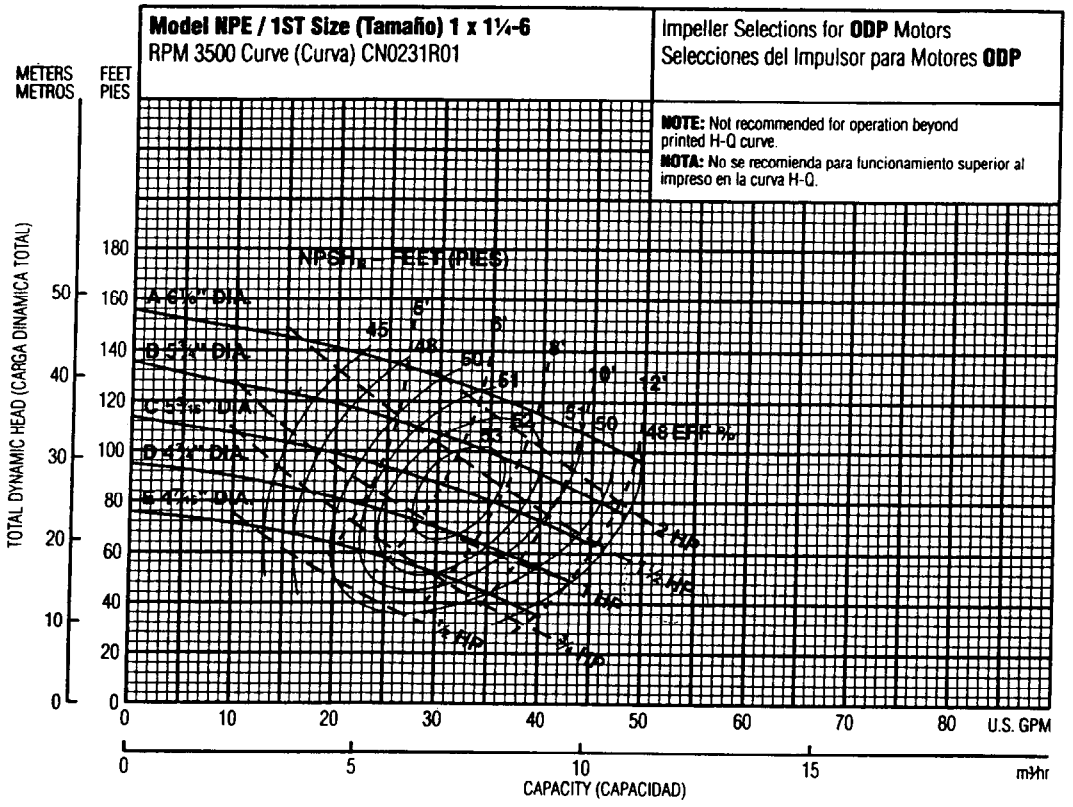
INTERIOR WEAR PARTS
Wear Rings ☒ Case ☒ Imp
Dia — In. Clearance In.
Interstage Bushings —
Dia. — In. Clearance In.

— VERTICAL PUMPS —
Pit or Sump Depth Δ
Min Submergence Req'd ☐
Column Pipe ☐ Flanged ☐ Threaded
Line Shaft ☐ Open ☐ Enclosed
Brgs ☐ Bowl ☐ Line Shaft
Brg Drf ☐ Water ☐ Oil ☐ Grease
Float & Rod Δ C S Δ S S Δ Brz Δ None
Float Switch ☐
Pump Thrust, Lb ☐ Up ☐ Down
Mounting Plate Req'd

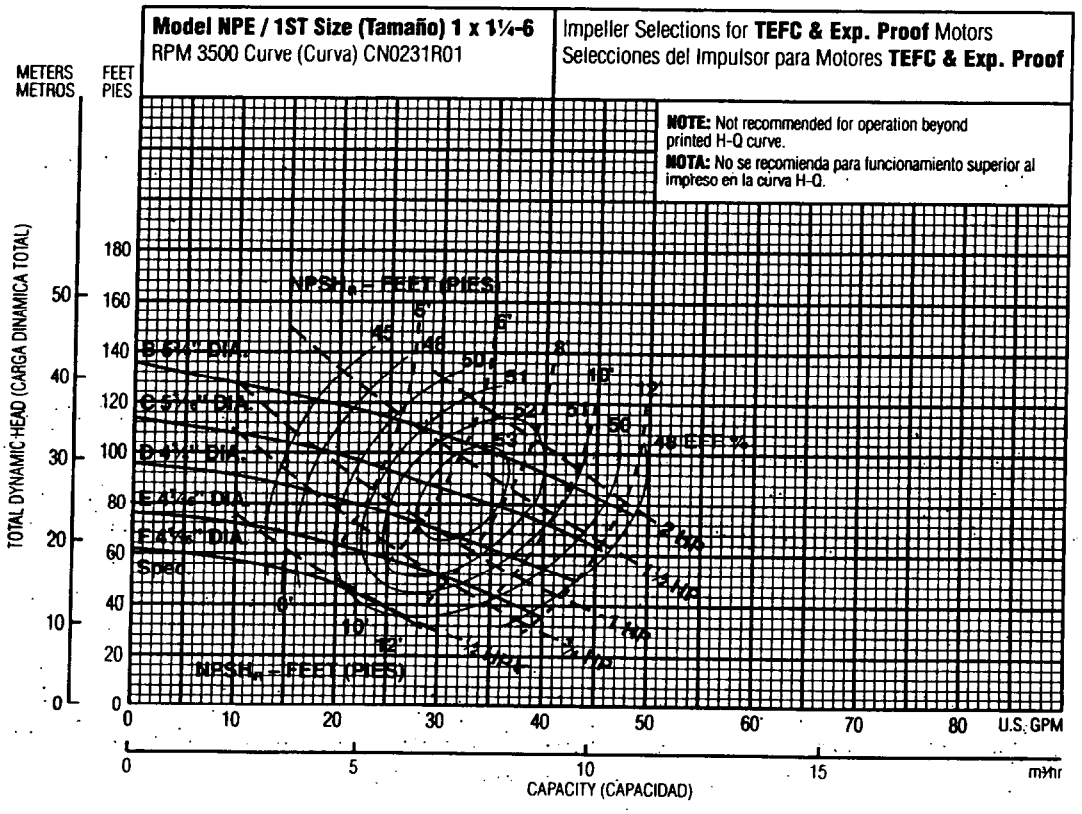
Approximate Weight Pump & Base
Motor Lbs Turbine Lbs

SITE CONDITIONS
Elevation Ft
Amb Temperature °F Max Min

Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM



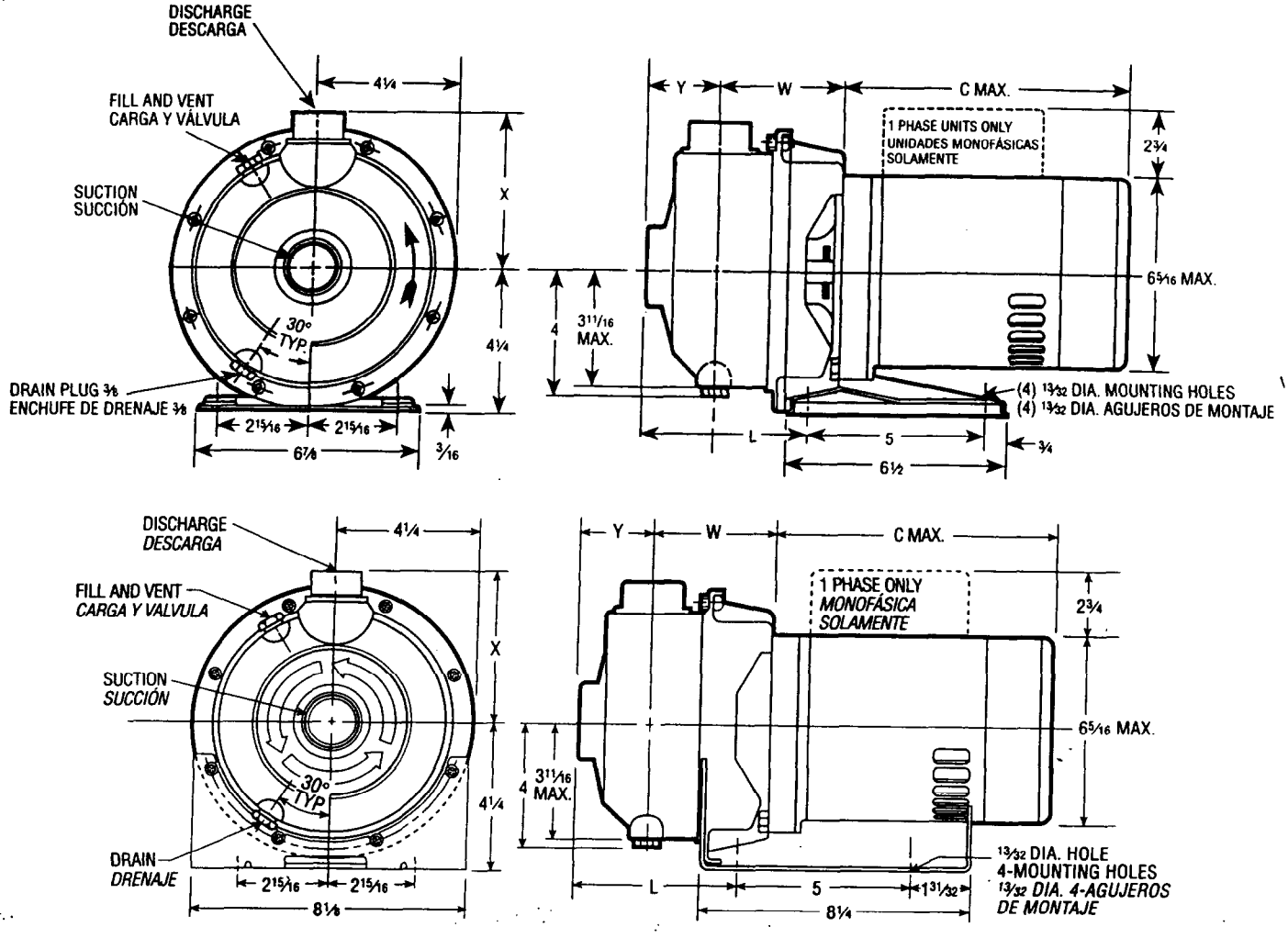
Ordering Code, Código de Pedido	Imp. Dia.
E	4 7/16"
D	4¾
C	5 3/16
B	5¾
A	6⅛



Ordering Code, Código de Pedido	Imp. Dia.
F	4 1/16" spec.
E	4 7/16
D	4¾
C	5 3/16
B	5¾

NPE Close Coupled – Dimensions, Weights and Specifications
NPE Acople Cerrado – Dimensiones, Pesos y Especificaciones

Clockwise Rotation Viewed from Drive End
Rotación en Dirección de las Agujas del Reloj Visto desde el Extremo del Motor



Specifications
Especificaciones

Capacities to:
75 GPM (283L/min) at 1750 RPM
150 GPM (550L/min) at 3500 RPM

Heads to:
39 feet (11 m) at 1750 RPM
150 feet (50 m) at 3500 RPM

Working pressures to:
125 PSIG (9 bars)

Maximum temperatures to:
212°F (100°C) with standard seal or 250°F (121°C) with optional high temperature seal.

Direction of rotation:
Clockwise when viewed from motor end.

Capacidades:
75 GPM (283L/min) a 1750 RPM
150 GPM (550L/min) a 3500 RPM

Cargas:
39 pies (11 m) a 1750 RPM
150 pies (50 m) a 3500 RPM

Presión de trabajo:
125 PSIG (9 baras)

Temperatura máxima:
212°F (100°C) con sello estándar o 250°F (121°C) con sello opcional para alta temperatura.

Dirección de rotación:
En dirección de las agujas del reloj visto desde el extremo final del motor.

Motor specifications:
NEMA 56J frame, 1750 RPM, ½ HP. 3500 RPM ½ through 3 HP. Open drip-proof, totally enclosed fan-cooled or explosion proof enclosures. Stainless steel shaft with ball bearings.

Single phase: Voltage 115/230 ODP and TEFC. (3 HP model – 230 V only) Built-in overload with auto-reset provided.

Three phase: Voltage 208-230/460 ODP, TEFC and EX PROOF.

NOTE: For three phase motors, overload protection must be provided in starter unit. Starter and heaters must be ordered separately.

Motores:
Armazón 56J NEMA, 1750 RPM ½ HP. 3500 RPM ½ a 3 HP. A prueba de goteo, ventilador totalmente encerrado o recintos a prueba de explosión. Eje de acero inoxidable con balineras de bolas.

Monofásicos: Voltaje 115/230 ODP y TEFC. (modelo 3 HP – 230 voltios solamente) Se proporciona protección térmica contra sobrecarga construida con reseteo automático.

Trifásicos: Voltaje 208-230/460 ODP, TEFC y EX PROOF.

NOTA: Para motores trifásicos se debe de proporcionar la protección térmica contra sobrecarga en la unidad de arranque. El arrancador y los calentadores se deben pedir por separado.

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

Autodialer

GUARD-IT™

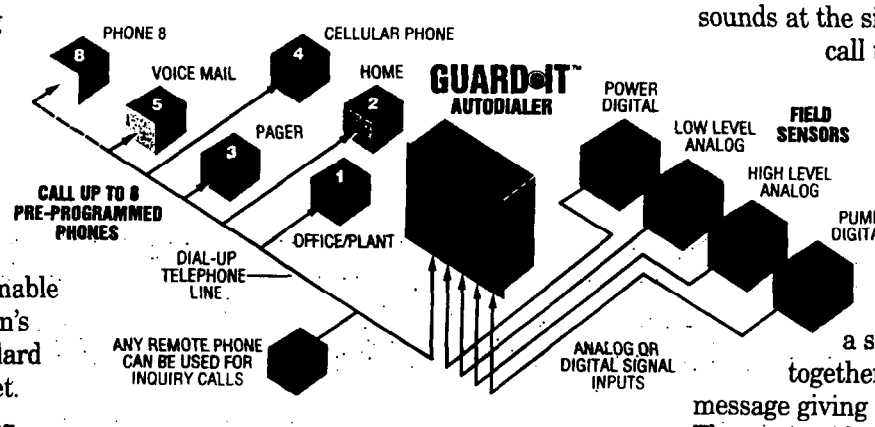
SINCE 1948
RACO®
REMOTE ALARMS AND CONTROLS

...a new low-cost autodialer with flexible features for dependable Alarm Autodialing and Remote Monitoring.

GUARD-IT delivers the functionality you need, and it's backed by RACO's reputation for dependability, quality, service, and factory support.

Analog or Digital Inputs

GUARD-IT monitors 4 input channels. Each channel can be configured for an analog or digital signal input. The system utilizes the public telephone network as a basic medium for transmission of alarm messages and status calls. It is field programmable by the user at the system's control panel via a standard touch tone phone handset.



Automatic Alarm Reporting

Upon detection of an alarm condition, GUARD-IT automatically calls a list of up to 8 pre-programmed phone numbers over the standard dial-up telephone network, calling until it gets an acknowledgement. When a connection is made, the system reports the station identity and the specific alarm condition in the form of a digitally pre-recorded voice message. In addition to standard phones in office, plant, or home, the alarm calling sequence can also include calls to pagers, cellular phones, and voice mail.

Alarm Acknowledgment

An alarm is acknowledged simply by pressing a button on the called phone. When acknowledging an alarm, a built-in microphone permits the caller to listen for background sounds at the site. The user can also call the system from any remote phone for a status report of all points being monitored.

Voice Messaging

The voice transmission consists of a station identification together with an alarm message giving details on the fault. The station identification and alarm messages are digitally recorded by the user. RACO pioneered the concept of using digitally-recorded and synthesized voice messages in autodialers. By using electronic voice reporting technology, GUARD-IT eliminates the need for often-unreliable audio tape autodialers.

(Continued on back page)

GUARD-IT™

Set-up and Programming

System set-up, voice recording, and programming is accomplished via an external touch tone phone which plugs into a standard phone jack on the system's front panel. The user simply follows voice instructions given over the phone.

System Controls

System operating status is provided by front panel LED indicators. System off/disarm/ready controls are provided on front panel. Surge protection and noise suppression are standard.

A Truly Modern Autodialer

GUARD-IT fills the requirement of a modern autodialer—it should be extremely reliable and be able to tell the called party as much information about the nature of an alarm as possible so that the right personnel can respond quickly and appropriately. Many other autodialers don't meet these requirements.

Compare GUARD-IT with all the others and you will see that this multi-featured system offers a way to get RACO flexibility, quality, and dependability at a price you'd expect to pay for one of the budget models.

Specifications

ELECTRICAL

Power Requirements: User supplied 10-14 VDC, 500 mA max.

Power consumption:
200 mA minimum standby
500 mA maximum active

Power failure: Automatic alarm for external power failure.

Battery Charging: Precision voltage controlled, automatic rapid recharge after drain.

Universal Signal Inputs:
Digital Inputs; open contacts see 5VDC, closed contacts see 5 mA DC
Analog Inputs; 4-20 mA, single ended. Maximum voltage drop 10 VDC. Resolution 0.2%; absolute accuracy 0.5%

Local Alarm Relay: Transistor output for TTL or relay drive (500 mA 24 VDC max) activated during unacknowledged alarm.

RJ11 Telephone line jack for connection to public telephone netowork.

PHYSICAL

Surge protection: Solid state protectors on phone, power, and signal lines.

Enclosure: Single circuit card in durable steel cabinet designed for mounting on control panel wall or flush mounted inside a larger control panel with faceplate visible.

Weight: 4 pounds, 6 pounds with battery

Dimensions: 6.85″H x 8.85″W x 2.85″D

Mounting Centers: 3.6″H x 9″W

ENVIRONMENTAL

Temperature range: 20° to 130°F.

Humidity: 0 to 95%, noncondensing.

TELEPHONE

Rotary pulse or tone dialing.

Dials up to 8 different numbers, each up to 60 digits long.

Time between alarm phone calls programmable 0.1 to 99.9 minutes.

