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OPERATIONS AND MAINTENANCE MANUAL GROUNDWATER EXTRACTION AND TREATMENT SYSTEM REVISION 1 SITE 11 OLD CAMDEN COUNTY LANDFILL NSB KINGS BAY GA

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ABB ENVIRONMENTAL SERVICES, INC

OPERATIONS AND MAINTENANCE MANUAL

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
REVISION NO. 1

SITE 11, OLD CAMDEN COUNTY LANDFILL
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

Unit Identification Code: N42237

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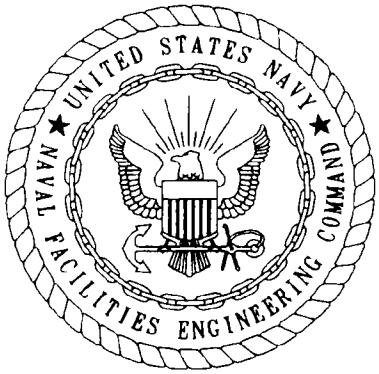

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, ABB Environmental Services, Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0317/094 are complete, accurate, and comply with all requirements of this contract.

DATE: February 26, 1997

NAME AND TITLE OF CERTIFYING OFFICIAL: Richard Tringale
Project Manager

(DFAR 252.227-7036)

The engineering recommendations and professional options rendered in this document describe operations and maintenance (O&M) activities for the groundwater extraction and treatment system (GETS) for Site 11, Naval Submarine Base, Kings Bay, Georgia. The engineering recommendations were developed in accordance with commonly accepted procedures consistent with applicable standards of practice. This document is the first revision to the Operations and Maintenance Manual, Groundwater Treatment System (ABB Environmental Services, Inc., 1995). It is not intended to certify the design or configuration of the GETS. Design certifications are contained in the applicable plans and specifications for the Site 11 GETS. Any changes in the site conditions or to the present configuration of the GETS may modify the O&M activities presented herein. Such changes should be reviewed and evaluated for possible modifications to this O&M manual in future revisions.

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Georgia Professional Engineer
Number 21594
Expires December 31, 1997

FOREWORD

To meet its mission objectives, the U.S. Navy performs a variety of operations, some requiring the use, handling, storage, or disposal of hazardous materials. Through accidental spills, leaks, and conventional methods of past disposal, hazardous materials may have entered the environment in ways unacceptable by today's standards. With growing knowledge of the long-term effects of hazardous materials on the environment, the Department of Defense initiated various programs to investigate and remediate conditions related to suspected past releases of hazardous materials at their facilities.

One of these programs is the Installation Restoration program. This program complies with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act; the Resource Conservation and Recovery Act (RCRA); and the Hazardous and Solid Waste Amendments (HSWA) of 1984. These acts establish the means to assess and clean up hazardous waste sites for both private-sector and Federal facilities.

The program that has been adopted to address present hazardous material management is RCRA and the HSWA (RCRA/HSWA) corrective action program. RCRA ensures that solid and hazardous wastes are managed in an environmentally sound manner. The law applies to facilities generating or handling hazardous waste. The HSWA corrective action program is designed to identify and clean up releases of hazardous substances at RCRA-permitted facilities.

The RCRA/HSWA program is conducted in four stages as follows:

- RCRA Facility Assessment,
- RCRA Facility Investigation,
- Corrective Measures Study, and
- Corrective Measures Implementation.

The Southern Division, Naval Facilities Engineering Command manages and the U.S. Environmental Protection Agency and the Georgia Department of Natural Resources Environmental Protection Division oversee the Navy environmental program at Naval Submarine Base (NSB), Kings Bay, Georgia. All aspects of the program are conducted in compliance with State and Federal regulation, as ensured by the participation of these regulatory agencies.

Questions regarding the RCRA program at NSB, Kings Bay should be addressed to Mr. Anthony Robinson, Code 18511, at (803) 820-7339.

EXECUTIVE SUMMARY

The purpose of this manual is to (1) familiarize operations personnel with the system layout, process equipment, and operating procedures; (2) present the system's operating procedures; (3) present the maintenance requirements that minimize operational problems; (4) present the monitoring requirements to meet Georgia Environmental Protection Division and base wastewater treatment facility standards; and (5) address health and safety issues for operational and maintenance activities of the Kings Bay Naval Submarine Base groundwater treatment facility at Site 11, Old Camden County Landfill.

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GLOSSARY

cfm	cubic feet per minute
CFR	Code of Federal Regulations
DAT	diffused aeration tank
°F	degrees Fahrenheit
gpm	gallons per minute
GWE	groundwater extraction
HASP	Health and Safety Plan
HVAC	heating, ventilation, and air conditioning
NSB	Naval Submarine Base
OSHA	Occupational Safety and Health Administration
PLC	programmable logic controller
PPE	personal protective equipment
PVC	polyvinyl chloride
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
w.c.	water column
WWTF	wastewater treatment facility

1.0 INTRODUCTION

The purpose of this manual is to (1) familiarize operations personnel with the system layout, process equipment, and operating procedures; (2) present the system's operating procedures; (3) present the maintenance requirements that minimize operational problems; (4) present the monitoring requirements to meet Georgia Environmental Protection Division and base wastewater treatment facility (WWTF) standards; and (5) address health and safety issues for operational and maintenance activities of the Kings Bay Naval Submarine Base (NSB) groundwater treatment facility at Site 11, Old Camden County Landfill.

1.1 FOREWORD. The primary objective of this manual is to serve as a guide for overall operation and maintenance of the treatment system. The manufacturers' operating and maintenance information for each piece of equipment is included as Appendix A and should be thoroughly reviewed by operating personnel. The manufacturers' information describes in detail the following:

- recommended operating procedures,
- recommended maintenance procedures,
- troubleshooting guidelines,
- wiring diagrams, and
- parts ordering information.

In addition, product specifications sheets have been included for meters, sensors, gauges, and materials used in the construction of the treatment system.

1.2 OPERATOR RESPONSIBILITIES. Treatment system operation personnel will be responsible for routine daily monitoring of the facility. Operator responsibilities include the following:

1. The system will be operated within design specifications to meet base WWTF discharge criteria.

2. The operator will conduct safety practices in accordance with 29 Code of Federal Regulations (CFR) 1910 and must apply sound judgment to all operational decisions.

3. Through routine system performance monitoring, the operator will ensure that flow rates and drawdown elevations are maintained at specified levels for each of the five recovery wells.

4. The operator will ensure that discharge criteria are being met by collecting samples for volatile, semivolatile, metal, and engineering treatability parameters analysis from the treatment system effluent. These samples will be collected every 6 months as outlined in the groundwater discharge permit presented in Appendix B.

5. The operator must maintain an accurate logbook of operations reflecting all activities. All entries will be proceeded by the

date and time the activities occurred. The operations logbook is a legal document and must be signed and dated by the operator.

6. Any alterations made to the treatment system, equipment, or instrumentation will be monitored to assess effects of the changes. This verification must be made to ensure that the effluent meets required standards.

7. The operator must ensure all equipment is in good operating condition and shall perform preventative maintenance in a timely manner.

2.0 DESCRIPTION OF TREATMENT FACILITY

Contaminated groundwater at NSB, Kings Bay is extracted from the surficial aquifer using five recovery wells that house a submersible pump that discharges groundwater from the aquifer to the treatment system. These recovery wells are located on the base and within the adjacent Georgia Spur 40 right of way. Flow is controlled from each well, and the groundwater is collected in an equalization tank located on the equipment pad. Contaminated groundwater is then gravity fed into a diffused aeration tank (DAT). After treatment, groundwater is discharged to the base's sanitary sewer system and ultimately to the WWTF. The DAT offgas airstream is treated with vapor-phase carbon prior to discharge.

2.1 GROUNDWATER TREATMENT SYSTEM. The treatment system is designed to collect, treat, and discharge water extracted from the surficial aquifer by the groundwater extraction (GWE) system, as well as water generated during the following operational activities:

- vehicle and equipment decontamination water,
- treatment area spills, leaks, and washdown water,
- process area stormwater (if contaminated), and
- water from periodic well development activities.

Groundwater samples extracted by the GWE system contain volatile organic compounds (VOCs). The VOCs that formed the design basis for the original treatment system are listed in Table 2-1. These contaminants, and any other detected VOCs, are readily volatilized by the diffused aeration process and can be reduced to concentrations below maximum contaminant levels set forth by Federal and State of Georgia safe drinking water standards (U.S. Environmental Protection Agency, 1996; Georgia Department of Natural Resources, 1994).

Average flow through the treatment system is approximately 45 gallons per minute (gpm). The maximum design flow for the treatment system is 60 gpm, which provides additional capacity for flow increase due to seasonal variations in groundwater levels, additional recovery wells, and flow from other sources listed above.

The diffused aeration system consists of a blower that directs air into a tank of contaminated water through diffusers that produce coarse bubbles. In this design, the water travels through eight consecutive aeration chambers. As the water is aerated, the contaminants are transferred into air bubbles, which are exhausted through a collection header at the top of the tank. To decrease the humidity in the exhaust vapor, the exhausted air is then transferred through a demister pad and a heat pump before vapor-phase carbon adsorption treatment. After the air has passed through the carbon vessels, it is discharged to the atmosphere. Treated groundwater is discharged to the sanitary sewer. A piping and instrumentation diagram for the treatment system is provided as Sheet C-6 of the as-built drawings in Appendix C.

2.1.1 Recovery Well Pumps Submersible pumps in each of the five recovery wells pump contaminated groundwater to the treatment system's equalization tank, which is located within a containment pad. RW-5 has been abandoned in place and no longer functions as part of this system. However, RW-6 was installed in December

Table 2-1
Treatment System Performance Criteria

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Constituent of Concern	Performance Criteria[1] ($\mu g/\ell$)
Benzene	5
2-Butanone	X
Chlorobenzene	X
1,4-Dichlorobenzene	75
1,1-Dichloroethane	X
1,2-Dichloroethane	5
cis-1,2-Dichloroethene	70
trans-1,2-Dichloroethene	100
1,2-Dichloropropane	5
Ethylbenzene	700
2-Hexanone	X
4-Methyl-2-pentanone	X
Tetrachloroethene	5
Toluene	1,000
Trichloroethene	5
Xylenes (total)	10,000
Vinyl chloride	2

[1] Performance criteria are the maximum contaminant levels (MCLs) for constituents of concern as established by the State of Georgia (1994) and the U.S. Environmental Protection Agency (1996).

Notes: $\mu g/\ell$ = micrograms per liter.
X = No MCL or health-based advisory established.

1996. The flow rate through the conveyance piping is regulated by manually operated ball valves located in the recovery well vaults and on the treatment pad. The submersible pumps were chosen based on low flow and low system head loss conditions.

Two submersible pump models have been installed. A 1/2-horsepower pump, Grundfos® model no. 10S03-9, with a capacity of 5 to 14 gpm has been installed in recovery wells RW-1, RW-2, RW-3, and RW-4, and a 1/3-horsepower pump, Grundfos® model no. 16S03-6, with a flow capacity of 5 to 14 gpm has been installed in RW-6. Performance curves for each of these pumps are included in Appendix A. A Grundfos® model 10S03-6 pump is a suitable replacement for the 1/2-horsepower pumps in RW-1, RW-2, RW-3, and RW-4 if the model 10S03-9 pumps malfunction. There are five spare pumps (model 16S03-6) in the site storage trailer.

The pumps are both cooled and lubricated by the groundwater and do not require external lubrication. Under no circumstances should the pumps be operated for any prolonged periods (greater than 1 to 2 minutes) of time without flow through the pump. This can result in both motor and pump damage due to overheating.

Each recovery well pump is fitted with a perforated shroud to force water flow past the pump motor, which will assist in cooling (see as-builts, Sheet C-5, Appendix C). It is recommended that shrouds be installed in any new wells and maintained on existing pumps.

Each recovery well is equipped with high- and low-level sensors to start and stop the recovery well pump automatically. A time delay is provided in the pump control circuit to prevent the pumps from cycling too frequently. In addition to the level sensors, the programmable logic controller (PLC) will prevent the pumps from running if

- the equalization tank level is high,
- the DAT sump level is high,
- the DAT blower flow rate is too low, or
- the heat pump is not working properly.

A [hand/off/auto] switch is provided for each pump on the main control panel. The [hand] position manually activates each pump. The [off] position disables the pumps. In the [auto] position, the pumps respond to the level sensors to activate or deactivate the pump depending on the water level in the well. The high and low water-level sensors are located above the screened interval. The recommended setting for the low-level sensor is 2.0 feet above the well screen level, and the high-level sensor should be placed 7 feet above the low-level sensor.

2.1.2 Flow Control The flow from each submersible pump is directed through a 1.25-inch-diameter, flexible hose and then through a 1.5-inch-diameter, Schedule 40, polyvinyl chloride (PVC) pipe for recovery wells RW-1, RW-2, RW-3, and RW-4. The piping for RW-6 consists of 1.5-inch-diameter high density polyethylene pipe. The flexible hose is attached to the submersible pump and extends 2 feet beyond the top of the well casing. The flexible hose is then attached to the groundwater influent pipe using a quick disconnect fitting.

Located inside each recovery well vault is a check valve, a Y-strainer, a ball valve, and a pressure gauge. There is also a turn-and-lock electrical plug located in the well vault in case the power needs to be disconnected while the operator is working at the individual wells, as well as a level sensor control box. At the piping manifold on the equipment pad, each conveyance line is fitted with an additional pressure gauge, a totalizing flow meter, a ball valve, a check valve, and a sample port. Under normal operating conditions, the ball valve located in the recovery well vault needs to be partially closed (approximately 50 percent), and the ball valve located on the equipment pad needs to be partially closed to maintain the specified flow and drawdown elevation for each well. Valve settings are determined by monitoring the flow rates.

2.1.3 Equalization Tank Groundwater from the recovery wells, system wastewater, and stormwater is transferred to a 1,500-gallon, epoxy (paint)- coated, carbon-steel equalization tank. The tank provides a means to equalize the process flow by

- combining and equalizing flow, thus averaging flow rates;
- combining and equalizing chemical concentrations; and
- serving as a sedimentation chamber.

Groundwater is collected in the equalization tank until the liquid level reaches a head of approximately 4 feet above the tank invert. This head (4 feet) allows water to gravity flow into the DAT through a 4-inch-diameter PVC pipe. A diaphragm valve, located in the 4-inch PVC pipe, is used to maintain this head and regulate the flow into the DAT. A gate valve in the 4-inch PVC pipe is utilized to isolate the equalization tank during maintenance operations.

Assuming a maximum process flow rate of 60 gpm and a normal operating capacity of 920 gallons, the equalization tank provides a minimum 15-minute retention time. Retention time increases with a decrease in flow rate. A process flow of 45 gpm will allow a retention time of approximately 20 minutes. Liquid-level indicators and switches in the equalization tank are interfaced with the operation of the recovery well pumps via the PLC. A high liquid level in the equalization tank will activate an alarm and shut off the recovery well pumps. The level switch has a time delay for restart of pumps to avoid excessive cycling.

A piping and instrumentation diagram is provided in the as-built drawings located in Appendix C.

2.1.4 Diffused Aeration Tank The DAT is constructed of 1/2-inch-thick PVC plate welded together and measures 72 inches wide by 156 inches long by 40 inches high (Appendix A). There are eight sequential chambers fitted with three diffuser pipes in each of the first six chambers and two diffuser pipes in the last two chambers. A wet well, or sump, is located at the exit end of the DAT and collects the treated groundwater before discharge to the sanitary sewer. A Grundfos® 1/3-horsepower series 7000 pump is used to transfer water from the DAT to a sewer manhole.

In the DAT, air is released into the water through diffusers that produce coarse air bubbles. The diffusers are made of Schedule 80, 1-inch-diameter PVC pipe with two rows of holes located at the bottom of the pipe. An air to water ratio of between 50 and 100 to 1 is maintained by regulating air flow from the blower

to the DAT with a manually operated inlet damper. An air flow rate of 550 cubic feet per minute (cfm) must be maintained to provide for the volatilization of the contaminants in the water.

Three level switches are used in the DAT sump to control the transfer pump and recovery well pumps. A [high]-level switch turns the transfer pump on and moves treated groundwater from the DAT sump to a manhole that feeds into the sanitary sewer via a 3-inch-diameter, Schedule 40 PVC line. A [low]-level switch shuts the transfer pump off and allows the DAT sump to refill. The third switch is a [high/high]-level switch that shuts the recovery well pumps off and actuates an alarm on the control panel. This switch activates in the event that the flow rate into the sump exceeds the discharge rate and the sump becomes too full. This condition can be caused by the shutdown of the transfer pump, excessive head loss due to fouling of the discharge line, etc.

Effluent from the DAT can be diverted back to the equalization tank and recycled through the DAT for supplemental treatment if the system is not meeting performance criteria. Recycling is accomplished by closing the 3-inch ball valve in the effluent line and by opening the 2-inch ball valve located on the recirculation line. Recovery well pumps can be turned off at the control panel until the system is functioning properly.

A vacuum relief valve has also been plumbed into the effluent line to prevent a siphon across the transfer pump. Siphoning evacuates water from the pump and introduces air into the line causing the pump to lose its prime. This pump malfunction causes the system to back up hydraulically.

Vapors within the DAT are collected in a header system that discharges to the vapor-phase carbon system.

2.2 VAPOR-PHASE TREATMENT. The vapor-phase treatment system consists of a demister pad, a heat pump, a carbon adsorption system, and an exhaust stack. The purpose of the vapor-phase treatment system is to reduce VOCs from the vapor stream prior to discharge to the atmosphere.

The carbon adsorption system consists of four carbon canisters arranged in parallel. The carbon canisters are 85-gallon drums filled with granular, activated carbon.

For efficient utilization of the activated carbon, the relative humidity of the airstream must be controlled. This is accomplished in two steps. First, airborne water droplets are removed when the air passes through a demister pad located on the hood of the DAT. The second step involves cooling the airstream in order to condense the moisture and then reheating the airstream by using a second stage hot gas reheat. A heat pump is used to accomplish the second step of moisture control. The relative humidity should be maintained at less than 50 percent and less than 120 degrees Fahrenheit (°F) during normal operation.

A differential pressure indicator is provided on each carbon unit to monitor pressure drop across the unit. An increase in pressure differential indicates fouling or moisture buildup within the units. Pressure drop should normally be 10 to 12 inches of water column (w.c.) at 150 cfm. Operating pressure for the canisters should not exceed 20 inches w.c..

The units are operated until breakthrough occurs, and then they are replaced with fresh carbon. Appendix B contains the discharge criteria for the offgas air-stream. Placement of the new canisters requires renting a boom truck. All spent carbon vessels must be put into over-pack drums for transportation to a disposal facility. All manifest must be signed by Harold Pace of Public Works before they can be transported off site.

2.3 UTILITIES. Electrical power is supplied from an existing transformer located along U.S.S. Jackson Road, approximately 1,500 feet southeast of the treatment pad. Record drawings of the compound area including the treatment pad, decontamination pad, and field office are provided in Appendix C, Sheet C-3 and show the layout of all utilities. There are also three light poles located at the site. Two poles are located inside the compound area, and one pole is located outside the equipment pad area.

Water is supplied from an existing 6-inch water main located along U.S.S. Jackson Road, southeast of the treatment pad. The 6-inch water main was tapped with a 1.5-inch PVC line that supplies potable water to the site.

A 1.5-inch-diameter backflow preventer has been provided on the influent water. The backflow device prevents contamination due to (1) pressure loss on the influent side and (2) ruptures. When a pressure drop or a ruptured water line occurs, the three check valves close firmly, preventing (potentially) contaminated water from being syphoned back into the water supply system.

Periodically, sand or other abrasive material (from the distribution system) may become lodged on the back side of the check valve, preventing it from closing properly. Water flows continuously from the valve's overflow when this occurs. To clean the valve, the operator should open the flushing connections adjacent to each check valve and flush out the accumulated debris. The operator should inspect this backflow preventer bimonthly.

Two 3/4-inch-diameter faucets are located on the west side of the decontamination pad and inside the compound area adjacent to the office trailer. The water can be turned off at the backflow preventer located adjacent to the transformer pad across from the child care center.

3.0 OPERATING PROCEDURES

This chapter provides procedural activities associated with the operation of the interim measure groundwater treatment system. Operational activities include startup and shutdown of the system, normal operations, and process monitoring of the system.

3.1 STARTUP PROCEDURES. Prior to initial startup, the controls (on the control panel) for all five recovery well pumps need to be in the [off] position. The pumps and all other system equipment are controlled at a centralized control panel located on the equipment pad (see as-builts, Sheet C-5, Appendix C). Each pump has an [on/off/auto] switch on the panel.

The DAT blower (B-01) and the vapor treatment system blower (B-02) should be in the [auto] position. These blowers can be started before water enters the DAT.

The transfer pump (P-03) should be in the [auto] position so that the level sensors in the DAT sump will be activated. If the transfer pump needs to be turned on manually, then the operator can turn the switch to the [on] position and bypass level sensor controls. However, caution must be taken not to allow the pump to run dry. The ball valve located on the discharge pipe of the DAT should be set in the open position.

The control switch for the heat pump should be turned to the [on] position after all other system controls have been set. When this switch is turned on, the heat pump will be activated. The heat pump has been wired on a separate circuit so that it does not cycle (on and off) if the rest of the system cycles. Cycling can cause damage to the heat pump.

The equipment pad sump pump has a switch on the control panel and a breaker switch located in the breaker box. The number 17 breaker inside the breaker box needs to be in the [on] position and the switch located on the equipment control panel also needs to be in the [on] position.

Once each of the above switches has been set, the operator shall check the main power breaker switch to verify that it is in the [on] position. This main switch is located on the front side of the control panel on the right door. When this breaker is activated, the doors to the control panel cannot and will not open. This is a safety feature of the control panel.

The system can now be energized by turning the power control switch to the [on] position. This is the top, left-hand switch located on the left door panel of the control panel. Once this switch is turned on, a white indicator light will be illuminated. Each time a piece of equipment is energized, a green indicator light will be illuminated. After the system has received power, the recovery wells can be switched to the [auto] position one at a time. If alarm conditions occur, red indicator lights will be illuminated along the top of the control panel, indicating which alarm condition(s) exists.

After approximately 4 to 5 feet of head has accumulated in the equalization tank, the valves in line between the equalization tank and DAT should be opened. The gate valve needs to be completely opened. The diaphragm valve needs to be opened

approximately three complete turns to allow water to flow into the DAT chambers. The operator should be careful not to open the diaphragm valve too much to avoid hydraulically overloading the DAT. The ball valve located on the discharge side of the DAT also needs to be checked to verify that it is completely open.

3.2 NORMAL OPERATION. During normal operation, the recovery well pumps will be operated in the [auto] position. Optimum pumping rates and pumping levels to meet Interim Measure objectives are shown in Table 3-1. The level sensors inside the well monitor the drawdown and permit the system to automatically shut the pumps off if the system operating constraints are not being met within the treatment process.

Table 3-1
Drawdown and Flow Rate Recommendations

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Location	Optimum Pumping Water Level (feet btoc)	Optimum Drawdown Elevation (feet, mlw)	Corresponding Flow Rate (gpm)
RW-1	16 to 17.5	16.47 to 14.97	6 to 7
RW-2	16 to 17	14.49 to 13.49	9 to 10
RW-3	15.5 to 16.5	12.20 to 11.20	8 to 9
RW-4	19.5 to 22	9.39 to 6.89	8 to 9
RW-6	5 to 5.5	28.82 to 28.32	13 to 14

Notes: RW-5 has been abandoned.

btoc = below top of casing (piezometer).
mlw = mean low water.
gpm = gallons per minute.

Liquid-level switches in the equalization tank will control the operation of the recovery well pumps as long as the pumps are operating in the [auto] position. A high/high level in the equalization tank will activate an alarm and shut off the recovery well pumps when the water level in the tank reaches 6 feet. The level switch has a time delay (set at 7 minutes) to avoid excessive cycling of the pumps. A low-level switch in the equalization tank restarts the pumps at 4 feet of head in the tank.

The two blowers (B-01 and B-02) should be in the [auto] mode during normal operation. There is a pressure switch monitoring flow from the DAT blower (B-01); both blowers are shut off if insufficient amounts of air are being delivered.

The heat pump is operated from the main control panel and has an alarm signal that sounds if the heat pump is not functioning. Any failures or shortcomings

with the heat pump should be serviced and/or inspected by a certified heating, ventilation, and air conditioning (HVAC) contractor.

The transfer pump (P-03) is controlled by level sensors and switches located in the DAT sump when operating in the [auto] mode. A [high/high]-level switch in the DAT sump will shut off the recovery well pumps and activate an alarm. The transfer pump (P-03) should only be operated in the [on] mode if water needs to be drained from the DAT instantly, and the operator should always be present. If the pump is allowed to pump dry, it can be permanently damaged. Always switch (at control panel) the pump back to the [auto] or [off] position after operating it in the [on] position.

The pump located in the equipment pad sump is controlled by a float switch. As the water rises in the sump, the float switch will automatically turn the pump on and automatically turn it off after the water level is drawn down. The operator will verify that the switch on the control panel is in the [on] position and that the number 17 breaker (located in the breaker box) is in the [on] position. The sump water can be directed to the equalization tank, which is normal operating procedure, or to the surface. The ball valve which allows the water to be discharged to the surface should be closed at all times unless the operator is present to discharge excess rain water.

Also during normal operation, the operator shall routinely check and record data from all gauges and instruments that monitor the system performance. A data collection sheet and checklist that provides maintenance and performance tasks that should be accomplished and their frequencies are provided in Appendix D.

3.3 SHUTDOWN PROCEDURES. During normal shutdown activities, the operator should (1) turn off the recovery well pumps at the control panel, (2) close the diaphragm valve (located between the equalization tank and the DAT), and (3) turn off the blowers by turning the power switch to the [off] position. Then the operator will check and verify that the transfer pump is no longer cycling and then close the ball valve on the discharge line (located next to the transfer pump). This will prevent the DAT sump from syphoning dry and will leave the DAT flooded for the next startup. If the DAT is syphoned dry and is then later refilled, an air pocket will develop in the discharge line that may cause the pump to cavitate and water to accumulate in the DAT sump. The heat pump will be the last piece of equipment turned off by turning the switch on the control panel to the [off] position.

3.4 PROCESS MONITORING SYSTEMS. The operation and function of most equipment and various process flow and level parameters are monitored by the PLC. Table 3-2 lists the instruments used to monitor various process flows or fluid levels within the tanks. The sensors provide continuous monitoring of various operational constraints or parameters for process control at a central location.

Alarm circuits (Table 3-3) are provided that indicate various conditions, system constraints, or equipment failures that must be corrected to continue proper functioning of the treatment processes. Alarm conditions are indicated on the main control panel by red lights. When an alarm condition occurs, a red strobe light will flash and a horn will sound. The horn will automatically silence after 30 seconds, or it can be turned off manually by pushing the cancel button

located at the bottom left-hand side door panel. The red strobe light will continue to flash until the alarm condition has been corrected. A high/high level in the equalization tank or in the DAT will shut off the recovery well pumps and activate an alarm. Once the water level subsides to the lower level sensor, the system will reactivate. A 60-minute timer has been set in the PLC to shut the blowers off in the event the water in the equalization tank does not subside and trip the low-level sensor. The same timer is activated if a high-level alarm condition occurs in the DAT sump. All alarm conditions are indicated on the control panel by red lights.

Table 3-2
Process Monitoring System

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Monitored Operational Parameter	Gauge(s) Identifier	Instrument Function	Range
Recovery well flow	FQI-1 to FQI-4	Indicate and totalize	0 to 10 gpm
Recovery well flow	FQI-6	Indicate and totalize	0 to 15 gpm
Recovery well pump discharge pressure	P-1A/B to P-5A/B	Indicate	0 to 100 psi
Effluent pump discharge flow	FQI-E	Indicate and totalize	0 to 65 gpm
DAT vapor discharge temperature	TI-1	Indicate	70 to 90 °F
Carbon canister pressure differential	DPI-1 to DPI-4	Indicate	0 to 20 in. w.c.
Carbon canister discharge manifold temperature	TI-3	Indicate	70 to 100 °F

Notes: gpm = gallons per minute.
DAT = diffused aeration tank.
in. w.c. = inches of water column.
psi = pounds per square inch.
°F = degrees Fahrenheit.

Table 3-3
Alarm Conditions

Operations and Maintenance Manual
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Location	Alarm Initiation
Equalization tank T-01	High/high level
DAT blower B-01 discharge	Air flow low pressure failure
Heat pump failure	Pressure drop and high discharge temperature
DAT tank	High/high level

Notes: If heat pump fails, contact a certified heating, ventilation, and air conditioning contractor.

DAT = diffused aeration tank.

Recovery well pumps will shut off if the water level comes in contact with the low-level sensor, which is situated approximately 2.0 feet above the top of screen. The pump(s) will restart automatically when the water level rises and comes in contact with the high-level sensor. This does not cause the alarm to sound.

The heat pump compressor pressure and discharge temperature are monitored at all times. If the internal pressure is lost due to leaks or if the discharge temperature rises above 110 °F, an alarm will be activated and the entire treatment system will shut off. The heat pump should be serviced and/or inspected by a certified HVAC contractor before normal operations continue.

Table 3-4 lists problems that can occur to the process equipment and the probable causes and solutions for these problems. If other conditions occur, refer to the individual manufacturer's manuals and specification sheets provided in Appendix A.

Table 3-4
Common Operating Problems

Operations and Maintenance Manual
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Problem	Cause	Solution
Centrifugal Pumps		
Pump will not start	Blown fuses	Replace fuse
	Faulty circuit	Check circuit
	Pump shaft binding	Inspect shaft
Reduced discharge	Low motor speed	Check voltage
	Impeller partly clogged	Clean impeller
	Pump cavitation	Pull and inspect pump
	Head losses in discharge pipe too high	Clean discharge pipe
High power requirements	Bent pump shaft	Install new shaft
	Damaged bearings or impeller	Replace
Noisy pump	Incomplete priming	Reprime
	Suction lift too high	Raise pump
	Suction inlet not submerged	Submerge inlet
	Improper lubrication	Lubricate
	Head losses in discharge pipe too high	Clean discharge pipe
	Pump not secured to foundation	Tighten bolts
DAT Blower		
Low capacity	Incorrect rotation	Reverse rotation
	Speed too low	Check voltage and amperage
	Louver not properly adjusted	Adjust louver
	Piping partially plugged	Clear piping
	Air leak in system	Seal leak
	Wheel mounted backwards on shaft	Remount wheel
Low flow, high pressure	Scale buildup on diffuser pipes	Clean diffusers
Vibration or noise	Loose foundation or supports	Tighten supports
	Worn bearings	Replace bearings
	Broken or loose set screws	Replace screw
	Damaged wheel or motor	Replace wheel or motor
	Bent shaft	Replace shaft
	Unbalanced wheel or drive	Install new wheel
Overheated bearings	Improper lubrication	Lubricate
	Poor alignment	Check alignment
	Bent shaft	Replace shaft
Blower will not run	Circuit breaker tripped	Reset breaker
	Overload relay tripped	Reset relay
	DAT sump level high	Discharge water from DAT
	Air flow switch inoperative	Replace air flow switch
	Blower vanes plugged	Clean blower vanes
	Selector switch off	Turn switch to [on] position

See notes at end of table.