Smart calling call progress monitoring detects dial tone, basic ringback and busy signal.

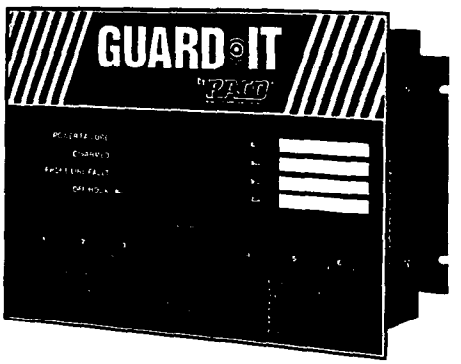
Alarm acknowledgement by touch tone key or callback.

Compatible with most pager, cellular, and voicemail systems.

User-furnished standard touch tone handset required for programming. FCC Registered.

PROGRAMMING

Standard phone jack on front panel for programming phone. Voice menu instructions guide programming.



SPEECH MESSAGES

User digitally records five messages, Station ID and four channel alarm messages. High definition digital recordings up to 12 seconds per message. Resident synthesized voice vocabulary for programming guidance.

FACTORY OPTIONS

Power Supply, UL Class 2 120 VAC 50/60 Hz adaptor.

Battery backup, internal 6 volt; 4 AH gel cell provides 20 hours operation during power failure.

NEMA 4X enclosure.

Cellularm cellular communication system.

WARRANTY

Two year parts and labor warranty. See separate warranty card for details.

For ordering information, call toll free at... 800-722-6999

SINCE 1948

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CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

Valves and Valve List

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM

MASTER VALVE LIST

Valve Tag	No.	Type	Size (inch)	Material	Connections	Seals	Specification	Location
BV-	01	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	02	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	03	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	04	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	05	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	06	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	07	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	08	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	09	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	10	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	11	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	12	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	13	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Well
BV-	14	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Air Bleed
BV-	15	Ball	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Moisture Separator (M-1)
BV-	16	Ball	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Condensate Transfer Pump (P-01)
BV-	17	Ball	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Existing Moisture Separator
BV-	18	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Soil Vapor Extraction Sample Port
BV-	19	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Effluent Carbon Adsorption Sample Port
BV-	20	Ball	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Effluent Carbon Adsorption Drain Valve

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM

MASTER VALVE LIST

Valve Tag	No.	Type	Size (inch)	Material	Connections	Seals	Specification	Location
BV-	21	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	22	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	23	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	24	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	25	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	26	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	27	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	28	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	29	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	30	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Injection Air Well
BV-	31	Ball	1 1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption Sample Port
BV-	32	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption Sample Port
BV-	33	Ball	2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	34	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	35	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	36	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	37	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	38	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	39	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	40	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM

MASTER VALVE LIST

Valve Tag	No.	Type	Size (inch)	Material	Connections	Seals	Specification	Location
BV-	41	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	42	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	43	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	44	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	45	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	46	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	47	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	48	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	49	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	50	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	51	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	52	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	53	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	54	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	55	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	56	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	57	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BV-	58	Ball	1/2	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Extraction Well Sample Port
BT-	01	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	02	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM

MASTER VALVE LIST

Valve Tag	No.	Type	Size (inch)	Material	Connections	Seals	Specification	Location
BT-	03	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	04	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	05	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	06	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
BT-	07	Butterfly	6	PVC	Wafer Flange	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Carbon Adsorption System
CK-	01	Ball Check	1	PVC	Socket	Viton	Hayward Industrial Products, Inc. or equal; Type I Grade A PVC	Condensate Transfer Pump (P-01)

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

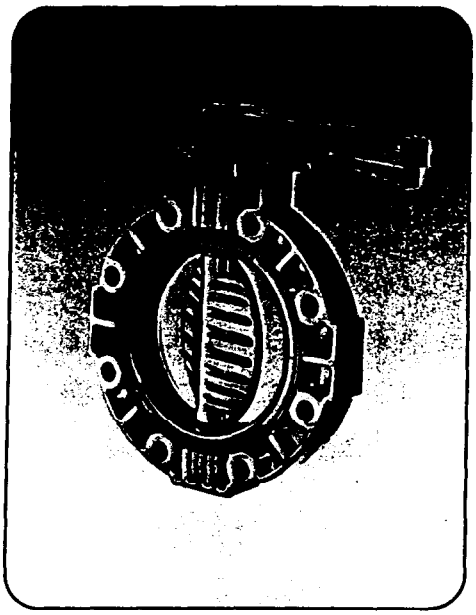
Hayward 1-1/2" through 8" Lever Operated PVC Butterfly Valves are rated at a full 150 psi. They provide quick quarter turn off and are ideal for flow throttling applications. The integrally molded mounting pad has seven stops to position the disc at 0°, 15°, 30°, 45°, 60°, 75°, and 90°. The lever assembly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

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

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

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

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

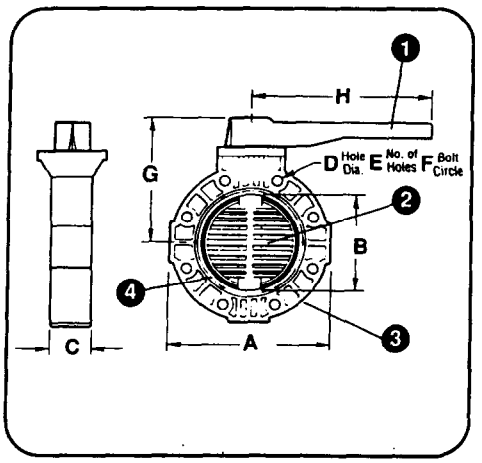


Features

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

Options

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



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

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

Dimensions

Dimensions are in inches. For reference only.

Size	A	B	C	D	E	F	G	H	Weights in lbs.
1-1/2	6.00	2.18	1.50	.63/.75	4	3.88/4.75	6.25	10.50	3.5 lbs.
3	7.50	3.13	2.00	.75	4	6.00	6.69	10.50	7.50 lbs.
4	9.25	3.94	2.09	.75	8	7.50	7.94	12.00	9.80 lbs.
6	11.25	5.81	2.81	.88	8	9.50	9.50	14.00	14.10 lbs.
8	13.75	7.75	2.60	.88	8	11.75	10.63	16.00	16.50 lbs.

Selection Chart

Size	Body Material	Disc Material	Liner & Seals	Pressure Rating
1-1/2"	PVC	PVC	EPDM	150 psi @ 73°F
		PPL	Nitrile or Viton	

Engineering Specifications

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

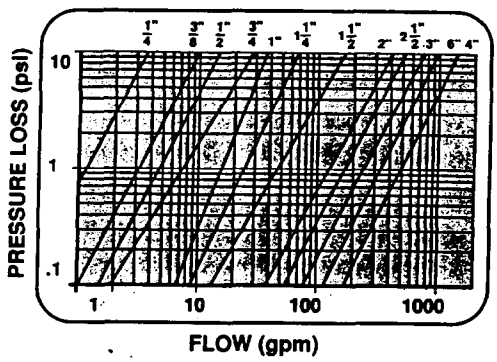
HAYWARD® 900 Fairmount Avenue, Elizabeth, New Jersey 0720
908/351-5400 Fax: 908/351-770

Ball Check Valves

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

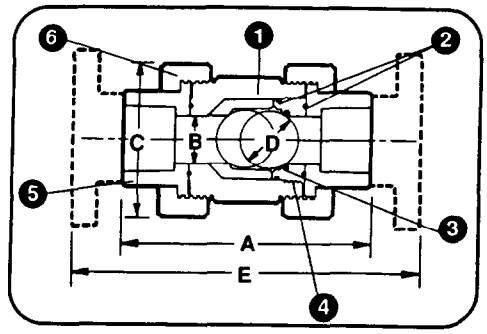
Hayward True Checks up to 4" feature a full port, safe block design, and can be installed either horizontally or vertically. Our unique 1/4" and 3/8" "Trim Checks", because of their compact design, are not True Union. They are, however, fully repairable and retain all of the other features of our True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

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



Engineering Specifications

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



Features

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

Ball Check Valves Parts List

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

Dimensions

Size	A	B	C	D	E	F	G	Weight in lbs. Soc/Thd	Flanged
1/4"	3.06	0.31	1.38	0.50	N/A	N/A		0.13	N/A
3/8"	3.06	0.31	1.38	0.50	N/A	N/A		0.13	N/A
1/2"	4.38	0.50	2.25	0.75	6.75	4.88	2.32	0.75	1.00
3/4"	4.75	0.75	2.63	1.00	7.19	5.00	2.60	0.75	1.38
1"	5.25	1.00	3.00	1.25	7.75	5.88	2.88	1.25	2.13
1-1/4"	6.44	1.25	3.56	1.50	9.44	6.94	3.25	1.75	2.75
1-1/2"	6.75	1.50	4.00	1.75	9.75	7.06	3.75	2.00	3.75
2"	8.00	1.94	4.75	2.25	11.25	8.56	4.50	3.75	5.75
2-1/2"	10.56	2.88	6.56	3.25	14.38	11.25	2.50	11.00	15.00
3"	10.56	2.88	6.56	3.25	14.44	11.25	2.50	10.00	14.00
4"	12.94	4.00	8.56	4.25	17.00	14.63	4.25	17.00	25.00
6"	N/A	4.00	8.56	4.25	19.19	N/A		N/A	30.20

*3" valve bushed down to 2½"

Dimensions are in inches. For reference only.

Selection Chart

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

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

Foot Valve

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

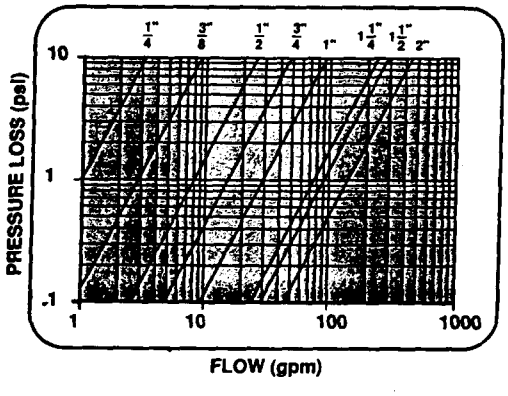
HAYWARD® 900 Fairmount Avenue, Elizabeth, New Jersey 072
908/351-5400 Fax: 908/351-77

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

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

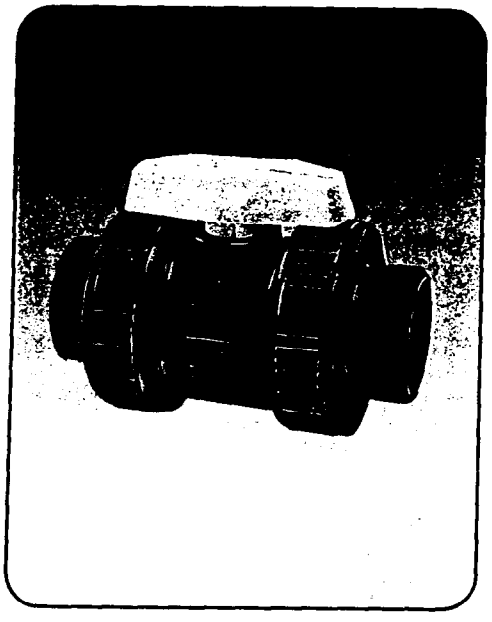
All Hayward True Union Valves are Sure Blocked and rated to 225 psi. The valve's seal retainer incorporates a fine pitch thread for accurate seat adjustment. Sure Bock valves feature reversible Teflon seats. Should they become worn or scored, they simply have to be removed, turned over, and reinstalled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

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



Engineering Specifications

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

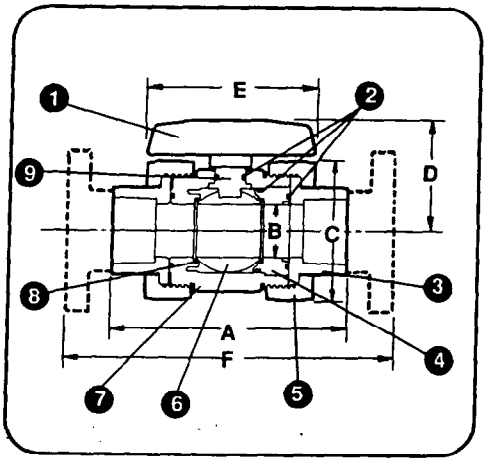


Features

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

Options

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



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

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

Dimensions

Size	A	B	C	D	E	F	Weight in lbs. Soc/Thd	Flanged
1/4"	1.63	.50	2.25	.88	3.00		.75	
3/8"	1.63	.50	2.25	.88	3.00		.75	
1/2"	1.63	.50	2.25	.88	3.00	6.75	.75	1.00
3/4"	1.75	.75	2.63	1.13	3.00	7.13	.75	1.00
1"	1.25	1.00	3.00	2.63	4.00	8.00	1.50	2.13
1 1/4"	6.44	1.25	3.56	2.88	4.00	9.44	1.75	2.75
1 1/2"	6.75	1.50	4.00	3.00	4.00	9.88	2.13	3.63
2"	8.00	2.00	4.75	3.63	5.00	11.38	3.75	6.25

Dimensions are in inches. For reference only.

Selection Chart

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

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

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING

SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

Moisture Separator

Product Recovery Management

205 Broadway St
Durham, NC 27701
(919) 682-2054 fax (919) 682-0066

Quote No. FW110497

SALES QUOTE

Employee

Name	Mel Phillips	Emp #	
Position		Region	NC
Department		Manager	RMP

Dates

First Contact	
Quote Issued	11/5/97
Accept/Reject	

Product/Service Name	Build Custom Moisture Separator	Quantity	Price	TOTAL
Moisture Separator ~~tank~~ Tank		1	$3,050.00	$3,050.00

550 gallon upright tank, 7gauge carbon steel, 4'D x 6'H
rated for 75"WC. Vacuum
6" NPT tangentially mounted inlet and 6" NPT discharge port
Anchor ring and lifting eyelets
Enamel coated exterior
2" Vacuum relief valve ,adjustable to 85"W.C.
2" brass drain valve mounted on bottom of tank with safety plug
Explosion-proof stainless steel high level float switch
CAD drawings for approval prior to fabrication
Crate unit for shipment

Customer

Customer	Reino Starks	Company	Foster Wheeler, Inc.
Address	8 Peachtree Hill Rd.		
City	Livingston	State	NJ
ZIP	07039	Email	
Phone	973-597-7162	Fax	973-597-7433

Sub Total	$3,050.00
Discount	
Taxes	
TOTAL	$3,050.00

Notes

Quote does not include freight. Common carrier estimated cost of approx $300.00-$400.00

Status

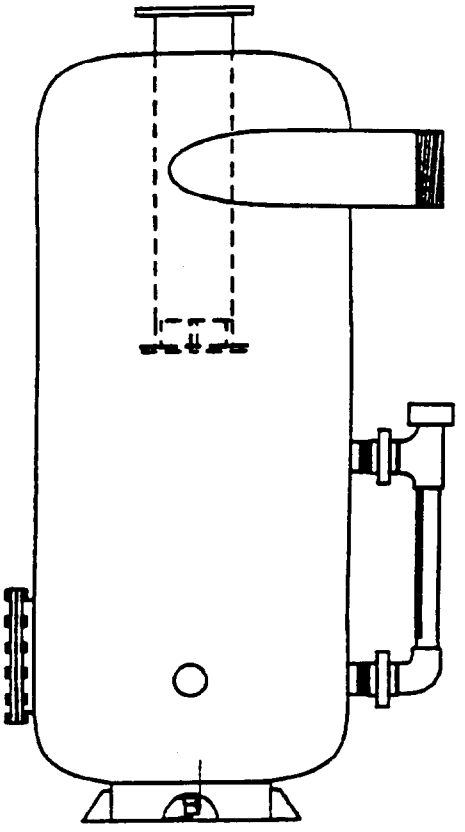
O Established Customer ● New Customer O Prospective Customer

Office Use Only

Terms are net 30 days 1.5% interest assessed on past due invoices

PRODUCT RECOVERY MANAGEMENT

MS-30, 60 and 80, Moisture Separation Units



PRM Moisture Separators were designed exclusively for groundwater remediation using SVE technology. The are designed for your maximum blower protection and extended vapor phase carbon life while offering durability, service and flexibility of applications.

FEATURES

- High pressure construction with 12 gauge carbon steel
- Cyclonic separation of water (in liquid and vapor form) from the air stream
- Equipped with water level sight tube
- Low pressure drop
- Industrial enamel coating over primer
- Access port for cleaning
- Extra ports for gauges and sensors
- Optional sight tube / level control assembly

Note: Model no. indicates total volume of vessel, MS-30= 30gallon size tank, etc.

Shown with optional level control.