Table 3-4 (Continued)
Common Operating Problems

Operations and Maintenance Manual
Groundwater Extraction and Treatment System
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Naval Submarine Base
Kings Bay, Georgia

Problem	Cause	Solution
Carbon Exhaust Blower		
Blower will not run	Circuit breaker tripped	Reset breaker
	Overload relay tripped	Reset relay
	Selector switch off	Turn switch to [on] position
	Air flow switch inoperative	Replace air flow switch
	Blower vanes plugged	Clean blower vanes
Recovery Well Pumps		
Pumps will not run	Plug at well head disconnected	Connect electrical plug
	Circuit breaker tripped	Reset circuit breaker
	Blown fuses at circuit breaker	Replace fuses
	Overload relay tripped	Reset relay
	Selector switch off	Turn switch to [on] position
	DAT blower inoperative	Inspect blower
	DAT tank high/high-level alarm	Check water level in DAT sump
	Sensing probe dirty	Clean probes
	Equalization tank liquid level high	Release water from equalization tank
Reduced discharge	Low motor speed, pump dropped on well bottom	Check pump position of pump and shroud in well
	Impeller partly clogged	Clean impellers
	Y-strainer partially clogged	Clean Y-strainer
	Head losses in discharge	Check pipe for corrosion
	Impeller worn	Replace impellers
Noisy pump	Excessive strain on suction	Remove debris
	Pump resting on bottom of well	Raise pump
Heat Pump		
Severe vibration	Scale has built up on internal blower wheel	Replace blower wheel
Heat pump will not run	Circuit breaker tripped	Reset breaker
	Blown fuses at circuit breaker	Replace fuses
	Selector switch in [off] position	Turn switch to [on] position
	Compressor lost pressure	Contact HVAC contractor
	Corrosion breakthrough of header piping or coil	Replace copper tubing
Carbon Canisters		
Pressure drops	Excessive moisture	Replace canisters and check demister pad and heat pump
Corrosion	Hydrogen sulfide, oxidation	Replace canisters
Demister Pad		
Increased (vapor) back pressure	Saturated, clogged pad	Replace pad

Notes: DAT = diffused aeration tank.
HVAC = heating, ventilation, and air conditioning.

4.0 SAFETY

The operating contractor will maintain full responsibility for the health and safety of its employees. Chapter 6.0 is designed to provide the operating contractor with specific health and safety issues that may arise during the course of operating the groundwater treatment system. The operating contractor must complete its own health and safety plan (HASP) to meet its company. The contractor shall also comply with Occupational Safety and Health Administration (OSHA) 29 CFR 1910.

4.1 GENERAL. Accident prevention is the result of thoughtfulness and the application of a few basic safety principles. The three major concerns associated with the operation and maintenance of the treatment facility at NSB, Kings Bay are

- physical injury;
- dangers from noxious gases, vapor, or oxygen deficiency; and
- electrical shock.

4.2 PERSONNEL SAFETY. It is the responsibility of management to see that personnel are fully instructed in the hazards of their work. The operator must take precautions to ensure his or her own safety at work by following the safety precautions for the work involved. The suggested safety policies for this site are contained in the HASP, which was prepared before treatment compound construction and interim measure activities began. The HASP shall be modified by the operating contractor's health and safety officer for their use. The operator should be thoroughly familiar with the site HASP prior to performing any work at this site.

The prevention of physical injury begins with good housekeeping. Tools, parts, and other objects should not be left lying around. Bending the knees and lifting with the muscles of the legs can prevent back injuries due to sprains or ruptures.

4.2.1 Personal Protective Equipment Compounds of concern at this site include VOCs and semivolatile organic compounds. Exposure pathways for compounds of concern include dermal contact and inhalation. Normal work activities at this site will be conducted in Level D personal protective equipment (PPE) protection. The recommended clothing for Level D protection is

- hard hat,
- chemical-resistant rubber gloves,
- safety glasses or chemical splash goggles,
- steel-toed boots,
- coveralls, and
- hearing protection (optional).

Cartridge-type full face respirators should be kept on the site so that personnel can upgrade to Level C protection, if required.

4.2.2 Personal Habits Smoking, eating, or drinking is not allowed inside the treatment pad fencing or near the extraction wells. Smoking is a potential source of ignition for any flammable vapors present.

4.3 RESPIRATORY DANGERS. Air normally contains by volume about 21 percent oxygen and 79 percent nitrogen and traces of other gases. Air containing less than 19 percent and more than 23 percent oxygen by volume represents a dangerous working atmosphere. The oxygen content should be checked for any working atmosphere before work is accomplished.

The water from the site may contain many potentially harmful organic vapors. To protect the operators from exposure to these gases, continuous air monitoring should be conducted, and respirators should be kept onsite and worn during any maintenance procedures if harmful vapors are detected. Vapor emissions from the treatment process will be vented to the atmosphere after passing through a series of carbon adsorption units. Special care should be taken when changing the vapor-phase carbon canisters. The lower explosive limit should be continuously monitored when personnel are working at the well heads or on the DAT.

4.4 ELECTRICAL SAFETY. The following precautions should be followed to ensure safe working conditions around electrical equipment.

- A regular and organized program of preventive maintenance should be instituted for all electrical equipment to reduce or eliminate electrical hazards.
- All operating and maintenance personnel should be trained in the handling and use of electrical machinery and equipment.
- To extinguish fires in electrical equipment, use only nonconducting extinguishing agents that minimize shock hazard to the operator and do not permanently damage the equipment, e.g., carbon dioxide or dry chemical extinguishers.
- Allow only authorized and qualified electricians to work on any part of the electrical system.
- Provide lockout switches and tags on the controls to all offsite or remotely located electrical equipment for use during maintenance and repair work.
- Do not work on energized equipment.
- Use emergency stop buttons to isolate electrical equipment (remote from the main control center) and tag the equipment "out-of-service."
- Be sure electrical controls, switch boxes, and distribution panels are identified and easily accessible.
- Safety tools, special devices, and protective clothing should be used when working on or near energized circuits.

The above recommendations are not inclusive of safety precautions that may be recognized by the operators through normal work experience.

4.5 MECHANICAL SAFETY. Use extreme caution when working around groundwater treatment equipment. Valve handles, sample ports, and other protruding components can cause severe injury to body parts that strike them. Workers should wear hard hats and safety glasses and should move cautiously when working under piping and around the equipment.

Before attempting to perform maintenance on system components and equipment and especially when attempting to disassemble individual components, workers must be certain that the components are isolated from pressure, fluids, and electricity. Spring-loaded devices such as valves should be in their "relaxed" state, that is, with no compression on the loading spring to avoid the sudden and accidental motion of individual parts. An accidental and sudden release of pressure or fluid, accidental contact with energized electrical components, or the sudden movement of equipment parts during maintenance procedures can result in severe injury to workers.

4.6 HEALTH AND SAFETY TRAINING. All operating personnel must be properly trained in accordance with OSHA 1910.120 (USEPA, 1993) prior to commencement of any work at this site. Workers must also be familiar and comply with all requirements of the HASP prepared for this site. The HASP includes, but is not limited to, the following:

- the name of a site health and safety officer and the names of key personnel and alternates responsible for site safety and health;
- a health and safety risk analysis for existing site conditions and for each site task and operation;
- a description of PPE to be used by employees for each of the site tasks and operations being conducted;
- medical surveillance requirements;
- a description of the frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used;
- site control measures;
- decontamination procedures;
- standard operating procedures for the site;
- a contingency plan that meets the requirements of 29 CFR 1910.120 (USEPA, 1993);
- a roster of trained and certified personnel allowed on the site; and
- location of nearest hospital.

5.0 MAINTENANCE

An efficient and well-run treatment facility has to incorporate a comprehensive preventive and corrective maintenance program. The maintenance of any treatment facility is totally dependent upon the competence and the attitude of the personnel who carry out the work. A thorough knowledge of the facility's equipment and maintenance systems by the operators will, over a period of years, keep operating costs to a minimum. This chapter provides an overview of the maintenance activities that must be conducted to maintain trouble-free operations of the interim measure groundwater treatment system.

5.1 GENERAL. A routine preventive maintenance program involving inspection, lubrication, and upkeep of a concise system of recordkeeping will help minimize equipment repairs. Preventive maintenance is the process of inspecting, cleaning, and adjusting equipment to prevent costly equipment failures. When equipment no longer functions as designed, corrective maintenance becomes necessary and system efficiency suffers. In order to minimize system down time, it is recommended to have a reasonable number of necessary spare parts on hand for minor items expected to require periodic replacement, e.g., submersible pump, meters, valves, o-rings, PVC pipe and fittings, etc.

The treatment system at NSB, Kings Bay requires routine maintenance in 13 major areas. These include the following:

- recovery well pumps,
- recovery well vaults (includes plumbing components),
- manifold (includes plumbing components),
- equalization tank,
- DAT,
- transfer pump,
- 3-inch discharge line,
- demister pad,
- heat pump,
- vapor-phase carbon canisters,
- carbon canister differential pressure indicators,
- equipment pad and decontamination pad sumps, and
- recovery wells.

The frequency at which these items require maintenance is shown in Table 5-1. The sections of the operations and maintenance manual where maintenance procedures are described are also shown in this table. A checklist for scheduled maintenance activities is provided in Appendix D.

5.2 RECOVERY WELL PUMPS. A complete understanding of pump construction and operation is essential to provide proper maintenance. To better understand the performance and operating characteristics of the recovery well extraction pumps, the operator should become familiar with the pump curve that is supplied by the manufacturer for each pump installed (Appendix A). The pump curves usually show three curves on one sheet. The head capacity curve shows the discharge in gpm that the pump will deliver against various heads when operating at the proper speed. A study of this curve will show that as the head increases, the discharge

decreases until there is no further discharge. The head at which this happens is called the shutoff head. A second curve shows the efficiency at which the pump will operate at the various points on the head capacity curve. The third curve shows the horsepower input required to pump at various points on the curve. This is called the brake horsepower curve. The power required by the pump, as well as the pump efficiency, can be computed or read from the curve for any set of conditions.

Table 5-1
Maintenance Requirements for Treatment System

Operations and Maintenance Manual
Groundwater Extraction and Treatment System
Revision No. 1
Naval Submarine Base
Kings Bay, Georgia

Item	Minimum Maintenance Frequency	Section and Page Number
Recovery well pumps	Semiannually	5.2, page 5-1
Recovery well vaults	Monthly, annually	5.3, page 5-3
Totalizing flow meters	Monthly	5.4, page 5-4
Equalization tank	Monthly	5.5, page 5-4
Diffused aeration tank	Biweekly, monthly	5.6, page 5-5
Transfer pump	Annually	5.7, page 5-6
3-inch discharge line	Annually	5.6, page 5-5
Heat pump	Quarterly	5.8, page 5-7
Vapor-phase carbon canisters	Quarterly	5.9, page 5-7
Carbon canister differential pressure indicators	Weekly	5.9, page 5-7
Equipment pad and decontamination pad sumps	As needed	5-10, page 5-7
Recovery wells	Annually	5.11, page 5-8

Weekly inspections of specific pressure gauges and strainers will aid in prevention of damage to individual pumps. Special attention should be given to the following items:

- unusual noise inside the well vaults,
- clogging of the Y-strainers,
- vibration and noise in the pump operation,
- abnormal pressure drops as indicated by the pressure gauges, and
- rotation of shaft(s) when pumps are pulled semiannually or as needed. If left in place (submerged) and not operated, they should be operated for short periods of time (on a monthly basis).

Pumping groundwater often results in higher wear than potable water due to the presence of grit, biological growth, and groundwater chemistry. Pumps should be inspected semiannually (at a minimum). Amperage draw should be checked annually.

When a pump does require maintenance, follow the steps outlined below.

1. Tag-out the system power at the control panel and at the main breaker.

2. Tag-out the pump to be worked on.

3. Unplug the power cord located in the well head and then disconnect the level sensors. The sensors have to be disconnected before the pump and discharge hose can be removed from the well.

4. Remove the pump from the recovery well, being careful not to cut the level sensor wires or the discharge hose on the sharp edge of the stainless-steel casing. The pump and discharge hose should be coiled to allow easy transporting and cleaning.

5. Take the pump and discharge hose back to the decontamination pad for dismantling and cleaning.

6. Disconnect the flexible discharge hose from the nipple on top of the pump.

7. Remove the pump shroud and clean off any debris that may have collected on it during operation. Inspect impellers and bearings for excessive wear (on lower side, upper sides, or vanes).

8. Disassemble the pump and clean the impellers as per manufacturer's guidelines. Note the proper sequence (top to bottom) of the impellers and bowls to ensure proper reassembly.

9. Check the motor for any signs of overheating and inspect all seals.

10. Reassemble the pump, making sure that the impellers are turned in the correct position.

11. Put the shroud back on and reconnect the flexible discharge hose.

12. Clean and inspect each level sensor for any cuts or exposed wires. Exposed wires create an electrical short circuit and may cause the pump to cycle on and off improperly. If any damage is detected, replace the wiring or sensors as needed.

13. Install the pump back into the recovery well and connect level sensor wires. Connect power plug.

14. Turn system power back on and check pump operation.

5.3 RECOVERY WELL VAULTS. The recovery well vaults need to be kept free of sand and water as much as possible. This can be accomplished by maintaining a shallow

trench (0 to 6 inches deep) around the well vaults to divert surficial runoff (of water and debris). Weeds and grass also need to be removed from around the edges. During weekly activities that include collection of pressure readings from within the vaults, the operation of equipment should be observed. If any deficiencies are observed with ball valves, Y-strainers, check valves, groundwater pumps, etc., they should be corrected as soon as possible. Monthly activities within the well vaults will consist of cleaning and checking the Y-strainers, check valves, and ball valves. If large amounts of sand or biological growth are detected in the strainers, the pumps should also be inspected and cleaned.

Annual activities include cleaning the vault of sand, debris, etc. Check that "floor" drains are not clogged so that water may drain freely out of the well vaults. The weatherstripping on the well vault lid should also be replaced. It has been observed that groundwater enters into well vaults #3 and #4 through the floor drains due to the vault bottom elevation in relation to the groundwater elevation.

5.4 TOTALIZING FLOW METERS. This section contains information for servicing and maintaining the in-line flow meters. Maintenance should be preventive in nature and consist of periodic inspections and cleaning. Cleaning procedures should be performed on the meters monthly, and any defects should be corrected before attempting further operation of the meter. The flow meters should also be checked for accuracy during cleaning activities by using a bucket of known quantity, which can be checked against the meter register. If a meter is found inaccurate, a spare should be used in place of the meter, and the inaccurate meter should be sent back to the manufacturer for calibration.

The effluent totalizing flow meter has an internal screen that filters particulates out of the water before it is discharged to the sanitary sewer manhole. If the discharge flow rate starts to decrease, take this meter apart and clean the screen. Detailed assembly instructions for all meters can be found in Appendix A.

Visually inspect the meters for loose connections, broken register glass, indicator dials not working, or any other signs of wear or deterioration. Repair or replace components as required. A spare meter should be kept onsite in case a meter becomes defective.

5.5 EQUALIZATION TANK. The equalization tank does not require a great deal of maintenance. Visually inspect the tank monthly to determine when maintenance is needed. When biological buildup does become a problem in the equalization tank, follow the steps outlined below.

1. Turn off all recovery well pumps so that no additional water is being pumped into the tank. Shut down the system as outlined in Section 3.3.

2. Allow as much water to gravity drain into the DAT as possible and then shut the diaphragm valve and gate valve located on the 4-inch PVC pipe that feeds into the DAT.

3. After the water has been removed from the equalization tank, loosen the two unions in the 4-inch PVC line and clean out any sludge that has accumulated in this pipe. Entry into the equalization tank should never be attempted during cleaning activities.

4. After the equalization tank is completely empty, it can be thoroughly cleaned with a high-pressure wash system. Refer to Chapter 6.0 for health and safety issues. Sand or other debris remaining in the tank bottom can be removed with a wet and dry vacuum.

5.6 DAT. Under normal operating conditions, the DAT can become fouled with biological growth and iron from the groundwater. Biomass builds up on the diffuser pipes and the (drop pipe) weirs. This fouling causes restrictions in the DAT chambers, which causes back pressure on the DAT blower with loss of efficiency and effectiveness of stripping. If allowed to accumulate, fouling will restrict flow through the DAT, resulting in automatic system shutdown.

Biweekly shocking of the DAT with household bleach or calcium hypochlorite helps to break down the biological growth in the system and reduces unscheduled system shutdowns. This also allows the system to operate longer between routine cleaning. Follow the steps listed below for shocking the treatment system.

1. Turn off all recovery well pumps.

2. Close the 3-inch ball valve on the discharge pipe. This valve is located next to the transfer pump.

3. Be sure the flexible recirculation pipe is connected from the transfer pump discharge to the equalization tank and then open the 2-inch ball valve. This puts the treatment system in a closed loop process.

4. Add a bag of Shock-It℠ to the equalization tank.

5. Allow the system to recirculate this water for approximately 2 hours.

6. After the chlorination treatment is complete, test for residual chlorine. If less than or equal to 3 percent chlorine, open the 3-inch ball valve on the discharge pipe, close the 2-inch ball valve on the recirculation line, and restart the recovery well pumps.

In addition to periodic chlorination, it will be necessary to conduct more extensive cleaning when excessive accumulation does occur. It is best to conduct this cleaning following the shock treatment. The steps are listed below for cleaning the system.

1. Turn recovery well pumps off and allow as much water to discharge to the sanitary sewer as possible.

2. When the water level in the equalization tank has dropped so that no additional water is coming into the DAT, turn the main switch on the control panel to the [off] position.

3. Close the diaphragm valve on the feed pipe of the DAT.

4. Conduct air monitoring at the openings of the DAT to ensure that no harmful vapors are present.

5. Use a portable centrifugal pump to discharge the water from the DAT chambers and sump to the sanitary sewer.

6. After all the water has been removed, the diffuser pipes can be removed by loosening the unions and lifting the diffusers out of the DAT chambers.

7. Each of the eight chambers and the DAT sump can now be cleaned by using a pressure washer along with cleaning agents or by using scouring pads and a soft-scrub cleaner.

8. The demister pad needs to be removed from the top of the DAT and sprayed with a hose to remove any buildup. After the pad is clean, replace it.

9. Clean each diffuser pipe, being careful not to lose the o-rings at the inlet of each pipe. If these are lost, a tight seal cannot be maintained and the diffusers will leak. Extra o-rings should be kept in the supply trailer. A spare set of diffusers is kept onsite to reduce system downtime.

10. Reinstall three diffusers in each chamber except chambers 7 and 8, which only have two diffusers.

11. Once the DAT has been cleaned, follow normal startup procedures outlined in Section 3.1.

In addition to the periodic maintenance that must be conducted on the DAT, maintenance is also required on the 3-inch-diameter discharge line that connects the DAT to the sewer manhole. After a period of time, biological mass builds up on the inner walls of the discharge pipe and creates a restriction. The operator can monitor the effluent totalizing flow meter to detect restrictions in the pipe. Three clean-outs were installed in the discharge piping so that any buildup in the pipe could be easily removed. It is suggested that this line be serviced by a certified plumber once per year.

5.7 TRANSFER PUMP. The transfer pump accumulates biological growth with resultant loss of efficiency. The efficiency of the pump usually increases each time the DAT is shocked with chlorine. Standard operating range for the transfer pump is between 57 to 65 gpm. If the pump flow rate does not increase after shocking, the pump should be dismantled and inspected. See Appendix A for equipment submittals. The manufacturer's manual has detailed instructions on how to take the pump apart and clean it. Follow manufacturer's instructions carefully.

Occasionally, loss in performance of the transfer pump may be due to buildup of biological growth in the effluent pipe to the sewer manhole. The pipe should be checked for fouling and cleaned if necessary. Also, biological or sediment buildup may occur in the effluent flow meter. Check the totalizing flow meter

for particles that may have become trapped on the internal filter. If the filter is clogged, clean the filter with water and reassemble the meter.

5.8 HEAT PUMP. High levels of hydrogen sulfide gas have been detected during the operation of the treatment system. To reduce the corrosion potential, the heat pump is coated with heresite. This will prevent the copper tubing and coil from corroding and causing the system to shut down. The refrigerant levels in the compressor need to be checked periodically and refilled when needed. Occasionally inspect the condensation drain and remove any debris that could cause it to be clogged. Noncoated equipment and/or components will result in rapid failure. The heat pump should be checked by licensed HVAC personnel for proper operation on a quarterly basis.

5.9 VAPOR-PHASE CARBON CANISTERS. The effluent vapor from the DAT is routed into an 8-inch-diameter header pipe that splits the vapor stream into four parallel streams. These vapor streams are drawn through vapor-phase carbon canisters by the second blower (B-02), which applies negative pressure to the canisters. The relative humidity and temperature of the vapor is controlled by a demister pad and a heat pump before entering the four activated carbon canisters.

The flexible hose connecting the PVC header to the inlet of the carbon vessels should be checked periodically for any cuts or punctures. Hoses found to be damaged should be replaced immediately.

Differential pressure gauges have been installed on each carbon canister. These gauges shall be monitored weekly to detect any increase in pressure. If the pressure begins to increase, isolate the vessel. Drain ports in the bottom of each canister need to be opened to drain off excess water that has collected. If the humidity control is operating properly, there should not be any water accumulating in the canisters.

The 3/8-inch flexible tubing that is used on each of the differential pressure gauges shall be inspected weekly. If the hose is cut, punctured, or decayed, replace it.

The differential pressure gauges shall be checked each time the system is down for maintenance to verify that the needles are pointing to zero. If any gauge is not reading zero, then refer to the manufacturer's product sheet in Appendix A for instructions on calibrating the instrument.

5.10 EQUIPMENT PAD AND DECONTAMINATION PAD SUMPS. The equipment pad and decontamination pad both have sumps that collect all washdown water and rain water. The equipment pad also collects any process water that may be present from leaks or system cleaning operations. Each sump has a pump that is controlled by a float switch that empties collected water into the equalization tank so that it can be treated.

Over a period of time, debris and sand collect in the sumps. The sumps shall be monitored for proper operation weekly. Debris shall be removed from the sump and inlet section of the pump monthly, or as needed.

5.11 RECOVERY WELLS. During the installation and continued operation of recovery wells, the filter packs surrounding the well casings can become less efficient. This reduction in efficiency can be attributed to the existence of clay material from drilling fluids, natural silt and clay buildup, and bioaccumulation and scale buildup. To help maintain the production of the recovery wells, redevelopment activities should be accomplished annually. These activities include injecting acids into the wells and surging the wells to help push the acids into the filter pack. After treatment, these acids along with any clay and biogrowth particles can be removed from the well utilizing high capacity pumps. The removed liquids can then be transported and treated with the existing groundwater treatment system.

5.12 WARRANTY PROVISIONS. Most manufacturers warrant their products against defective workmanship and materials for a period of 1 year after date of installation. If a piece of equipment fails during the warranty period, the manufacturer should be notified at once prior to any service being performed. Unauthorized service can invalidate the warranty. The operator should become familiar with the warranty certificates for each piece of equipment. The operator should not attempt to service the equipment unless he or she is qualified by the manufacturer.

5.13 ELECTRICAL SERVICE MAINTENANCE. Before any electrical work is undertaken, proper lock-out procedures shall be implemented. All electrical maintenance shall be completed by a qualified technician. Maintenance of electrical components, which include motor starters and contactors, relays, control circuits, wiring, and general control systems, shall be conducted annually at a minimum and shall include voltage and current resistance checks. The control panel shall also be inspected yearly and electrical components shall be cleaned of any dust, oil, rust, corrosion, or moisture observed. All connections shall be inspected for tightness.

6.0 MONITORING REQUIREMENTS

6.1 COMPLIANCE MONITORING. During the continued operation of the treatment facility, samples must be collected and analyzed to document compliance with the discharge criteria set forth in the discharge permit (Appendix B). The current permit will expire on December 15, 1999.

The sample collection frequency and the analyses to be performed are listed in Tables 6-1, 6-2, and 6-3. Following the treatment process, samples should be collected from the effluent pipe prior to discharge to the sanitary sewer. The sample port for collection of this sample is labeled ET-07. Samples of offgases should also be collected from the sample port labeled IC-17 located in the air effluent stack. The air permit is also located in Appendix B.

Table 6-1
Performance Monitoring

Operations and Maintenance Manual
Groundwater Extraction and Treatment System
Revision No. 1
Naval Submarine Base
Kings Bay, Georgia

Analysis	Frequency	Analytical Method
Volatiles	1 per 6 months	CLP-TCL
Semivolatiles	1 per 6 months	CLP-TCL
Metals		Methods 6010, 7421[1]
ETPs		Parameter dependent[2]

[1] Effluent samples for metals.

[2] Effluent samples will be collected for the following ETPs and will be analyzed by their respective analytical methods: chloride (U.S. Environmental Protection Agency [USEPA] Method 325.2), total organic carbon (USEPA Method 415.1), total suspended solids (USEPA Method 160.2), total dissolved solids (USEPA Method 160.1), hardness (USEPA Method 130.2), and biological oxygen demand (5-day) (USEPA Method 405.1).

Notes: This monitoring schedule is subject to change based on GEPD approval and acceptance or changes in plume chemistry and migration.

ETP = engineering treatability parameters, as indicated in Table 6-2.
CLP-TCL = Contract Laboratory Program, target compound list.

6.2 PERFORMANCE MONITORING. During the operation of the treatment system, specific hydraulic data should be collected and monitored. This is done so that (1) flow from the recovery wells and drawdown elevations are at optimum conditions, (2) the capture zone created by the GWE system is maintained, and (3) problems within the equipment can be detected and corrected before damage or failure occurs.

Table 6-2
Analytical Requirements for Interim Measure Phase II Operations

Operations and Maintenance Manual
Groundwater Extraction and Treatment System
Revision No. 1
Naval Submarine Base
Kings Bay, Georgia

Parameter	Analytical Method	Constituent	Reference
Volatile organic compounds	1990 CLP SOW	TCL (Table 6-3)	(1)
Semivolatile organic compounds	1990 CLP SOW	TCL (Table 6-3)	(1)
Metals	USEPA Method 6010	Cadmium Chromium Iron Manganese	(2)
	USEPA Method 7421	Lead	(2)
	1991 CLP SOW	TAL (Table 6-3)	(3)
Engineering treatability parameters			
• pH	Field method		
• Chloride	USEPA Method 325.2		(4)
• Total organic compound	USEPA Method 415.1		(4)
• Total suspended solids	USEPA Method 160.2		(4)
• Total dissolved solids	USEPA Method 160.1		(4)
• Hardness, total (as $CaCO_3$)	USEPA Method 130.2		(4)
• Biochemical oxygen demand (5-day)	USEPA Method 405.1		(4)

References:

(1) CLP SOW for Organic Analysis (USEPA, 1992).
(2) Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846, 3rd edition (USEPA, 1986).
(3) CLP SOW for Inorganic Analysis (USEPA, 1991).
(4) Methods for Chemical Analysis of Water and Wastes, USEPA-600/4-79-020, revised March 1983.

Notes: CLP = Contract Laboratory Program (USEPA).
SOW = Statement of Work.
TCL = target compound list.
USEPA = U.S. Environmental Protection Agency.
TAL = target analyte list.
$CaCO_3$ = calcium carbonate.

Table 6-3
Target Compound List and Target Analyte List

Operations and Maintenance Manual
Groundwater Extraction and Treatment System
Revision No. 1
Naval Submarine Base
Kings Bay, Georgia

Parameter: Volatile Organic Compounds
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multimedia, Multiconcentration.

1,1-Dichloroethane	2-Hexanone	Chlorobenzene	Tetrachloroethene
1,1-Dichloroethene	4-Methyl-2-pentanone	Chloroethane	Toluene
1,1,1-Trichloroethane	Acetone	Chloroform	trans-1,3-Dichloropropene
1,1,2-Trichloroethane	Benzene	Chloromethane	Trichloroethene
1,1,2,2-Tetrachloroethane	Bromodichloromethane	cis-1,3-Dichloropropene	Vinyl chloride
1,2-Dichloroethane	Bromoform	Dibromochloromethane	Xylene (total)
1,2-Dichloroethene (total)	Bromomethane	Ethylbenzene	
1,2-Dichloropropane	Carbon disulfide	Methylene chloride	
2-Butanone	Carbon tetrachloride	Styrene	

Parameter: Semivolatile Organic Compounds
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multimedia, Multiconcentration.

1,2-Dichlorobenzene	2,4,6-Trichlorophenol	Benzo(a)pyrene	Fluoranthene
1,2,4-Trichlorobenzene	2,5-Dinitrotoluene	Benzo(b)fluoranthene	Fluorene
1,3-Dichlorobenzene	3-Nitroaniline	Benzo(g,h,i)perylene	Hexachlorobenzene
1,4-Dichlorobenzene	3,3'-Dichlorobenzidine	Benzo(k)fluoranthene	Hexachlorobutadiene
2-Chloronaphthalene	4-Bromophenyl-phenylether	bis(2-Chloroethoxy)methane	Hexachlorocyclopentadiene
2-Chlorophenol	4-Chloro-3-methylphenol	bis(2-Chloroethyl)ether	Hexachloroethane
2-Methylnaphthalene	4-Chloroaniline	bis(2-Ethylhexyl)phthalate	Indeno(1,2,3-cd)pyrene
2-Methylphenol	4-Chlorophenyl-phenylether	Butylbenzylphthalate	Isophorone
2-Nitroaniline	4-Methylphenol	Carbazole	n-Nitroso-di-n-propylamine
2-Nitrophenol	4-Nitroaniline	Chrysene	n-Nitrosodiphenylamine
2,2'-oxybis(1-Chloropropane)	4-Nitrophenol	Di-n-butylphthalate	Naphthalene
2,4-Dichlorophenol	4,6-Dinitro-2-methylphenol	Di-n-octyl phthalate	Nitrobenzene
2,4-Dimethylphenol	Acenaphthene	Dibenz(a,h)anthracene	Pentachlorophenol
2,4-Dinitrophenol	Acenaphthylene	Dibenzofuran	Phenanthrene
2,4-Dinitrotoluene	Anthracene	Diethylphthalate	Phenol
2,4,5-Trichlorophenol	Benzo(a)anthracene	Dimethylphthalate	Pyrene

Parameter: Inorganic Analytes
Method: Contract Laboratory Program Statement of Work for Inorganic Analysis

Aluminum	Calcium	Lead	Selenium
Antimony	Chromium	Magnesium	Silver
Arsenic	Cobalt	Manganese	Sodium
Barium	Copper	Mercury	Thallium
Beryllium	Cyanide	Nickel	Vanadium
Cadmium	Iron	Potassium	Zinc

Weekly measurements of water levels and flow rates of each recovery well shall be taken during operation. These data should be compared to historic flow rates and drawdowns to gauge performance of each well (Table 6-4). All measurements should be recorded in a bound, field notebook. The data can be used to continue engineering evaluation of the GWE system.

Table 6-4
Drawdowns to Gauge Well Performance

Operations and Maintenance Manual
Groundwater Extraction and Treatment System
Revision No. 1
Naval Submarine Base
Kings Bay, Georgia

Flow Rates	Goal Flow Rates (gallons per minute)	Well	Associated Drawdown (feet)
FQI-01	6 to 7	RW-1	16 to 17.5
FQI-02	9 to 10	RW-2	16 to 17
FQI-03	8 to 9	RW-3	15.5 to 16.5
FQI-04	8 to 9	RW-4	19.5 to 22.0
FQI-06	13 to 14	RW-6	5 to 5.5

In addition to recovery well flow rates, the transfer pump flow rate shall be monitored to detect hydraulic flow problems with the effluent of the DAT. When the system begins to foul due to biological growth or iron buildup, the transfer pump flow rate will steadily decrease, indicating that maintenance procedures on the DAT, transfer pump, or 3-inch-diameter discharge line connecting the treatment system to the sewer manhole are required. Refer to Sections 4.6 and 4.7 of this manual for maintenance procedures.

As shown on the system monitoring data sheet in Appendix B, other system monitoring parameters include

- conveyance line pressure readings taken at the treatment pad and at the well head;
- total gallons pumped from each recovery well;
- flow readings for combined flow going into the equalization tank;
- velocity of the airstream leaving the stack;
- temperature readings of the airstream and ambient temperature;
- precipitation events using a rain gauge indicating when the event occurred, duration of the event, and the rainfall quantity;

- differential pressure readings on each vapor-phase carbon canister; and

- estimated flow into the DAT.

Each of these system parameters shall be checked and recorded each day the operator is on the site. The operations contractor needs to establish a complete data and information tracking system so that trends can be readily assessed.

REFERENCES

ABB Environmental Services, Inc., 1995, Operation and Maintenance Manual, Groundwater Treatment System, Naval Submarine Base, Kings Bay, Georgia, April 1995.

Georgia Department of Natural Resources, 1994, Rules of Georgia Department of Natural Resources Environmental Protection Division; Rules for Safe Drinking Water: Chapter 391-3-5, revised March 1994.

U.S. Environmental Protection Agency (USEPA), 1983, Methods for Chemical Analysis of Water and Wastes: EPA-600/4-79-020, Cincinnati, Ohio, March 1983.