CUSTOM UNIT SIMILAR TO THIS DESIGN

Unit	Max. H_2O Capacity	Maximum Airflow *	Inlet (NPT)	Outlet (NPT)	Weight
MS-30	15 Gal.	300 cfm	2"or 3"	4"	105#
MS-60	30 Gal.	700 cfm	4"	6"	150#
MS-80	40 Gal.	900 cfm	6"	8"	220#

20" x 54" Dia

* Airflow rated at less than 6 (iwg) inches of water gauge pressure drop

Product Recovery Management is a division of Phillips Electric Co. of Durham, Inc.
205 Broadway Street • Durham, NC 27701 • (919) 682-2054 • Fax (919) 682-0066
Toll Free: Southeast 1-888-PRM-Will Northeast 1-888-Treat-It

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING SYSTEM

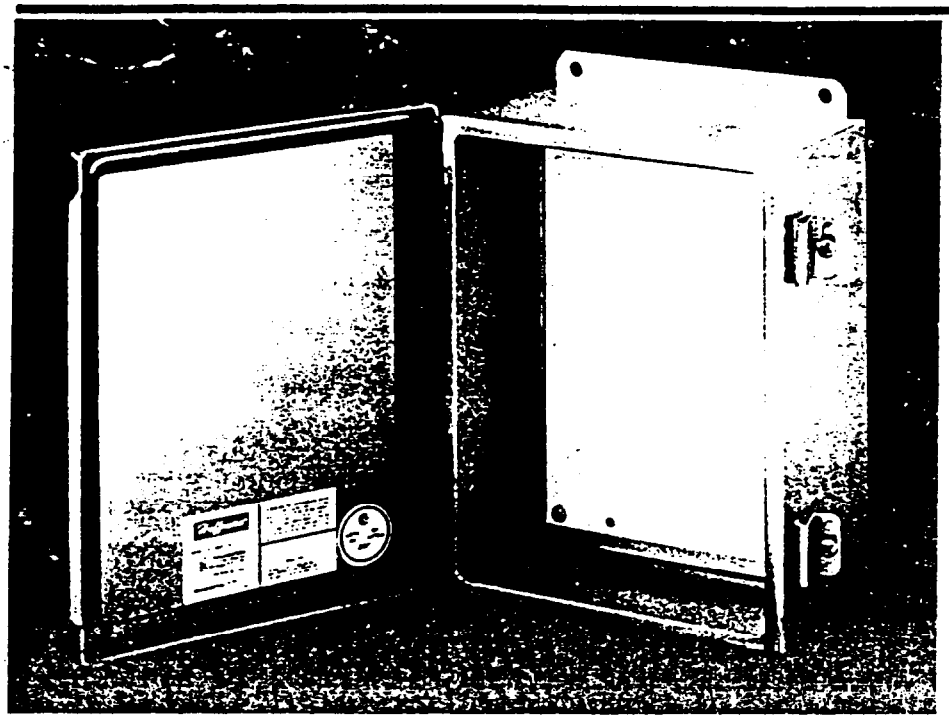
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

Local Control Panel and Electrical Detials

Hoffman

Stainless Steel Continuous Hinge Type 4X "CHNFSS" Junction Boxes



Application

Designed for use in areas which may be regularly hosed down or are otherwise very wet. Suitable for use outdoors, or in dairies, breweries, and similar installations. Also designed for use in areas where serious corrosion problems exist.

Construction

- 16 or 14 gauge Type 304 or Type 316L stainless steel
- Seams continuously welded and ground smooth, no holes or knockouts
- Seamless foam-in-place gasket assures watertight and dust-tight seal
- Stainless steel screws and clamps assure watertight seal
- Door removed by pulling stainless steel continuous hinge pin
- Weldnuts provided for mounting optional panels and terminal kits
- Specify side to be hinged when ordering custom boxes

Finish

Enclosures are unpainted. Cover and sides of body have smooth brushed finish. Optional stainless steel panels are unpainted. Optional steel panels are white.

Industry Standards

UL 50 Type 4 and Type 4X
NEMA/EEMAC Type 4, Type 4X, Type 12, and Type 13
JIC standard EGP-1-1967
CSA Type 4 and Type 4X
IEC 529, IP66

Price List Page 6.01

Accessories

See General Accessories index page 492.

Corrosion Inhibitors
Electrical Interlocks
Fast Operating Junction Box Clamp
Lock Kit
Panels (See table)
Swing-Out Panel Kit
Terminal Kit Assembly
Window Kit
Wiring Duct

Standard Sizes Continuous Hinge Type 4X "CHNFSS" Junction Boxes

Box Catalog Number Type 304	Box Catalog Number Type 316L	Gauge	Box Size A x B x C	* Stainless Steel Panel Catalog Number	* Steel Panel Catalog Number	Panel Size D x E	Mounting G x H	Overall L x W	F	J	N	T	V	Y
A-6044CHNFSS	◊ A-6044CHNFSS6	16	6.00x4.00x4.00 (152x102x102)	A-6P4SS	A-6P4	4.88x2.88 (124x73)	6.75x2.00 (171x51)	7.50x4.94 (191x125)	3.50 (89)	2.62 (67)	2.38 (60)	3.00 (76)	0.31 (8)	0.56 (14)
A-606CHNFSS	◊ A-606CHNFSS6	16	6.00x6.00x4.00 (152x152x102)	A-6P6SS	A-6P6	4.88x4.88 (124x124)	6.75x4.00 (171x102)	7.50x6.94 (191x176)	3.50 (89)	2.62 (67)	2.38 (60)	5.00 (127)	0.31 (8)	0.56 (14)
A-8064CHNFSS	◊ A-8064CHNFSS6	14	8.00x6.00x4.00 (203x152x102)	A-8P6SS	A-8P6	6.75x4.88 (171x124)	8.75x4.00 (222x102)	9.50x6.94 (241x176)	3.50 (89)	2.62 (67)	1.38 (35)	5.00 (127)	0.25 (6)	0.62 (16)
A-1008CHNFSS	◊ A-1008CHNFSS6	14	10.00x8.00x4.00 (254x203x102)	A-10P8SS	A-10P8	8.75x6.88 (222x175)	10.75x6.00 (273x152)	11.50x8.94 (292x227)	3.50 (89)	2.62 (67)	1.38 (35)	7.00 (178)	0.25 (6)	0.62 (16)
A-12106CHNFSS	◊ A-12106CHNFSS6	14	12.00x10.00x6.00 (305x254x152)	A-12P10SS	A-12P10	10.75x8.88 (273x225)	12.75x8.00 (324x203)	13.50x10.94 (343x278)	5.50 (140)	5.62 (143)	2.38 (60)	2.38 (60)	0.25 (6)	0.62 (16)
A-1212CHNFSS	◊ A-1212CHNFSS6	14	12.00x12.00x6.00 (305x305x152)	A-12P12SS	A-12P12	10.75x10.88 (273x276)	12.75x10.00 (324x254)	13.50x12.94 (343x329)	5.50 (140)	5.62 (143)	2.38 (60)	11.00 (279)	0.25 (6)	0.62 (16)
A-1412CHNFSS	◊ A-1412CHNFSS6	14	14.00x12.00x6.00 (356x305x152)	A-14P12SS	A-14P12	12.75x10.88 (324x276)	14.75x10.00 (375x254)	15.50x12.94 (394x329)	5.50 (140)	5.62 (143)	2.38 (60)	11.00 (279)	0.25 (6)	0.62 (16)
A-1614CHNFSS	◊ A-1614CHNFSS6	14	16.00x14.00x6.00 (406x356x152)	A-16P14SS	A-16P14	14.75x12.88 (375x327)	16.75x12.00 (425x305)	17.50x14.94 (445x379)	5.50 (140)	5.62 (143)	2.38 (60)	13.00 (330)	0.25 (6)	0.62 (16)

Millimeter dimensions ( ) are for reference only; do not convert metric dimensions to inch.
◊ Standard product available for shipment within 10 working days.
* Panels must be ordered separately. Optional aluminum panels are also available for most sizes. See Accessories.

eneral Purpose "Midget" Relays
A Contact Rating
2, 3, & 4 Form C Contact

Features

- Compact "Midget" size package saves space
- Large switching capacity, (10A)
- Choice of blade or PCB style terminals
- Relay options include indicator light, check button, and top mounting bracket
- DIN rail, surface, panel and PCB type sockets available for a wide range of mounting applications
- UL recognized and CSA certified

UL Recognized
Files No. E67770
E59804
E64245

CSA Certified
File No.LR35144

RH Series Part List

Termination	Contact Configuration	Basic Part No.	Basic Part No. w/ Indicator Light	Check Button	Indicator Light & Check Button	Top Bracket
B (Blade)	SPDT	RH1B-U				RH1B-UT
	DPDT	RH2B-U	RH2B-UL	RH2B-UC	RH2B-ULC	RH2B-UT
	3PDT	RH3B-U	RH3B-UL	RH3B-UC	RH3B-ULC	RH3B-UT
	4PDT	RH4B-U	RH4B-UL	RH4B-UC	RH4B-ULC	RH4B-UT
V2 (0.078" (mm) wide)	SPDT	RH1V2-U				
	DPDT	RH2V2-U	RH2V2-UL	RH2V2-UC	RH2V2-ULC	
	3PDT	RH3V2-U	RH3V2-UL	RH3V2-UC	RH3V2-ULC	
	4PDT	RH4V2-U	RH4V2-UL	RH4V2-UC	RH4V2-ULC	

Ratings

ed oltage	Rated Current ±15% @20°C; 60Hz				Rated Current ±15% @20°C; 50Hz				Coil Resistance ±15% @ 20°C			
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT
6V	150mA	200mA	280mA	330mA	170mA	238mA	330mA	387mA	18.8Ω	9.4Ω	6.0Ω	5.4Ω
12V	75mA	100mA	140mA	165mA	86mA	118mA	165mA	196mA	76.8Ω	39.3Ω	25.3Ω	21.2Ω
24V	37mA	50mA	70mA	83mA	42mA	59.7mA	81mA	98mA	300Ω	153Ω	103Ω	84.5Ω
120V	7.5mA	11mA	14.2mA	16.5mA	8.6mA	12.9mA	16.4mA	19.5mA	7680Ω	4170Ω	2770Ω	2220Ω
240V		5.5mA	7.1mA	8.3mA		6.5mA	8.2mA	9.8mA		15210Ω	12100Ω	9120Ω
	SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT
V	128mA		150mA		240mA		250mA		47Ω	40Ω	25Ω	24Ω
2V	64mA		75mA		120mA		125mA		188Ω	160Ω	100Ω	96Ω
4V	32mA		36.9mA		60mA		62mA		750Ω	650Ω	400Ω	388Ω
0V	18mA		18.5mA		30mA		31mA		2660Ω	2600Ω	1600Ω	1550Ω
0V			9.1mA		12.8mA		15mA			12100Ω	8600Ω	7340Ω

ional Characteristics

m continuous applied voltage (AC/DC) @ 20°C	110% of rated voltage
operating voltage (AC/DC) @ 20°C	80% of rated voltage
voltage (AC)	30% or more of the rated voltage
voltage (DC)	10% or more of the rated voltage

*Note: Rated voltage marked with asterisk are not available in SPDT.

Note: See page D2-14 for dimensions.

Ratings

	UL Ratings	
oad	SPDT, DPDT	3PDT
AC	1/6HP	1/6 HP
AC	1/3 HP	1/3 HP

ntact ratings continued on following page.

Ordering Information

Ordering standard voltages results in quickest delivery. Allow extra delivery time for non-standard voltages.

Basic Part No. — Coil Voltage:
RH2B-U — AC120V

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING

SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

Vapor Phase Carbon System

CALGON

SERVICE BULLETIN

VAPOR PAC

Calgon Carbon's Vapor Pac Service meets industrial needs for cost-effective removal of volatile organic compounds (VOCs) at air emission sources.

The Vapor Pac Service features a small, easily transportable adsorber which contains 1,800 pounds of activated carbon. The adsorber can handle air flows up to 1,000 cfm.

Designed to remove both toxic and non-toxic VOCs, the adsorption system is especially useful for short-term projects and for treatment of low volume flows that contain low to moderate VOC concentrations. Common applications include VOC removal from process vents, soil remediation vents, and air stripper off-gases.

To accommodate a wide variety of process conditions, Vapor Pac adsorbers are available in two basic designs: a polyethylene model that offers excellent corrosion-resistance, and a stainless steel model than can withstand higher temperatures, and slight pressure or vacuum conditions.

Calgon Carbon provides the adsorber, carbon, spent carbon handling and carbon reactivation (after the carbon meets the company's acceptance criteria) as part of the Vapor Pac Service. Ductwork and fans are the only equipment requiring a capital expenditure by the user.

When carbon becomes saturated with VOCs, the system is replaced with another adsorber containing fresh carbon.

By utilizing this unique service, users can generally achieve VOC removal and regulatory compliance objectives, minimize operating costs, and eliminate maintenance costs* (as the equipment is owned and maintained by Calgon Carbon). Furthermore, because organic compounds are safely destroyed through the carbon reactivation process, costs and regulations typically associated with waste disposal can be eliminated.

Please contact a Calgon Carbon Technical Sales Representative to learn more about the advantages of the Vapor Pac Service for your specific VOC control needs.

**Damage to Vapor Pac Unit caused by negligence or misapplication is the responsibility of the user.*

FEATURES AND BENEFITS OF VAPOR PAC SERVICE

- Adsorbers are specifically designed for ease of installation and operation.
- Adsorbers are available in plastic (polyethylene) and metal (stainless steel) construction to accommodate a wide variety of applications.
- System can be operated in series or parallel mode or a combination of both modes to handle a variety of flows and concentrations.
- System exchange eliminates on-site carbon handling.
- Recycling of spent carbon eliminates disposal problems.
- Capital expenditure is eliminated since Calgon Carbon Corporation owns and maintains equipment.

VAPOR PAC (PLASTIC) SPECIFICATIONS

Vessel dimensions:	44¼" x 44¼" x 89⅜"
Inlet & discharge connections:	6" PS 15-69 duct flanges
Carbon volume:	60 cu. ft. (1800 lbs)
System shipping weight:	New - 2200 lbs Spent - 4000 lbs
Temperature rating:	150°F max
Static pressure rating above carbon level:	20" W.C. max
Vacuum pressure rating above carbon level:	2" W.C. max

All units shipped F.O.B., Pittsburgh, Pennsylvania

MATERIALS OF CONSTRUCTION

Vessel:	Polyethylene
Frame:	Carbon steel coated with Sherwin Williams Tile Clad II
Inlet flanges, elbow, septum:	PVC
Discharge flange:	Polyethylene
Fasteners & bottom valve support plate:	Steel, plated
Sample fittings & sample canister:	PVC

VAPOR PAC (STAINLESS STEEL) SPECIFICATIONS

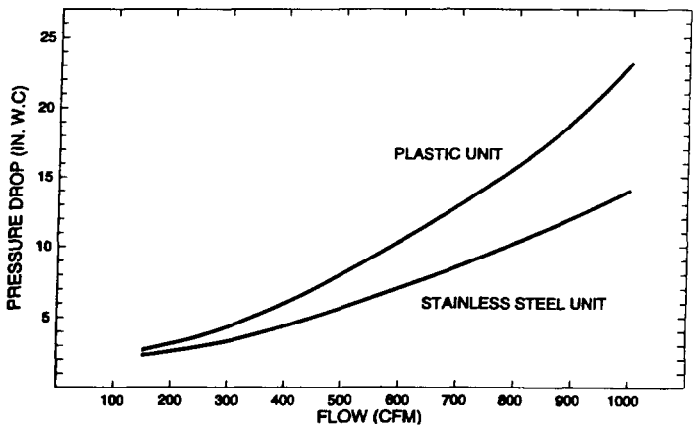
Vessel dimensions, diameter:	5'
height:	7'3"
Inlet & discharge connections:	8" PS 15-69 duct flanges
Carbon volume:	60 cu. ft. approx. (1800 lbs)
System shipping weight:	New - 2840 lbs Spent - 4640 lbs
Static pressure rating above carbon level:	15 psig
Vacuum pressure rating above carbon level:	Full

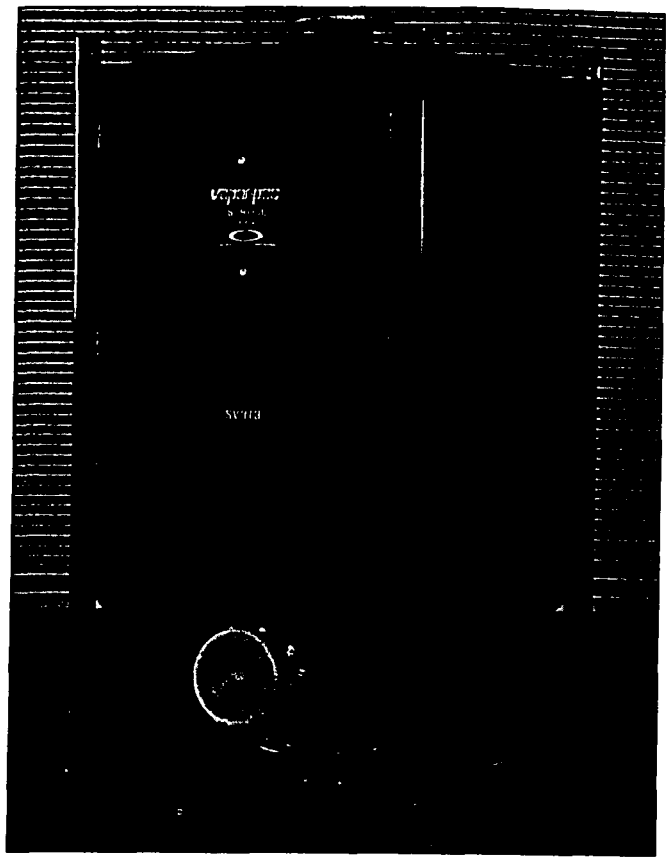
All units shipped F.O.B., Pittsburgh, Pennsylvania

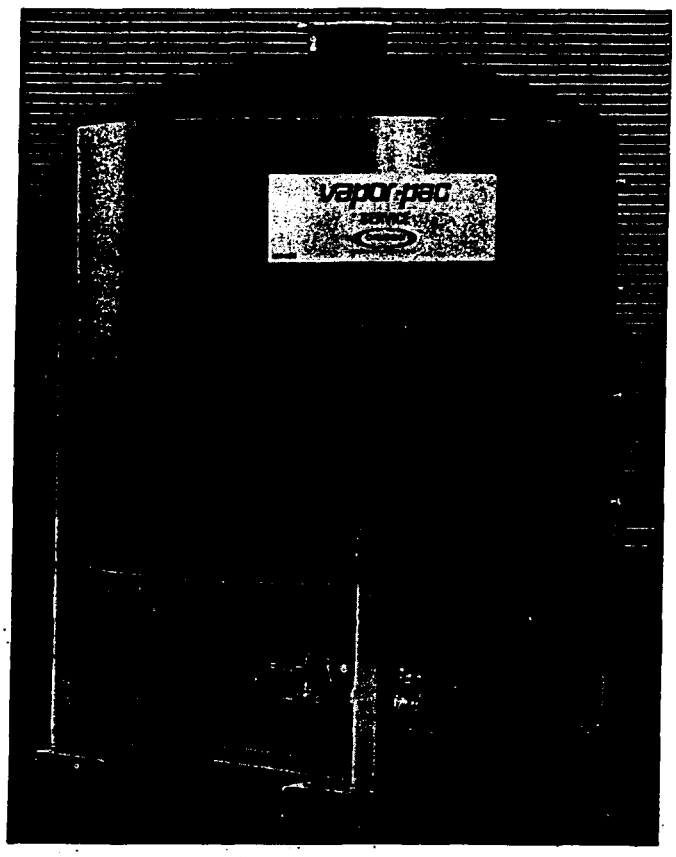
MATERIALS OF CONSTRUCTION

Vessel ..... 316L stainless steel
Skid and support frame: ..... 304 stainless steel
Inlet flanges, elbow, septum: ..... 316L stainless steel
Discharge flange: ..... 316L stainless steel
Fasteners & bottom valve
support plate: ..... Steel, plated
Sample fittings &
sample canister: ..... 316L stainless steel

VAPOR-PAC UNIT PRESSURE DROP
UPFLOW WITH 1800LBS., 4x10 MESH CARBON DENSE PACKED







CAUTION

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing activated carbon, appropriate sampling and work procedures should be followed, including all applicable federal and state requirements.