USEPA, 1986, Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846, 3rd edition.

USEPA, 1991, Contract Laboratory Program, Statement of Work for Inorganic Analysis: USEPA Document No. ILM02.1, last revised October 1991.

USEPA, 1992, Contract Laboratory Program, Statement of Work for Organics Analysis: USEPA Document No. OLC01.6, October.

USEPA, 1993, Occupational Safety and Health Standards, Subpart Z, Toxic and Hazardous Substances, Air Contaminants: Title 29, Code of Federal Regulations, Part 1910, Section 1000, revised July 1.

USEPA, 1996, Drinking Water Regulations and Health Advisories, revised October 1996.

APPENDIX A

MANUFACTURER SUPPLIED EQUIPMENT SPECIFICATIONS AND EQUIPMENT MANUALS

Manufacturer Supplied Specifications and Equipment Manuals Index

A-1 Diffused Aeration Tank
A-2 Equalization Tank
A-3 Heat Pump
A-4 Carbon Units
A-5 Blower
A-6 Effluent Transfer Pump
A-7 Sump Pumps
A-8 Groundwater Extraction Pumps
A-9 Flowmeters (Hershey, Kent)
A-10 Pressure Gauges (Liquid Filled, Differential)
A-11 Valves (Flap Check, Ball Check, Ball, Butterfly, Diaphragm, Gate, Globe, Lab Cocks)
A-12 Wye Strainer
A-13 Level Controls (Well, EQ, and DAT Level Sensors)
A-14 Extraction Well Pumps Electrical Receptacle Plug
A-15 Control Panel Layout

FHP MANUFACTURING
Florida Heat Pump Environmental Equipment

INSTALLATION MANUAL

SL SERIES

TABLE OF CONTENTS

Model Nomenclature..... 1
Installation..... 2
Duct System..... 3
Electrical..... 3
Well Water Application..... 4
Cooling Tower/Boiler Application..... 5
Earth Coupled Application..... 6
In-Warranty Material Return..... 6
Options..... 7
Trouble Shooting..... 8

MODEL NOMENCLATURE

SL 040 -1 VT C - F L T

SERIES:
SL - SUPER LOW-TEMP

NOMINAL CAPACITY:

VOLTAGE DESIGNATION:
0 - 115/1/60
1 - 208/1/60 & 230/1/60
2 - 277/1/60
3 - 208/3/60 & 230/3/60
4 - 460/3/60
5 - 575/3/60

CABINET CONFIGURATION:
VT - VERTICAL
HZ - HORIZONTAL
CF - COUNTERFLOW

HEAT EXCHANGER MATERIAL:
C - COPPER
N - CUPRO-NICKEL

WATER CONNECTION LOCATION:
F - FRONT

RETURN AIR LOCATION:
L - LEFT
R - RIGHT
B - BACK
F - FRONT

SUPPLY AIR LOCATION:
T - TOP
F - FRONT
R - REAR
S - STRAIGHT THRU
E - END BLOW
B - BOTTOM

FHP Manufacturing a HARROW Company 601 N.W. 65th Court, Fort Lauderdale, FL 33309
Phone: 305 / 776-5471 FAX: 305 / 776-5529

GENERAL DESCRIPTION:

The FHP SL Water-to-Air Heat Pumps provide the best combination of performance and efficiency available. Safety devices are built into each unit to provide the maximum system protection possible when equipment is properly installed and maintained.

The FHP SL Water-to-Air Heat Pumps are Underwriters Laboratories (UL) listed and Canadian Standards Association (CSA) certified for safety. The FHP SL Water-to-Air Heat Pumps are designed to operate with entering liquid temperature between 20°F and 110°F.

SAFETY CONSIDERATIONS:

Installation and servicing of this system can be hazardous due to system pressure and electrical components. Only trained and qualified service personnel should install, repair, or service equipment. Untrained personnel can perform basic functions of maintenance such as cleaning coils and replacing filters.

WARNING: Before performing service or maintenance operations on system, turn off main power to unit. Electrical shock could cause personal injury or death.

When working on this equipment, always observe precautions described in the literature, tags and labels attached to the unit. Follow all safety codes. Wear safety glasses and work gloves. Use a quenching cloth for brazing operations and place a fire extinguisher close to the work area.

MOVING AND STORAGE:

Move units in the normal "up" orientation as indicated by the arrows on each carton. Horizontal units may be moved and stored per the information on the carton, "Do Not Stack More Than 3 Units in Total Height". Vertical units are not to be moved, but may be stored one upon another at a maximum height of two units. When the equipment is received all items should be carefully checked against the bill of lading to be sure all crates and cartons have been received. Examine units for shipping damage, removing the units from the cartons if necessary. Units in question should also be internally inspected. If unit is damaged, the carrier should make the proper notation on the delivery receipt acknowledging the damage.

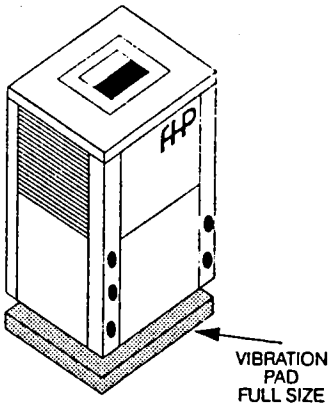
LOCATION:

Locate the unit in an indoor area that allows easy removal of the filter and access panels, and has enough space for service personnel to perform maintenance or repair. Provide sufficient room to make water, electrical and duct connection(s). If the unit is located in a confined space such as a closet, provisions must be made for return air to freely enter the space. On horizontal units, allow adequate room below the unit for a condensate drain trap and do not locate the unit above supply piping. These units are not approved for outdoor installation and therefore must be installed inside the structure being conditioned. Do not locate in the areas subject to freezing.

INSTALLATION:

MOUNTING VERTICAL UNITS:

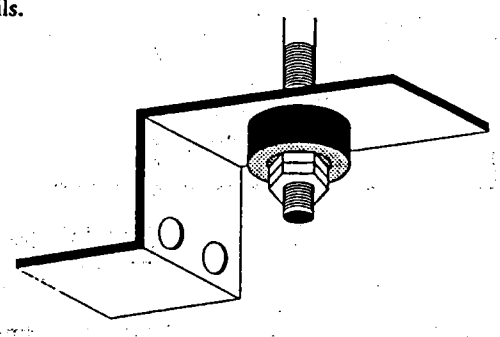
Vertical units are available in left, right, back, or front air return configurations. Vertical units should be mounted level on a vibration absorbing pad slightly larger than the base to provide isolation between the unit and the floor. (See Figure #1). It is not necessary to anchor the unit to the floor. Vertical units larger than five tons are available with front or back air return configurations. These units should be vibration isolated according to the design engineers specifications.



(Figure #1)

MOUNTING HORIZONTAL UNITS:

Horizontal units are available with side or end discharge. Horizontal units are normally suspended from a ceiling by threaded rods. The rods are usually attached to the unit corners by hanger bracket kits. (See Figure # 2). The rods must be securely anchored to the ceiling. Refer to the hanging bracket assembly and installation instructions for details.



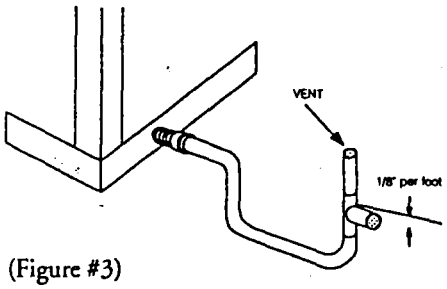
(Figure #2)

Horizontal units installed above the ceiling must conform to all local codes. An auxiliary drain pan if required by code, should be at least four inches larger than the bottom of the heat pump. Plumbing connected to the heat pump must not come in direct contact with joists, trusses, walls, etc..

Some applications require an attic floor installation of horizontal units. In this case the unit is set in a full size secondary drain pan on top of a vibration absorbing mesh. The secondary drain pan prevents possible condensate overflow or water leakage damage to the ceiling. The secondary drain pan is usually placed on a plywood base isolated from the ceiling joists by additional layers of vibration absorbing mesh. In both cases, a 3/4" drain connected to this pan should be run to the eave at a location that will be noticeable. If the unit is located in a crawl space, the bottom of the unit must be at least 4" above grade to prevent flooding of electrical parts due to heavy rains.

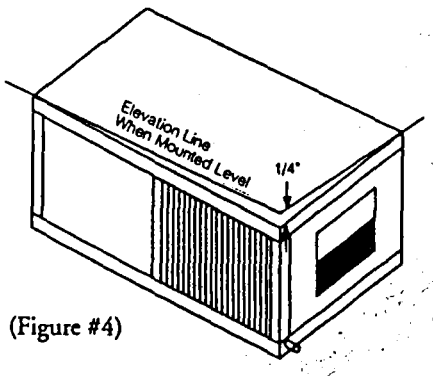
CONDENSATE DRAIN:

A drain line must be connected to the heat pump and pitched away from the unit a minimum of 1/8" per foot to allow the condensate to flow away from the unit. A trap must be installed in the condensate line to insure free condensate flow. A vertical air vent tube is sometimes required to avoid air pockets. The length of the trap depends on the amount of positive or negative pressure on the drain pan. A second trap must not be installed. This connection should be in conformance to local plumbing codes. (See Figure #3)



(Figure #3)

The horizontal unit should be pitched approximately 1/4" towards the drain in both directions, to facilitate condensate removal. (See Figure # 4)



(Figure #4)

DUCT SYSTEM:

A supply air outlet collar and return air duct flange are provided on all units to facilitate duct connections. Refer to the FHP individual data specification sheet for physical dimensions of the collar and flange.

A flexible connector is recommended for supply and return air duct connections on metal duct systems. All metal ducting should be insulated with a minimum of one inch duct insulation to avoid heat loss or gain and or forming condensate during cooling operation. Application of the unit to uninsulated duct work is not recommended as the unit's performance will be adversely affected. The factory filter is to be removed when using a filter back return air grill. The factory filter should be left in place with a free return system.

If the unit is to be installed in a new installation which includes new duct work, the installation should be designed using current ASHRAE procedures for duct sizing. If the unit is to be connected to existing ductwork, a check should be made to assure that the duct system has the capacity to handle the air required for the unit application. If the duct system is too small, larger ductwork should be installed. Check for existing leaks and repair.

The duct system and diffusers should be sized to handle the designed air flow quietly. To maximize sound attenuation of the unit blower, the supply and return plenums should be insulated. There should be no direct straight air path thru the return air grille into the heat pump. The return air inlet to the heat pump should have at least one 90 degree turn away from the space return air grille. If air noise or excessive air flow are a problem, the blower speed can be changed to a lower speed to reduce air flow.

ELECTRICAL:

Field wiring must comply with local and national fire, safety and electrical codes. Power to the unit must be within the operating voltage range indicated on the nameplate or on the performance data sheet. On three phase units, phases must be balanced within 2%.

CAUTION: Operation of unit on improper line voltage or with excessive phase imbalance will be hazardous to the unit and constitutes abuse and is not covered by warranty.

Properly sized fuses or HACR circuit breakers must be installed for branch circuit protection. See equipment rating plate for maximum size.

The unit is supplied with an opening for attaching conduit. Connect the ground lead to the ground lug in

the control box. Connect the power leads as indicated on the wiring diagram.

PIPING:

Supply and return piping must be at least as large as the unit connections on the heat pump (larger on long runs). Unit may be furnished with either a copper or optional cupro-nickel coil. Copper is adequate for closed loop systems and ground water which is not high in mineral content. Should your well driller express concern regarding the quality of well water available or should any known hazards exist in your area, we recommend proper testing to assure well water quality suitable for use with water source equipment. In conditions anticipating moderate scale formation or in brackish water a cupro-nickel heat exchanger is recommended. In situations where scaling could be heavy, or where biological growth such as iron bacteria will be present a closed loop system is recommended. Never use flexible hoses of a smaller inside diameter than that of the water connection on the unit. Check carefully for water leaks.

CAUTION: Galvanized pipe or fittings are not recommended for use with these units due to the possible galvanic corrosion.

Pipe will sweat if low temperature water is run through the supply and discharge lines. These lines should be insulated to prevent damage from condensation.

Improper heat exchanger water flow due to piping, valving or improper pump operation is hazardous to unit and constitutes abuse which will void heat exchanger and compressor warranty.

All manual flow valves used in the system must be ball valves. Globe and gate valves must not be used due to high pressure drop or poor throttling characteristics.

Do not exceed recommended condenser water flow rates. Serious damage or erosion of the water to refrigerant heat exchanger could occur.

WELL WATER SYSTEMS: (Figure #5)

Water pressure must always be maintained in the heat exchanger by placing a water control valve on the outlet of the unit. A bladder type expansion tank may be used to maintain pressure on the system.

When a water well exists for the purpose of supplying domestic water providing the well is of sufficient flow, it may be used to supply water to the heat pump. With this type of installation an electric slow closing on-off solenoid valve is required. When using a low voltage solenoid valve (24 volt) it may overload the unit transformer or interfere with the lock-out impedance circuit. If a low voltage solenoid valve is used, an upsized VA transformer may be required. Low voltage solenoid valves should be hooked to Y & C on the unit low voltage terminal board. If using a line voltage solenoid valve connect to the load side of the compressor contactor T1 & T2.

When a water well is used exclusively for the heat pump, the well pump will operate only when the unit operates. A double pole single throw (DP/ST) relay (Figure #6) can be used to control the well pump. Two or more units (Figure #7) may be supplied from one well pump.

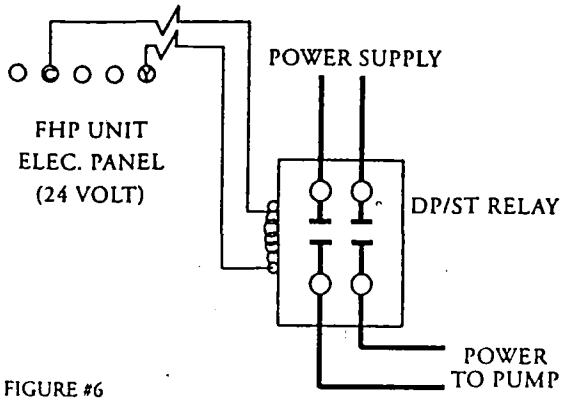
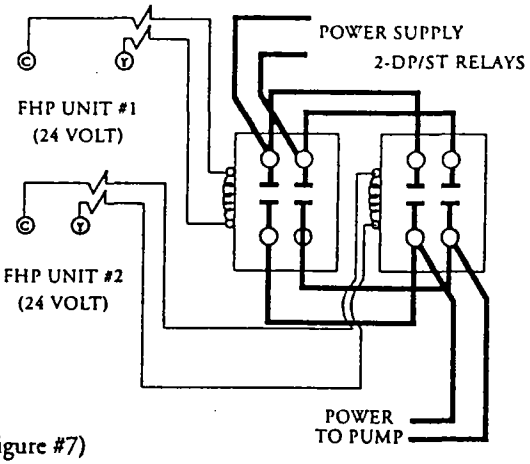
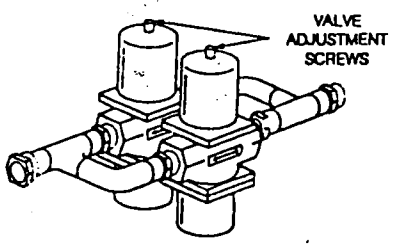


FIGURE #6

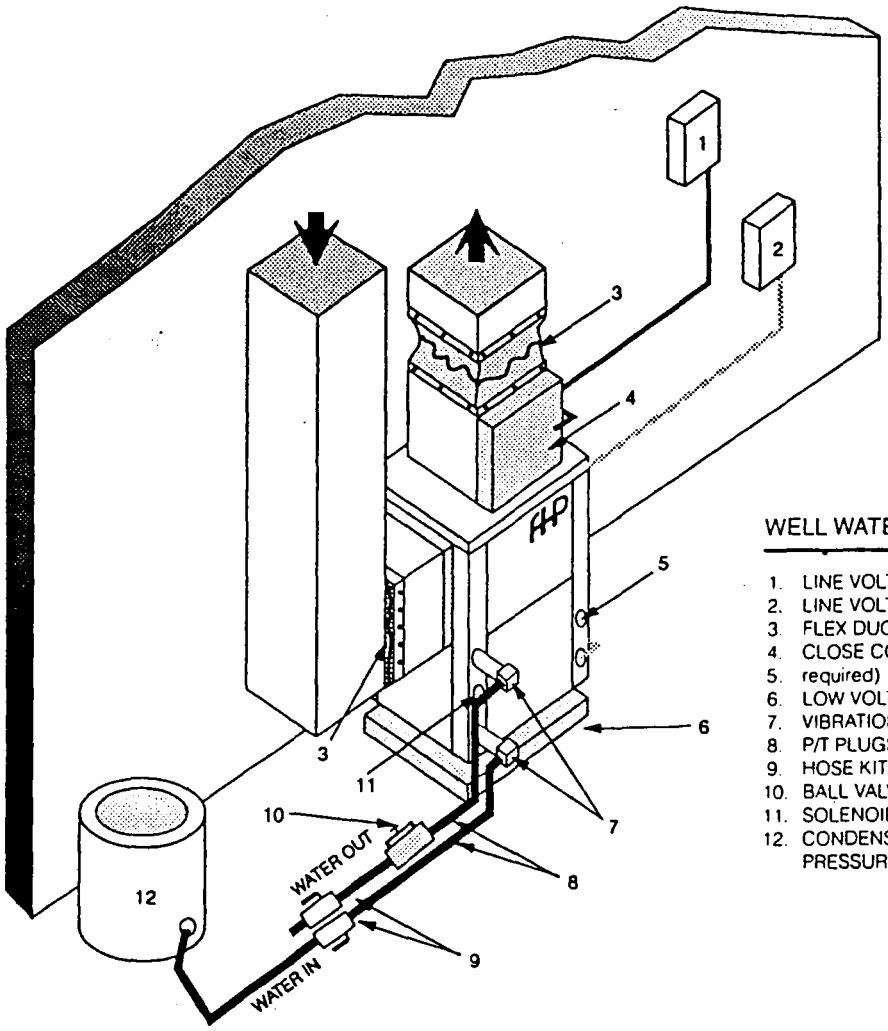


(Figure #7)

Pressure regulating valves are used to increase or decrease water flow through the heat pump in response to refrigerant pressure. (Figure#8) In some cases more water may be required in heating than in cooling, or vice versa. With the SL and LT heat pumps these valves are not required. However, if installed, a pair of valves are required for proper operation. One valve for cooling (direct acting) and another valve for heating (indirect acting) are required. A refrigerant tap is required in the refrigerant line located between the reversing valve and the water-to-refrigerant heat exchanger for proper monitoring of the refrigerant pressures.



(Figure #8)



WELL WATER APPLICATION

1. LINE VOLTAGE DISCONNECT ELECTRIC HEATER
2. LINE VOLTAGE DISCONNECT
3. FLEX DUCT CONNECTION
4. CLOSE COUPLED ELECTRIC HEATER (When
5. required)
6. LOW VOLTAGE CONTROL CONNECTION
7. VIBRATION PAD
8. P/T PLUGS
9. HOSE KITS
10. BALL VALVES
11. SOLENOID VALVE
12. CONDENSATE DRAIN CONNECTION
    PRESSURE TANK

(Figure #5)

The discharge water from the heat pump is not contaminated in any manner and can be disposed of in various ways depending on local building codes (i.e. discharge well, dry well, storm sewer, drain field, stream or pond etc.) Most local codes forbid the use of a sanitary sewer for disposal. Consult your local building and zoning department to insure compliance in your area.

COOLING TOWER/BOILER APPLICATION:

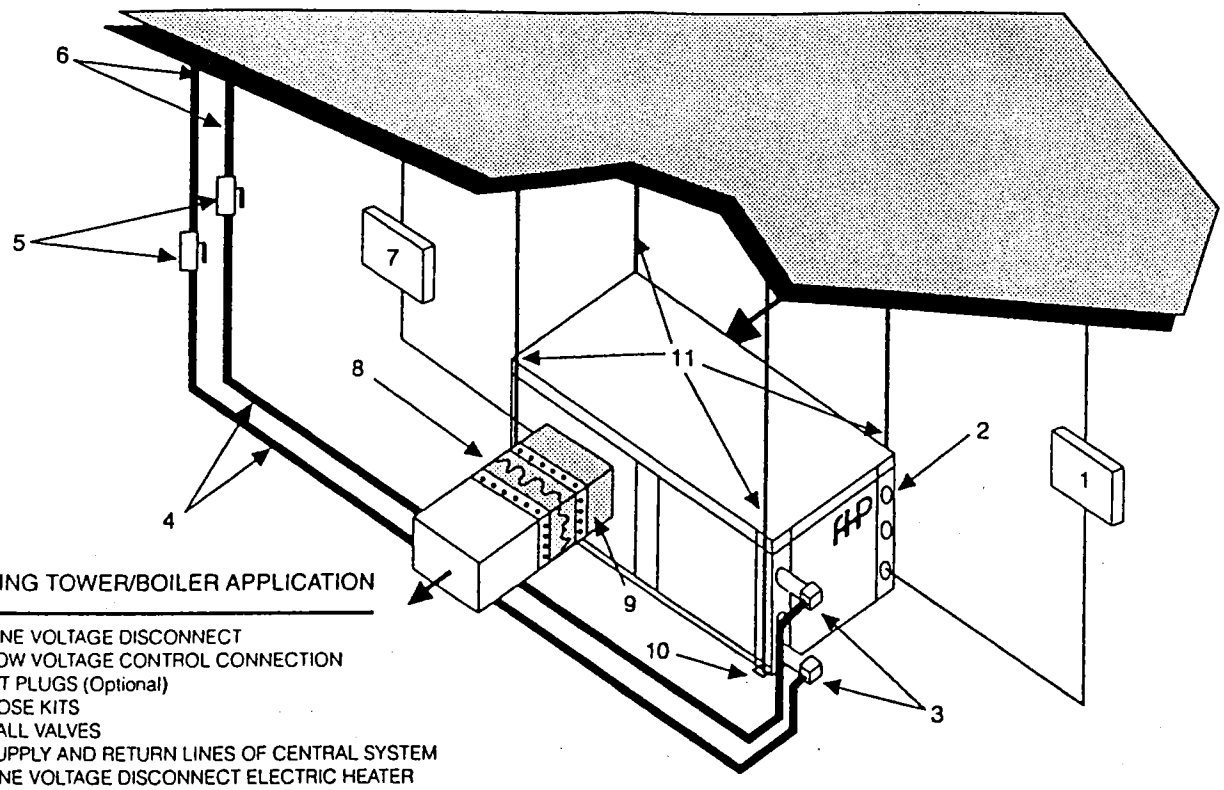
Cooling Tower and Boiler Loop Systems: (Figure #9)
The cooling tower and boiler water loop temperature is usually maintained between 50° F to 100° F to assure adequate cooling and heating performance.

In the cooling mode, heat is rejected from the FHP unit into the water loop. A cooling tower provides evaporative cooling to the loop water thus maintaining a constant supply temperature to the unit. When utilizing open cooling towers chemical water treatment is mandatory to ensure the water is free from corrosive minerals. A secondary heat exchanger (plate frame between the unit and the open cooling tower may also be used. It is imperative that all air be eliminated from the closed loop side of the heat exchanger to insure against fouling.

In the heating mode, heat is absorbed from the water loop. A boiler can be utilized to maintain the loop at the desired temperature.

CAUTION: Water piping exposed to extreme low ambient temperatures are subject to freezing .

Units are equipped with female pipe thread fittings. Consult the specification sheets for sizes. Teflon tape sealer should be used when connecting to the unit to insure against leaks and possible heat exchanger fouling. Do not overtighten the connections. Flexible hoses should be used between the unit and the rigid system to avoid possible vibration. Ball valves should be installed in the supply and return lines for unit isolation and unit water flow balancing.



COOLING TOWER/BOILER APPLICATION

1. LINE VOLTAGE DISCONNECT
2. LOW VOLTAGE CONTROL CONNECTION
3. P/T PLUGS (Optional)
4. HOSE KITS
5. BALL VALVES
6. SUPPLY AND RETURN LINES OF CENTRAL SYSTEM
7. LINE VOLTAGE DISCONNECT ELECTRIC HEATER
8. FLEX DUCT CONNECTION
9. CLOSE COUPLED ELECTRIC HEATER (When required)
10. HANGING BRACKETS ASSEMBLY
11. THREAD ROD

(Figure #9)

Pressure/temperature ports are recommended in both supply and return lines for system flow balancing. Water flow can be accurately set by measuring the water-to-refrigerant heat exchangers water side pressure drop. See specification sheets for water flow and pressure drop information.

Before final connection to the unit, the supply and return hose kit must be connected together and the system flushed to remove dirt, piping chips and other foreign material.

EARTH COUPLED SYSTEMS (Figure #10)

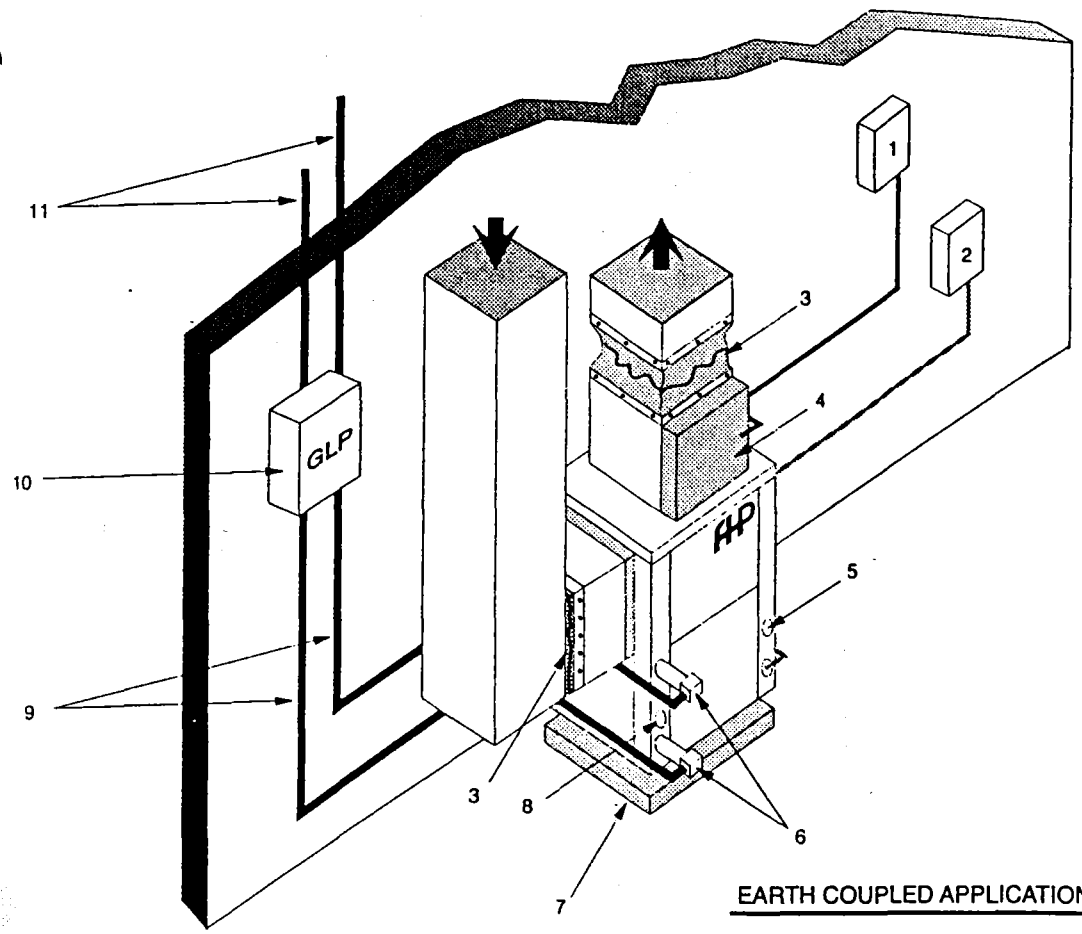
Closed loop and pond applications require specialized design knowledge. No attempt at these installations should be made unless the dealer has received specialized training.

Utilizing FHP's Ground Loop Pumping Package (GLP), makes the installation easy. Anti-freeze solutions are utilized when low evaporating conditions are expected to occur. Refer to the installation manuals for more specific instructions.

IN-WARRANTY MATERIAL RETURN

When contacting your FHP representative for service or replacement parts, refer to the model and serial number of the unit as stamped on the data plate attached to the unit.

Material may be returned only with permission by an authorized factory representative. A "Returned Goods" tag will be forward to be attached to the returned material. Enter the information as called for on the tag in order to expedite handling and insure prompt issuance of credits. All parts shall be returned to the FHP factory as



(Figure #10)

EARTH COUPLED APPLICATION

1. LINE VOLTAGE DISCONNECT ELECTRIC HEATER
2. LINE VOLTAGE DISCONNECT
3. FLEX DUCT CONNECTION
4. CLOSE COUPLED ELECTRIC HEATER (When required)
5. LOW VOLTAGE CONTROL CONNECTION
6. P/T PLUGS (Optional)
7. VIBRATION PAD
8. CONDENSATE DRAIN
9. GROUND LOOP CONNECTION KIT
10. GROUND LOOP PUMPING PACKAGE
11. POLYBUTYLENE OR POLYETHELENE WITH INSULATION

designated on the "Returned Goods" tag, freight charges prepaid. The return of the part does not constitute an order for replacement. Therefore, a purchase order must be entered through your nearest FHP representative. The order should include the part number, model number and the serial number of the unit involved. If the part is within the warranty period, and after our inspection of the returned part proves that the failure is due to faulty material or workmanship a credit/or replacement part will be issued.

OPTIONS:

- HEAT RECOVERY PACKAGE - A factory installed heat recovery package is available for water heating. See HRP literature.
- HOT GAS BYPASS – A factory installed hot gas bypass option is available for capacity control.
- ECONOMIZER COILS - A factory installed water side economizer for cooling and heating.
- HOT GAS REHEAT - A factory installed option for humidity control.
- GROUND LOOP PUMPING PACKAGE – is available for field installation. See GLP literature.
- CONTROL OPTIONS – Various control options are available such as time delays relays, random start relays, aquastats, etc. Consult factory for application assistance.

TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE	CHECKS AND CORRECTIONS
ENTIRE UNIT DOES NOT RUN	Blown fuse Broken or loose wires Voltage supply low Thermostat	Replace fuse or reset circuit breaker (Check for correct fuse) Replace or tighten the wires If voltage is below minimum voltage specified on dataplate, contact local power company. Check 24 volt transformer for burnout or voltage less than 18 volts Set thermostat to "COOL" and lowest temperature setting, unit should run. Set thermostat to "HEAT" and highest temperature, unit should run. Set fan to "ON", fan should run. If unit does not run in all 3 cases, the thermostat could be wired incorrectly or faulty. To ensure faulty or miswired thermostat, disconnect thermostat wires at unit and jumper between "R", "Y", "G" and "W" terminals and unit should run in cooling.
BLOWER OPERATES BUT COMPRESSOR DOES NOT	Voltage supply low Thermostat Wiring Safety controls	If voltage is below minimum voltage specified on the dataplate, contact local power company. Check setting, calibration and wiring Check for loose or broken wires at compressor, capacitor or contactor. The unit could be off on the cutout control safety circuit. Reset the thermostat to "OFF". After a few minutes turn to "COOL" or "HEAT". If the compressor runs, unit was in safety control lock out(See problems for possible causes)
UNIT OFF ON HIGH PRESSURE CONTROL	Discharge pressure too high Refrigerant charge High pressure switch	In "COOLING" mode: Lack of adequate water flow. Entering water too warm. Scaled or plugged condenser. In "HEATING" mode: Lack of adequate air flow. Entering air too hot Blower inoperative, clogged coil or dirty filter, restrictions in ductwork The unit is overcharged with refrigerant. Reclaim, evacuate and recharge with specified amount of R-22. Check for defective or improperly calibrated high pressure switch
UNIT OFF ON LOW PRESSURE CONTROL	Suction pressure too low Refrigerant charge Low pressure switch	In "COOLING" mode: Lack of inadequate air flow. Entering air too cold. Blower inoperative, clogged coil or dirty filter, restrictions in duct work. In "HEATING" mode: Lack of adequate water flow. Entering water too cold. Scaled or plugged condenser. The unit is low in charge of refrigerant. Locate the leak repair evacuate and recharge with specified amount of R-22 Check for defective or improperly calibrated low pressure switch.
UNIT SHORT CYCLES	Thermostat Wiring and controls Compressor overload	The differential is set too close in the thermostat. Readjust heat anticipator. Loose connections in the wiring or the control contactors defective Defective compressor overload, check and replace if necessary. If the compressor runs too hot it may be due to the deficient refrigerant charge
INSUFFICIENT COOLING OR HEATING	Unit undersized Loss of conditioned air by leaks Thermostat Airflow Refrigerant charge Compressor Reversing valve Operating pressure Refrigerant system	Recalculate heat gains or losses for space to be conditioned. If excessive rectify by adding insulation shading etc. Check for leaks in ductwork or introduction of ambient air thru doors and windows Improperly located thermostat (e.g. near kitchen sensing inaccuarately the comfort level in living areas) Lack of adequate airflow or improper distribution of air. Low on refrigerant charge causing inefficient operation. Check for defective compressor, If discharge pressure is too low and suction pressure is too high, compressor is not pumping properly. Replace compressor. Defective reversing valve creating bypass of refrigerant from discharge to suction side of compressor. Incorrect operating pressure (See chart) Check expansion valve for possible restrictions to flow of refrigerant. The refrigerant system may be contaminated with moisture, noncondensables, and particles. Dehydrate, evacuate and recharge the system

A-4

Carbon Units

GENERAL CARBON CORPORATION

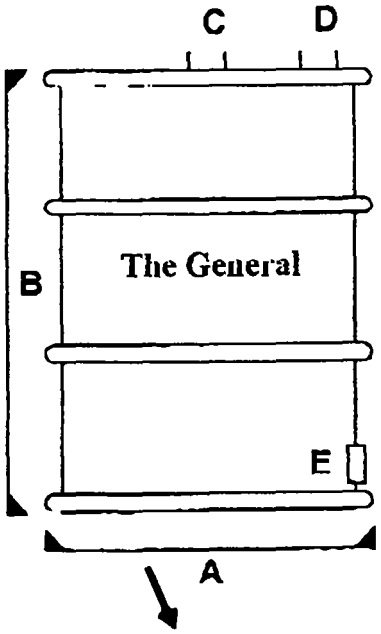
Activated Carbon

33 Paterson Street
Paterson, New Jersey 07501
Phone: (201) 523 2223
Fax: (201) 523-1494

The General

Air Pollution Control Barrels

The General air pollution barrels are ready to use, low cost, self contained air purification units that can treat air flows up to 250 CFM. **The General** is available in three different sizes to better fit your treatment application.



Specifications	55 Gallon	85 Gallon	110 Gallon
A-Diameter, Outside	24"	28"	32"
B-Height, Outside Wall	35"	39"	43"
Inlet Fitting	E 2"MPT	C 4"FPT	C 4"FPT
Outlet Fitting	C-2"MPT	D-4"FPT	D-4"FPT
Drain Fitting	E-2"MPT	E-1"FPT	E-1"FPT
Carbon Weight, Lbs	150	300	400
Max. Recommended Flow Rate, CFM	100	180	250
Maximum Pressure, psig	10	7	7
Max. design Temp., Deg F	140	140	140
Flow Direction	Upflow	Downflow	Downflow

Activated Carbon - The General vapor adsorbers are filled with virgin, high activity GC C-40 pelletized carbon. Other virgin coal, coconut shell, reactivated or impregnated carbons are available.

Removable Lid - 16 gauge lid with ring & bolt closure, poly-clad cellulose gasket.

Connections - Metal connections with standard pipe threads insure easy, durable and leakproof hookup to your system. Unions or quick connect fittings are advised to make drum exchange easy. Drains let you remove any accumulated condensate.

Flow Distributors - The 55 gallon barrel uses an air chamber to insure even distribution of the air flow through the carbon. Low pressure drop, slotted Schedule 40 PVC collectors are used in the 85 gallon and 110 gallon drums for proper flow distribution. Stainless Steel internals and drums are available for special applications.

Coatings - The General pollution control barrels are coated on the inside with heat cured phenolic epoxy. The outside coating is industrial enamel. A polyethylene liner is available for extra corrosion resistance for the 55 gallon and 85 gallon units.

Installation & Start Up - The General air pollution control barrel requires no special procedure for start up. Just connect the inlet and outlet to the treatment system and start it up. Multiple units are usually connected in series with testing advised between the units to determine when the first unit needs to be changed out.

Maintenance - Once connected, **The General** requires no maintenance other than the monitoring of the influent and effluent air streams and the operating pressure of the system. Monitoring the air stream into the last Air Pollution Control Barrel in series mode is a recommended safeguard against breakthrough in the final discharge. When the concentration of contaminants in the outflow equals the concentration in the inflow, **The General** has reached its removal capacity and should be removed from service. The working life of each adsorber is dependent upon the type of contaminant in the air as well as its concentration and the air flow rate. A pressure relief device is advised to prevent damage to the canister in the event of excessive pressure buildup.

Recharging The General - Once the carbon has reached its pollutant removal capacity, the unit should be removed and replaced with a fresh one. To purchase replacement carbon or to arrange for a carbon change out, please contact our office.

Disposal - Dispose of the spent carbon in accordance with Federal, State and Local regulations.

WARNING !

Wet activated carbon readily absorbs free oxygen. ANY entry into carbon vessels requires procedures for confined space entry and oxygen depletion be followed!

A-5

Blower

OPERATING & MAINTENANCE INSTRUCTIONS AND PARTS LIST

for
HDBI - Backward Inclined Blowers
RBE - Radial Blade Exhausters
HP - High Pressure Blowers

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⚠ DANGER

ALL FANS AND BLOWERS SHOWN HAVE ROTATING PARTS AND PINCH POINTS. SEVERE PERSONAL INJURY CAN RESULT IF OPERATED WITHOUT GUARDS. STAY AWAY FROM ROTATING EQUIPMENT UNLESS IT IS DISCONNECTED FROM ITS POWER SOURCE AND ALL ROTATING PARTS HAVE STOPPED MOVING.

READ ALL OPERATING INSTRUCTIONS CONTAINED HEREIN BEFORE INSTALLING EQUIPMENT.

⚠ DANGER

NO GUARANTEE OF ANY LEVEL OF SPARK RESISTANCE IS IMPLIED BY SPARK RESISTANT CONSTRUCTION. IT HAS BEEN DEMONSTRATED THAT ALUMINUM IMPELLERS RUBBING ON RUSTY STEEL MAY CAUSE HIGH INTENSITY SPARKS. AIR STREAM MATERIAL AND DEBRIS OR OTHER SYSTEM FACTORS MAY ALSO CAUSE SPARKS.

cincinnati fan

PART # 01001
CATALOG # PMK-992
SUPERSEDES: PMK-991

I GENERAL SAFETY NOTES

1. Rotating parts including shaft and V-belt drives must be properly guarded to prevent personal injury.

2. Electrical wiring must be accomplished by a qualified electrician in accordance with all applicable codes.

3. Care should be taken:
- Not to run fan above its safe speed (See Performance Tables in Sales Catalog or call CFV sales office).
- Not to operate in excessive temperatures (See limitations in Sales Catalog or call CFV sales office).
- Not to operate in dangerous environments.
- Read all instructions carefully.

II RECEIVING

Receiving Inspection

When unit is received, inspect immediately for damaged or missing parts. Even though all units are carefully inspected and prepared for shipment at the factory, rough handling enroute may cause concealed damage or cause nuts, set screws, bolts or locking collars to work loose. Be certain all fasteners are tightened securely. Rotate wheel by hand to verify that it rotates freely and that there are no obstructions.

Table #1

TORQUE VALUES FOR TAPERED BUSHINGS		
	MINIMUM RECOMMENDED TORQUE (INCH-LBS)	
Bushing Size	Steel Parts	Alum. Parts
H	95	60
P	192	80
Q	350	155
R	350	155

Inspect all shipments carefully for damage. THE RECEIVER MUST NOTE ANY DAMAGE ON THE CARRIER'S BILL OR LADING AND FILE A CLAIM IMMEDIATELY WITH THE FREIGHT COMPANY IN THE CASE OF ANY DAMAGE. Keep a record of all equipment received, including inspection details and date of receipt because of the possibility of partial shipments.

III HANDLING

Handle your equipment with care. Some fans are provided with lifting lugs or holes for easy handling. Others must be handled using nylon straps or well-padded chains and cables which protect the fan's coating and housing. Spreader bars should be used when lifting large parts.

Axial fans should be lifted using straps around the fan housing only. DO NOT LIFT AXIAL FANS BY THE MOTOR, MOTOR BASE, WHEEL OR FLANGES.

Centrifugal fans are best lifted using one strap under the fan's scroll and another strap around the bearing base. DO NOT LIFT CENTRIFUGAL FANS BY THE FAN SHAFT, WHEEL, FLANGES OR INLET SUPPORT.

Roof ventilators should be lifted using straps around the fan housing or base only. Spreader bars should also be used to avoid damage to stack caps or hoods. DO NOT LIFT ROOF VENTILATORS BY THE STACK CAP OR HOOD.

IV GENERAL INSTALLATION INSTRUCTIONS

Foundations

Fan foundation must be flat, level and rigid. Where foundation is not completely flat, shims must be placed under fan support at each anchor bolt as required. Bolting fan to an uneven foundation distorts alignment and causes vibration.

Structural steel foundations should be heavily cross-braced for load support.

Table #2

SET SCREW TORQUE VALUES			
SET SCREW SIZE		MINIMUM REQUIRED TORQUE (INCH-LBS)	
Diameter & No. of Threads/Inch	Hex Size Across Flats (Allen Wrench)	Steel Set Screw Into Steel Threads	Steel Set Screw Into Alum. Threads or Stainless Steel Set Into Stainless Steel Threads
1/4-20	1/8"	65	65
5/16-18	5/32"	165	100
3/8-16	3/16"	228	155
7/16-14	7/32"	348	230
1/2-13	1/4"	504	330
5/8-11	5/16"	1104	700

NOTE: If wheel set screws are loosened and/or wheel is removed from shaft, set screws must be replaced. Set screws cannot be used more than once. Use knurled, cup point set screws with a locking patch.

OPERATION

Before Connecting Power

1. Inspect all fasteners and retighten if necessary:
   a. Foundation bolts.
   b. Set screws in fan and wheel and V-belt drive (See Tables #1 & #2 on preceding page).
   c. Housing, bearing and motor mounting.

2. Inspection doors should be tight and sealed.

3. Bearings should be checked for alignment and lubrication (See Fan Bearing Maintenance, page 5).

4. Turn rotating assembly by hand to insure that it does not strike housing. If the wheel strikes the housing, the wheel may have moved on the shaft or the bearings may have shifted in transit. Correction must be made prior to start up.

5. Check motor to insure proper speed and electrical characteristics.

6. Check V-belt drive for alignment and correct belt tension.

7. After wiring, energize motor for 1 second to check for proper rotation.

V GENERAL MAINTENANCE

CAUTION

Before any maintenance or service is performed, assure that unit is disconnected from power source to prevent accidental starting.

The key to good fan maintenance is a regular and systematic inspection of all fan parts. Severity of the application should determine frequency of inspection. The components requiring service are generally the moving parts which include bearings, fan wheel, belts, sheaves and motor.

Cast Aluminum & Metal Parts

Cast aluminum and steel parts usually do not require maintenance during the life of the unit except painted metal surfaces that may require periodic repainting. In a severe, dirty operation, the wheel should be cleaned with a wire brush to prevent an accumulation of foreign matter that could result in fan unbalance. After cleaning wheel, inspect for possible cracks or excessive wear, which can cause unbalance. DO NOT operate a wheel that is cracked, chipped, has broken blades or excessive wear. NOTE: If wheel set screws are loosened and/or wheel is removed from shaft, set screws must be replaced. Set screws cannot be used more than once. Belts on V-belt drive units require periodic inspection and replacement when worn. For multiple belt drives, belts should be replaced with matched sets.

Motor Maintenance

1. Disconnect power to motor.

2. Removing dust and dirt: Blow out open type motor windings with low pressure air to remove dust or dirt. Air pressure above 50 P.S.I. should not be used as high pressure may damage insulation and blow dirt under loosened tape. Dust accumulation can cause excessive insulation temperatures.

3. Lubrication: The motor bearings and the fan bearings on the belt drive fans should be greased at regular intervals. Motor manufacturers' greasing instructions and recommendations should be followed closely. Avoid the use of a pressure greasing system which tends to fill the bearing chamber completely. Do not overgrease. Use only 1 or 2 shots with a hand gun in most cases. Maximum hand gun rating 40 P.S.I. Rotate bearings during lubrication where good safety practice permits. NOTE: On motors with non-regreasable sealed bearings, no lubrication is required for the life of the bearings.

To prevent rusting of bearing parts, the rotor must be rotated at regular intervals (30 days) to assure these parts are will covered with oil or grease.

VI V-BELT DRIVES

Care should be taken not to over tighten V-belt drive. Excessive belt tension overloads fan and motor bearings. It is much less expensive to replace belts worn from slippage than to replace bearings damaged from excessive loading.

Fans shipped completely assembled have had V-belt drive aligned at the factory. Alignment should be rechecked before operation as a precaution due to handling during shipment.

A WORD OF CAUTION

ABOUT MOTORS

Using your hand to test the running temperature of a motor can be a very painful experience:

Normal body temperature	98.6° F
Threshold of pain caused by heat	120.0° F
Average temperature of hottap water	140.0° F
Average temperature of hot coffee	180.0° F
Normal operating temperature of a fully loaded electric motor, open type, 70° F ambient temperature	174.0° F

1. Be sure sheaves are locked in position.

2. Key should be seated firmly in keyway.

3. Place straight edge or taut cord across faces of driving and driven sheaves to check alignment. The motor and fan shafts must be parallel with V-belts and at right angles to the shafts.

4. Start the fan. Check for proper rotation. Run fan at full speed. A slight bow should appear on slack side of belt. Disconnect power and adjust belt tension by adjusting motor on its sliding base. All belts must have some slack on one side.

5. If belts squeal at start up, they may be too loose.

6. When belts have had time to seat in the sheave grooves, then readjust belt tension.

V-belt drive assembly can be mounted as follows:

1. Clean motor and fan shafts. Be sure they are free from corrosive material. Clean bore of sheaves and coat with heavy oil for ease of shaft entry. Remove oil, grease, rust or burrs from sheaves.

2. Place fan sheave on fan shaft and motor sheave on its shaft. **Do not pound sheaves on** as this may damage bearings. Tighten sheaves per Table # 1 on page 2.

Table #3 (See Fan Bearing Maintenance, page 5.)

Conditions Around Bearing	Operating Temperature of Fan	**Greasing Intervals
Fairly Clean	up to 120 °F	6 -12 months
	120°-160°F	2-3 months
	160°-200°F plus*	1-2 months
Moderate to Extremely Dirty	up to 160°F	1-2 months
	160°-200°F plus*	2-4 weeks
Cold Storage Room		every defrosting period or no more than 4 months

* For fan applications over 200°F: greasing intervals should be from several days to 2 weeks, depending on the temperature.

**For vertical installations, greasing intervals should be twice as frequent as table values.

The following greases, or one that is equivalent to the general description, are recommended for the following temperatures or excessive moisture applications.

Operating Conditions	Use Grease Equivalent to these Grades
Temperatures -65°F to 0°F	Esso-Beacon #325 (-65°F) Mobil Grease #28 (-65°F) Shell Oil Aeroshell No. 7 (-100°F)

General Description: Versatile multipurpose microgel thickened synthetic hydrocarbon grease with corrosion inhibitors, anti-oxidant additives, water resistance tendencies and EP characteristics.

Temperature 0°F to 200° F inclusive (Also use for heavy condensation or direct splash of water)	Mobil Oil - Mobilux EP #2 Shell Oil - Shell Alvania EP #2 Chevron - Chevron SRI #2

General Description: Multipurpose NLGI#2 grease from lithium soap with EP characteristics, rust inhibitors, anti-oxidant additives and good water resistance tendencies.

Temperatures over 200°F	Dow Corning-DC44 (400°F) (Not compatible with non-silicon based greases)

General Description: Versatile multipurpose microgel thickened synthetic hydrocarbon grease with corrosion inhibitors, anti-oxidant additives, water resistance tendencies and EP characteristics.

3. Move motor on slide base so belts can be placed in grooves of both sheaves without forcing. Do not roll belts or use a tool to force belts over the grooves.

4. Align fan and motor shafts so they are parallel. The belts should be at right angles to the shafts. A straight edge or taut cord placed across the face of the sheaves will aid in alignment.

5. Tighten belts by adjusting motor base. Correct tension gives the best drive efficiency. Excessive tension causes undue bearing pressure.

6. Start the fan and run it at full speed. Adjust belt tension until only a slight bow appears on the slack side of the belts. If slippage occurs, a squeal will be heard at start-up. Eliminate this squeal by disconnecting power and tightening up the belts.

7. Give belts a few days running time to become seated in sheave grooves, then readjust belt tension.

If the shafts become scratched or marked, carefully remove sharp edges and high spots such as burrs with fine emery cloth or honing stone. Avoid getting emery dust in the bearings.

Do not apply any belt dressing unless it is recommended by the drive manufacturer. V-belts are designed for frictional contact between the grooves and sides of the belts. Dressing will reduce this friction.

Belt tension on an adjustable pitch drive is obtained by moving the motor, not by changing the pitch diameter of the adjustable sheave.

VII FAN BEARING MAINTENANCE

Sealed Bearings

Sealed for life bearings are pre-lubricated with the correct amount of manufacturer approved ball bearing grease, and are designed for application where relubrication is not required.

Relubricatable Bearings

The motor bearings and fan bearings on belt drive fans should be greased at regular intervals. Motor manufacturers greasing instructions and recommendations should be followed closely. Avoid the use of a pressure greasing system which tends to fill the bearing chamber completely. Do not over grease.

NOTE: On motors with non-regreasable, sealed bearings, no lubrication is required for the life of the bearing.

Table #3 (page 4) lists the time intervals between fan greasing to insure proper lubrication in adverse conditions of heat and dust. Use only 1 or 2 shots with a hand gun in most cases. Maximum handgun rating 40 P.S.I.

VIII WARRANTY

Cincinnati Fan & Ventilator Company warrants products of its own manufacture against defects of material and workmanship under normal use and service for a period of eighteen (18) months from date of shipment or twelve (12) months from date of installation, whichever occurs first.

This warranty does not cover ordinary wear and tear, abuse, misuse, overloading, negligence, alteration or systems and/or materials not of Seller's manufacture. Expenses incurred by Buyer(s) in repairing or replacing any defective product will not be allowed except where authorized in writing and signed by an officer of the Seller.

The obligation of Seller under this warranty shall be limited to repairing or replacing F.O.B. Seller's plant, or allowing credit at Seller's option. This warranty is expressly in lieu of all other warranties expressed or implied including the warranties of merchantability and fitness for use and of all other obligations and liabilities of the Seller. The Buyer acknowledges that no other representations were made to him or relied upon him with respect to the quality or function of the products herein sold.

On equipment furnished by the Seller, but manufactured by others, such as motors, Seller extends the same warranty as Seller receives from the manufacturer thereof. Repairs for motors should be obtained from nearest authorized motor service station for the make of motor furnished. All motors used are products of well-known manufacturers with nationwide service facilities. Check the yellow pages of your telephone directory for the location of the nearest service shop.

Cincinnati Fan & Ventilator Company assumes no responsibility for material returned to our plant without our prior written permission.

IX ORDERING REPLACEMENT PARTS

Replacement or spare parts may be ordered through your local Cincinnati Fan representative. (Refer to drawings that begin on page 7.)
The following information should accompany parts orders:

1. Motor horsepower, frame size, motor speed, voltage, phase, cycle and enclosure. Motor manufacturer's model number from motor nameplate.
2. Fan Speed (if V-belt driven).
3. Fan serial and model numbers from the fan nameplate and a complete description of the part.

An adequate stock of repair parts is maintained where possible. If your fan is vital to production or to plant operation, it is advisable to have all spare parts on hand to minimize the possibility of downtime.

X FAN TROUBLE SHOOTING

In the event that trouble is experienced in the field, the following are the most common fan difficulties. These points should be checked in order to prevent needless delay and expense.

1. CAPACITY OR PRESSURE BELOW RATING

a. Incorrect direction of wheel rotation.
b. Speed too slow.
c. Dampers not properly adjusted.
d. Poor fan inlet or outlet conditions (elbows, restrictions).
e. Air leaks in system.
f. Damaged wheel.
g. Total resistance of system higher than anticipated.
h. Wheel mounted backwards on shaft.
i. Fan not properly selected for a high temperature and/or high altitude application.

2. VIBRATION AND NOISE

a. Misalignment of bearings, coupling, wheel or V-belt drive.
b. Unstable foundation or supports.
c. Foreign material in fan causing unbalance.
d. Worn bearings.
e. Damaged wheel or motor.
f. Broken or loose bolts and set screws.
g. Bent shaft.
h. Worn coupling.
i. Fan wheel or drive unbalanced.
j. 120 cycle magnetic hum due to electrical input. Check for high or unbalanced voltage.
k. Fan delivering more than rated capacity.
l. Loose dampers.
m. Speed too high or fan rotating in wrong direction.
n. Vibration transmitted to fan from some other source.

3. OVERHEATED BEARINGS

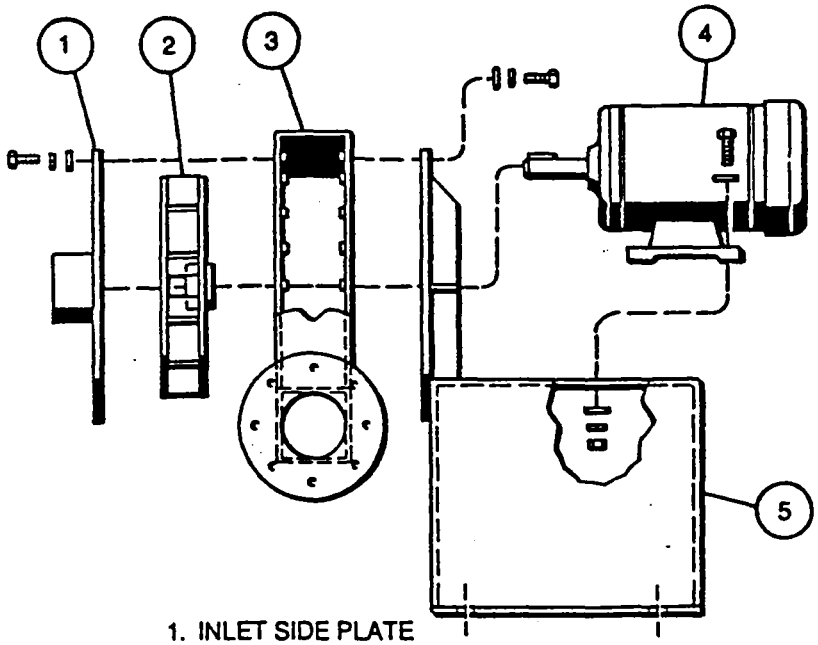
a. Check bearing lubrication.
b. Poor alignment.
c. Damaged wheel or drive.
d. Bent shaft.
e. Abnormal end thrust.
f. Dirt in bearings.
g. Excessive belt tension.

4. OVERLOAD ON MOTOR

a. Speed too high.
b. Fan over capacity due to existing system resistance being lower than original rating.
c. Specific gravity or density of gas above design value.
d. Wrong direction of wheel rotation.
e. Shaft bent.
f. Poor alignment.
g. Wheel wedging or binding on fan housing.
h. Bearings improperly lubricated.
i. Motor improperly wired.
j. Defective motor. Motor must be tested by motor manufacturer's authorized repair shop.

MODEL HP

ARRANGEMENT 4

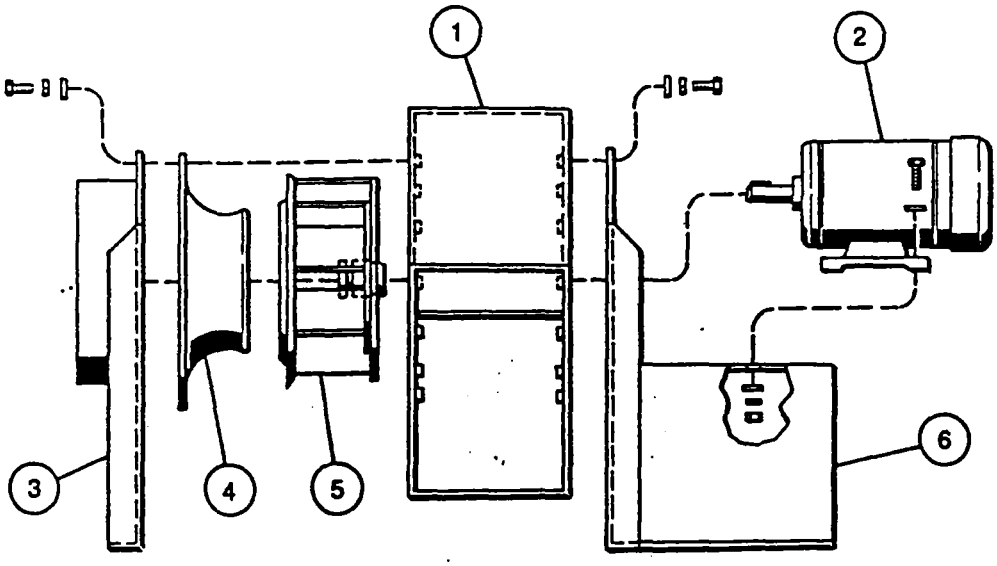


1. INLET SIDE PLATE
2. WHEEL
3. HOUSING
4. MOTOR
5. BASE

NOTE: SHAFT SEAL IS NOT SHOWN.

MODELS HDBI & RBE

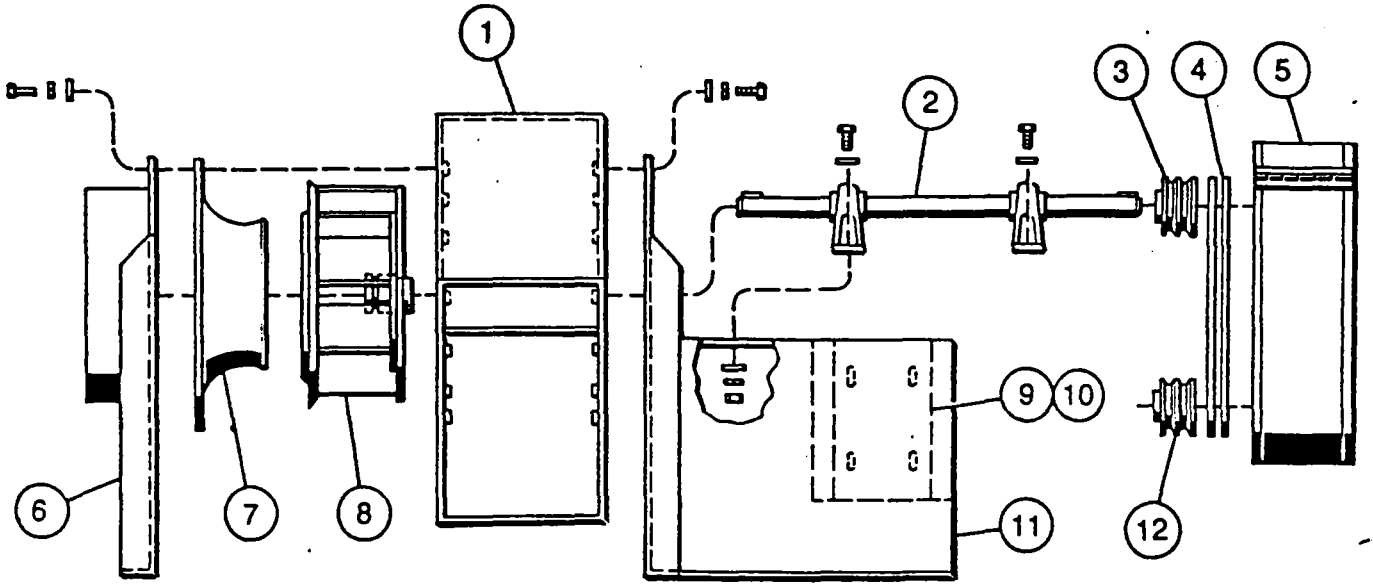
ARRANGEMENT 4



1. HOUSING
2. MOTOR
3. INLET SIDE PLATE
4. INLET BELL (ON MODEL HDBI ONLY)
5. WHEEL (HDBI WHEEL SHOWN)
6. BASE

MODELS HDBI & RBE

ARRANGEMENT 1 AND 9

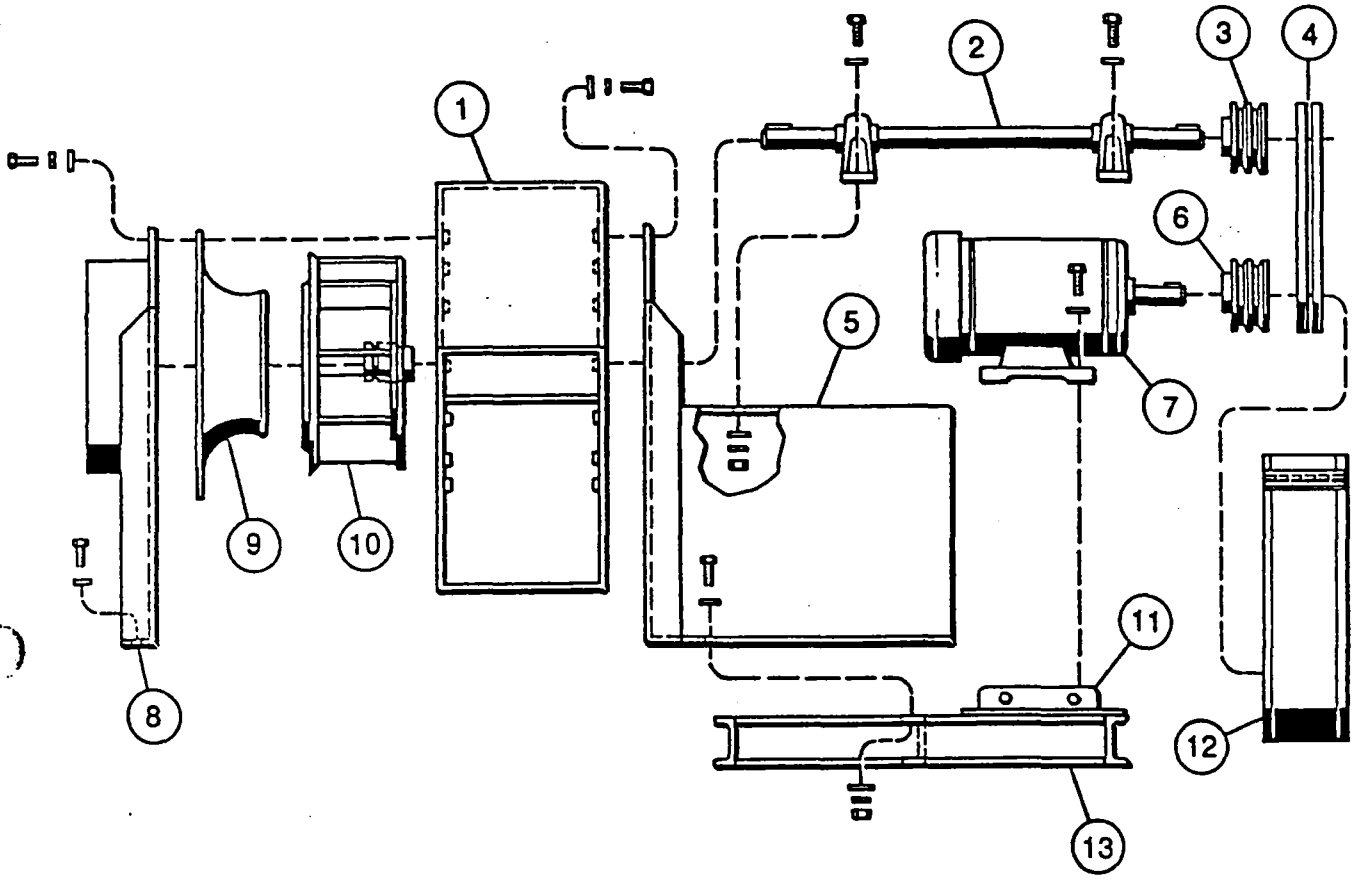


1. HOUSING
2. SHAFT AND BEARING ASSEMBLY
3. FAN SHAFT PULLEY (ARR. 9 ONLY)
4. BELT(S) (ARR. 9 ONLY)
5. BELT GUARD (ARR. 9 ONLY)
6. INLET SIDE PLATE
7. INLET BELL (ON MODEL HDBI ONLY)
8. WHEEL (HDBI WHEEL SHOWN)
9. MOTOR SLIDE BASE (ARR. 9 ONLY)
10. MOTOR (ARR. 9 ONLY) *
11. BASE, FAN
12. MOTOR SHAFT PULLEY (ARR. 9 ONLY)