For information regarding human and environmental exposure, call Calgon Carbon's Regulatory and Trade Affairs personnel at (412) 787-6700.

INSTALLATION INSTRUCTIONS

See Bulletin #27-199 for details on how to install a Vapor-Pac.

SAFETY CONSIDERATIONS

See Safety Bulletin #27-198 for important safety considerations.

OPTIONAL EQUIPMENT

Inlet and outlet flange connectors for ANSI hose connections.

For additional information, contact
Calgon Carbon Corporation,
Box 717, Pittsburgh, PA 15230-0717
Phone (412) 787-6700

CALGON

CALGON CARBON CORPORATION

CALGON

CALGON CARBON CORPORATION

VAPOR-PAC 10 SERVICE FOR VOC CONTROL

The increasing emphasis on cleaner air presents industry with new challenges to control and reduce toxic volatile organic compounds (VOCs) at air emission sources.

To help plant managers comply with current and future VOC regulations, Calgon Carbon has available the Vapor-Pac 10 Service which utilizes adsorption on granular activated carbon to remove VOCs from air emissions and other vapors. The service also minimizes capital expenditures and eliminates on-site spent carbon transfer and regeneration.

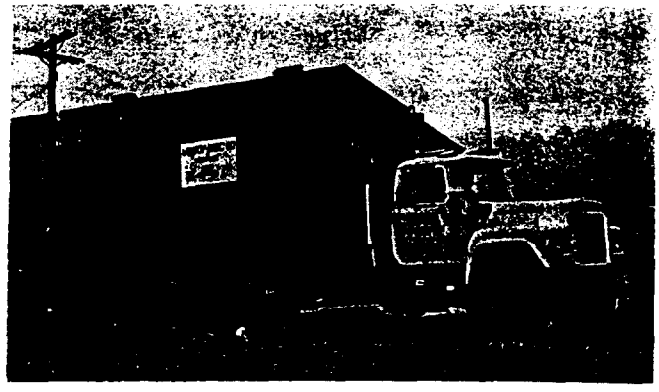
The Vapor-Pac 10 Service uses a transportable adsorber which contains approximately 12,500 pounds of granular activated carbon and can treat air flows up to 10,000 scfm. When the activated carbon has fully utilized its capacity to remove the VOCs, the onstream adsorber is replaced with one containing fresh carbon. The use of the Vapor-Pac 10 Service minimizes capital expenditure, as the only site facilities normally required would be ductwork and a fan. Calgon Carbon provides the entire service for the adsorption process which includes spent carbon removal, transport and reactivation. The use of the service is dependent upon the spent carbon material being acceptable by Calgon Carbon's reactivation facility. The Vapor-Pac 10 adsorbers are owned by Calgon Carbon, who will maintain the units in operable condition.

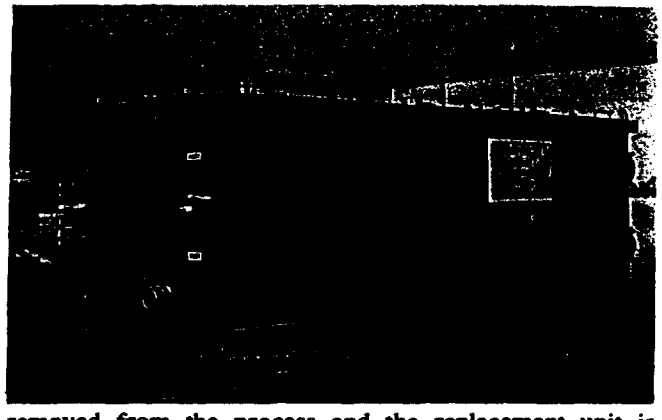
Vapor-Pac 10 units are ideally suited to remove low concentrations of VOCs from industrial plant emissions and soil remediation vents, as well as VOCs from air stripper off-gases.

In order to handle a wide range of flows and VOC concentrations efficiently, the Vapor-Pac 10 unit as an option can contain two separate adsorber beds. Each bed would contain approximately 6,500 pounds of activated carbon. Depending on the flow and VOC concentration, the beds can be used one at a time or both beds can be operated in parallel and used simultaneously. A three-foot deep carbon bed in each section is provided for effective removal of VOCs, even during periods of peak concentrations.

To determine carbon life in the Vapor-Pac 10, Calgon Carbon recommends monitoring the performance via the sample ports which are provided. Frequency of unit exchange will depend on the types and concentrations of VOCs being treated. Exchange should be scheduled before carbon breakthrough occurs. If the beds are used sequentially, the timing of the breakthrough from the second bed can be estimated by comparing it with the breakthrough time for the first bed (assuming that they operate under similar conditions).

When an exchange is required, Calgon Carbon delivers a replacement unit from Pittsburgh, Pa. Upon delivery of the replacement, the unit containing the spent carbon is removed from the process and the replacement unit is placed on-line to continue treatment. The unit removed from the process is returned to our reactivation facility, where it is emptied, inspected, refilled, and stored in preparation for the next exchange.





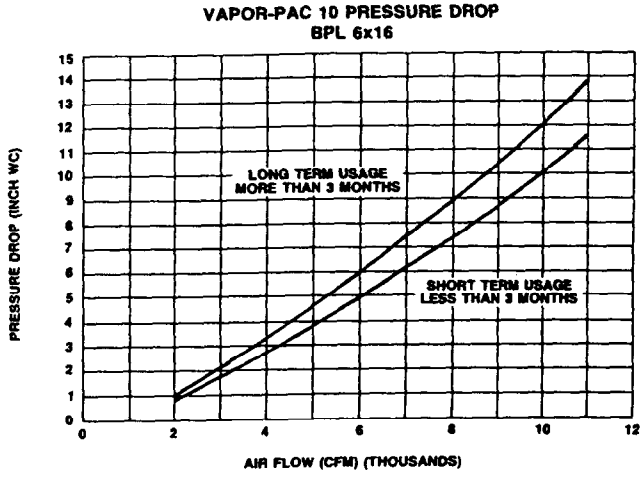
Your Calgon Carbon Technical Sales Representative can help in the evaluation of the suitability of the Vapor-Pac 10 Service to satisfy your air treatment requirements. If required, evaluation studies to determine applicability and economics can be arranged. Calgon Carbon offers other adsorption equipment, including permanent installations, smaller service equipment, and unique systems incorporating on-site regeneration to meet particular needs.

BENEFITS

- Removes toxic VOCs
- Eliminates on-site carbon handling
- Minimizes spent carbon disposal concerns
- No major capital investment required
- Supply of virgin activated carbon
- No on-site equipment required for loading or offloading

SPECIFICATIONS

Vessel Dimensions.....22′-4″ x 8′-0″ x 8′-4″
Inlet Duct Connections.....20″ ID (two on each end)
Outlet Duct Connections.....20″ ID (four on top)
Carbon Volume.....425 ft³
Carbon Weight (Approximate).....12,500 lbs (Coal)
12,000 lbs (Coconut)
Shipping Weight.....Fresh — 27,500 lbs (max)
Spent — 35,000 lbs (max)
Temperature Rating.....150° F max
Static Pressure Rating.....0.5 psig
Vacuum Pressure Rating.....None



MATERIALS OF CONSTRUCTION

Vessel.....Epoxy Carbon Steel
Internals.....Epoxy Carbon Steel
Internal Screen.....Polypropylene
Carbon Acceptance Canister
and Associated Fittings.....PVC

CAUTION

Wet activated carbon preferentially removes oxygen from the air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed, including all applicable federal and state requirements.

For additional information regarding human and environmental exposure, please call Calgon Carbon's Regulatory & Trade Affairs department at (412) 787-6700.

For additional information, contact Calgon Carbon Corporation, Box 717, Pittsburgh, PA 15230-0717 Phone (412) 787-6700

CALGON

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING

SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

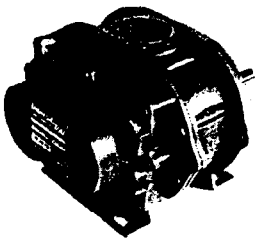
BETHPAGE, NY

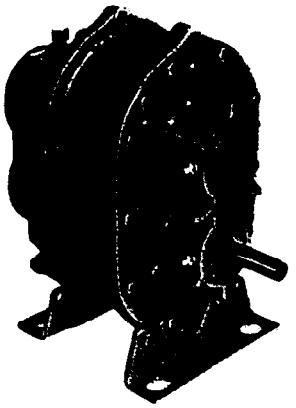
Soil Vapor Extraction Blower B-01

SPECIFICATIONS

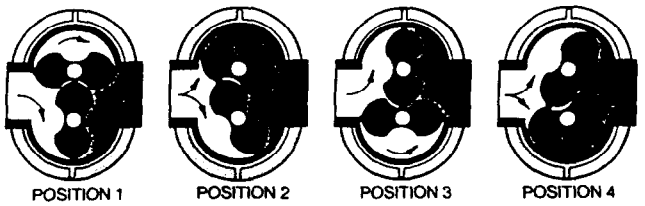
Roots Universal RAI® ROTARY POSITIVE BLOWERS

FRAMES 22 THRU 718





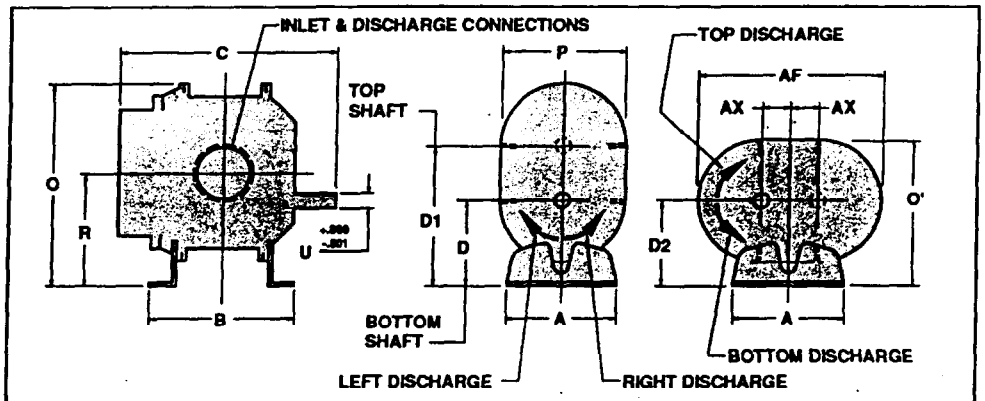
OPERATING PRINCIPLE



Two figure-eight lobe impellers mounted on parallel shafts rotate in opposite directions. As each impeller passes the blower inlet, it traps a definite volume of air and carries it around the case to the blower outlet, where the air is discharged. With constant speed operation, the displaced volume is essentially the same regardless of pressure, temperature or barometric pressure.

Timing gears control the relative position of the impellers to each other and maintain small but definite clearances. This allows operation without lubrication being required inside the blower casing.

OUTLINE DRAWING & DIMENSIONAL TABLE



Frame Size	A	B	C	Drive shaft location D Bottom Shaft	D1 Right Hand Shaft	D2 Left Hand Shaft	O	O'	P	R	U	Keyway	Inlet & Discharge Dia.	AF	AX	Approx. Net Wt. (Lbs.)
22	5.13	5.00	9.75	3.75	6.25	3.75	9.63	6.88	6.25	5.00	.625	.188 x .094	1.0 NPT	9.25	1.25	32
24	5.13	7.00	11.75	3.75	6.25	3.75	9.63	6.88	6.25	5.00	.625	.188 x .094	2.0 NPT	9.25	1.25	43
32	7.25	6.75	11.25	5.00	8.50	5.00	12.81	8.88	7.75	6.75	.750	.188 x .094	1.25 NPT	12.13	1.75	69
33	7.25	7.63	12.13	5.00	8.50	5.00	12.81	8.88	7.75	6.75	.750	.188 x .094	2.0 NPT	12.13	1.75	74
36	7.25	10.00	14.63	5.00	8.50	5.00	12.81	8.88	7.75	6.75	.750	.188 x .094	2.5 NPT	12.13	1.75	102
42	8.00	7.25	13.00	6.25	10.25	6.25	15.06	10.63	8.75	8.25	.875	.188 x .094	1.5 NPT	13.63	2.00	88
45	8.00	10.00	15.50	6.25	10.25	6.25	15.06	10.63	8.75	8.25	.875	.188 x .094	2.5 NPT	13.63	2.00	109
47	8.00	11.75	17.63	6.25	10.25	6.25	15.06	10.50	8.50	8.25	.875	.188 x .094	3.0 NPT	13.63	2.00	128
53	10.50	8.38	15.38	6.25	11.25	6.75	17.38	11.88	10.25	8.75	1.125	.250 x .125	2.5 NPT	17.25	2.50	143
56	10.50	11.00	18.00	6.25	11.25	6.75	17.38	12.25	11.00	8.75	1.125	.250 x .125	4.0 NPT	17.25	2.50	170
59	10.50	14.00	21.18	6.25	11.25	6.75	17.38	12.25	11.00	8.75	1.125	.250 x .125	4.0 NPT	17.25	2.50	204
65	11.00*	10.00	18.38	8.75	14.75	8.75	21.63	15.13	12.75	11.75	1.375	.312 x .156	3.0 NPT	19.75	3.00	245
68	11.00*	13.00	21.38	8.75	14.75	8.75	21.63	15.13	12.75	11.75	1.375	.312 x .156	5.0 NPT	19.75	3.00	285
615	11.00*	20.00	28.38	8.75	14.75	8.75	21.63	16.25	15.00	11.75	1.375	.312 x .156	6.0 FLG	19.75	3.00	425
76	14.00**	11.75	19.94	11.00	18.00	11.00	26.13	20.69	19.38	14.50	1.562	.375 x .188	4.0 NPT	23.25	3.50	400
711	14.00**	16.75	25.19	11.00	18.00	11.00	26.13	19.50	17.00	14.50	1.562	.375 x .188	6.0 FLG	23.25	3.50	530
718	14.00**	23.75	32.19	11.00	18.00	11.00	26.13	19.50	17.00	14.50	1.562	.375 x .188	8.0 FLG	23.25	3.50	650

* 17.00 in horizontal configuration
** 21.00 in horizontal configuration

All dimensions in inches

BASIC BLOWER DESCRIPTION

Universal RAI blowers are heavy duty rotary blowers designed with detachable rugged steel mounting feet, which permit easy in-field adaptability to either vertical or horizontal installation requirements. The Universal RAI blowers can even be hung from overhead supports.

Because of the detachable mounting feet, these units can be easily adapted to any of four drive shaft positions – right hand, left hand, bottom or top. The compact, sturdy design is engineered for continuous service when operated in accordance with speed and pressure ratings.

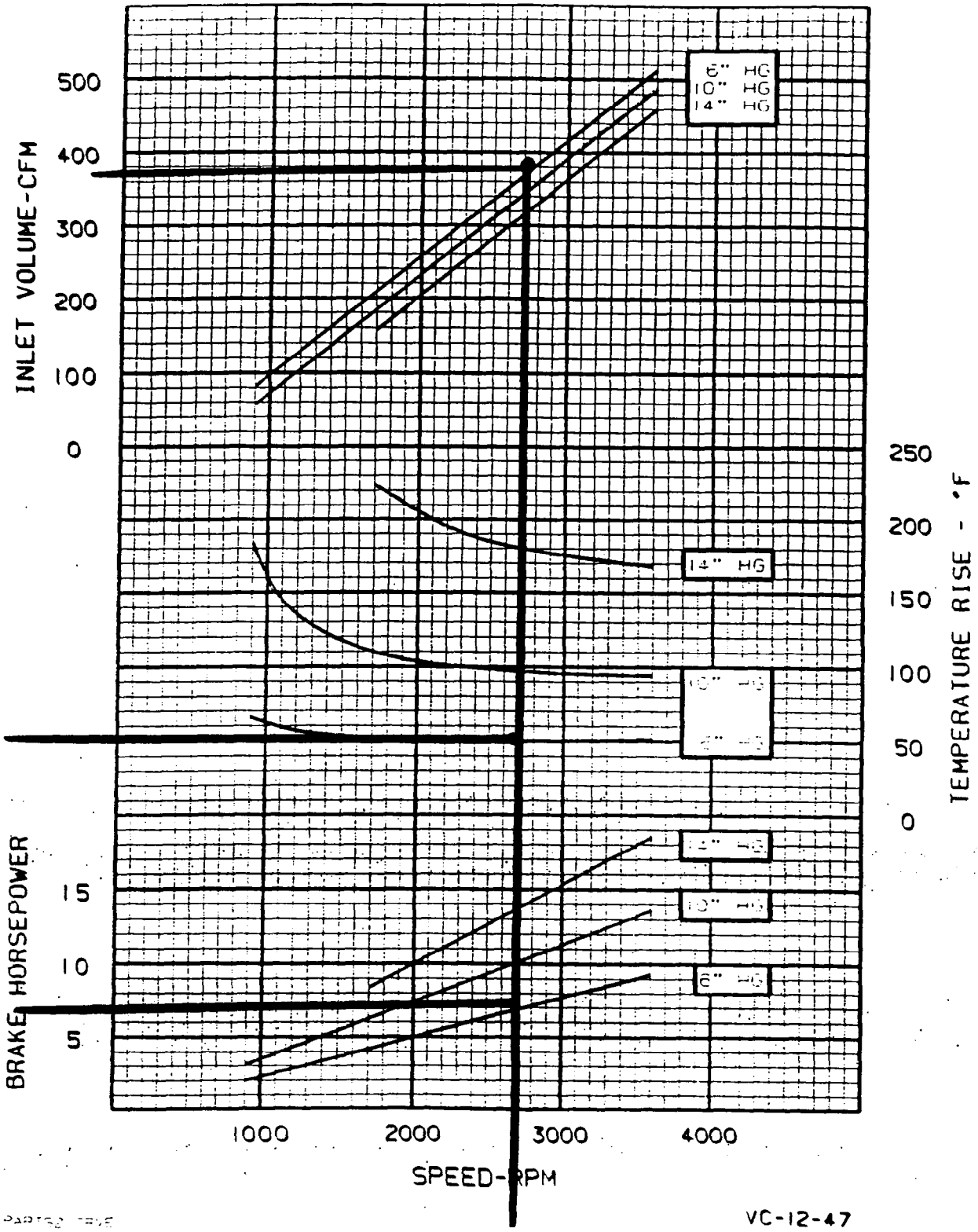
The basic model consists of a cast iron casing, carburized and ground alloy steel spur timing gears secured to steel shafts with a taper mounting and locknut, and cast iron involute impellers. Oversized anti-friction bearings are used, with a cylindrical roller bearing at the drive shaft to withstand V-belt pull. The Universal RAI features thrust control, with splash oil lube on the gear end and grease lube on the drive end. After standard tests, the unit is sprayed with a protective paint and boxed or placed on skids.

Available accessories include driver, relief valve, inlet and discharge silencer, inlet filter, check valve, extended base, V-belt or flexible coupling and drive guards.

EVERY GROWING PLANT NEEDS ROOTS

ROOTS DIVISION

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

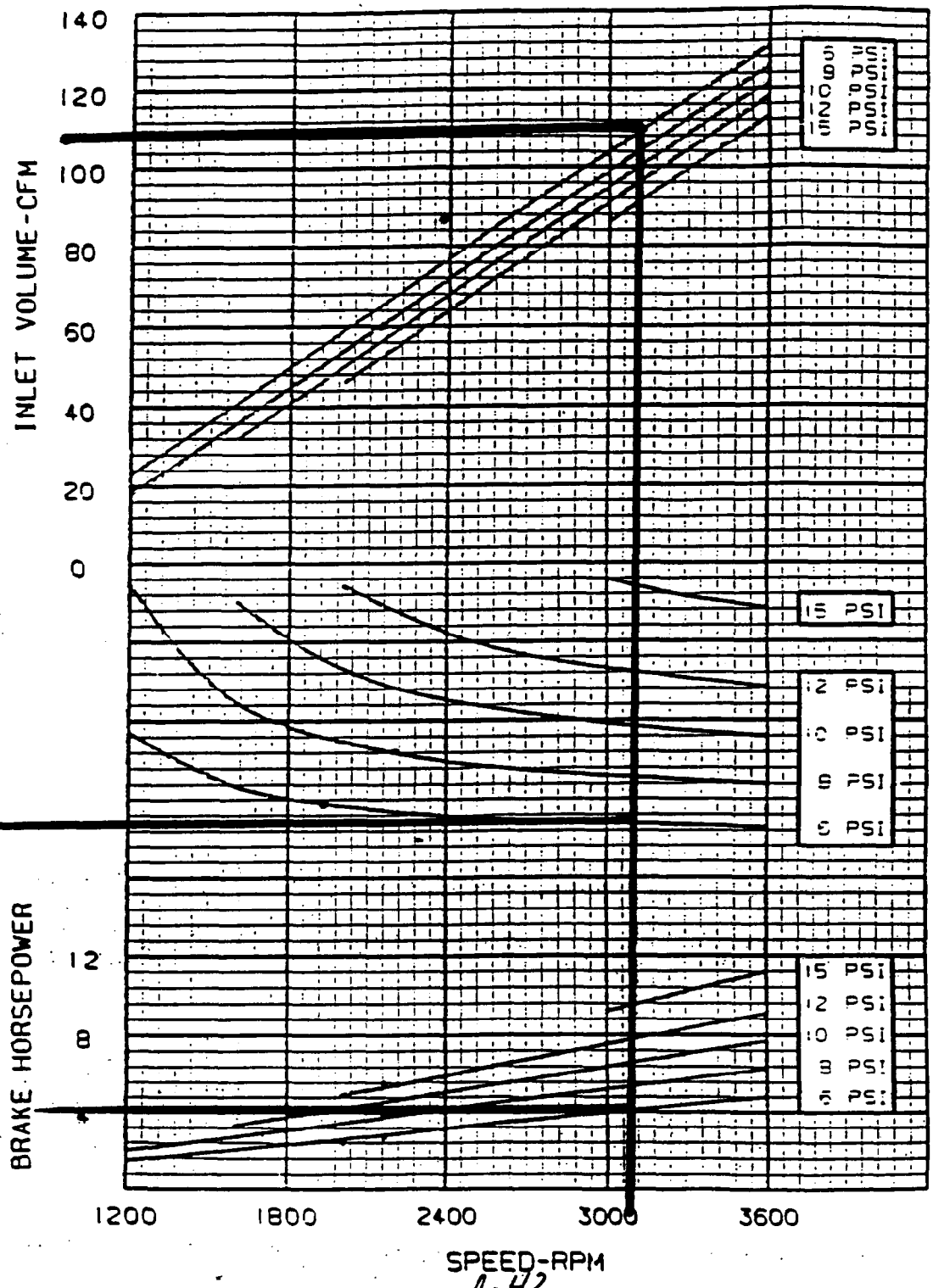


VC-12-47

POOTS DIVISION

B-02

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



A-43

DRESSER/ROOTS

Roots Blower Selection 2.9-97e Monday November 17, 1997 9:31 am

Selected Unit

Model:	47 URAI		Summary:	<list>
Inlet Volume (ACFM):	441	SCFM: 350	Gas:	AIR
Inlet Pressure (PSIA):	12.74		K-Value:	1.395
Inlet Temp(Deg.F):	95		Specific Gravity:	0.990
Discharge Pressure (PSIA):	14.70		Molecular Weight:	28.685
Inlet Vacuum (HG):	4.00	26%	Elevation/Feet:	0
Ambient Pressure (PSIA):	14.70		Relative Humidity:	40%
Speed (RPM):	3072	85%	Amb/Jet Temperature:	95
Brake Horsepower:	5.6		Motor Type:	TEFC
Temperature Rise (Deg. F):	33	14%		

Discharge Temperature (Deg. F):	128
Discharge Volume (ACFM):	404
Gear Tip Speed (FPM):	3219
Estimated B10 Bearing Life (HRS):	7932000
Estimated Noise Level at 1 Meter (DBA):	82.4

<Esc> Print Proposal, <F7> Cancel, <F10> Next, <F8> Previous

Roots Blower Selection 2.9-97e Monday November 17, 1997 9:32 am

Selected Unit

Model:	45 URAI		Summary:	<list>
Inlet Volume (ACFM):	350	SCFM: 278	Gas:	AIR
Inlet Pressure (PSIA):	12.74		K-Value:	1.395
Inlet Temp(Deg.F):	95		Specific Gravity:	0.990
Discharge Pressure (PSIA):	14.70		Molecular Weight:	28.685
Inlet Vacuum (HG):	4.00	26%	Elevation/Feet:	0
Ambient Pressure (PSIA):	14.70		Relative Humidity:	40%
Speed (RPM):	3215	89%	Amb/Jet Temperature:	95
Brake Horsepower:	4.5		Motor Type:	TEFC
Temperature Rise (Deg. F):	33	14%		

Discharge Temperature (Deg. F):	128
Discharge Volume (ACFM):	321
Gear Tip Speed (FPM):	3370
Estimated B10 Bearing Life (HRS):	9999999
Estimated Noise Level at 1 Meter (DBA):	83.0

SUGGESTED SPECIFICATIONS UNIVERSAL RAI BLOWERS

General

The contractor shall furnish and install, in the manner shown on the contract plans, _____ Universal RAI frame size _____ rotary positive displacement air blower(s) as manufactured by Roots Division of Dresser Industries, Inc. Each blower shall be designed for the following conditions:

Inlet volume _____ ACFM (at blower inlet connection)
Inlet temperature _____ °F
Relative humidity _____ %
Barometer _____ psia
Inlet pressure _____ psia (at blower inlet connection)
Discharge pressure _____ psia (at blower discharge connection)
Minimum rated pressure rise _____ psi
Maximum blower speed _____ RPM
Maximum BHP at blower shaft _____
Minimum motor HP _____

The blower performance shall be guaranteed with an allowable tolerance of plus or minus four (4) percent at the above design conditions.

Blowers

The air blowers shall be of the rotary positive displacement type, and shall be constructed with inlet and discharge connections oriented as shown on the contract drawings. Each blower shall be equipped with steel mounting feet.

Casing: The blower casing shall be one-piece, with separate headplates, and shall be made of close-grained cast iron.

Impellers: Each impeller shall be made from high-strength cast iron. The impellers shall be of the straight, two-lobe involute type, and shall operate without rubbing or liquid seals or lubrication. The impellers shall be dynamically balanced by removing metal from the impeller body, and shall be center-timed to permit rotation in either direction.

Shafts: The blower shafts shall be alloy steel, and shall be pressed into the impeller body and pinned.

Impeller/shaft assemblies: Each impeller and shaft assembly shall be supported by oversized anti-friction bearings engineered for long-service life and fixed to control the axial location of the impeller/shaft in the unit. A cylindrical roller bearing shall be provided at the drive shaft designed to handle the stresses of V-belt drive, while single-row ball bearings shall be used at all other locations.

Timing gears: The impellers shall be timed by a pair of carburized and ground steel spur gears, mounted on the shafts with a tapered fit, and secured by a locknut.

Lubrication: Each bearing shall be provided with a positive lip-type oil seal designed to prevent lubricants from entering the air stream. Further provision shall be made to vent the impeller side of the oil seal to atmosphere to eliminate any possible carry-over of lubricant into the air stream.

The drive end bearings shall be grease lubricated, and shall be provided with grease fittings. The timing gears and the gear end bearings shall be lubricated by splash from the gears dipping into the oil.

Drive system

A V-belt or coupling drive may be used, depending upon application and user preference. An appropriate service factor shall be applied. A suitable guard meeting OSHA specifications shall be supplied.

Drive motor

The motor shall be sized for appropriate horsepower, RPM and other appropriate electrical characteristics as determined for the application.

Accessories

Refer to *Suggested Piping Arrangement*, Figure 4.G-3 for recommended accessories.

Tests

See *Testing and Performance Guarantees*, Section 4.F.

PERFORMANCE TABLE

FRAME SIZE	SPEED RPM	1 PSI CFM	1 PSI BHP	2 PSI CFM	2 PSI BHP	3 PSI CFM	3 PSI BHP	4 PSI CFM	4 PSI BHP	5 PSI CFM	5 PSI BHP	6 PSI CFM	6 PSI BHP	7 PSI CFM	7 PSI BHP	10 PSI CFM	10 PSI BHP	11 PSI CFM	11 PSI BHP	12 PSI CFM	12 PSI BHP	15 PSI CFM	15 PSI BHP	MAX. VACUUM "Hg	MAX. VACUUM CFM	MAX. VACUUM BHP
	1160	10	0.2	7	0.3	4	0.3	2	0.4															4	6	0.3
22	3600	49	0.6	46	0.8	43	1.1	41	1.3	39	1.6	38	1.8	36	2.1	32	2.8	31	3.1	29	3.3			14	28	2.0
	5275	76	0.8	73	1.2	70	1.6	68	1.9	66	2.3	64	2.7	63	3.1	59	4.2	57	4.5	56	4.9			15	53	3
	1160	24	0.3	19	0.4	15	0.6	11	0.8	8	0.9													6	12	1
24	3600	102	0.8	97	1.3	93	1.8	89	2.3	86	2.8	83	3.3	81	3.8									14	69	3.8
	5275	156	1.2	150	1.9	146	2.7	143	3.4	140	4.2	137	4.9	135	5.6									15	119	5.8
	1160	40	0.4	34	0.6	30	0.9	27	1.1	24	1.3	21	1.6	19	1.8									10	18	1.3
32	2800	113	1.0	108	1.6	104	2.1	101	2.7	98	3.2	95	3.8	93	4.3	86	6.0	84	6.5	82	7.1	77	8.7	15	78	4.5
	3600	149	1.3	144	2.0	140	2.7	137	3.4	134	4.1	131	4.8	129	5.5	122	7.7	120	8.4	118	9.1	113	11.2	15	114	5.8
	1160	55	0.5	48	0.8	43	1.1	39	1.4	35	1.7	31	2.1	28	2.4									10	27	1.7
33	2800	156	1.2	149	2.0	144	2.7	140	3.5	136	4.2	132	5.0	129	5.7	120	8.0	118	8.7	116	9.5			14	113	5.6
	3600	205	1.6	199	2.5	193	3.5	189	4.5	185	5.4	181	6.4	178	7.4	170	10.3	167	11.2	165	12.2			15	159	7.6
	1160	95	0.7	85	1.2	78	1.7	72	2.3	66	2.8	61	3.3	57	3.8									10	55	2.7
36	2800	262	1.7	253	3.0	245	4.2	239	5.4	234	6.7	229	7.9	224	9.2									12	213	7.8
	3600	344	2.2	334	3.8	327	5.4	321	7.0	315	8.6	310	10.2	306	11.8									15	278	12.3
	860	38	0.4	32	0.6	28	0.9	24	1.1	21	1.3	18	1.5	15	1.8									8	19	1.1
42	1760	92	0.8	87	1.3	82	1.8	78	2.2	75	2.7	72	3.1	69	3.6	62	5.0	60	5.5	58	5.9			14	56	3.5
	3600	204	1.7	198	2.6	194	3.6	190	4.5	186	5.5	183	6.4	181	7.4	173	10.2	171	11.2	169	12.1	163	15.0	15	164	7.6
	860	79	0.6	68	1.1	60	1.5	53	2.0	48	2.4	42	2.9	37	3.4									8	46	1.9
45	1760	188	1.3	177	2.2	169	3.1	162	4.1	156	5.0	151	5.9	146	6.9	133	9.6							12	134	5.8
	3600	410	2.6	400	4.5	392	6.4	385	8.3	379	10.2	374	12.1	369	14.0	356	19.7							15	339	14.6
	860	109	0.8	97	1.4	89	2.0	81	2.6	74	3.2	68	3.8	63	4.4									8	72	2.5
47	1760	253	1.6	241	2.8	232	4.0	225	5.3	218	6.5	212	7.7	206	8.9									12	193	7.5
	3600	546	3.2	535	5.7	526	8.2	518	10.7	511	13.2	505	15.8	500	18.3									15	467	19.0
	700	72	0.6	63	1.0	56	1.4	51	1.8	46	2.2	42	2.6	38	3.0									10	36	2.2
53	1760	211	1.5	203	2.6	196	3.6	191	4.6	186	5.6	181	6.6	177	7.6	167	10.7	163	11.7	160	12.7			14	158	7.5
	2850	355	2.5	346	4.1	340	5.8	334	7.4	329	9.1	325	10.7	321	12.3	310	17.2	307	18.9	304	20.5	295	25.4	15	296	12.8
	700	123	0.9	110	1.6	100	2.2	92	2.9	85	3.6	78	4.3	72	4.9									10	70	3.5
56	1760	358	2.2	345	3.9	335	5.6	326	7.3	319	9.0	312	10.7	306	12.4	290	17.5							14	276	12.1
	2850	598	3.6	585	6.4	575	9.1	567	11.9	560	14.6	553	17.3	547	20.1	531	28.3							15	510	21.0
	700	187	1.2	170	2.2	158	3.2	147	4.2	138	5.1	130	6.1											8	135	4.1
59	1760	529	3.0	513	5.5	500	8.0	490	10.5	480	12.9	472	15.4	464	17.9									12	445	15.1
	2850	881	4.9	865	8.9	852	12.9	842	16.9	832	20.9	824	25.0	816	29.0									15	770	30.3
	700	140	1.0	126	1.8	116	2.6	107	3.3	100	4.1	93	4.8	86	5.5	70	7.8							12	71	4.7
65	1760	400	2.6	387	4.5	377	6.4	368	8.3	360	10.2	353	12.1	347	13.9	330	19.6	325	21.5	320	23.4	307	29.1	16	300	1
	2350	546	3.5	532	6.0	522	8.5	513	11.1	506	13.6	499	16.1	492	18.6	475	26.2	470	28.7	466	31.2	452	38.8	16	445	2
	700	224	1.5	203	2.7	187	3.9	172	5.1	160	6.3	149	7.5	139	8.7									10	135	6.2
68	1760	643	3.8	621	6.8	605	9.8	591	12.9	579	15.9	567	18.9	557	22.0	530	31.0	522	34.1	515	37.1			15	495	23.0
	2350	876	5.0	855	9.1	838	13.1	824	17.2	812	21.2	801	25.3	790	29.3	763	41.5	755	45.5	748	49.6			16	715	32.6
	700	420	2.6	380	4.8	351	7.1	323	9.3	301	11.6	279	13.8											8	292	9.1
615	1760	1205	6.4	1164	12.1	1133	17.8	1107	23.5	1084	29.1	1063	34.8											12	997	34.1
	2350	1641	8.6	1601	16.1	1570	23.7	1544	31.3	1521	38.9	1500	46.5											12	1433	45.5
	575	195	1.3	179	2.3	168	3.3	158	4.3	150	5.4	142	6.4	134	7.4	115	10.4							12	117	6.2
76	1400	526	3.2	511	5.7	500	8.1	490	10.6	481	13.0	473	15.5	466	17.9	447	25.3	441	27.8	436	30.2	421	37.6	16	413	20.0
	2050	788	4.7	772	8.3	761	11.9	751	15.5	742	19.1	734	22.7	727	26.3	708	37.1	703	40.7	697	44.2	682	55.0	16	674	29.2
	575	362	2.2	336	4.0	316	5.9	299	7.7	284	9.6	271	11.4	258	13.3	226	18.8							12	228	11.2
711	1400	970	5.3	944	9.8	925	14.3	908	18.8	893	23.3	880	27.8	867	32.3	835	45.8							15	793	33.8
	2050	1450	7.7	1424	14.3	1404	20.9	1387	27.5	1373	34.1	1359	40.7	1347	47.3	1315	67.1							16	1256	52.7
	575	600	3.3	563	6.3	534	9.3	510	12.3	489	15.4	470	18.4											10	446	15.0
718	1400	1590	8.1	1553	15.4	1524	22.7	1500	30.1	1479	37.4	1460	44.7											12	1398	43.8
	2050	2370	11.9	2333	22.6	2304	33.3	2280	44.0	2259	54.8	2240	65.5											12	2178	64.1

Notes: 1. Pressure ratings based on inlet air at standard pressure of 14.7 psia, standard temperature of 68°F, and specific gravity of 1.0.
2. Vacuum ratings based on inlet air at standard temperature of 68°F, discharge pressure of 30" Hg and specific gravity of 1.0.