* MOTOR NOT SHOWN IN FIGURE

MODELS HDBI & RBE

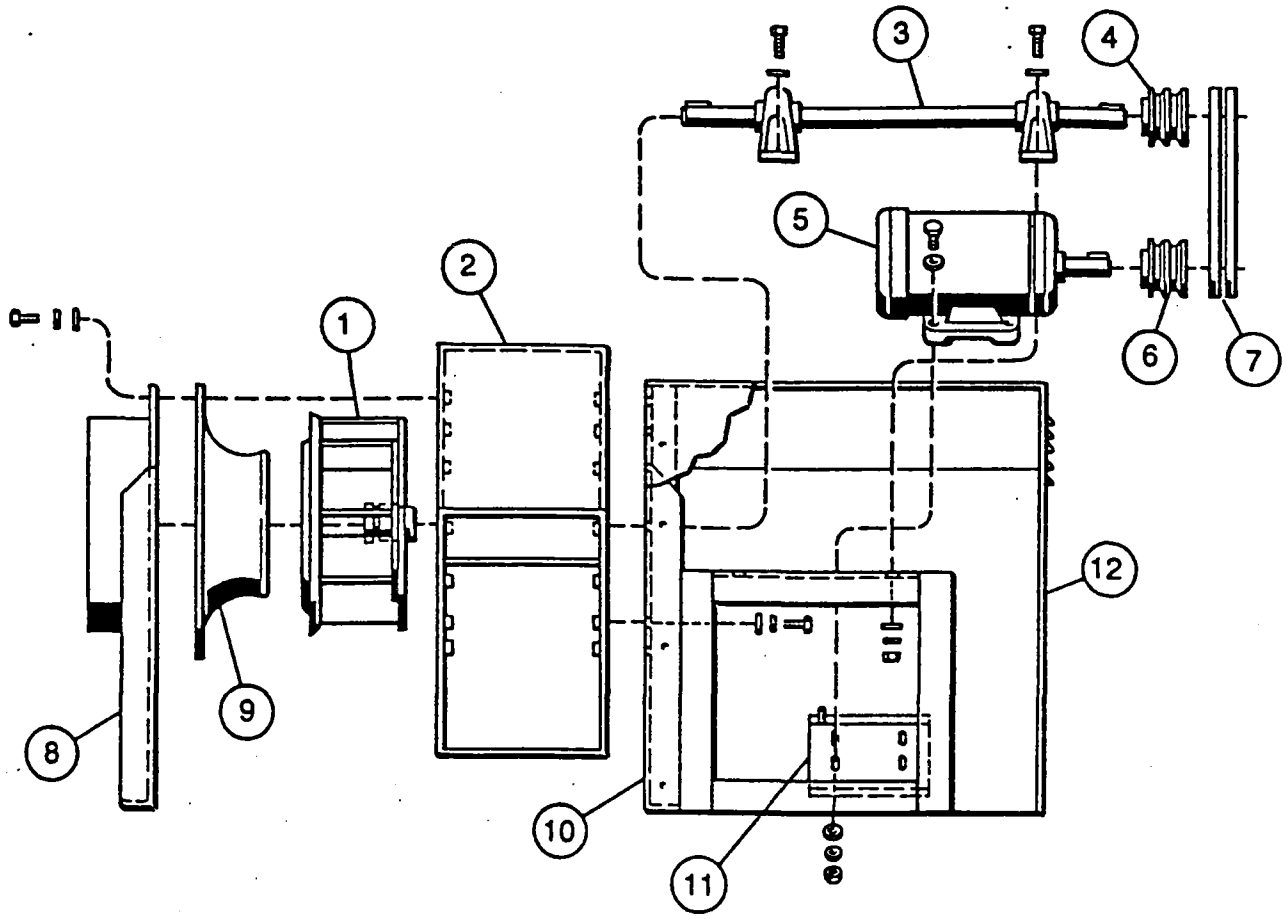
ARRANGEMENT 9CB CHANNEL BASE



1. HOUSING
2. SHAFT AND BEARING ASSEMBLY
3. FAN SHAFT PULLEY
4. BELT(S)
5. BASE, FAN
6. MOTOR SHAFT PULLEY
7. MOTOR
8. INLET SIDE PLATE
9. INLET BELL (ON MODEL HDBI ONLY)
10. WHEEL (HDBI WHEEL SHOWN)
11. MOTOR SLIDE BASE
12. BELT GUARD
13. BASE, CHANNEL

MODELS HDBI & RBE

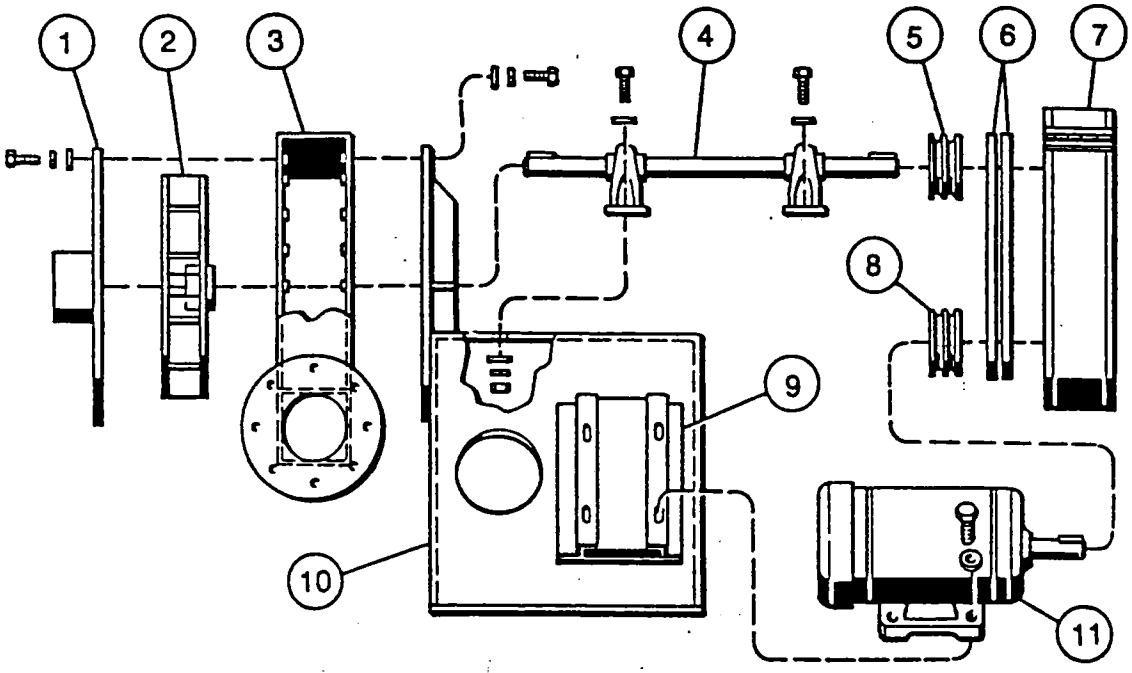
ARRANGEMENT 10



1. WHEEL (HDBI WHEEL SHOWN)
2. HOUSING
3. SHAFT AND BEARING ASSEMBLY
4. FAN SHAFT PULLEY
5. MOTOR
6. MOTOR SHAFT PULLEY
7. BELT(S)
8. INLET SIDE PLATE
9. INLET BELL (ON MODEL HDBI ONLY)
10. BASE
11. MOTOR BASE
12. WEATHER COVER

MODEL HP

ARRANGEMENT 1 AND 9

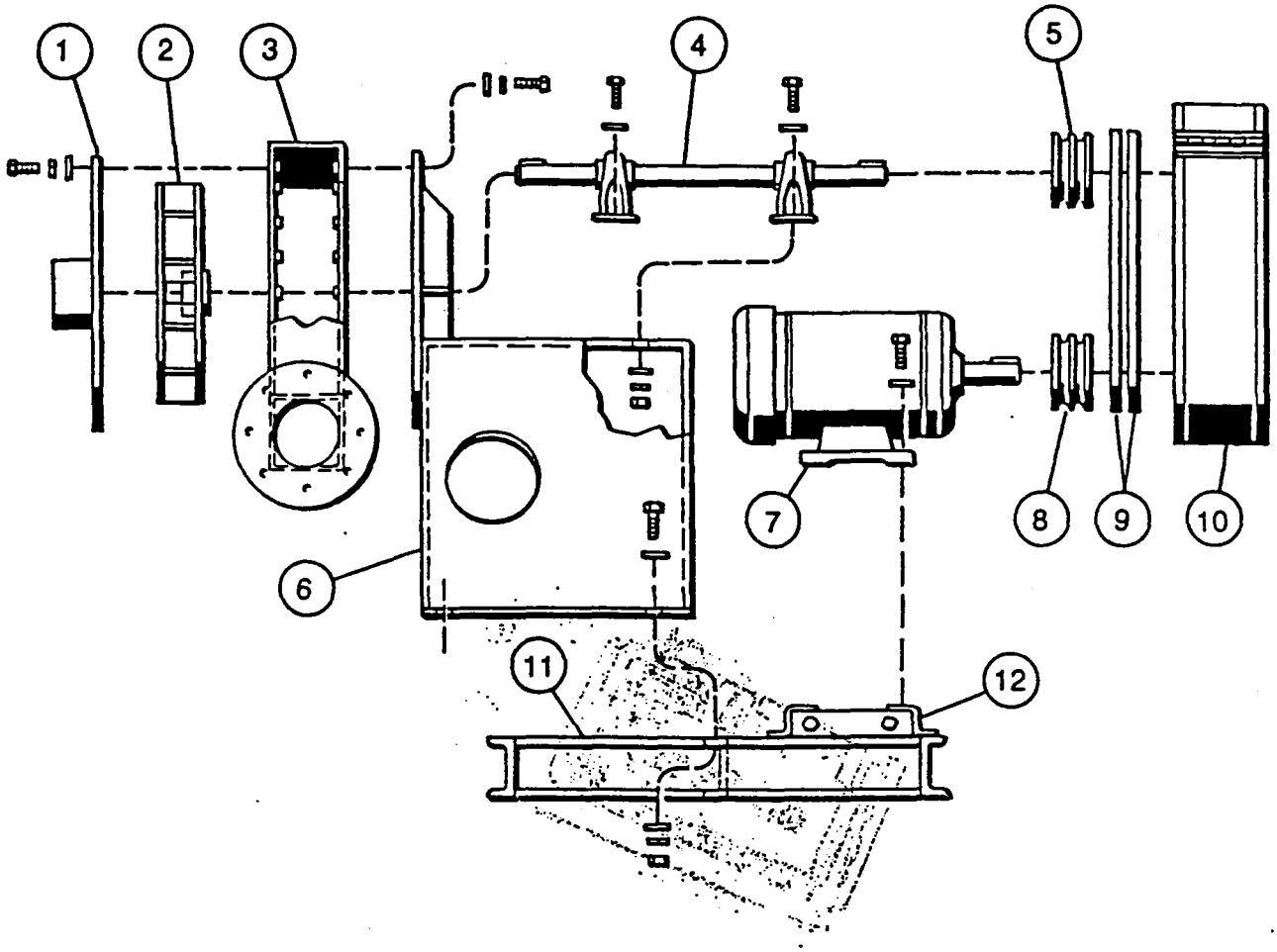


1. INLET SIDE PLATE
2. WHEEL
3. HOUSING
4. SHAFT AND BEARING ASSEMBLY
5. FAN SHAFT PULLEY (ARR. 9 ONLY)
6. BELT(S) (ARR. 9 ONLY)
7. BELT GUARD (ARR. 9 ONLY)
8. MOTOR SHAFT PULLEY (ARR. 9 ONLY)
9. MOTOR SLIDE BASE (ARR. 9 ONLY)
10. BASE, FAN
11. MOTOR (ARR. 9 ONLY)

NOTE: SHAFT SEAL IS NOT SHOWN.

MODEL HP

ARRANGEMENT 9CB CHANNEL BASE



1. INLET SIDE PLATE
2. WHEEL
3. HOUSING
4. SHAFT AND BEARING ASSEMBLY
5. FAN SHAFT PULLEY
6. BASE, FAN
7. MOTOR
8. MOTOR SHAFT PULLEY
9. BELT(S)
10. BELT GUARD
11. BASE, CHANNEL
12. MOTOR SLIDE BASE

NOTE: SHAFT SEAL IS NOT SHOWN.

A-6

Effluent Transfer Pump

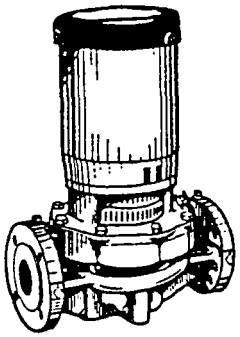
GRUNDFOS®

In-Line, Single Stage, Circulator Pump

UMT/UPT 65

Submittal Data

60 Hertz



JOB or CUSTOMER:	
ENGINEER:	
CONTRACTOR:	
SUBMITTED BY:	DATE:
APPROVED BY:	DATE:
ORDER NO.:	DATE:
SPECIFICATION REF.:	

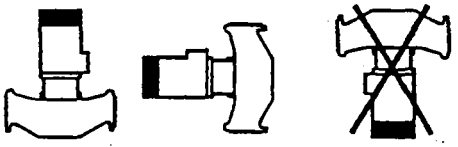
QUANTITY	TAG NO.	MODEL NO.	GPM	FEET	VOLT	PHASE	COMMENTS

Technical Data

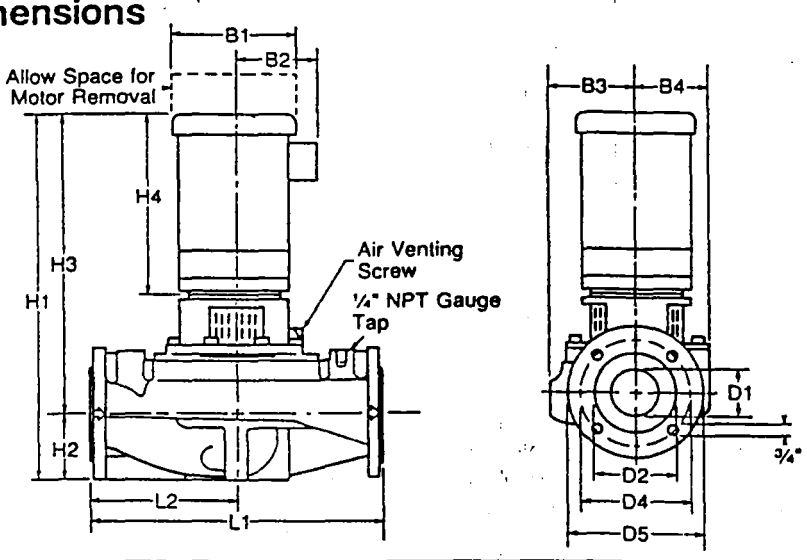
FLOW RANGE: 15 to 150 U.S. GPM
MIN FLOW RATE: 15 U.S. GPM
HEAD RANGE: 3 to 55 Ft. (.9 to 17m)
MAXIMUM WORKING PRESSURE: 145 PSI
TEMPERATURE RANGE: 5°F to 250°F
(-15°C to 121°F)

FLANGE RATING: 2½" ANSI 125lb., R.F.
MOTORS: ODP – Standard
TEFC – Optional

Mounting Positions



Dimensions



Type Designation

UMT65-40

- UMT = Circulator Pump
- 65 = Nominal diameter of ports in mm.
- 40 = Maximum head in meters x 10
- M = 4-Pole Motor
- P = 2-Pole Motor
- Direct coupled in-line pump

Weights

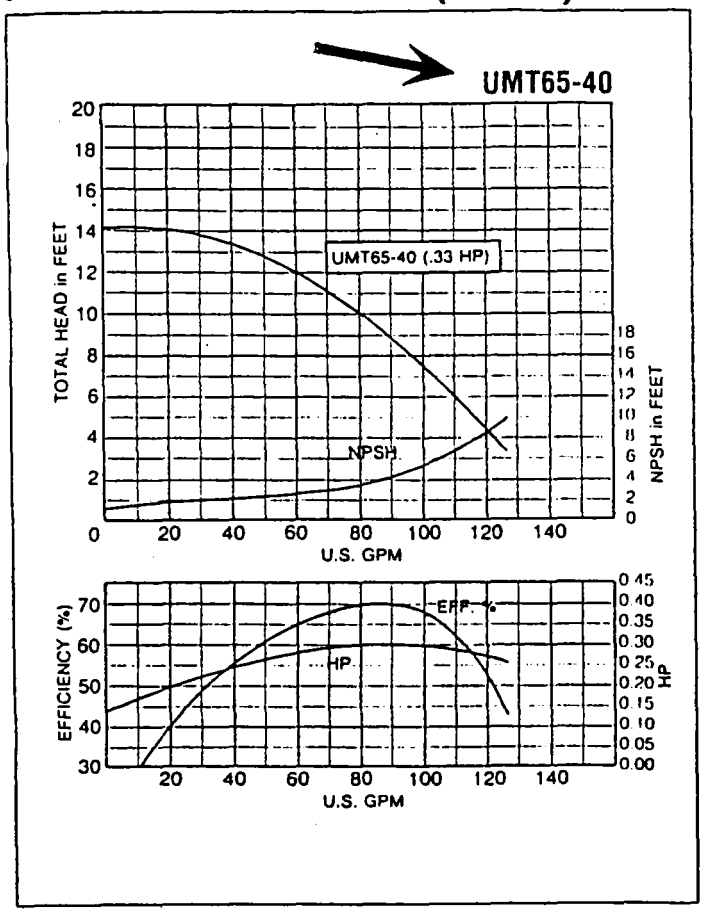
PUMP TYPE	HP	PH	NET WT. (LBS.)	SHIP WT. (LBS.)	SHIP VOL (CU.FT.)
UMT 65-40	.33	1 3	68 64	72 70	2.6
UMT 65-80	.75	1 3	80 73	88 81	2.6
UMT 65-160	2.0	1 3	92 83	96 87	2.6

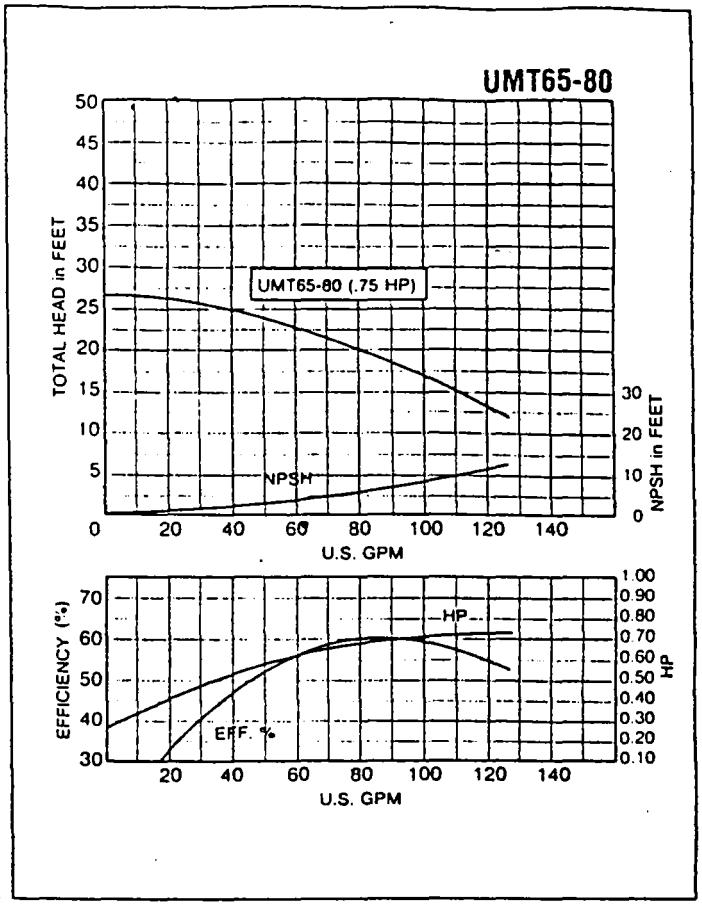
Electrical Data and Dimensions

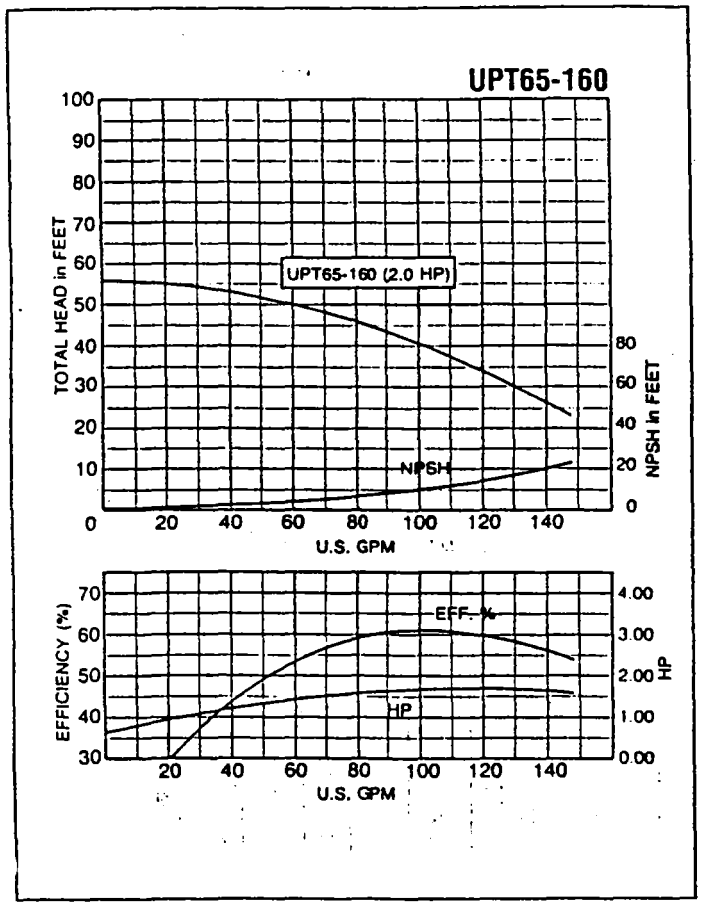
PUMP TYPE	HP	MOTOR SERVICE FACTOR	PH.	VOLTS	NEMA FRAME SIZE	DISCHARGE SUCTION SIZE	DIMENSIONS IN INCHES													
							H1	H2	H3	H4	D1	D2	D4	D5	L1	L2	B1	B2	B3	B4
UMT65-40	.33	1.35	1	115/208-230	56C	2½	19	3 5/16	15 11/16	9 3/8	2½	4 15/16	5½	7 1/16	12	6	6 1/8	4½	4 3/4	3 3/8
	.33	1.35	3	208-230/460	56C	2½	17 5/8	3 5/16	14 5/16	8	2½	4 15/16	5½	7 1/16	12	6	6 1/8	4 3/8	4 3/4	3 3/8
UMT65-80	.75	1.15	1	115/230	56C	2½	19½	3 5/16	16 3/16	10¼	2½	4 15/16	5½	7 1/16	12	6	7 3/16	5¼	5	4
	.75	1.25	3	208-230/460	56C	2½	17⅞	3 5/16	14 9/16	8 5/8	2½	4 15/16	5½	7 1/16	12	6	6 1/8	4 3/8	5	4
UMT65-160	2.0	1.15	1	115/208-230	56C	2½	20½	3 5/16	17 3/16	11¼	2½	4 15/16	5½	7 1/16	12	6	7 3/16	5¼	5	4
	2.0	1.15	3	208-230/460	56C	2½	19½	3 5/16	16 3/16	10¼	2½	4 15/16	5½	7 1/16	12	6	7 3/16	5¼	5	4

NOTE: Data for Baldor O.D.P. motors.

Performance Curves (60 Hz)







Materials of Construction

DESCRIPTION	MATERIALS
Upper Seal Driver	AISI 304 SS
Lower Seal Driver	AISI 304 SS
Sealing Plate	AISI 304 SS
Distributing Cup	AISI 304 SS
Impeller	AISI 304 SS
Impeller Seal Ring	AISI 304 SS
Split Cone and Nut	AISI 304 SS
Coupling Guard	AISI 304 SS
Spring	AISI 301 SS
Pump Shaft	AISI 431 SS
Mechanical Shaft Seal Faces	Tungsten Carbide
Pump Housing*	Cast Iron
Motor Stool*	Cast Iron
Coupling	Cast Iron
Air Vent Screw	Brass
O-rings	EPDM Rubber

* Bronze – optional

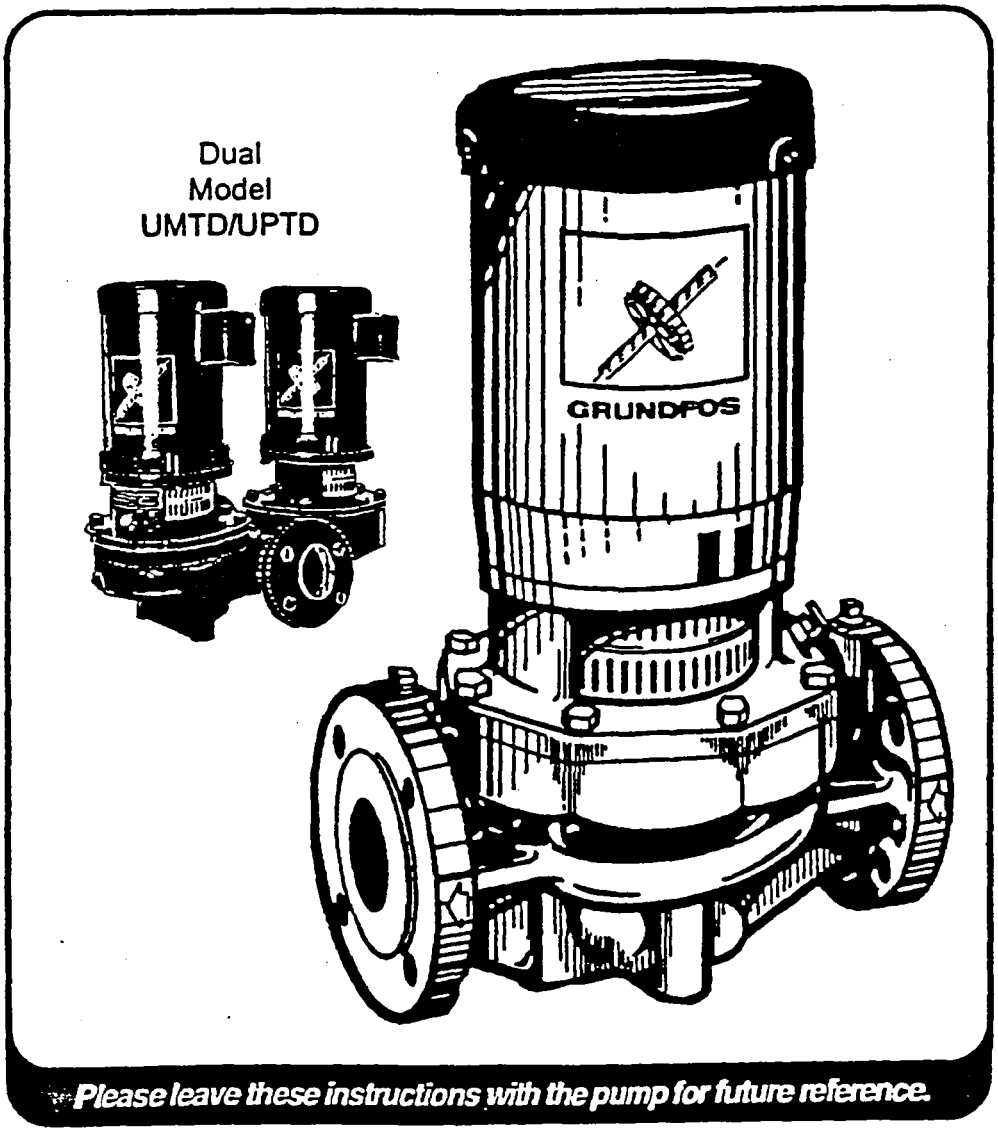
GRUNDFOS Pumps Corp. • 2555 Clovis Ave. • Clovis, CA 93612
Support Centers: Allentown, PA • Atlanta, GA • Mississauga, Ontario, Canada

L-UMT-TL-065 | 5/10/91
PRINTED IN U.S.A

Series 7000

UMT/UPT, Direct Coupled In-Line Single Stage Circulator Pumps

Installation and Operating Instructions



Please leave these instructions with the pump for future reference.

GRUNDFOS

SAFETY WARNING

Electrical Work

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

Shock Hazard

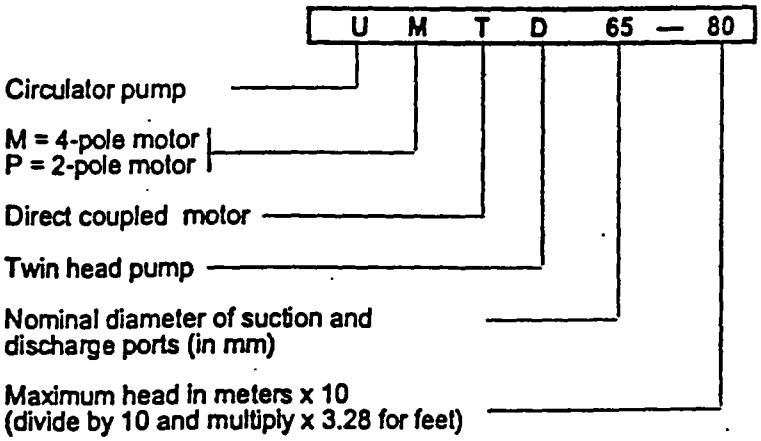
A faulty motor or wiring can cause electrical shock that could be fatal, whether touched directly or conducted through standing water. For this reason, proper grounding of the pump to the power supply's grounding terminal is required for safe installation and operation. The ground wire should be a copper conductor at least the size of the circuit conductors supplying power to the motor. Do not ground to a gas supply line.

In all installations, the above-ground metal plumbing should be connected to the power supply ground as described in Article 250-80 of the National Electrical Code.

Pre-Installation Checklist

1. Confirm You Have the Right Pump

Read the pump nameplate to make sure it is the one you ordered. The nomenclature for the Series 7000 line of Grundfos pumps is:



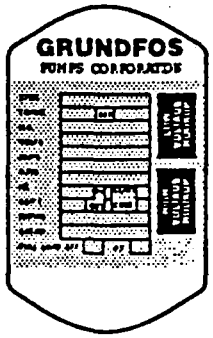
2. Check the Condition of the Pump

The Series 7000 shipping carton is designed around your pump during production to prevent damage. The pump should remain in the carton until you are ready to install it. At that point, examine the pump for any visible damage that may have occurred during shipping.

Pre-Installation Checklist

3. Electrical Requirements

Check the motor nameplate to determine the proper voltage, phase, and frequency required. The voltage must be within ± 10% of the specified motor nameplate voltage. Dual voltage motors must be internally wired to match the electrical supply. A wiring connection diagram is affixed to the motor.