DESIGN & CONSTRUCTION FEATURES

1. Detachable steel mounting feet
2. Rigid one-piece cast iron casing
3. Anti-friction bearings
4. Thrust control
5. Splash-lubricated spur timing gears
6. Connections in standard pipe sizes
7. Straight, precision machined two-lobe impellers
8. Ground steel shafts

ROOTS DRESSER

DRESSER INDUSTRIES, INC.
ROOTS DIVISION
900 WEST MOUNT STREET, CONNERSVILLE, INDIANA 47331
TELEPHONE: 317/827-9200 FAX: 317/825-7669

S-5124
Revised January, 1994

PERFORMANCE CHARACTERISTICS OF UNIVERSAL RAI, RCS AND RCS-J BLOWERS AND RGS-J GAS PUMPS

MODEL	FRAME SIZE	DISPLACEMENT CFR	1 PSI SLIP N_1	MAX. SHAFT SPEED RPM	GHP FACTOR F_g	FHP PER 1,000 RPM	TEMP. RISE FACTOR F_t	MAXIMUM ALLOWABLE PRESSURE RISE ΔP	MAXIMUM ALLOWABLE TEMPERATURE RISE ΔT
U-RAI	22	.016	510	5,275	.00436	.090	.70	12	225
	24	.032	405	5,275	.00436	.090	.70	7	185
	32	.045	280	3,600	.00436	.165	.75	15	225
	33	.0616	267	3,600	.00436	.165	.75	12	170
	36	.1020	228	3,600	.00436	.165	.75	7	145
	42	.0605	233	3,600	.00436	.203	.80	15	240
	45	.1210	209	3,600	.00436	.203	.80	10	170
	47	.1595	176	3,600	.00436	.203	.80	7	140
	53	.1318	157	2,850	.00436	.306	.85	15	195
	56	.2210	142	2,850	.00436	.306	.85	10	180
	59	.3230	122	2,850	.00436	.306	.85	7	145
	65	.246	132	2,350	.00436	.419	.95	15	250
	68	.395	132	2,350	.00436	.419	.95	12	240
	615	.740	132	2,350	.00436	.419	.95	6	130
	76	.405	91	2,050	.00436	.550	.95	15	250
	711	.738	85	2,050	.00436	.550	.95	10	210
	718	1.200	75	2,050	.00436	.550	.95	6	130
RCS, RCS-J & RGS-J	404	.111	250	4,000	SEE FIGURE 2.E-2	SEE FIGURE 2.E-3	.97	18	275
	406	.167	250	4,000			.97	18	275
	409	.250	250	4,000			.97	18	275
	412	.333	250	4,000			.97	15	275
	418	.500	250	4,000			.97	10	275
	616	.789	160	3,000			.97	15	230
	624	1.184	160	3,000			.97	10	230
RCS	817	1.558	125	2,250	.00436		.97	15	230
	824	2.104	125	2,250	.00436		.97	15	230
	827	2.411	125	2,250	.00436		.97	13	230
RCS-J	817	1.558	125	2,250	SEE FIGURE 2.E-2		.97	18	230
	821	1.870	125	2,250			.97	15	230
	826	2.338	125	2,250			.97	12	230
	832	2.805	125	2,250			.97	10	230

FIGURE 2.E-1

GAS HORSEPOWER FACTOR - F_g VS. GEAR SPEED
RCS, RCS-J, AND RAS-J BLOWERS AND RGS-J GAS PUMPS

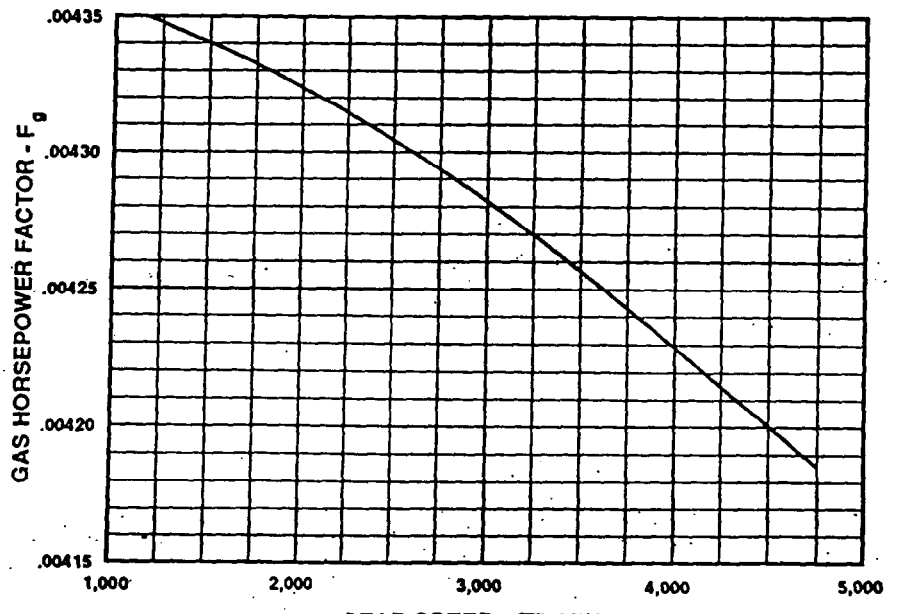


FIGURE 2.E-2

ROOTS DIVISION, DRESSER INDUSTRIES, INC.
900 WEST MOUNT STREET
CONNERSVILLE, INDIANA 47331
PHONE (317)827-9200 FAX (317)825-7669

FRICTION HORSEPOWER – FHP VS. GEAR SPEED
404 THROUGH 827 FRAMES RCS BLOWERS
404 THROUGH 624 FRAMES RGS-J WHISPAIR GAS PUMPS
404 THROUGH 832 FRAMES RCS-J WHISPAIR BLOWERS

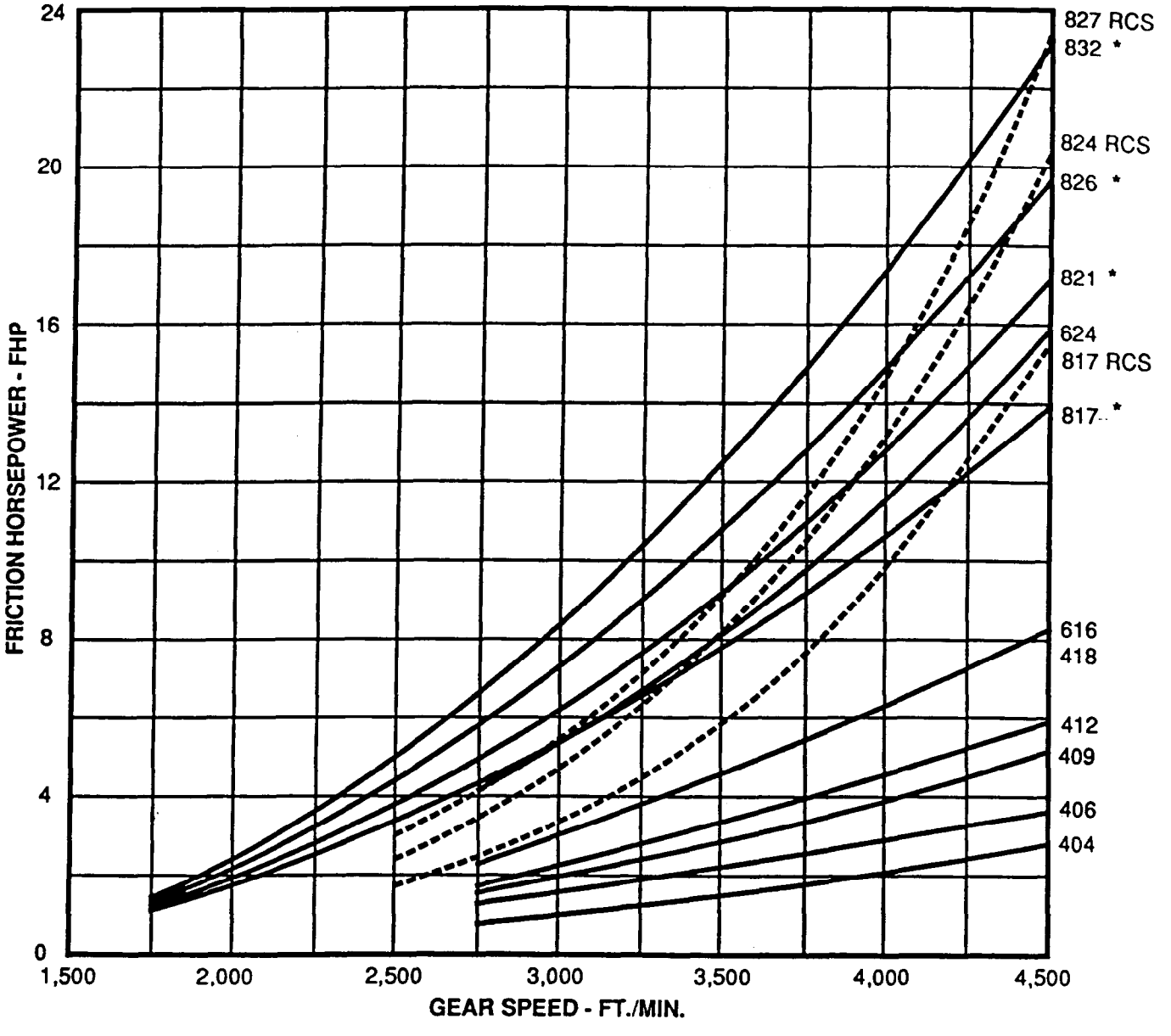


FIGURE 2.E-3

* THESE FRAMES NOT AVAILABLE IN RGS-J

FRAMES 817 THROUGH 827 RCS CURVES ARE SHOWN IN DOTTED LINES

ROOTS DIVISION, DRESSER INDUSTRIES, INC.
900 WEST MOUNT STREET
CONNERSVILLE, INDIANA 47331
PHONE (317)827-9200 FAX (317)825-7669

ROOTS (DRESSER)

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

CONFIDENTIAL

THIS DOCUMENT CONTAINS CONFIDENTIAL INFORMATION OF ROOTS DIVISION, DRESSER INDUSTRIES, INC. IT SHALL BE HELD IN STRICTEST CONFIDENCE, AND BE USED ONLY IN CONJUNCTION WITH ROOTS DIVISION BUSINESS.

COMPANY : _____ PHN. : _____

ATTN. : _____ FAX : _____

REFERENCE : _____

PERFORMANCE

BAROMETER (PSIA) _____ DISCHARGE PRESSURE (PSIA) _____

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

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

INLET FLOW (ACFM) _____ BLOWER BRAKE HP _____

BILL OF MATERIALS - 2F PACKAGE

■ ITEMS SUPPLIED IN PACKAGE

■ BLOWER _____

☐ MOTOR: FRAME _____ HP _____ RPM _____

MFG. _____ VOLT _____

☐ INLET FILTER _____ ■ INLET FILTER/SILENCER _____

☐ INLET SILENCER _____ ■ DISCHARGE SILENCER 2"

☐ CHECK VALVE: Techno-Check 5002 class A

☐ BUTTERFLY VALVE: PDC

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

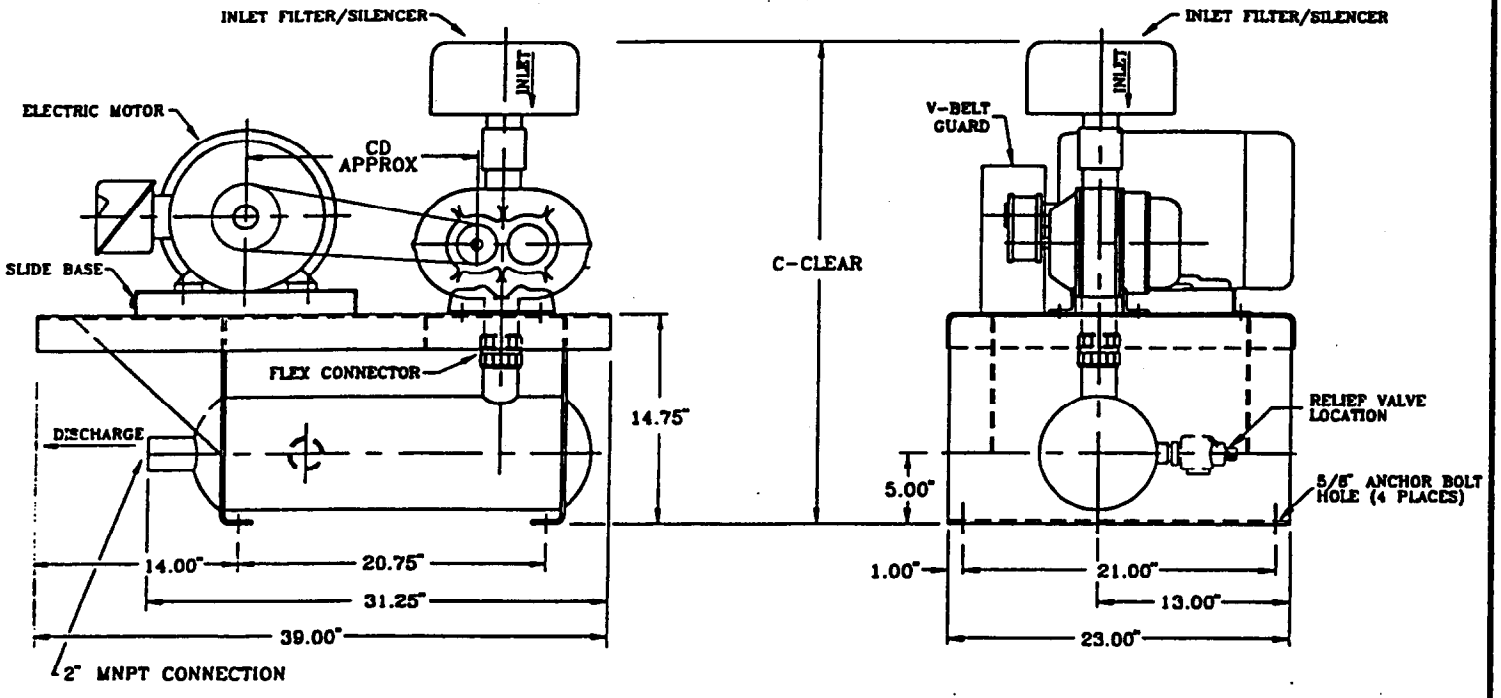
☐ TEMP. SWITCH: 0-425°F RANGE NEMA 4 ( ) NEMA 7 ( )

☐ PRESS. GAUGE: WIKA ; 0-15 PSI RANGE

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

■ RELIEF VALVE: 2"-337

ROOTSPAK STANDARD ARRANGEMENT



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

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

PROPOSAL

PACKAGE PRICE AS SHOWN: _____ EA. QTY: _____

F.O.B. _____ FREIGHT COLLECT

DELIVERY: _____ WEEKS A R O

TERMS OF PAYMENT : NET 30 DAYS

OPTIONAL PRICING : _____

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

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING

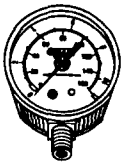
SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

Pressure/Vacuum Gauges

Pressure-Vacuum Gauge

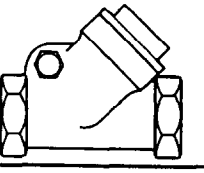
To monitor the system performance so maximum duties are not exceeded. Using two gauges (one on each side of the filter) is a great way to know when the filter needs servicing.



AJ497	Vacuum gauge	0-60" H_2O, 1/4" NPT connection	Blowers
AE134	Vacuum gauge	0-160" H_2O, 1/4" NPT connection	Blowers
AE134F	Vacuum gauge	0-15" HG, 1/4" NPT connection	H Series Blowers
AA644B	Pressure gauge	0-30 psi, 1/4" NPT	80 Series, 2567, 2067, 6066, 0823
AE133	Pressure gauge	0-160" H_2O, 1/4" NPT connection	Blowers
AE133A	Pressure gauge	0-200" H_2O, 1/4" NPT connection	Blowers
AE133F	Pressure gauge	0-15 psi, 1/4" NPT connection	R3H, R4H Blowers
AJ496	Pressure gauge	0-60" H_2O, 1/4" NPT connection	SVE Blowers

Check Valve

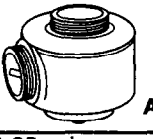
Designed to prevent back-wash of fluids that would enter the blower. Also prevents air back-streaming if needed. Can be mounted with discharge either vertical or horizontal. Valve will open with 3" of water pressure.



AH326D	Check valve	1-1/2" NPT (3" H_2O cracking pressure)	Blowers
AH326F	Check valve	2" NPT (3" H_2O cracking pressure)	Blowers
AH326G	Check valve	2-1/2" NPT (3" H_2O cracking pressure)	R7 Blower

Relief Valve

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



AG258

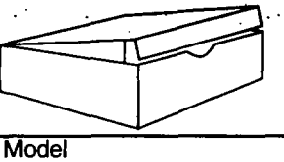
AN225

PV Series

AA307	Relief valve	For pressure, 3/4" NPT, adjustable 2-25 psi	6066, 2567 Series
AA600	Relief valve	For pressure, 3/8" NPT, adjustable 2-30 psi	0823
AG258	Relief valve	1-1/2" NPT adjustable 30-170" H_2O, vac. or press., 200 CFM max.	Blowers
AG258F	Relief valve	2-1/2" NPT adjustable for higher flows, vacuum or pressure	Blowers
PV065	Relief valve	For pressure, pre-set for 6.5 psi, 1-1/4" NPT connection (60Hz)	R3H Blower
PV072	Relief valve	For pressure, pre-set for 7.2 psi, 1-1/4" NPT connection (60Hz)	R3H Blower
PV084	Relief valve	For pressure, pre-set for 8.4 psi, 1-1/4" NPT connection (50Hz)	R4H Blower,R8H, R9H
PV091	Relief valve	For pressure, pre-set for 9.1 psi, 1-1/4" NPT connection (50Hz)	R4H Blower, R9H
PV098	Relief valve	For pressure, pre-set for 9.8 psi, 1-1/4" NPT connection (50Hz)	R7H Blower
PV102	Relief valve	For pressure, pre-set for 10.2 psi, 1-1/4" NPT connection (60Hz)	R7H Blower
AN225	Relief valve	15-45 cfm, 3/4" NPT connection, adjustable 0-20 psi	2080, 3080, 4080 Series

Service Kit

If pump performance on rotary vane models diminishes, installation of the Service Kit replacement parts will have it performing like new again.



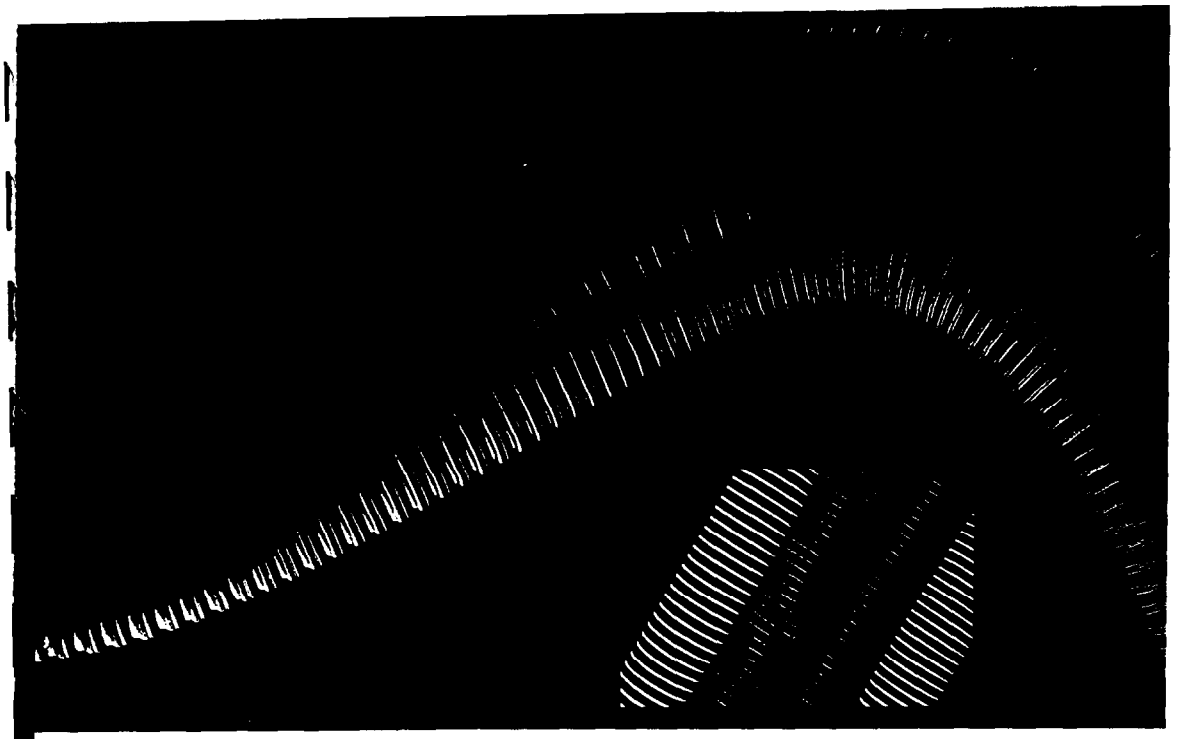
K479A	Service Kit	Includes items for unit repair	0823 Model
K504	Service Kit	Includes items for unit repair	6066, 1290 (uses 2)
K583	Service Kit	Includes items for unit repair	2567 Models
K584	Service Kit	Includes items for unit repair	2080, 3080, 4080 Models
K585	Service Kit	Filter/Muffler Kit only	2080, 3080, 4080 Models

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING

SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

Flexible Hose



RFH

Constructed of thermoplastic rubber and reinforced with a wire helix, RFH is the *most versatile general purpose hose* available today. No cements, solvents, chemicals, adhesives or glues are used in the manufacturing process of RFH. RFH has *superior chemical resistance* and is capable of handling fumes as tough as Methyl Ethyl Ketone, sulfuric acid or toluene.

RFH can be manufactured in other colors. RFH can also be supplied with a color stripe. Please consult us as to minimums and prices for other lengths and non-standard diameters, including metric sizes from 51mm to 500mm.

- *Wide temperature range: -60° F to 275° F continuous service, intermittent to 300° F*
- *Sizes: 2" through 20"*
- *Standard Lengths: 25', 50' or 100*
- *Standard color: Black*
- *Excellent ozone resistance*
- *Superior chemical resistance*
- *Good abrasion resistance*
- *Low compression set*

RFH045

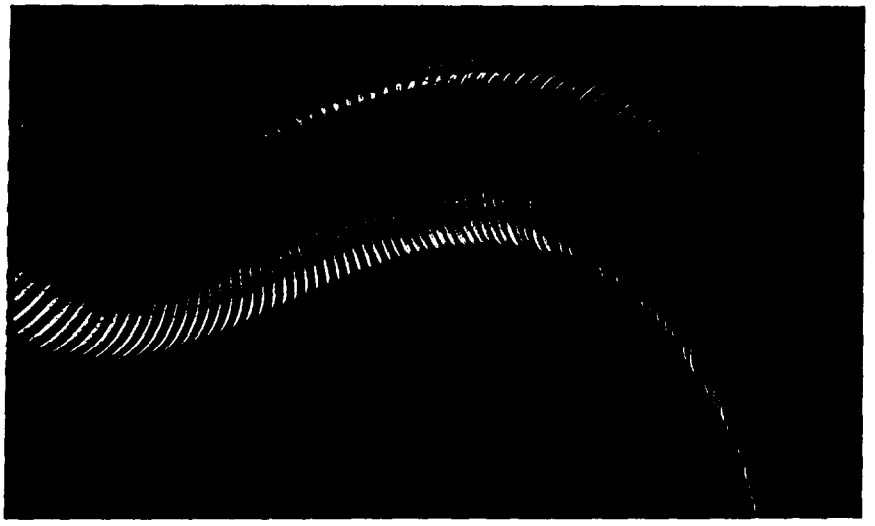
RFH045 is a *heavier* version of RFH. For applications involving higher pressures or more severe abrasion, RFH045 is an ideal solution. Constructed in the same manner as RFH, RFH045 has higher pressure capability at elevated temperatures. RFH045 has the same characteristics as RFH and is available in other sizes. Consult us about minimums.

- *Standard sizes: 4", 6", 8", 10", 12"*

RFH-W

RFH-W is identical to RFH except for an external orange wearstrip which covers the wire. This wearstrip helps prevent premature wire wear-through in the case of dragging or rough use. Because we use no cements, solvents, adhesives, glues or chemicals in our manufacturing process, the wearstrip on RFH-W will not come off or delaminate. The RFH-W wearstrip is *molecularly* bonded to the hose wall.

Other sizes up to 20" are available. Consult us about minimums.



- *Standard sizes: 2" through 12"*
- *See RFH for other characteristics*

CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING

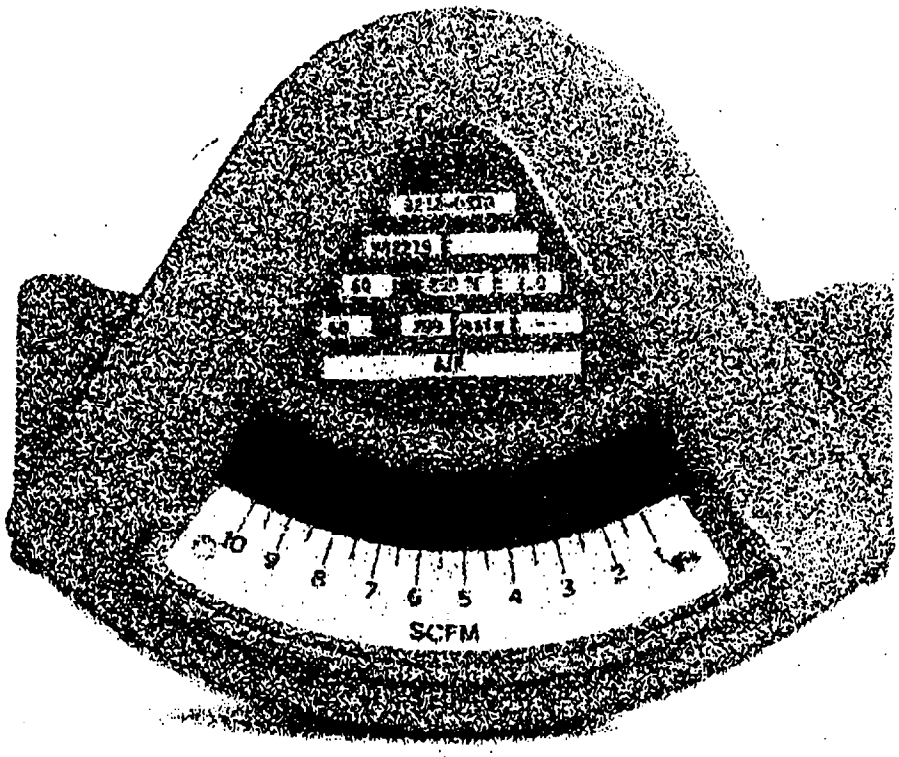
SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

Air Flow Meters

ERDCO Engineering Corporation

See-Flo®



Rugged vane flowmeters and sight flow indicators that measure process fluids in vertical or horizontal pipelines.

See-Flo® benefits

1 Simple design

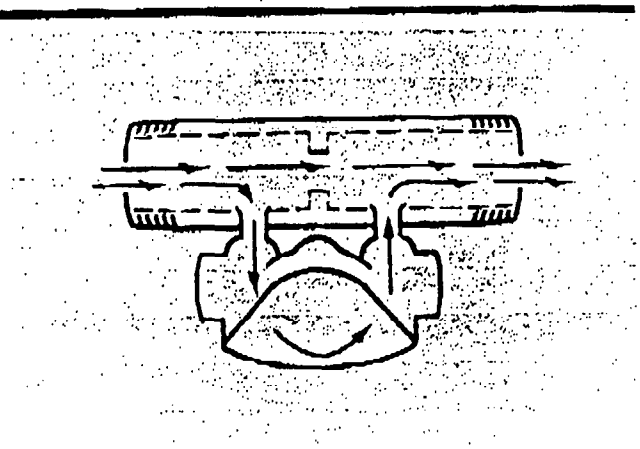
See-Flo® is available as a direct reading flowmeter or as a sight flow indicator. Both include a tempered glass window for visual inspection of fluid color, clarity and flow. The alloy vane indicator moves in proportion to flow rate and is not affected by mounting orientation.

2 Rugged construction

Cast housings with corrosion resistant 316 stainless steel fittings stand up to harsh conditions. Sight windows are full air tempered soda lime glass. There are no floats to get stuck, tubes to break or shaft seals to leak. ERDCO® variable area vane flowmeters are shock qualified and meet the stringent requirements of MIL-S-901B.

3 Low installed cost

Ready to use. Install in-line without saddle clamps, hot taps or electricity. Connection sizes larger than 1 inch include an integral shunt that eliminates the need for special piping.



3100 See-Flo® indicators

See-Flo® sight flow indicators show you at a glance, the color, clarity and flow of liquids in process lines. The large tempered glass window permits easy observation of fluid conditions and vane indicator position for a wide range of fluids in vertical or horizontal piping runs.

The wedge shape of the meter housing makes See-Flo® practically self-cleaning. Where periodic maintenance might be necessary, the window is easily removed and replaced. **As it is intended to be used as a flow indicator, the scale is not calibrated.**

Write-on scale

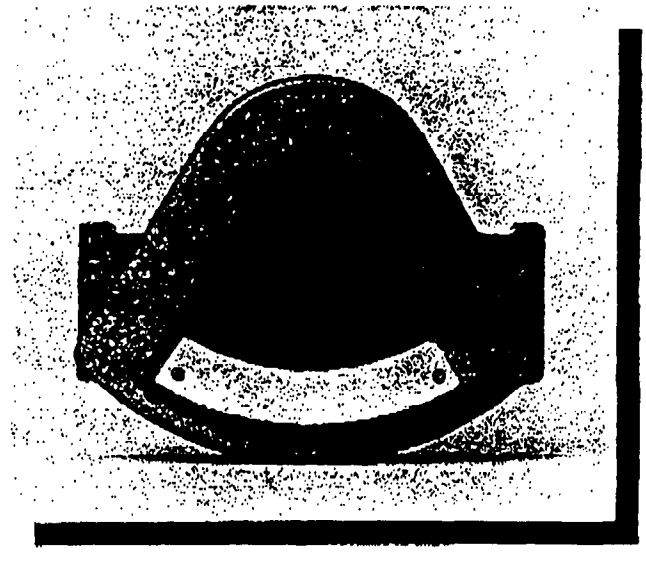
Vane position is a relative indication of flow rate. A special write-on surface is provided along the sweep of the indicator on which system reference points may be marked. This can help you establish normal operating limits, rate efficiency or balance a process system.

Important features

- Large tempered glass sight window for all sizes.
- Use in vertical or horizontal piping systems.
- Unique write-on scale.
- Relative rate indication.
- Economical for pipe connections ½" to 12".

Connections

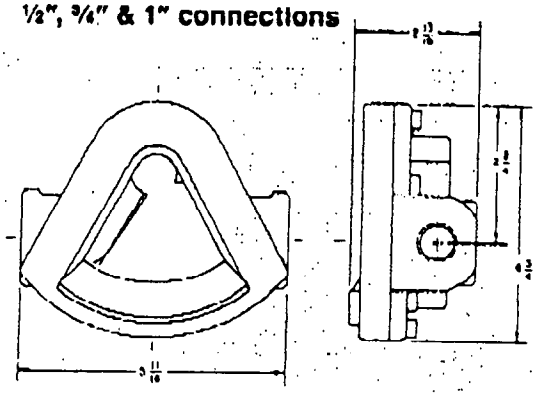
½", ¾" and 1" have female NPT threaded ends. Sizes from 1½" through 12" are available with male NPT threaded ends or 150# ANSI flanges and include an integral shunt. Special sizes and connection types are available on request.



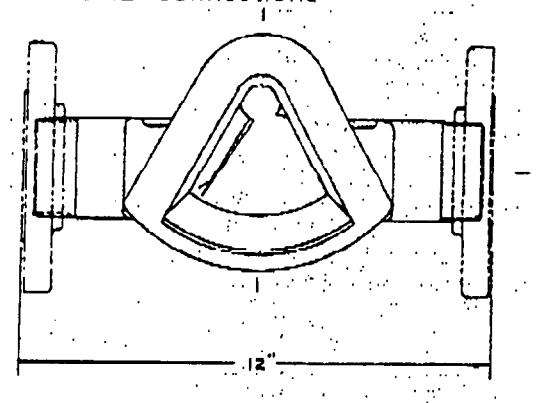
Specifications

See-Flo® indicators are sight flow indicators for liquids in industrial applications. A full air tempered soda lime sight glass permits process fluid observation. Vane position indicates relative flow rate.

3100 Series
½", ¾" & 1" connections



3100 Series
1½" to 12" connections



3100 Series indicators

Materials of construction: (wetted parts)

Housing:	Aluminum, brass or 316 stainless steel
Shunt:	Carbon steel
Window:	Tempered glass
Vane:	17-7 ph stainless steel
"O" rings:	Buna-n, ethylene propylene, Viton® or Teflon®,

Piping connections:
- ½" to 1" NPT Female
- 1½" to 12" NPT Male
- ½" to 1" Tri-clamp
- 1½" to 12" Grooved
- 1½" to 12" Beveled
- ½" to 12" 150#/300#, RF/FF ANSI Flanges (carbon stl)
- ½" to 12" 150# RF ANSI Flanges (stainless stl)
- ½" to 6" 150# RF ANSI Flanges (aluminum)
- ½" to 6" 150# FF ANSI Flanges (brass)
- 15 to 25 mm DIN 2999/BS21/ ISO R7 Female threaded
- 15 to 150 mm DIN PN 10/16 Flanges (316 stainless stl & carbon stl)

Pressure limits: 200 psig (1.3 MPa)

Temperature limits: 32° to 250°F (0° to 120°C)
400°F (204°C) with Viton® or ethylene propylene o-ring

Installation: In-line

Not intended for use with opaque liquids or steam. ERDCO reserves the right to alter design and/or specifications without notice. Viton® and Teflon® are registered trademarks of E.I. duPont de Nemours and Co.

3200 See-Flo® meters

See-Flo® meters indicate flow rate and permit visual inspection of water, air or other transparent fluids. For general purpose industrial service, See-Flo® meters handle a wide range of process fluids in vertical or horizontal piping runs.