Nameplate Wiring Diagram (in this case, for dual voltage motor)

4. Is the Application Correct for This Pump ?

Compare the pump's nameplate data or its performance curve with the application in which you plan to install it. Will it perform the way you want it to perform? Also, make sure the application falls within the following limits:

- Approved applications
  - Open or closed water systems
  - Chilled or hot glycol solutions up to 50% by volume
  - Condenser or cooling tower circulation
  - Solar thermal fluids

- Temperature range
  - Minimum +5°F (-15°C)
  - Maximum 250°F (121°C)

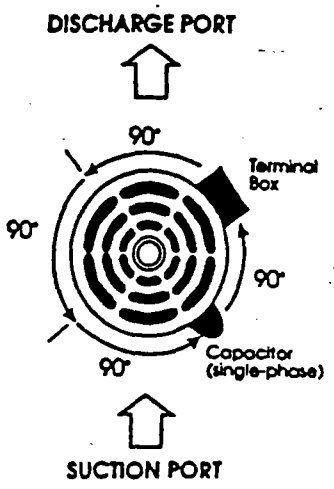
- Maximum working pressure: 145 PSI (10 bars)

5. Read this Guide Thoroughly

Even if you are very familiar with the installation of this pump, a quick glance through the remaining sections of this guide may help you avoid a potential problem.

Installation Procedures

1. Electrical Preparation



Terminal Box Position

Before installing the pump, you must determine the most convenient position for the terminal box, which can be rotated in 90° increments. To rotate the terminal box, remove the four bolts securing the motor to the pump, lift and rotate the motor, and retighten the bolts.

Single-phase motors

These motors are multi-voltage with built-in automatic resetting thermal protection to prevent overheating.

Three-phase motors

A motor starter is required to ensure the motor is protected from damage caused by low voltage, phase failure, current imbalance, and overloads.

Motor starter – should be properly sized, have a manual reset, and ambient-compensated extra quick trip in all three legs.

Overload – should be sized and adjusted to trip at the full-load current rating of the motor. If the motor is lightly loaded, the overload should be re-sized or adjusted to a lower value. **Under no circumstances should the overloads be set to a higher value than the full load current shown on the motor nameplate.** Overloads for auto transfers and resistant starters should be sized in accordance with the recommendations of the manufacturer.

Fused disconnect – recommended for each pump where service and standby pumps are installed. An alternating switch should be used so each pump can be equally operated to even the wear.

Other Wiring Considerations

The pump **must** be grounded. Wire sizes should be based on the ampacity (current carrying properties of a conductor) as required by the latest edition of the National Electrical Code or local regulations. In most cases, direct on line (D.O.L.) starting is approved due to the extremely fast run-up time of the motor and the low moment of inertia of the pump and motor. If D.O.L starting is not acceptable, an auto transformer or resistant starter should be used.

2. Piping Considerations

Whenever possible, avoid high pressure-loss fittings (elbows, branch tees, etc) directly on either side of the pump. The pump and piping should be adequately supported on both sides to reduce thermal and mechanical stresses on the pump.

Pipe, valves, and fittings should be at least the same diameter as the discharge pipe to reduce excessive fluid velocities and friction losses. They should also have a pressure rating equal to or greater than the maximum system pressure.

A bypass or pressure relief valve should be installed in the discharge pipe if there is any possibility the pump may operate against a closed valve in the discharge line. Circulation through the pump is required to ensure adequate cooling and lubrication of the pump.

Minimum Pumping Rates:	UMT/UPT 50 ..... 5 GPM UMT/UPT 65 ..... 10 GPM UMT/UPT 80 ..... 15 GPM

The bypass should be routed back to a heat dissipating source or to drain, depending on the liquid being pumped and local codes.

3. Install the Pump

Pump Location

The pump should be installed in a dry, well ventilated area which is not subject to freezing or large variations in temperature. The pump should never be mounted within six inches of any obstruction or hot surface. Pumps to be installed outdoors or in a dusty environment should be ordered with a totally-enclosed-fan-cooled motor (TEFC) attached to prevent motor failure.

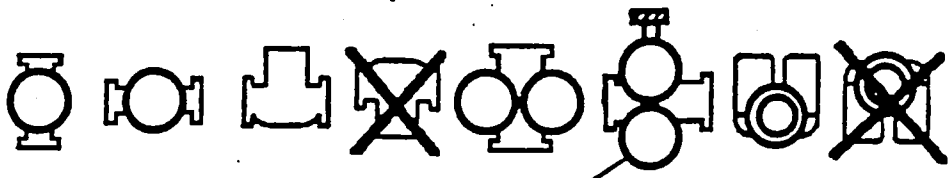
Position In Piping System

Do not mount the pump at the highest or lowest point in the piping system. If the pump is installed at the highest point in the piping system, it may experience reduced performance and increased noise due to air trapped in the pump. If the pump is located at the lowest point in the piping system, the dirt and sediment in the system may collect inside the pump, causing premature wear to the shaft seal.

Installation Procedures

Proper Orientation

Series 7000 UMT/UPT pumps can be mounted either vertically or horizontally, and all positions in between. **However, the motor shaft must never fall below the horizontal plane.**



An air vent must always be installed at the hight point of the pump housing when a dual pump is installed in a horizontal pumping line. Use the 1/8" NPT drain tap.

Direction of Flow for Specific Applications

Arrows on the flanges of the pump volute show the flow direction of water through the pump.

Pumps used to circulate domestic water should ALWAYS be installed in a vertical section of the circulating pipe and pump upwards, and an effective air vent should be used in the same vertical section of pipe. If the pump must be installed in a vertical pipe pumping down, an air vent should be installed at the highest point before the pump.

Suggested Accessories

Isolation valves – should be installed on each side of the pump to avoid having to drain the system if the pump needs to be cleaned or repaired.

Check valve – should be installed in the discharge pipe.

Plugged tee or capped pipe – should be installed in the suction line to fill the pump and pipe before start-up, especially if the system is not pressurized.

Vibration isolators – should be used in noise-sensitive areas to prevent vibration from being transmitted to the structure.

Relief valve of bypass line – should be installed to allow sufficient water to circulate through the pump to provide adequate cooling and lubrication of the pump's bearings and seals.

3. Electrical Hookup

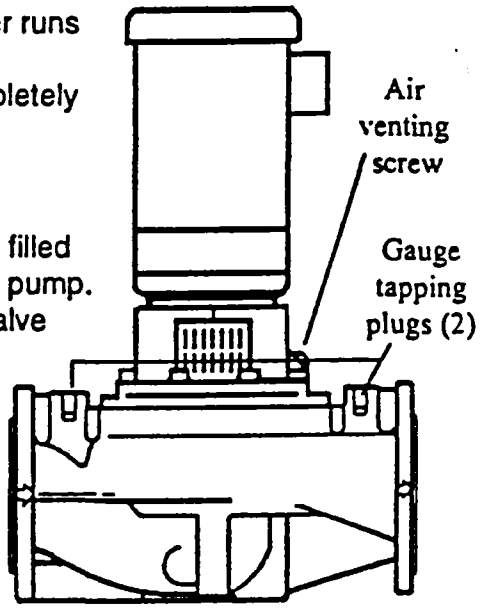
Turn the incoming POWER OFF and make the proper electrical connections according to the diagram on the motor and the latest edition of the National Electrical Code. **Do not start the pump – even to check the direction of rotation – until it has been filled with water.** The pump may be seriously damaged if it is run dry.

Starting the Pump The First Time

1. Prime the Pump

In Closed/Open System Where Water Source Is Above the Pump

1. Close the pump isolation valves and open the air vent screw.
2. Gradually open the suction isolation valve until a steady stream of airless water runs out the air vent hole.
3. Tighten the air vent screw and completely open the isolation valves.



In Open Systems

1. The suction pipe and pump must be filled and vented of air before starting the pump.
2. Close the discharge side isolation valve and open the air vent screw and suction valve.
3. Fill the suction line through the plugged tee or capped pipe (if one is installed). If not possible, remove one of the gauge tapping plugs in the pump flanges and pour water into the hole using a funnel or hose with an adapter.

All air in the pump and suction line must be purged before starting the pump.

2. Check the Direction of Rotation

a. Switch the POWER OFF.
b. Check to make sure the pump has been filled and vented.
c. Remove the coupling guard and rotate the pump shaft to be certain it turns freely. Replace the coupling guard.
d. Verify that the electrical connections are in accordance with the wiring diagram on the motor.
e. Switch the power on and observe the direction of rotation. When viewed from the motor end, the pump should rotate counter-clockwise.

f. To reverse the direction of rotation, TURN OFF the power supply.
g. On three-phase motors, interchange any two power leads at the load side of the starter. On single-phase motors, refer to the connection diagram on the motor nameplate. Change the wiring as required.
h. TURN ON the power and again check for proper motor rotation.

Starting the Pump the First Time

3. Starting and Adjusting

a. Make sure that:
   - The pump has been primed.
   - The rotation is counter-clockwise when viewed from the motor end.
   - The piping connections are tight and adequately supported.

b. Open the suction line valve completely (if one is installed).

c. Close the isolation valve in the discharge pipe. It should be opened gradually after the pump is turned on. Opening the valve too fast may result in water hammer in the discharge pipe.

d. Start the pump.

e. Gradually open the isolation valve in the discharge piping as explained in step c. Open the valve completely.

f. Check the voltage and amperage at the motor and record them. Adjust the motor overloads if required.

g. If pressure gauges have been installed, check and record the values as the pump operates.

h. Check all controls for proper operation. If the pump is controlled by a pressure switch, check and adjust the cut-in and cut-out pressures. If low-water level controls are used, be sure the low-level switch is properly adjusted so the pump cannot run if the pump breaks suction.

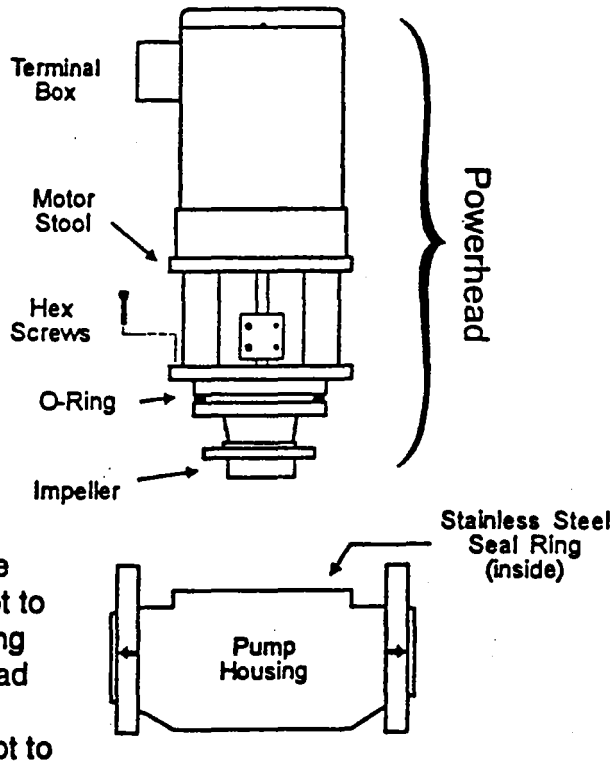
Replacing the Powerhead

STEP 1 - Remove the Old Powerhead

1. Turn OFF the power to the motor.
2. Close any isolation valves on either side of the pump.
3. Disconnect the electrical leads and conduit from the terminal box.
4. Loosen and remove the hex screws connecting the powerhead assembly to the pump housing (8 or 10 mm). **Note the position of the motor terminal box relative to the pump housing.**
5. Remove the powerhead assembly from the pump housing.
6. Clean the machines surfaces in the pump housing.
7. Inspect the pump housing and stainless steel ring for any damage. Check to be sure the seal ring is mounted securely in the pump housing.

STEP 2 - Installing the New Powerhead

1. Carefully remove the new powerhead assembly from its packaging.
2. Refer to the pump's nameplate data to confirm you have the correct replacement powerhead.
3. Examine the entire assembly for any damage that may have occurred during shipment.
4. Lubricate the O-ring with soapy water.
5. With the motor terminal box in the desired position, carefully place the new powerhead assembly into the pump housing. Be careful not to damage the impeller or mating seal ring. Once the powerhead seal ring is engaged with the pump housing, do not attempt to rotate the powerhead, since doing so may damage the O-ring.



6. Make sure the powerhead assembly is properly seated on the pump housing. DO NOT force the two together.
7. Check to make sure the motor shaft turns freely.
6. Insert and tighten the hex screws evenly to secure the powerhead assembly.

Hex Screw	Torque
8 mm	15 ft lbs
10 mm	25 ft lb

Maintenance

Pump Lubrication

Grundfos Series 7000 in-line centrifugal pumps installed in accordance with these instructions and sized for correct performance will operate efficiently and provide years of service. The pumps are lubricated by the fluid they pump, and do not require any additional lubrication. **However, this also means the pump should never be operated for any prolonged periods of time without fluid flowing through the pump.** The motors will require periodic lubrication as noted in the following paragraphs.

Motor Lubrication

Electric motors are pre-lubricated at the factory and do not require additional lubrication at start-up. Motors containing sealed bearings do not require additional lubrication during the first 15,000 hours of operation. Motors with grease fittings should only be lubricated with a lithium based grease.

How Often Is Pump Used?	Frequency of Greasing	Approved Types of Grease
Seasonally (motor is idle for more than six months)	Once a year	Shell Dolium R FSSO Beacon 3 BP-XRB2 Shell Alvania 3
Intermittently	Twice a year	Mobil Grease 2 Texaco Regal
Continuously	Every 3 months	Starfos Premium

Do not over grease the bearings. Over greasing will cause increased bearing heat and can result in bearing/motor failure.

Periodic Safety Checks

At regular intervals depending on the conditions and time of operation, the following checks should be made:

1. Pump meets required performance and is operating smoothly and quietly.
2. There are no leaks, particularly at the shaft seal.
3. The motor is not overheating.
4. Remove and clean all strainers or filters in the system.
5. Verify the tripping of the motor overload protection.
6. Check the operating of all controls. Check unit control cycling twice and adjust if necessary.
7. If the pump is not operated for unusually long periods, the unit should be maintained in accordance with these instructions. In addition, if the pump is not drained, the pump shaft should be manually rotated or run for short periods of time at monthly intervals.

Maintenance

If the pump fails to operate or there is a loss of performance, refer to the Troubleshooting section on pages 13-14.

Rapid Cycling

Pump cycling should be monitored to make sure the pump is not starting more than 20 times per hour. If it is, premature motor failure is quite likely, due to the increased heat build-up in the motor. Make any adjustments to controls necessary to reduce the frequency of stops and starts.

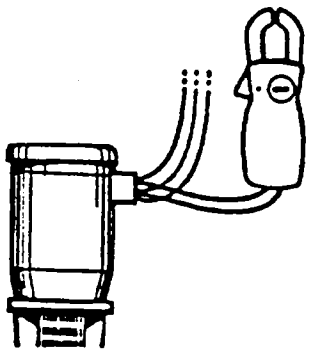
Freeze Protection

If the pump is installed in an area where freezing could occur, the pump and system should be drained during freezing temperatures to avoid damage. To drain the pump, close both isolation valves and loosen the suction and discharge flanges. Allow water to flow out of the pump before reconnecting the pump to the flanges. Do not tighten the flanges completely until the pump is ready to be used again.

Troubleshooting

Preliminary Checks

Supply Voltage



How to Measure

Use a volt meter, (set to the proper scale) measure the voltage at the pump terminal box or starter.

On single-phase units, measure between power leads L1 and L2 (or L1 and N for 115 volt units). On three-phase units, measure between:

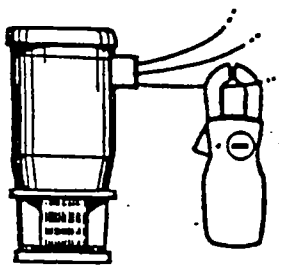
- Power leads L1 and L2
- Power leads L2 and L3
- Power leads L3 and L1

What it Means

When the motor is under load, the voltage should be within ±10% of the nameplate voltage. Larger voltage variation may cause winding damage and indicate a poor electrical supply. The pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

Current Measurement



How to Measure

Use an ammeter, (set on the proper scale) to measure the current on each power lead at the terminal box or starter.

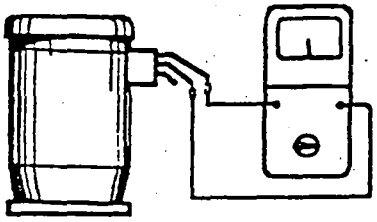
Current should be measured when the pump is operating at constant discharge pressure.

What it Means

If the amp draw exceeds the listed service factor amps (SFA) or if the current imbalance is greater than 5% between each leg on three-phase units, check the following:

1. Burned contacts on motor starter.
2. Loose terminals in starter/terminal box or possible wire defect.
3. Too high or too low supply voltage.
4. Motor windings are shorted or grounded. Check winding and insulation resistances.
5. Pump is damaged causing a motor overload.

Winding Resistance



How to Measure

Turn off power and disconnect the supply power leads in the pump terminal box. Using an ohmmeter, set the scale selector to R x 1 and zero adjust the meter by touching the two ohmmeter leads together.

Touch the leads of the ohmmeter to two motor leads.

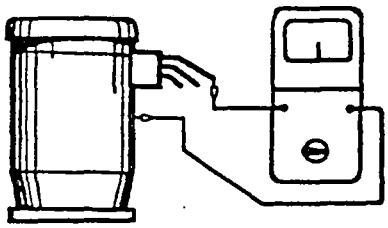
Single phase motors - touching the leads of the ohmmeter to the two outgoing "hot" motor leads (either a single motor lead or combination of leads joined together) will measure the main winding's resistance.

Three phase motors - touching the leads of the ohmmeter to any two hot leads will measure that winding's resistance. Repeat for all three possible lead combinations (L_1 and L_2, L_2 and L_3, L_1 and L_3)

What it Means

If all ohm values are normal, the motor windings are neither shorted nor open. If any one ohm value is less than normal (-25%), that motor winding may be starting to short. If any one ohm value is greater than normal (+25%), the winding may be starting to open. If some values are high and some are low, the leads may be connected incorrectly, or they may have a break in the insulating jacket.

Lead-To-Ground Resistance



How to Measure

Turn off power and disconnect the supply power leads in the pump terminal box. Using an ohmmeter, set the scale selector to R x 100 and zero adjust the meter by touching the two ohmmeter leads together. Touch one ohmmeter lead to a motor lead and one to ground. Repeat for each lead.

What it Means

The resistance values for new motors must exceed 1,000,000 ohms. If they do not, replace the motor.

Troubleshooting

Diagnosing Specific Problems

If The Pump...	*It May Be Caused By...*	*Check This By..*
Does Not Run	1. No power at motor	Check for voltage at terminal box
	2. Fuses are blown or circuit breakers are tripped.	Turn off power and remove fuses and check for continuity with an ohmmeter.
	3. Motor starter overloads are burned or have tripped	Check for voltage on the line and load side of the starter.
	4. Starter does not energize	Energize control circuit and check for voltage at the holding coil.
	5. Defective controls	Check all safety and pressure switches for operation. Inspect contact in control devices.
	6. Motor is defective	Turn off power. Disconnect the wiring. Measure the lead-to-lead resistance with an ohmmeter (set at R x 1). Measure lead-to-ground values with a megohmmeter (R x 100K). Record the measured values.
	7. (Single-phase motors) Defective capacitor	Turn off the power, then discharge the capacitor. Disconnect the leads and check them with an ohmmeter (R x 100K).
Pump Runs, But At A Reduced Capacity or **Doesn't Deliver Water**	1. Wrong rotation *(3 phase only)*	Check for proper electrical connections in terminal box.
	2. Pump is not primed or is airbound	Turn pump off, close isolation valves, remove priming plug. Check fluid level.
	3. Strainers, check valves, or foot valves are clogged.	Remove strainer, screen, or valve and inspect
	4. Suction lift too large	Install compound pressure gauge at the suction side of the pump. Start pump and compare reading to performance data.
	5. Suction and/or discharge piping leaks	Pump shaft spins backwards when turned off. Air in suction pipe.
	6. Worn pump	Install pressure gauge, start the pump, gradually close the discharge valve and read pressure at shut-off.
Pump Cycles Too Much	1. Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation.
	2. Level control is not properly set or is defective.	Check voltage across closed contacts.
	3. Insufficient air charging or leaking tank or piping.	Check setting and operation.
	4. Tank is too small.	Pump air into tank or diaphragm chamber.
Fuses Blow or Circuit Breakers Trip	1. High or low voltage	Check tank size and air volume in tank.
	2. Starter overloads are set too low.	Check voltage at the starter panel or terminal box.
	3. Three-phase current is unbalanced	Cycle pump and measure amperage.
	4. Motor is shorted or grounded.	Check the current draw on each lead to the motor.
	5. Wiring or connections are faulty.	Turn off power and disconnect incoming power supply from terminal box. Measure lead-to-ground and lead-to-ground resistance as explained on the previous page.
	6. Pump is stuck	Check for proper wiring and loose terminals.
	7. (Single-phase only) Defective capacitor	Turn off power and manually rotate pump shaft. Turn off power and discharge capacitor.

Troubleshooting

Correct It By...
If no voltage at motor, check feeder panel for tripped circuits
Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the terminal box wiring must be checked.
Replace burned heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
If no voltage, check the control circuit fuses. If there is voltage, check the holding coil for shorts. Replace bad coil.
Replace worn or defective parts.
If the motor windings are open or grounded, replace the motor.
When the meter is connected, the needle should jump toward "0" ohms and slowly drift back to infinity. Replace capacitor if defective.
Correct wiring and change leads as required.
Refill the pump, replace lug and start the pump. Long suction lines must be filled before starting the pump.
Clean and replace. Re-prime the pump.
Reduce suction lift by lowering pump, increase suction line size or by removing high friction-loss fittings.
Repair and leaks and retighten all loose fittings.
Convert PSI to feet (PSI x 2.31 = ___ ft). Refer to the specific pump curve for shutoff head for that pump model. If actual head is close to curve, the pump is probably OK. If not, remove pump and inspect.
Readjust switch or replace if defective.
Readjust setting (refer to level control manufacturer's data). Replace if defective.
Check diaphragm for leak. Check tank and piping for leaks with soap and water solution. Check air-to-water volume.
Tank volume should be approximately 10 gal. for each gpm of pump capacity. The normal air volume is 2/3 of the total tank volume at the pump cut-in pressure.
If voltage varies more than ±10%, contact power company. Check wire sizing.
Increase heater size or adjust trip setting.
Must be within ± 5%. If not, check motor and wiring.
If an open or grounded winding is found, repair or replace the motor.
Tighten loose terminals. Replace damaged wire.
If shaft does not rotate, remove pump and inspect. Disassemble and repair.
When the meter is connect to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity (∞). Replace if defective.

LIMITED WARRANTY

Products manufactured by GRUNDFOS PUMPS CORPORATION (GRUNDFOS) are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

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Support Centers: Allentown, PA • Atlanta, GA

A-7

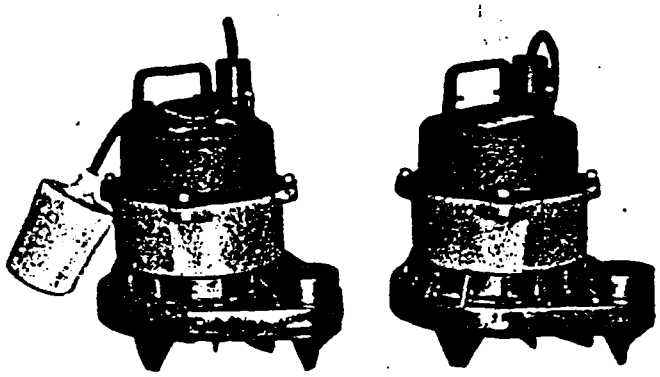
Sump Pumps

GOULDS PUMPS, INC.
SENECA FALLS, NEW YORK 13148

G&L
A GOULDS PUMPS COMPANY

Installation, Operation and Maintenance Instructions

Model 3871



DESCRIPTION & SPECIFICATIONS:

The Model 3871 embraces a series of submersible effluent pumps designated as EP0411, EP0412, EP0411C and EP0412C. The single-phase EP0411 pumps are for 115 volt service and draw a maximum of 10.6 amps. The single-phase EP0412 pumps are for 230 volt service and draw a maximum of 5.3 amps. The "C" suffix designates the optional 20 foot power cord, whereas, the standard power cord is 10 feet in length.

1. Important:

1.1. Inspect unit for damage. Report any damage to carrier/dealer immediately.

1.2. Electrical supply must be a separate branch circuit with fuses or circuit breakers, wire sizes, etc., per National and Local electrical codes. Install an all-leg disconnect switch near pump.

CAUTION

Always disconnect electrical power when handling pump or controls.

1.3. A grounded 3-wire outlet must be provided within reach of pump and float switch electrical cords. Pump and float switch are equipped with 3-prong ground type plugs. Do not remove the ground prong.

1.4. Motor has a built-in thermal protector which opens the circuit when overload condition is encountered. Protector automatically resets when motor cools.

1.5. Do not carry or hang pump by the electrical cord. Use the handle or discharge pipe for this purpose.

1.6. Pump is not designed for use in swimming pools or hazardous liquids..

1.7. Maximum Operating Limits:

Liquid Temperature:	140F (60C)
Submergence:	10 feet
Starts Per Hour:	20, evenly distributed
Solids Handling:	3/4"

1.8. Flammable gases can be present in a wet-well due to bacterial action. Exercise extreme caution when working in and around such areas. Insure no sparks are generated that could ignite said gases.

2. Installation:

2.1. Store excess pump/switch electrical cord on wall near electrical outlet. Never store excess electrical cord in sump or wet well.

2.2. Sump basin or wet-well size should allow sufficient room for unimpeded movement of the float switch, if employed. It should be large enough to stay within the recommended maximum of twenty starts per hour.

2.3. If a sump basin is not used, sump bottom must be solid concrete. If a packed gravel bottom is used, the stone size must be larger than 3/8" diameter and bricks must be placed under pump for support.

2.4. A sump cover is recommended to prevent solid matter from falling into the sump, to control odors, and to guard against injury.

3. Piping:

3.1. Pump discharge is threaded for 1 ½" pipe. For maximum capacity do not reduce.
3.2. DO NOT APPLY PIPE DOPE TO DISCHARGE PIPE THREADS. Use Teflon tape. Thread pipe into casing hand-tight, then tighten with wrench about ½ turn to seal.
3.3. Install a check valve specifically designed for solids handling on the discharge pipe so as to prevent back flow. Follow valve manufacturer's recommendation regarding valve orientation.
3.4. Install a full flow isolation valve on the discharge line, after the check valve, to aid in maintenance work.
3.5. When lowering unit into sump, grasp by both the handle and discharge pipe. Never grasp by pipe alone.

4. Operation:

4.1. Float switch, when furnished, is attached to the pump at the factory for a liquid-level differential of 6". Readjust only if necessary and space is sufficient. Increasing tether length increases differential between on and off. Allow 1" minimum clearance between bottom of float and bottom of pump. Also, insure that the influent does not cascade directly on the switch.
4.2. Complete unit should be placed against side of the sump as shown. "Kick-back" of pump will then be against side of sump.
4.3. When installation is complete, fill sump several times to make sure the unit operates properly and automatically.

5. Maintenance:

5.1. Submersible pump/motor units are oil filled and no further lubrication is required.

6. Disassembly:

6.1. Disconnect power. Remove pump from sump or wet-well. Flush as necessary.
6.2. To gain access to impeller (15), lay the unit on its side and remove the thread forming screws (16) and base (17).
6.3. To clean behind the impeller, remove the klip ring (18) and impeller.

CAUTION

Do not remove mechanical seal (12) at this time.

6.4. If additional work is necessary, first place the unit back on its base. Remove screws (20). Lift the strain relief assembly, consisting of collet (2) and collet adapter (4), with the cord set (1) from the motor cover (7). Cord set is electrically connected to the motor cover by push-on connectors.
6.5. Remove the oil plug grommet (8) by placing one leg of a pair of needle nose pliers within the grommet hole to aid extraction.
6.6. Invert the unit, drain all oil and note its condition.
- 6.6.1. Clear oil with no burnt odor indicates pump and seals are in acceptable condition.
- 6.6.2. Dark oil with burnt odor indicates motor has been overheated. Check winding resistance to ground. It should be one megohm or higher.
- 6.6.3. Milky or emulsified oil indicates water leaking into sealed chamber through faulty O-rings or mechanical seal. Check motor, replace if faulty. Replace faulty seals.

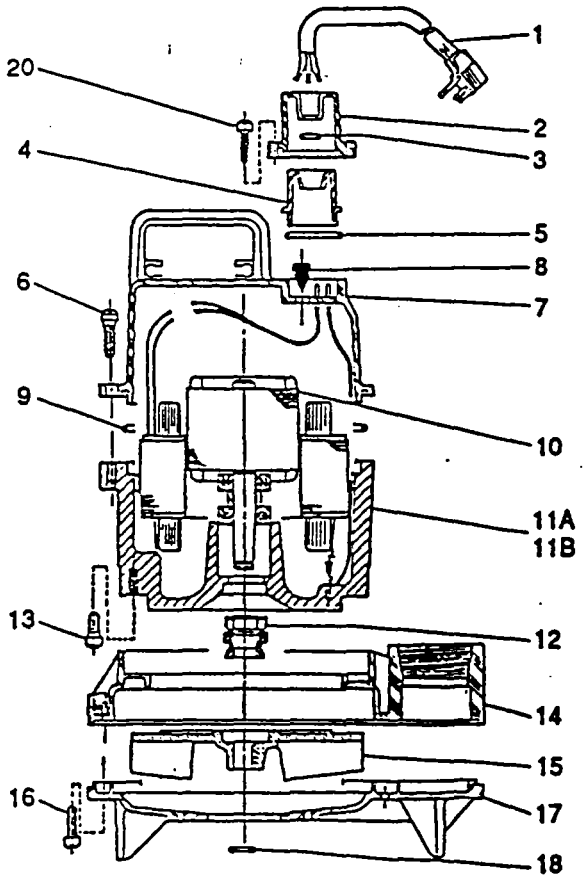
6.7. Refer to sectional drawing and reassembly instructions if further tear down is required.

7. Reassembly:

7.1. All parts should be cleaned before assembly.
7.2. Refer to parts list to identify required replacement items. Specify pump index number and part number when ordering parts.
7.3. All mechanical seal components must be in good condition or leakage may result. Replacement of complete seal assembly (12), whenever seal has been removed, is good standard practice.

It is permissible to use a light lubricant, such as glycerin, to facilitate assembly. Do not contaminate the mechanical seal faces with lubricant.
7.4. Push mechanical seal stationary seat into the bore of the motor housing/stator assembly (11) using the thumb or forefinger. Make sure it is seated properly, and square. Wipe with lint-free cloth.
7.5. Place rotor (10) on bench, shaft end up.
7.6. Invert motor housing/stator assembly, place over rotor being careful not to damage mechanical seal stationary seat, and press until bearings seat within their bore.

7.7. Position casing (14) on motor housing/stator assembly with the discharge 180 degrees opposite the green ground wire. Fasten with the short fillister head screws (13).
7.8. Press mechanical seal rotary on shaft until it contacts the stationary seat.
7.9. Place impeller (15) over shaft and secure with klip ring (18).
7.10. Place base (17) on casing and fasten with the short thread forming screws (16). Invert assembly.
7.11. Inspect motor housing O-ring (9) and replace if damaged. Place O-ring over lock of motor cover (7).
7.12. Secure motor leads to pin connectors on motor cover using needle nose pliers. The ground wire (green) is connected to the middle pin.
7.13. Position cover over motor so that cord connection is 90 degrees counterclockwise from the casing discharge connection. Tuck wires between the stator and motor cover to avoid pinching or interference with the rotor. Fasten with long fillister head screws (6).
7.14. Fill assembled motor housing with 1 quart of insulating oil (19).



7.15. Insert grommet (8) in oil fill hole. A 1/8" diameter rod inserted in the grommet will aid the assembly.
7.16. Inspect power cord O-ring (3) and strain relief O-ring (5). Replace if damaged.
7.17. Feed power cord (1) through strain relief collet (2) and follow with the O-ring, placing it about 2" up on the outer insulating jacket. Complete the subassembly with the collet adapter (4) and its O-ring.
7.18. When securing the cord set leads (1) to the pin connectors, connect the ground wire (green) to the middle pin as indicated by the ground symbol molded into the cover.
7.19. Place the collet adapter and its O-ring over the connections. Reposition the power cord O-ring to within 1/2" of the end of the outer insulating jacket and follow with the strain relief collet. Fasten the collet to the housing with the long thread forming screws (20).

CAUTION

Alternate back and forth between the two fasteners to avoid damaging the collet.

PARTS

Item No.	Part No.	Description
1	9K207 9K208 9K209 9K210	10' Cord Set EP0411-115V 10' Cord Set EP0412-230V 20' Cord Set EP0411C-115V 20' Cord Set EP0412C-230V
2	9K204	Strain Relief Collet
3	5K198	O-Ring–Power Cord
4	9K205	Collet Adapter
5	5K197	O-Ring–Strain Relief Assembly
6	13K175	Fillister Head Screw–Motor Cover
7	1K257	Motor Cover
8	6K87	Oil Plug Grommet
9	5K196	O-Ring–Motor Housing
10	9K213	Rotor
11A	1K259	Motor Housing/Stator Assembly (115V)
11B	1K260	Motor Housing/Stator Assembly (230V)
12	10K32	Mechanical Seal
13	13K181	Fillister Head Screw–Casing
14	1K233	Casing
15	2K467	Impeller
16	13K244	Thread Forming Screw–Base
17	1K258	Base
18	7K817	Klip Ring
19	4K245	Insulating Oil (Gal.)–1 Qt. Required
20	13K243	Thread Forming Screw–Strain Relief

8. Trouble Shooting Guide:

Extreme caution should be exercised when servicing electrical devices. Fatal injuries could result from electrical shock. Always disconnect the electrical power from the device being serviced unless it is necessary for the work being done.

MOTOR NOT RUNNING
(See causes 1, 2, 3, 4, 6, 8)

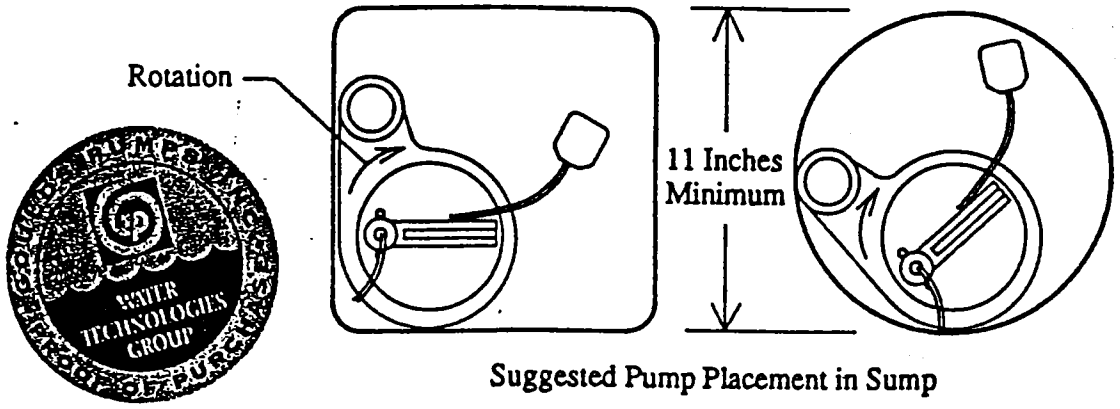
LITTLE OR NO LIQUID DELIVERED
(See causes 5, 6, 7, 8, 10)

PUMP WILL NOT TURN OFF
(See causes 7, 8, 9, 10, 12, 13)

PUMP CYCLES CONSTANTLY
(See causes 9, 11, 12, 13)

PROBABLE CAUSES:

1. Tripped thermal protector.
2. Open Circuit breaker or blown fuse.
3. Rotating parts binding.
4. Defective motor.
5. Air bound.
6. Low voltage.
7. System head too high.
8. Pump clogged.
9. Level control defective or switch not properly positioned.
10. Improper check valve direction.
11. Check valve leaking.
12. Incorrect size basin or wet-well.
13. Inflow excessive for size of pump.



Suggested Pump Placement in Sump

LIMITED WARRANTY

This warranty applies to all pumps and related accessories manufactured and/or supplied by Goulds Pumps, Inc. - Water Systems Division.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the buyer or any subsequent owner during the warranty period. The warranty period shall exist for twelve (12) months from date of installation, or eighteen (18) months from date of manufacture, whichever expires first.

A consumer who believes that a warranty claim exists must contact the authorized dealer from whom the equipment was originally purchased and furnish complete details regarding the claim. The dealer is authorized to adjust any warranty claim utilizing Goulds Customer Relations Department and its distributor organization.

This warranty excludes: (a) Labor, transportation and related costs incurred by the consumer to make the allegedly defective equipment available to the dealer for inspection. (b) Re-installation costs of repaired equipment. (c) Re-installation costs of replacement equipment. (d) Consequential damages of any kind. (e) Reimbursement for loss caused by interruption of service.

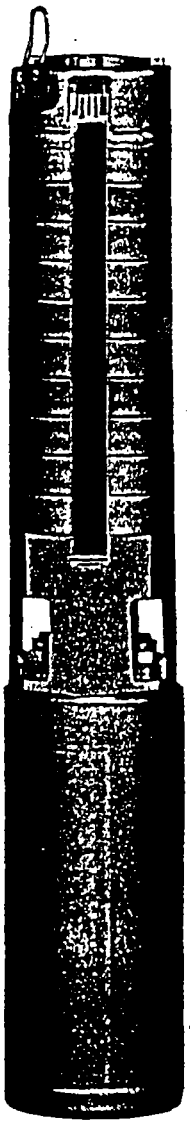
A-8

Groundwater Extraction Pumps

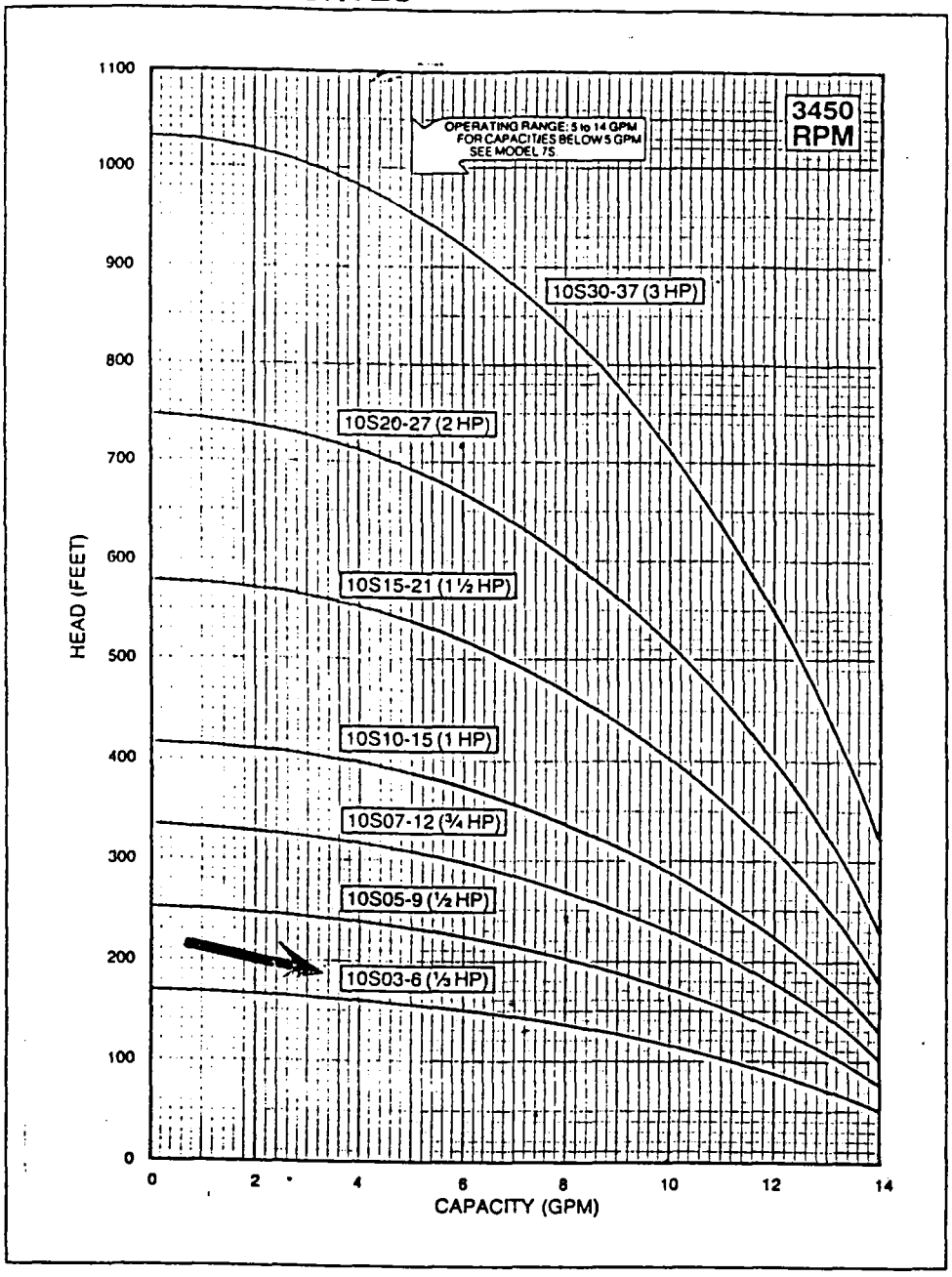
GRUNDFOS

FLOW RANGE
5 to 14 GPM

PUMP OUTLET
1¼" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
10S03-6	⅓	22	3¾	26
10S05-9	½	25⅛	3¾	29
10S07-12	¾	28¼	3¾	32
10S10-15	1	31¼	3¾	34
10S15-21	1½	37⅞	3¾	44
10S20-27	2	42	3¾	49
10S30-37	3	57⅜	3¾	83

Specifications are subject to change without notice.

GRUNDFOS

MODEL 10S

SELECTION CHARTS

(Ratings are in GALLONS PER HOUR – GPH)

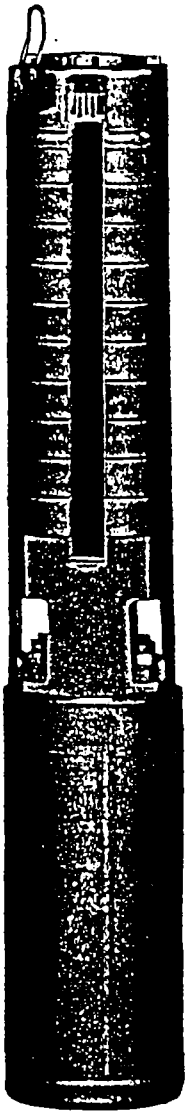
FLOW RANGE
5 to 14 GPM

PUMP OUTLET
1¼" NPT

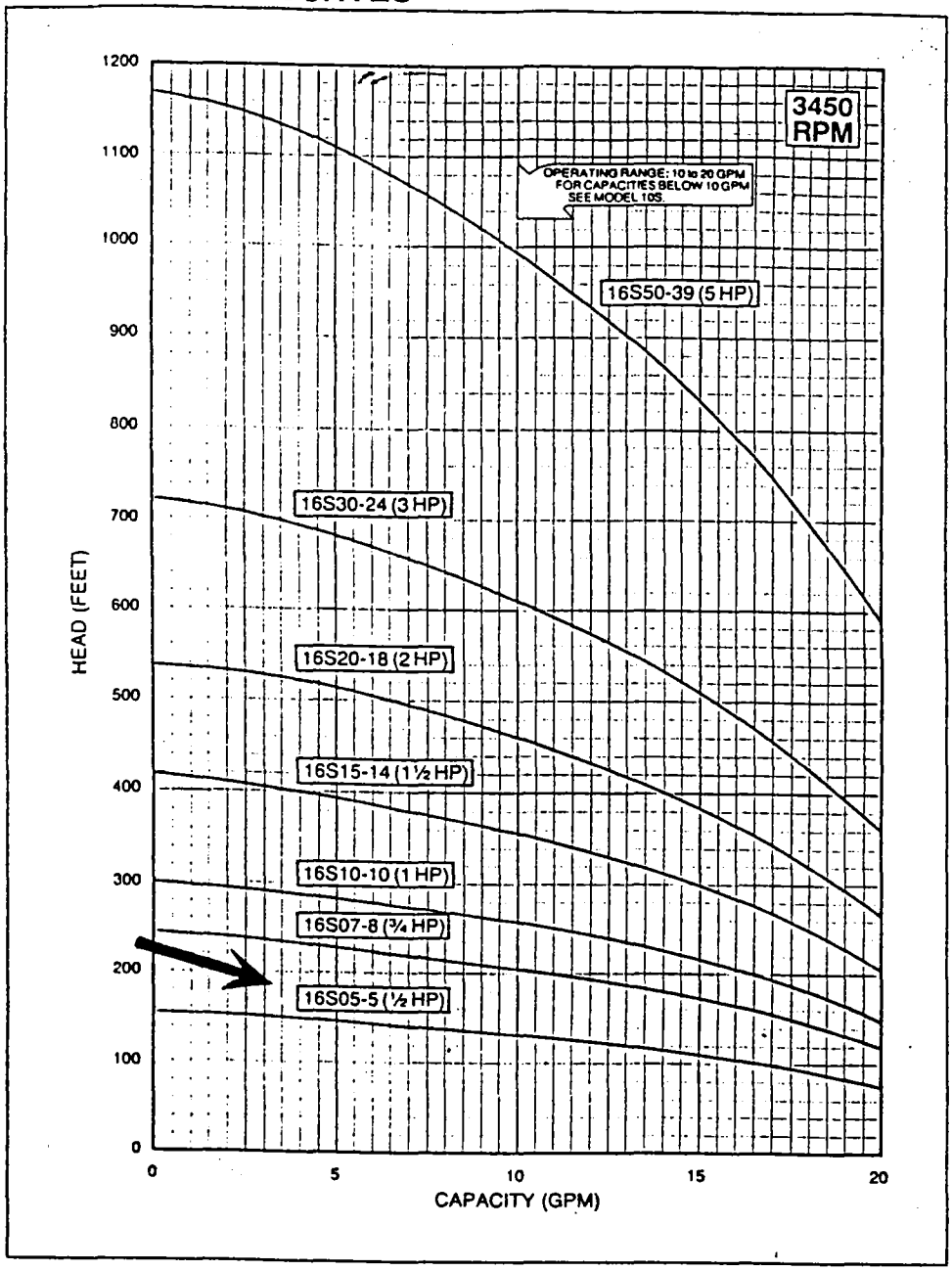
PUMP MODEL	HP	PSI	DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																								
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	340	400	460	520	600	700	800	900	1000	1100
10S03-6	⅓	0		856	811	766	665	564	398	233																	
		20	840	790	741	636	532	315	98																		
		30	790	706	621	501	380	190																			
		40	712	606	500	250																					
		50	588	447	306	153																					
		60	464	232																							
Shut-off PSI:			64	55	47	38	29	21	12	3																	
10S05-9	½	0				847	802	746	685	626	568	499	393	207													
		20		835	785	727	667	608	549	472	347	122															
		30	828	777	718	658	600	538	457	320	73																
		40	768	708	649	590	528	440	290																		
		50	699	639	581	516	422	258																			
		60	630	572	504	403	223																				
Shut-off PSI:			100	92	83	74	66	57	48	40	31	23	14	5													
10S07-12	¾	0					857	828	791	748	703	658	614	570	521	457	362										
		20			849	817	778	734	689	644	601	556	503	432	323	155											
		30		845	812	771	727	682	637	594	549	494	418	302	121												
		40	840	806	765	720	675	631	587	541	484	403	279	85													
		50	800	758	713	668	624	580	533	473	387	254															
		60	751	706	661	617	573	525	462	370	228																
Shut-off PSI:			137	129	120	111	103	94	85	77	68	59	51	42	33	25	16										
10S10-15	1	0							843	816	785	750	714	678	643	608	573	489	226								
		20					835	807	774	739	703	667	632	598	562	522	472	312									
		30				831	802	769	734	698	662	627	592	556	515	463	393	153									
		40		851	827	797	764	728	692	656	621	587	550	508	454	380	276										
		50	848	823	792	758	723	686	651	616	581	544	500	444	366	256	99										
		60	818	787	753	717	681	645	611	576	538	493	434	352	235												
Shut-off PSI:			174	165	157	148	139	131	122	113	105	96	87	79	70	61	53	35	10								
10S15-21	1½	0									853	836	817	795	772	747	721	669	594	511	375						
		20							848	831	811	788	764	739	713	687	661	611	533	415	176						
		30						845	828	807	784	760	735	709	683	657	632	583	495	344							
		40					843	825	804	781	756	731	705	679	653	628	604	552	449	248							
		50				840	822	800	777	752	727	701	675	650	625	600	575	519	389	120							
		60		854	837	818	797	773	748	723	697	671	646	621	596	571	544	478	308								
Shut-off PSI:				237	229	220	211	203	194	185	177	168	159	151	142	133	125	107	81	55	29						
10S20-27	2	0												847	834	819	803	766	707	647	589	500	284				
		20										844	830	814	797	779	760	720	660	602	541	425	87				
		30									842	827	812	795	776	757	737	697	638	580	514	373					
		40							852	839	825	809	792	773	754	734	714	674	615	556	483	309					
		50						850	837	823	807	789	770	751	731	711	691	651	593	531	445	228					
		60					848	835	820	804	786	767	748	728	708	688	668	629	570	502	398	126					
Shut-off PSI:							285	276	268	259	250	242	233	224	216	207	198	181	155	129	103	68	25				
10S30-37	3	0																841	808	769	725	667	596	519	399		
		20														847	838	816	778	736	691	634	562	472	309		
		30													846	836	826	802	762	719	675	617	545	444	252		
		40												845	835	824	813	787	746	702	658	601	525	411	185		
		50											843	833	822	811	798	772	729	685	641	585	504	372	105		
		60										842	832	821	809	796	783	756	711	668	625	568	481	326			
Shut-off PSI:												362	354	345	336	328	319	302	276	250	224	189	146	103	59		

FLOW RANGE
10 to 20 GPM

PUMP OUTLET
1¼" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
16S05-5	½	21 7/8	3 3/4	27
16S07-8	¾	25	3 3/4	29
16S10-10	1	27 1/8	3 3/4	32
16S15-14	1 ½	32	3 3/4	36
16S20-18	2	34 5/8	3 3/4	40
16S30-24	3	46 5/8	3 3/4	64
16S50-39	5	63 5/8	3 3/4	94

Specifications are subject to change without notice.

GRUNDFOS

MODEL
16S

SELECTION CHARTS
(Ratings are in GALLONS PER HOUR – GPH)

FLOW RANGE
10 to 20 GPM

PUMP OUTLET
1¼" NPT

PUMP MODEL	HP	PSI	DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																									
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	340	400	460	520	600	700	800	900	1000	1100
16S05-5	½	0			1260	1135	920	710																			
		20	1215	1090	845	600	300																				
		30	1035	865	480	95																					
		40	760	480	240																						
		50	390																								
		60	175																								
Shut-off PSI:			58	49	40	32	23	14																			
16S07-8	¾	0					1230	1150	1050	950	770	585	310														
		20			1205	1130	1015	910	710	510	255																
		30	1270	1195	1105	1015	860	705	450	190	95																
		40	1180	1100	980	860	645	430	215																		
		50	1075	980	810	640	370	100																			
		60	940	810	576	350	175																				
Shut-off PSI:			97	88	80	71	62	54	45	36	28	19	10														
16S10-10	1	0						1250	1185	1125	1040	955	820	685	480	280											
		20				1230	1165	1100	1010	920	775	630	420	210	105												
		30			1220	1160	1085	1010	890	770	585	400	200														
		40		1210	1145	1080	985	885	730	575	355	135															
		50	1200	1140	1060	980	850	720	530	335	170																
		60	1125	1055	950	845	680	515	290																		
Shut-off PSI:			123	115	106	97	89	80	71	63	54	45	37	28	19	11											
16S15-14	1½	0								1260	1215	1175	1125	1080	1015	950	860	640	200								
		20							1205	1160	1110	1060	995	925	825	730	600	305									
		30					1240	1200	1150	1105	1045	990	905	820	705	590	440	145									
		40				1235	1190	1145	1095	1045	960	900	800	695	560	420	255										
		50			1225	1185	1135	1090	1030	965	880	790	670	545	390	235	120										
		60		1220	1175	1130	1080	1025	950	870	765	660	515	375	205												
Shut-off PSI:				167	158	149	141	132	123	115	106	97	89	80	71	63	54	37	28								
16S20-18	2	0										1270	1235	1200	1170	1135	1090	1000	810	525	160						
		20									1225	1190	1160	1120	1080	1040	985	860	600	250							
		30								1220	1185	1150	1115	1075	1030	980	915	770	475	115							
		40							1215	1180	1145	1110	1065	1025	965	910	835	665	340								
		50						1210	1175	1140	1100	1060	1010	960	895	830	740	550	190								
		60					1205	1170	1135	1100	1050	1010	950	890	810	735	635	420									
Shut-off PSI:							194	186	177	168	160	151	142	134	125	116	108	90	65	39	13						
16S30-24	3	0																1175	1095	990	850	585	125				
		20													1220	1195	1170	1115	1020	885	710	390					
		30												1215	1190	1165	1140	1080	975	820	625	280					
		40											1210	1190	1160	1135	1105	1040	920	750	535	170					
		50										1210	1185	1160	1130	1100	1070	1000	860	675	440						
		60									1205	1180	1150	1125	1100	1070	1030	950	800	590	330						
Shut-off PSI:											239	230	221	213	204	195	187	169	143	117	91	57	13				
16S50-39	5	0																			1205	1140	1050	925	755	530	255
		20																			1170	1100	1000	855	660	410	110
		30																		1200	1150	1080	970	815	605	345	
		40																		1180	1135	1060	940	770	550	280	
		50																	1210	1165	1115	1035	905	725	540	210	
		60																	1190	1145	1090	1010	865	680	430	140	
Shut-off PSI:																			342	316	290	256	213	169	126	83	39

Redi-Flo

Limited Warranty

Redi-Flo Environmental Pumps manufactured by GRUNDFOS Pumps Corporation (GRUNDFOS) are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights and you may also have other rights which vary from jurisdiction to jurisdiction.

Attorney's Fees

Should any dispute arise between Buyer and GRUNDFOS with regard to this agreement or any sale of product pursuant to this agreement, the prevailing party in said dispute shall be entitled to reasonable attorney's fees.

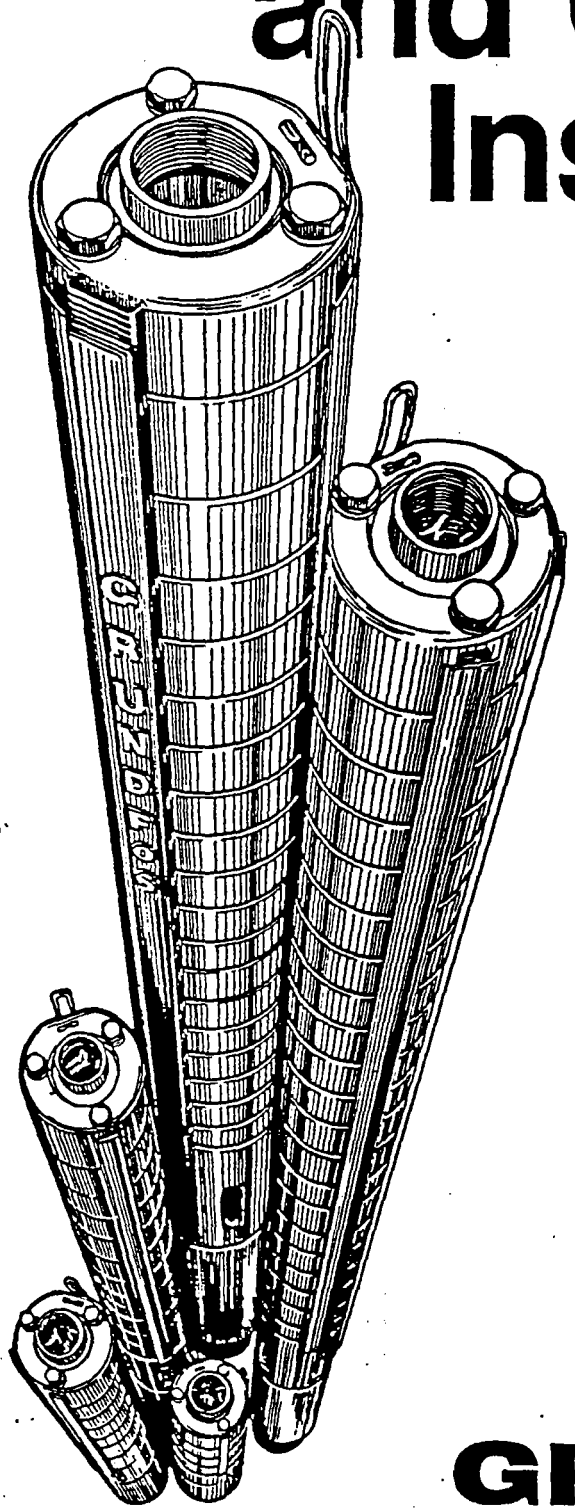
Choice of Law

This agreement shall be governed by and construed in accordance with the laws of the State of California. Buyer agrees that all actions or proceedings arising directly or indirectly out of a sale of products from GRUNDFOS to Buyer shall be litigated only in courts located within California, and Buyer consents to the jurisdiction of any such local, state or federal court.

GRUNDFOS

Installation and Operating Instructions

4-Inch Single Phase Stainless Steel Submersible Pumps



1. Pre-Installation
2. Splicing the Motor Cable
3. Installation
4. Electrical
5. Start Up

GRUNDFOS®

Installation and Operating Instructions

4-INCH SINGLE PHASE STAINLESS STEEL SUBMERSIBLE PUMPS

1. Pre-Installation

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the GRUNDFOS submersible makes it resistant to abrasion; however, no pump made of any material can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil lubricated line-shaft turbine in an existing well, the well must be blown or bailed clear of oil.

Determine the maximum depth of the well, and the drawdown level at the pump's maximum capacity. Pump selection and setting depth should be made based on this data.

Submersible well pumps are designed for pumping clear, cold water, free of air or gases. Decreased pump performance and life expectancy can occur if the water is not clear, cold or contains air or gases. Water temperature should not exceed 102°F.

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum drawdown level of the well.

The bottom of the motor should never be installed lower than the top of the well screen or within five feet of the well bottom.

Ensure that the requirement for minimum flow past the motor (Table A) is met.

2. Splicing the Motor Cable

If the splice is carefully made, it will be as efficient as any other portion of the cable, and will be completely watertight.

There are a number of cable splicing kits available today – epoxy filled, rubber-sealed and so on. Many perform well if the manufacturer's directions are followed carefully. If one of these kits is not used, we recommend the following method for splicing the motor cable to the drop cable:

Examine the motor cable and the drop cable carefully for damage. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads. Be sure to match the colors. Strip back and trim off one-half inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation. Insert a properly sized Sta-Kon-type connector on each pair of leads, again making sure that colors are matched. Using Sta-Kon crimping pliers, indent the lugs. Be sure to squeeze down hard on the pliers, particularly when using large cable. Form a piece of electrical insulation putty tightly around each Sta-Kon. The putty should overlap on the insulation of the wire. Use a good quality tape such as *#33 Scotch Waterproof* or *Plymouth Rubber Company Slipknot Grey*. Wrap each wire and joint tightly for a distance of about 2½ inches on each side of the joint. Make a minimum of four passes over each joint and overlap each pass approximately one inch to assure a completely watertight seal.

After splicing the motor cable, replace the cable guard by inserting into the slots at the discharge end of the pump. Resecure the tabs at the bottom end of the cable guard. **NOTE: For proper installation the cable guard must be pushed to the TOP end of the mounting slots before securing bottom tabs.**

3. Installation

A back-up wrench should be used when the riser pipe is attached to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. Under no circumstances grip the body of the pump, cable guard or motor.

When tightened down, the threaded end of the first section of the riser pipe or the nipple must not come in contact with the check valve retainer in the discharge chamber of the pump.

After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. Do not clamp the pump. When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only.

Make sure that the electrical cables are not cut or damaged in any way when the pump is being lowered in the well.

Do not use the power cable to support the weight of the pump.

To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade, utilizing a locally-approved well seal or pitless adapter unit.

We recommend that steel riser pipes always be used with the larger submersibles. A pipe thread compound should be used on all joints. Make sure that the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

It is recommended that plastic-type riser pipe be used only with the smaller domestic submersibles. The manufacturer or representative should be contacted to insure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the specific pipe manufacturer. Besides making sure that joints are securely fastened, we recommend the use of a torque arrestor when using plastic pipe.

Do not connect the first plastic riser section directly to the pump. Always attach a metallic nipple or adapter into the discharge chamber. The threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber when tightened down.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above each joint.

IMPORTANT: *Plastic pipe tends to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave three to four inches of slack between clips or taped points. This tendency for plastic pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge chamber of GRUNDFOS 4-inch submersibles is designed to accommodate this cable. (See figures 1A, 1B; and 2).*

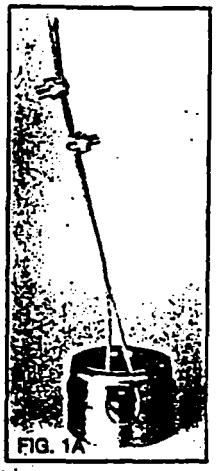


FIG. 1A

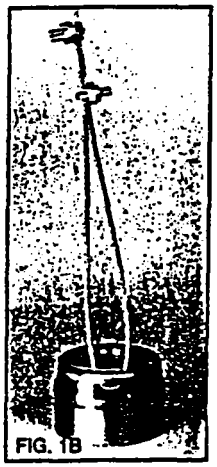


FIG. 1B

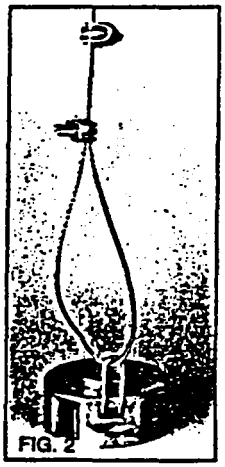


FIG. 2

CHECK VALVES: A check valve should always be installed at the surface of the well. In addition, for installations deeper than 200 feet, check valves should be installed at no more than 200 foot intervals.

4. Electrical

WARNING: *A faulty motor or wiring can be a serious electrical shock hazard if it or surrounding water are accessible to human contact. To avoid this danger, connect the motor frame to the power supply grounding terminal with copper conductor no smaller than the circuit conductors unless the motor and surrounding water are inaccessible, as in a drilled well. In all installations connect above-ground metal plumbing to the power supply ground per National Electrical Code Article 250-80 to prevent electrical shock hazard.*

Verification of the electrical supply should be made to insure the voltage, phase and frequency match that of the motor. Motor electrical data can be found in Table B.

If voltage variations are larger than ± 10%, do not operate the pump.

Single phase motor control boxes should be connected as shown on the wiring diagram mounted on the inside cover of the control box supplied with the motor.

The type of wire used between the pump and control boxes should be approved for submersible pump application. The conductor insulation should be type RW, RUW, TW or equivalent.

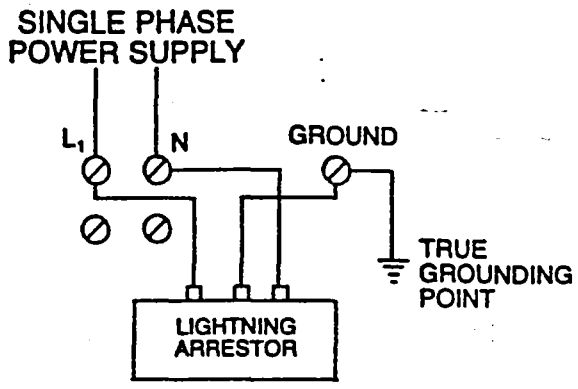
A high voltage surge arrestor should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated arrestor should be installed on the supply (line) side of the control box or starter (see figure 3). The arrestor must be grounded in accordance with the National Electrical Code and local governing regulations.