The wedge shape of the meter housing makes See-Flo® practically self-cleaning. Where periodic maintenance might be necessary, the tempered glass window is easily removed and replaced.

Direct reading

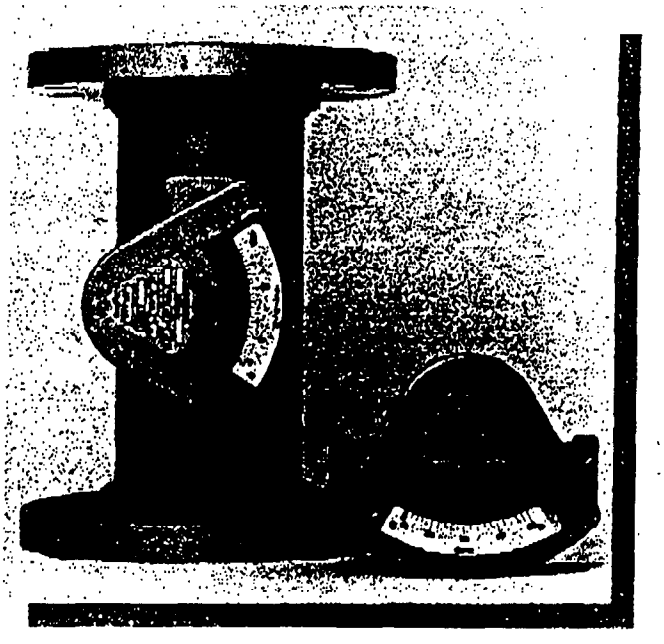
Each flowmeter is calibrated to be direct reading for a liquid or gas at its operating conditions. 10:1 turndown scale ranges may be selected within the capacity limits by connection size shown on page 7. Scales with special engineering units and dual units of measure are available.

Important features

- Instantaneous rate measurement.
- Use in vertical or horizontal piping systems.
- Specify the flow range/units of measure best for your application.
- Economical for pipe connections ⅛" to 12".
- Observe fluid conditions.

Connections

½", ¾" and 1" female NPT threaded ends. Sizes from 1½" through 12" are available with male NPT threaded ends or 150# ANSI flanges and include an integral shunt. Special sizes and connection types are available on request.



Specifications

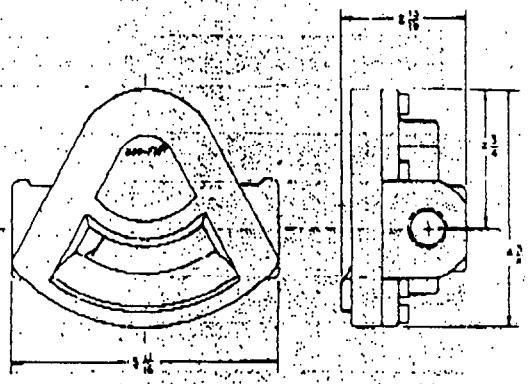
See-Flo® meters are variable area/differential pressure flow rate indicators for general purpose industrial application. A sight glass is incorporated in the design to permit process fluid observation. The tempered vane is displaced through the variable area of the triangular meter housing in direct proportion to changes in flow rate/differential pressure. Vane position directly indicates flow rate.

3200 Series meters

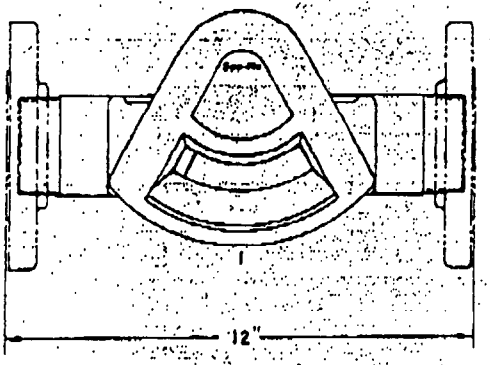
Accuracy:	± 2% full scale
Repeatability:	± 1% full scale
Scales:	Direct reading
Resolution:	Maximum-30 divisions Minimum-15 divisions
Rangeability:	10 to 1 turndown
Materials of construction:	(wetted parts)
Housing:	Aluminum, brass or 316 stainless steel
Shunt:	As housing or carbon steel
Window:	Tempered glass or polycarbonate
Vane:	17-7 ph stainless steel — (aluminum & brass housings) Cobalt/chromium/nickel alloy — (316 ss housings)
"O" rings:	Buna-n, ethylene propylene, Viton® or Teflon®.
Piping connections:	½" to 1" NPT Female 1½" to 12" NPT Male ½" to 1" Tri-clamp 1½" to 12" Grooved 1½" to 12" Beveled ½" to 12" 150#/300#, RF/FF ANSI Flanges (carbon stl) ½" to 12" 150# RF ANSI Flanges (stainless stl) ½" to 6" 150# RF ANSI Flanges (aluminum) ½" to 6" 150# FF ANSI Flanges (brass) 15 to 25 mm DIN 2999/BS21/ ISO R7 Female threaded 15 to 150 mm DIN PN 10/16 Flanges (316 stainless stl & carbon stl)
Pressure limits:	200 psig (1.3 MPa) other sizes
Temperature limits:	32°F to 250°F (0° to 120°C) 400°F (204°C) with Viton® or ethylene propylene o-ring
Installation:	In-line
Options:	Liquid calibration NIST traceable Cleaning for oxygen service

Not intended for use with opaque liquids or steam. ERDCO reserves the right to alter design and/or specifications without notice. Viton® and Teflon® are registered trademarks of E.I. duPont de Nemours and Co.

3200 Series
½", ¾" & 1" connections



3200 Series
1½" to 12" connections



Meter rangeability

Liquid applications

— specify 10:1 range at or between —

pipe size	lowest range gpm water @ 60°F	lowest range pressure drop (psi/gpm rate)	highest range gpm water @ 60°F	highest range pressure drop (psi/gpm rate)
½" - 15 mm	0.4-4	.4/4	1.5-15	3/15
¾" - 20 mm	0.5-5	1/5	3-30	5/30
1" - 25 mm	0.8-8	1.5/8	5-50	6/50
1½"	3-30	2/30	20-200	8/200
2"	4-40	2/40	25-250	8/250
3"	5-50	2/50	50-500	8/500
4"	10-100	2/100	100-1000	8/1000
5"	15-150	2/150	150-1500	8/1500
6"	25-250	2/250	200-2000	8/2000
8"	50-500	2/500	200-2000	8/2000
10"	80-800	2/800	200-2000	8/2000
12"	100-1000	2/1000	200-2000	8/2000

Gas applications

— specify 10:1 range at or between —

pipe size	lowest range scfm air @ 60°F	lowest range pressure drop (inches H_2O/scfm rate)	highest range scfm air @ 60°F	highest range pressure drop (inches H_2O/scfm rate)
½" - 15 mm	1-10	2/10	2-20	3/20
¾" - 20 mm	1-10	2/10	3-30	4/30
1" - 25 mm	1-10	2/10	5-50	6/50
1½"	1.5-15	2/15	20-200	8/200
2"	2-20	2/20	25-250	8/250
3"	4-40	2/40	50-500	8/500
4"	5-50	2/50	100-1000	8/1000
5"	6-60	2/60	150-1500	8/1500
6"	8-80	2/80	200-2000	8/2000
8"	10-100	2/100	200-2000	8/2000
10"	15-150	2/150	200-2000	8/2000
12"	20-200	2/200	200-2000	8/2000

Notes:
- Units of measure other than gpm and scfm can be specified.
- When specifying a calibration range consider that the nominal flow value should be approximately at mid-scale.
- Pressure drop data are typical for maximum flow reading of the range indicated. A flow that causes a midrange reading will have a pressure drop that is a square root function of the pressure drop at full range. Example: An instrument for a 6" piping system that has a range of 200 to 2,000 gpm will have a pressure drop of 8 psi at 2,000 gpm flow and a pressure drop of $\sqrt{8}$ or 2.828 psi at 1,000 gpm on the same scale.
- Typical pressure drop declines in value in a linear relationship between the maximum of the highest range and maximum of the lowest range. Example: An instrument for a 4" piping system that requires a calibrated range of 40 to 500 gpm will have a typical pressure drop at 500 gpm of 5 psi.
- Sizes designated mm (millimeters) are available with metric thread in accordance with DIN 2999/BS21/ISO R7.

Model number system

The example **3221-12F5** describes a 3200 Series See-Flo® meter with a brass body/carbon steel shunt for left to right flow. Connections are 3" 150# raised carbon steel flanges.

32	**2**	**1**	**12**	**F**	**5**
Series	Housing Material	Flow Direction	Size	Type	Shunt Material
31 — 3100 **32** — 3200	**1** — Aluminum **2** — Brass **6** — Stainless Steel	**1** — L to R **2** — R to L **3** — Up **4** — Down	**02** — ½" (15 mm) **03** — ¾" (20 mm) **04** — 1" (25 mm) **05** — 1¼" (32 mm) **06** — 1½" (40 mm) **08** — 2" (50 mm) **10** — 2½" (65 mm) **12** — 3" (80 mm) **16** — 4" (100 mm) **20** — 5" (125 mm) **24** — 6" (150 mm) **32** — 8" **40** — 10" **48** — 12"	**T** — NPT End **R** — NPT Back **S** — Tri-clamp **G** — Grooved **X** — Beveled **W** — Socket End ½"-1" **F** — Flange 150#RF **H** — Flange 150#FF **J** — Flange 300#RF **K** — Flange 300#FF **L** — Flange DIN PN 10/16 **M** — Metric Thread End **N** — Metric Thread Back	**0** — None **1** — Aluminum **2** — Brass **5** — Carbon Steel **6** — Stainless Steel

ERDCO®

ERDCO Engineering Corporation
Box 6318, 721 Custer Avenue
Evanston, Illinois 60204 USA

Telephone: 708-328-0550
Telefax: 708-328-3535

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CONSTRUCTION OF A SOIL VAPOR EXTRACTION/AIR SPARGING

SYSTEM
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT

BETHPAGE, NY

PVC Installation Instructions

Installation Instructions

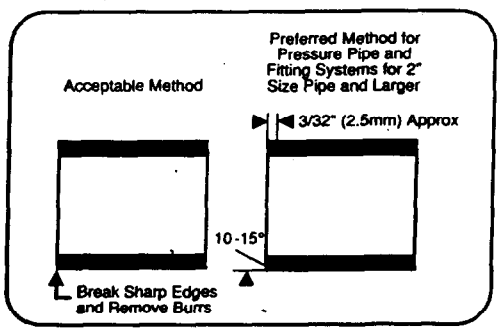
Hayward valves can be installed in a piping system by a solvent cement, threaded, or flanged connection. All three connections have specific requirements that must be followed in order to maintain joint integrity and a leak free system. We have detailed the necessary steps for solvent cementing, threading, and flanging pipe to a Hayward valve. These procedures are the only way to install Hayward valves in a piping system and performed properly, will provide years of trouble free service.

Solvent Cementing (PVC, CPVC)

Preparation:

Begin by cutting the end of the pipe square. Use a hand saw and miter box, or a circular cut-off saw. Use a fine toothed blade (16-18 teeth per inch) and little or no set (maximum 0.0025 inch). With a circular saw, a cutting speed of 6,000 RPM is recommended. Plastic tube cutters may also be used, however, they tend to produce a raised ridge at the end of the pipe. This must be removed with a file or chamfering tool, as it will wipe the cement away when the pipe is inserted into the valve socket.

Remove all burrs from both the inside and outside of the pipe with a knife, file, or chamfering tool. The pipe ends should be bevelled 10°-15°, within 3/32 from the edge of the pipe.



With a clean cloth, remove all dirt, grease, and moisture from the surface of the pipe and valve end connector. Dirt, grease, or moisture can prevent adhesion and create a joint failure. (It is not recommended to solvent cement in the rain.)

Priming:

Primer penetrates and softens the surfaces of both pipe and end connector so that the solvent cement can adhere well to the surfaces.

Using a dauber or a clean natural bristle or nylon brush (about 1/2 the size of the pipe diameter), apply with a scrubbing motion a liberal coating of primer to the end connector socket, keeping the surface and applicator wet until the surface has been softened. This will take between 5-15 seconds depending on the weather conditions. Avoid puddles of primer in the end connector. Now apply the primer to the pipe O.D. equal to or slightly greater than the depth of the fitting.

A second application of primer to the end connector and pipe is recommended. Check the penetration of primer by confirming that the surface has softened. Immediately following the second primer application, apply solvent cement as follows.

Solvent Cementing:

Notes:

1. It is good practice to disassemble the socket end connectors from a true union valve while priming and cementing. Remove assembly nuts and end connectors from valve body. Slide assembly nut, with threads facing valve, onto pipe to which the end connector is to be cemented. Reinstall the valve body only after the joint is cured.

2. When solvent cementing non true union valves, it is important to place all valves in the open position to evacuate the primer and cement vapor. Solvent cement and primer vapor can attack the valve's sealing area and must be exhausted from the piping system.

3. PVC cement should not be used with CPVC products.

Using a new applicator, apply an even layer of cement on the pipe O.D. for a distance equal to or greater than the depth of the end connector socket.

Next, apply a coat of cement to the inside of the end connector using a straight outward stroke to keep excess cement out of the socket.

A second coating of cement on the pipe is recommended so there is more than a sufficient amount of cement to fill any gap in the joint.

While both surfaces are still wet with solvent cement, insert the pipe into the end connector with a quarter turn twisting motion. The pipe must be inserted fully to the end connector. Hold the pipe and end connector together for a short time (approximately 30 seconds) to assure that the hydraulic effects of the assembly does not cause the pipe and end connector to separate.

After assembly, the joint should have a bead of cement completely around the juncture. If voids in the bead are present, sufficient cement was not applied and the joint may be defective. Using a cloth, wipe clean all excess cement including the bead. Handle newly assembled joints carefully and allow proper set time before disturbing the joints. Recommended set time is related to the temperature as follows (see Table 1).

Allow the joint to cure for an adequate time before pressure testing (see Table 2).

Table 1 Recommended Set Time

Temperature Range	Pipe Sizes 1/2" to 1 1/4"	Pipe Sizes 1 1/2" to 3"	Pipe Sizes 4" to 8"	Pipe Sizes 10" to 20"
60° - 100° F (15° - 40° C)	15 min.	30 min.	1 hr.	2 hrs.
40° - 60° F (5° - 15° C)	30 min.	2 hrs.	4 hrs.	8 hrs.
0° - 40° F (-20° - 5° C)	1 hr.	6 hrs.	12 hrs.	24 hrs.

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

Installation Instructions (cont'd)

Joint Cure Schedule

The following cure schedules may be used to determine the necessary time required after assembly before testing the system or before line pressure can be applied.

Table 2

Relative Humidity 60% or Less*	Cure Time pipe sizes 1/2" to 1 1/4"		Cure Time pipe sizes 1 1/2" to 3"		Cure Time pipe sizes 3 1/2" to 8"		Cure Time pipe sizes 10" to 14"	Cure Time pipe sizes 16" to 24"
Temperature Range During Assembly and Cure Periods	Up to 180 psi	Above 180 to 370 psi	Up to 180 psi	Above 180 315 psi	Up to 180 psi	Above 180 to 315 psi	Up to 180 psi	Up to 100 psi
60° - 100°F (15°C - 40°C)	1 Hr.	6 Hr.	2 Hr.	12 Hr.	6 Hr.	24 Hr.	24Hr.	48-72 Hr.
40° - 60°F (5°C - 15°C)	2 Hr.	12 Hr.	4 Hr.	24 Hr.	12 Hr.	48 Hr.	72 Hr.	5 days
0° - 40°F (-20°C - 5°C)	8 Hr.	48 Hr.	16 Hr.	96 Hr.	48 Hr.	8 days	8 days	10-14 days

* In damp or humid weather allow 50% more cure time.

Threading

Hayward threaded valves have NPT (American standard) tapered pipe threads that are molded or cut to the dimensions and tolerances for tapered pipe threads consistent with ANSI B1.20.1 standards.

When installing threaded plastic pipe into Hayward valves, it is important to use a thread sealant such as Teflon tape. Do not use oil based joint compound or Teflon paste. They may contain substances that could cause stress cracking of the plastic.

Facing the threaded end of the pipe, begin wrapping the tape in a clockwise direction, starting with the second thread nearest the end of the pipe. Overlap each wrap by one half the width of the Teflon tape. Pipe sizes 2" and larger may benefit with two wraps due to the greater depth of the thread.

Carefully screw the end connectors onto the end of the pipe and hand tighten. Using a strap wrench only (never use a stilson type wrench or "channel lock" type plier), tighten the end connector 1 to 1 1/2 turns beyond hand tight. Avoid distorting or cracking the end connector by over tightening.

Flange Joints:

Hayward valves with flanged end connectors are recommended for applications where frequent dismantling is required, or when the system piping is other than plastic (steel, fiberglass, metal lined pipe, etc...). All Hayward flanged valves have flanges with a bolt hole pattern that meets ANSI 150 lb. dimensions.

Elastomeric gaskets between the flanges must be used and should be a minimum 1/8" thick full face gasket with a hardness between 50 to 70 durometers. Bolts, nuts, and washers should be well lubricated.

Begin making the flanged joint by making sure that the bolt holes of the mating pipe flanges line up. Insert the bolts and make certain that the distances between the flanges is not excessive prior to bolting down the flanges. Using a torque wrench, tighten each bolt in sequence as detailed in the flange bolt tightening sequence sketch.

Tighten the bolts to the recommended torque valves as listed in table 3.

Flange Bolt Tightening Sequence

The following tightening pattern is suggested for the flange.

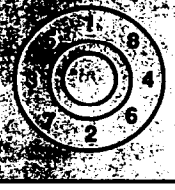


Table 3 Recommended Bolt Torque

Flange Size	Recommended Torque
1/2"	5 Ft. Lbs.
2" - 4"	25 Ft. Lbs.
6" - 8"	25 - 45 Ft. Lbs.
10"	53 - 75 Ft. Lbs.
12"	80 - 110 Ft. Lbs.

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908/351-5400 Fax: 908/351-770