PUMPS SHOULD NEVER BE STARTED UNLESS THE PUMP IS TOTALLY SUBMERGED. SEVERE DAMAGE MAY BE CAUSED TO THE PUMP AND MOTOR IF THEY ARE RUN DRY.

The control box shall be permanently grounded in accordance with the National Electrical Code and local governing codes or regulations. The ground wire should be a bare stranded copper conductor at least the same size as the drop cable wire size. Ground wire should be run as short a distance as possible and securely fastened to a true grounding point.

True grounding points are considered to be: a grounding rod driven into the water strata; steel well casing submerged into the water lower than the pump setting level; and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first, and then to the terminal in the control box.



SINGLE PHASE HOOK-UP

FIGURE 3

5. Start Up

A. Attach a temporary horizontal length of pipe to the riser pipe.

B. Install a gate valve and another short length of pipe to the temporary pipe.

C. Adjust the gate valve one-third of the way open.

D. Verify that the electrical connections are in accordance with the wiring diagram.

E. After proper rotation has been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.

F. Slowly open the valve in small increments as the water clears until the valve is all the way open. The pump should not be stopped until the water runs clear.

G. If the water is clean and clear when the pump is first started, the valve should still be slowly opened until it is all the way open.

Table A — Min. Water Flow Requirements for 4-Inch Submersible Pump Motors

Motor Diameter	Casing or Sleeve I.D. in Inches	Min. GPM Flow Passing the Motor
4-Inch	4	1.2
	5	7
	6	13
	7	21
	8	30

NOTES:

a. For Franklin Motors Only: A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.

b. For Franklin Motors Only: The minimum water velocity over 4" motors is 0.25 feet per second.

Table B — GRUNDFOS Electrical Data: 4-Inch, 2-Wire and 3-Wire, 60 Hertz Submersible Pump Motors

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)	
4-Inch, Two-Wire											
⅓	230	1	1.75	3.0	4.4	15	5	S	25.5	6.8-8.2	
½	230	1	1:60	4.3	5.9	15	7	R	34.5	5.2-6.3	
¾	230	1	1.50	6.6	8.0	20	9	N	40.5	3.2-3.8	
1	230	1	1.40	8.0	9.6	25	12	M	47.4	2.5-3.1	
1½	230	1	1.30	10.6	13.1	35	15	L	60.8	1.9-2.3	
4-Inch, Three-Wire										BY	RY
⅓	230	1	1.75	3.0	4.4	15	5	L	14.0	6.8-8.3	17.3-21.1
½	230	1	1.60	4.3	5.9	15	7	L	20.0	4.7-5.7	15.8-19.6
¾	230	1	1.50	6.6	8.0	20	9	L	30.8	3.2-3.9	14.0-17.2
1	230	1	1.40	8.0	9.6	25	12	K	36.3	2.6-3.1	10.3-12.5
1½	230	1	1.30	9.7	11.5	30	15	H	44.0	1.9-2.3	7.8-9.6

Table C

Franklin Electrical Data: 4-Inch, 60 Hz Submersible Pump Motors

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)
4-Inch, Two Wire										
⅓	115	1	1.75	7.0	8.9	25	10	S	48.4	1.5-1.9
	230	1	1.75	3.5	4.4	15	5	S	24.2	6.0-7.4
½	115	1	1.60	9.6	11.9	30	15	R	62.4	1.0-1.3
	230	1	1.60	4.8	5.9	15	7	R	31.2	4.2-5.2
¾	230	1	1.50	6.4	8.0	20	9	N	40.2	2.7-3.4
1	230	1	1.40	8.2	9.6	25	12	M	46.0	2.2-2.8
1½	230	1	1.30	10.6	13.1	35	15	L	56.8	1.5-1.9

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)	
										BY	RY
4-Inch, Three Wire											
⅓	115	1	1.75	7.0	8.9	20	8	N	32.8	1.5-1.9	5.7-7.1
	230	1	1.75	3.5	4.4	15	5	N	16.4	6.0-7.4	23.4-28.6
½	115	1	1.60	9.6	11.9	30	15	M	46.0	1.0-1.3	3.8-4.7
	230	1	1.60	4.8	5.9	15	7	M	23.1	4.2-5.2	15.5-19.6
¾	230	1	1.50	6.4	8.0	20	9	M	33.1	2.7-3.4	11.0-13.6
1	230	1	1.40	8.0	9.6	25	12	L	42.0	2.2-2.8	9.5-11.7
1½	230	1	1.30	10.0	11.5	30	15	J	52.8	1.5-1.9	6.2-8.5
2	230	1	1.25	10.0	13.1	35	15	G	51.0	1.6-2.3	5.2-7.1
3	230	1	1.15	14.0	16.5	45	20	F	71.0	0.9-1.5	3.0-4.9
5	230	1	1.15	23.0	27.5	60	30	F	118.0	0.7-1.0	2.1-2.8

LIMITED WARRANTY

Products manufactured by GRUNDFOS PUMPS CORPORATION (GRUNDFOS) are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

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Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction. GRUNDFOS PUMPS CORPORATION, 2555 Clovis Avenue, Clovis California 93612, telephone number (209) 292-8000.

GRUNDFOS®

GRUNDFOS Pumps Corp. • 2555 Clovis Ave.• Clovis, CA 93612
Support Centers: Allentown, PA • Atlanta, GA • Mississauga, Ontario, Canada

L-SP-TL-048 | 1/31/92
PRINTED IN USA

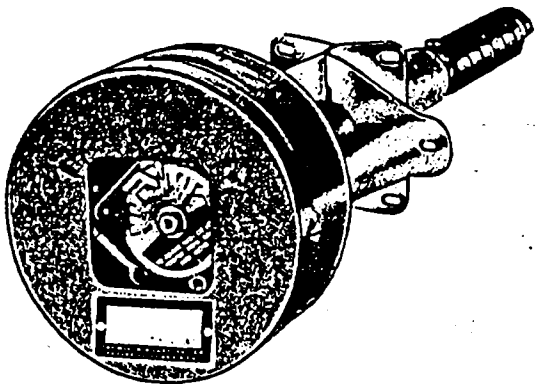
Mercoid® Series M-51, M-53 Air Type Temperature Controls Installation Instructions

CAUTIONS: Do not twist the bi-metal as it may permanently distort. Check nameplate on control case and make certain that the load to be handled is within designated rating. Do Not oil any parts. At no time should the control be subjected to temperatures higher than maximum shown on the nameplate or graduated scale. Mount in a vibration free area.

LOCATION: After proper location has been determined, cut a 2-3/8" or 2-1/2" dia. hole. Place the flange against the hole and in the correct position mark and punch the holes for the sheet metal screws provided. Do not tighten flange until instrument is level.

LEVELING: Mount control so the cover screws "A" are horizontal. Separate the High and Low adjustable pointers "C" and "D". See Illustration No. 1. If switch remains either to left or right after tilting with finger, the instrument is ready to be secured to flange.

SETTING: Hold the ratchet wheel with one hand, while pressing and moving either the "High" or "Low" pointers. By doing this, the catch between the teeth of the ratched wheel disengage. See Illustration No. 2. When releasing the pressure be certain that the catch is engaged.



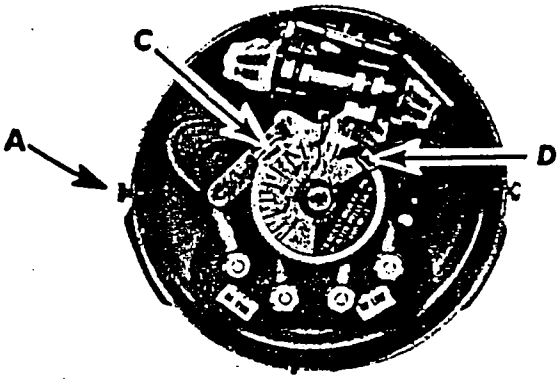


Illustration No. 1

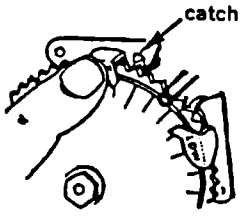


Illustration No. 2

SEMI-AUTOMATIC with MANUAL RESET

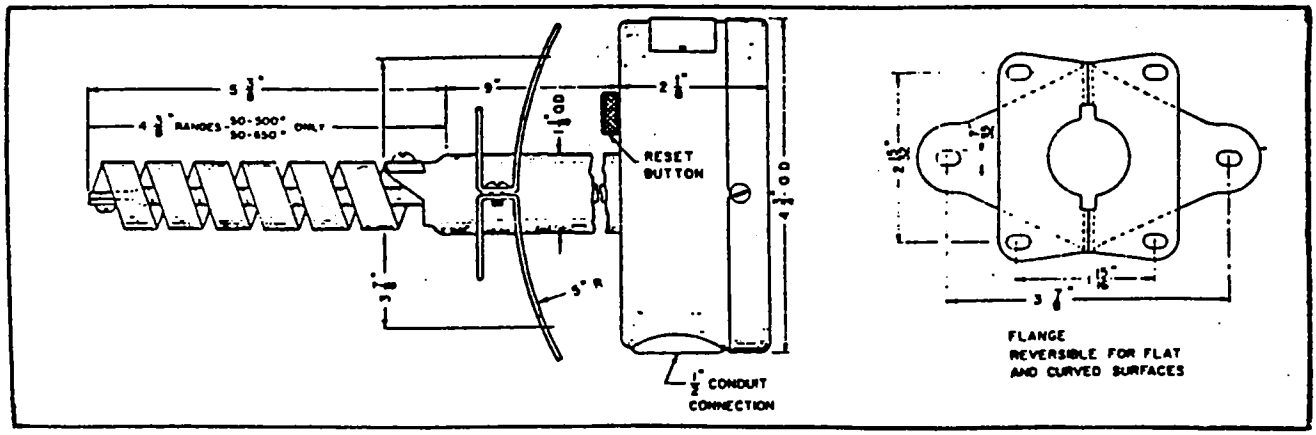
SEMI-AUTOMATIC: These controls operate in one direction only and must be reset to restore to normal position. See Table for semi-automatic operation.

SUMMER SWITCH — TYPE 53 ONLY:
Normally prevents operation of the fan unless the furnace is heated. To operate the fan for ventilating purposes, turn the knob on the back of the case. The control will automatically release and return to normal operation when the furnace is heated.

WIRING: Follow local codes. Use a short strip of BX to relieve control of conduit expansion and contraction. Do not tamper with switch wires. Position of these wires is essential to proper switch operation. Tampering with these wires will void warranty.

• OPERATING RANGES — DIFFERENTIALS •

—— See Reverse Side ——



OPERATING RANGES/DIFFERENTIALS,

SERIES M-51 & M-53

SPST—Fully Automatic

Type	Range No.	Switch Action on Temp. Rise	Adj. Range °F	Min. Diff. °F	Dimensions (In.)	
					A	B
M-51	74	OPENS	50-500	20	4-3/8	9
M-51	71	OPENS	25-125	12	5-3/8	9
MX-51	75	OPENS	50-650	20	4-3/8	9
M-53	74	CLOSES	50-500	20	4-3/8	9
MX-53	75	CLOSES	50-650	20	4-3/8	9

SPST—Semi-Automatic With Manual Reset

Type	Range No.	Adj. Range °F	Min. Diff. °F	Circuit Sequence		Dimensions (In.)	
				Auto.	Man.	A	B
M-51R	71	25-125	12	OPEN on rise	CLOSE	5-3/8	9
M-51R	74	50-500	20	OPEN on rise	CLOSE	4-3/8	9
MX-51R	75	50-650	20	OPEN on rise	CLOSE	4-3/8	9
M-51RL	74	50-500	20	CLOSE on drop	OPEN	4-3/8	9
MX-51RL	75	50-650	20	CLOSE on drop	OPEN	4-3/8	9
M-53R	74	50-500	20	CLOSE on rise	OPEN	4-3/8	9
MX-53R	75	50-650	20	CLOSE on rise	OPEN	4-3/8	9
M-53RL	74	50-500	20	OPEN on drop	CLOSE	4-3/8	9
MX-53RL	75	50-650	20	OPEN on drop	CLOSE	4-3/8	9

ELECTRICAL RATING (ALL TYPES)

AC or DC, 10A @ 120V, 5A @ 240. Motor rating 120/240V AC, Single-phase, 3/4 HP; 120/240V DC, 1/3 HP.

Mercoid®
MERCOID DIVISION
DWYER INSTRUMENTS, INC.
P.O. BOX 258
MICHIGAN CITY, IN 46360 (USA)
PHONE 219/879-8000 FAX 219/872-9057

FR 93-441857-00

A-9

Flowmeters (Hershey, Kent)

Hersey MEASUREMENT COMPANY

NIAGARA® LIQUID METERS

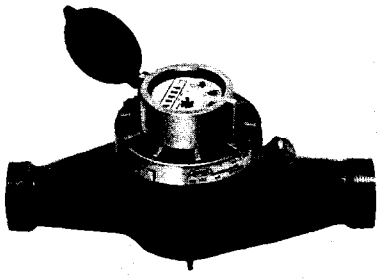
Series MTX

The Niagara Series MTX flowmeters are ideal for the measurement of cold or hot water in commercial and industrial applications. These high performance meters are unsurpassed in the marketplace today.

The Series MTX employs the latest technical achievements in multijet impeller meters. The impeller is the only moving part in the flow stream and is magnetically coupled to the register.

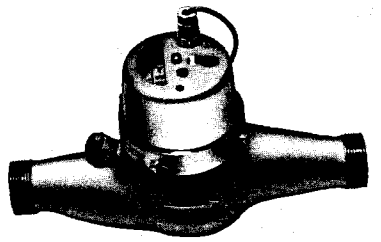
Features

- Brass main case resists corrosion.
- The hermetically sealed magnetically driven register prevents condensation or fogging due to variations of temperature. The magnetic coupling eliminates packing leaks.
- An impeller is the only moving part in the precision molded measuring chamber which assures long life and accuracy at all flow rates within the range of the meter.
- The multijet design balances the force on the impeller and extends the life of the meter.
- Modular construction allows ease of service and repair in the field.
- The strainer in the inlet port removes foreign material from the flow stream that would damage or clog the meter.



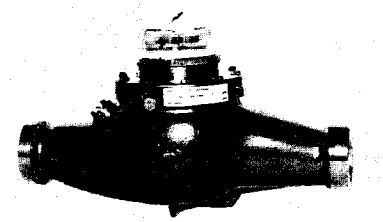
Model 123

Displays continuous totalization.



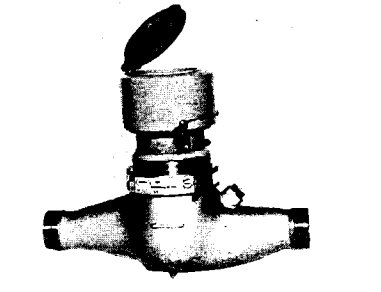
Model 414

Displays continuous totalization and provides a calibrated contact closure for hot water.



Model 433

Displays continuous totalization and provides a calibrated contact closure for cold water.



Model 420

Displays continuous totalization.

Options:

- It can be fitted with up to two Model 840 Switches to provide a calibrated contact closure.
- In addition a Model 860 Pulse Transmitter can be utilized for a high frequency signal.

Specifications

Model 123

Size		3/4"	1"	1 1/2"	2"
Flow Rate		1-20 gpm	2-50 gpm	3-85 gpm	4-130 gpm
Pressure		250 psi	250 psi	250 psi	250 psi
Temperature	Cold	120 F	120 F	120 F	120 F
	Hot	250 F	250 F	250 F	250 F
Accuracy		± 1%	± 1%	± 1%	± 1%
Registration *		US Gallons	US Gallons	US Gallons	US Gallons
Threads/Flanges		1" NPT	1 1/4" NPT	2" NPT	6 1/2" Flg

* Other units of registration available (consult factory).

Model 414

Size	3/4"	1"	1 1/2"	2"
Flow Rate	1-20 gpm	2-50 gpm	3-85 gpm	4-130 gpm
Pressure	250 psi	250 psi	250 psi	250 psi
Temperature	250 F	250 F	250 F	250 F
Accuracy	± 1%	± 1%	± 1%	± 1%
Registration *	US Gallons	US Gallons	US Gallons	US Gallons
Gallons per Contact	1	1	10	10
Threads/Flanges	1" NPT	1 1/4" NPT	2" NPT	6 1/2" Flg

* Other units of registration available (consult factory)

Model 420

Size		3/4"	1"	1 1/2"	2"
Flow Rate		1-20 gpm	2-50 gpm	3-85 gpm	4-130 gpm
Pressure		250 psi	250 psi	250 psi	250 psi
Temperature	Cold	120 F	120 F	120 F	120 F
	Hot	250 F	250 F	250 F	250 F
Accuracy		± 1%	± 1%	± 1%	± 1%
Registration *		US Gallons	US Gallons	US Gallons	US Gallons
Gallons per contact with 840 Switch		10 or 100	10 or 100	10 or 100	10 or 100
Full Scale Freq. HZ with 860 Pulser **	Cold	20.63	16.66	14.16	21.66
	Hot	38.57			
Pulses per gallon	Cold	61.89	20	10	10
	Hot	115.71			
Threads/Flanges		1" NPT	1 1/4" NPT	2" NPT	6 1/2" Flg.

* Other units of registration available (consult factory).
** Hz = GPM * PPG/60 PPG = Hz * 60/GPM

Model 433

Size	3/4"	1"	1 1/2"	2"
Flow Rate	1-20 gpm	2-50 gpm	3-85 gpm	4-130 gpm
Pressure	250 psi	250 psi	250 psi	250 psi
Temperature	120 F	120 F	120 F	120 F
Accuracy	± 1%	± 1%	± 1%	± 1%
Registration *	US Gallons	US Gallons	US Gallons	US Gallons
Gallons per contact	1	1	10	10
Threads/Flanges	1" NPT	1 1/4" NPT	2" NPT	6 1/2" Flg

* Other units of registration available (contact factory).

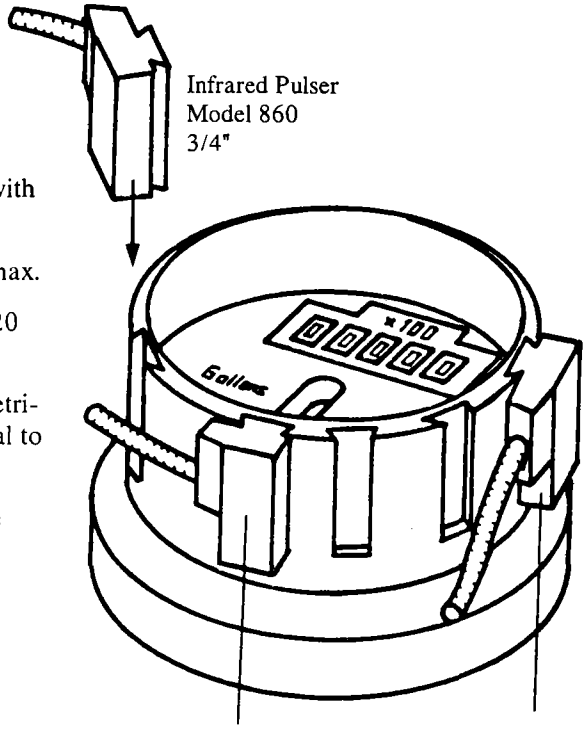
Wetted Material Of Construction

Body:	High Strength Brass Body for 2" flanged is cast iron
Measuring Element:	120 F - Polystyrene 250 F - Noryl
Impeller:	120 F - Polystyrene 250 F - Noryl
O Ring Seals:	EPDM

Options for Model 420

Model 860
Infrared Pulser

- Provides a high frequency pulse output for interface with Hersey instrumentation.
- Supply Voltage: 30 VDC max.
- Current Requirement: 15-20 mA.
- Output Signal: Non-symmetrical square pulse train (equal to supply voltage).
- Wiring: Pigtail, 36", 3-wire 22 gauge.



Model 840
Reed Switch

- Provides a calibrated contact closure.
- Contact Rating

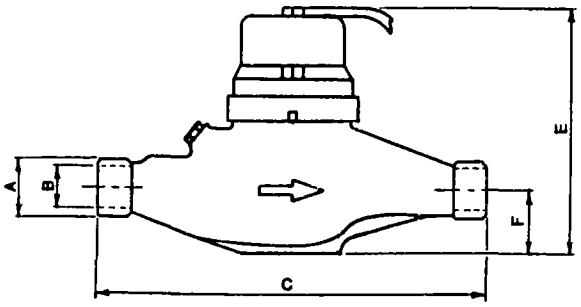
  Switching Voltage: 30 VDC max.

  Current DC Resistive 0.2A max.

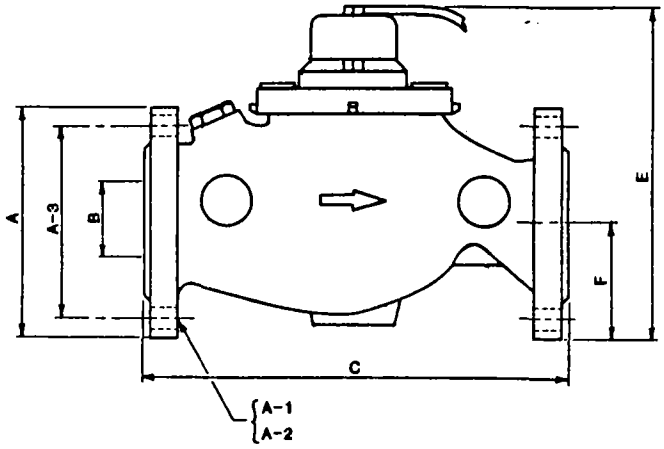
  Wattage: 3 WDC max.
- Wiring: Pigtail, 36", 3-wire 22 gauge.

Dimensions

All Models 3/4" - 1 1/2"



All Models 2"



Size inches (mm)		3/4"	1"	1 1/2"	2"
Threads/Flanges	A	1" NPT (25.4)	1 1/4" NPT (31.75)	2" NPT (50.80)	6 1/2" (165.10)
Bolt Holes	A-1	— — —	— — —	— — —	4
Bolt Holes Dia.	A-2	— — —	— — —	— — —	5/8" (15.88)
Bolt Circle Dia.	A-3	— — —	— — —	— — —	4 3/4" (120.65)
Bore Dia.	B	3/4" Nominal	1" Nominal	1 1/2" Nominal	2" Nominal
Length	C	7 1/2" (190.50)	10 1/2" (266.70)	12" (304.80)	10 3/4" (273.05)
Width	D	3 3/4" (95.25)	4" (101.60)	5 1/2" (139.70)	6 1/2" (165.10)
Height	E *	6" (152.40)	7 1/4" (184.15)	8 3/4" (222.25)	10 1/2" (266.70)
Center Line to Base	F	1 1/4" (31.75)	1 1/2" (38.10)	1 3/4" (44.45)	3 1/8" (79.37)
Weight lbs (kg)		4 1/2 lbs. (2.04)	6 1/2 lbs. (2.9)	11 1/2 lbs. (5.2)	27 1/2 lbs. (12.5)

* For 123/420 hot water meters, add 1 1/2 inches.

Hersey
MEASUREMENT
COMPANY

150 Venture Boulevard
P.O. Box 4585
Spartanburg, SC 29305
A division of **Flow Measurement, Inc.**
Phone: 803-574-8960
800-845-2102 (except in SC)
Fax: 803-578-7308

Hersey Distributor:

Form # S 211
4M-0193

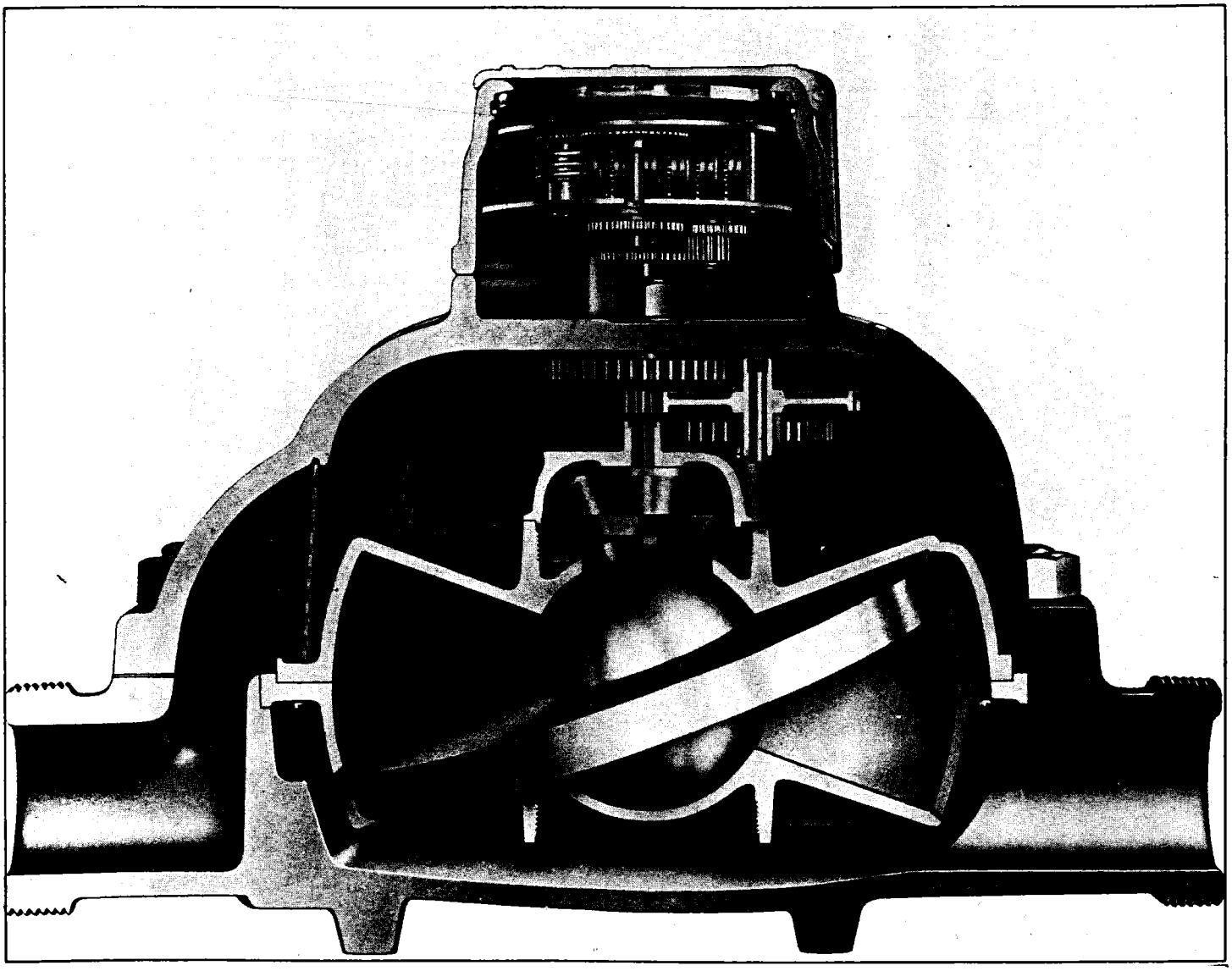
Hersey
MEASUREMENT
COMPANY

M 110

NIAGARA®
LIQUID METERS

Nutating Disc Meter

IOM (Installation, Operation, and Maintenance)



A miller Industries Company

NIAGARA®

NUTATING DISC METER

MAINTENANCE AND REPAIR GUIDE

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Hersey MEASUREMENT COMPANY

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P.O. Box 4585
Spartanburg, SC 29305

A Miller Industries Company

(803) 574-8960 / 1-800-845-2102 (Except in SC)

PRINCIPLES OF METER USE

The maintenance of volumetric liquid meters is in general so simple that little attention has been paid to it by many users. However, the increasing instrumentation of industry calls for more complete information where many meters are involved. This manual is intended to give definite suggestions on maintenance and repair. In each company using Niagara Meters a single man should be designated to have complete supervision of original installations, maintenance and repair.

Niagara Meters are built in four general classes of construction as follows:

1 - Cold water (under 100°F.) and cold non-corrosive water-base liquids.

2 - Hot water (over 100°F.) and heated non-corrosive water-base liquids.

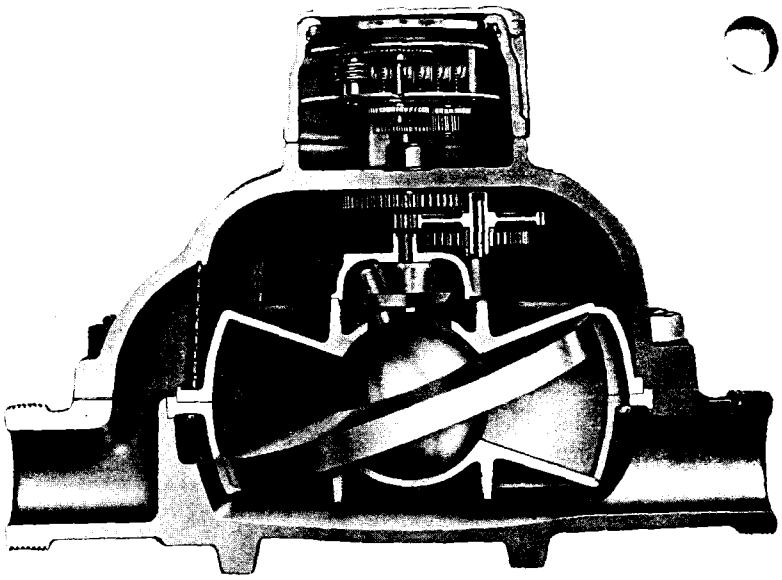
3 - Petroleum products and other non-corrosive oils and similar liquids.

4 - Chemical solutions that are corrosive to bronze but which can be metered by the use of type 316 stainless steel in the meter parts.

Use a meter only on the liquid for which it was ordered. Materials and calibrations are substantially different for each class. Cold water meters will be damaged immediately by heat or oil. Hot water meters may be run on cold water without physical damage but registration will be 1% to 4% inaccurate. Oil meters will be damaged in a day's time by water. Chemical meters are specially constructed for the particular chemical specified.

All these meters operate on the same principle of measurement and are of the nutating piston volumetric displacement type. The liquid enters the meter through the inlet, shown at the left in the sectional view and passes upward through a coarse strainer into the top of the main casing. Here it submerges and lubricates the internal gearing; then moves downward through the measuring chamber into the base of the meter and discharges through the meter outlet. When the liquid enters the measuring chamber it drives the single measuring piston which nutates, or rocks around on its central ball. The roller, or positive displacement cam, against which the piston pin bears, controls its movement and compels it to make a complete nutation at each movement. The position of the piston divides the chamber into compartments which are successively filled and emptied, each compartment holding a definite volume. The movements of the piston are transmitted by a train of gears to the meter register.

The edge of the flat portion of the piston is unusually thick. The liquid being measured forms a liquid seal between



the piston and the chamber wall, minimizing slippage and compelling accuracy at low rates of flow. Piston washers are avoided. Works are made of materials selected for the liquid to be measured. The bearings of the submerged gears carry the weight of the gears on the tops of the gear posts shown above, forming an enclosed, dirt-proof construction. For cold water meters only, in most sizes, the gears may be placed in a grease-filled chamber. Oil meters are all-metal. In gasoline meters, and oil meters used for exacting service, the piston has our exclusive long-wearing semi-steel bearing, moving in an extra hard bronze seat. Casings are usually cast semi-steel, hot-zinc dipped, or bronze.

The amount displaced by a single movement of the piston remains constant for any specified liquid. With the correct train of gears, accurate registration on the register is thus assured. Each Niagara Meter is individually tested and calibrated at the factory to run within close tolerances at all rates of flow within its rated capacity, on the liquid for which it is intended. Oil meters are tested on oil and the tolerance is not over 1%, sometimes much smaller.

Like all volumetric meters, Niagara Meters are intended for operation on clean liquids only. Solids such as sediment, pipe scale, etc., must be removed before metering by a filter or fine mesh strainer.

IDENTIFYING OPERATING DIFFICULTIES

This is intended as a guide to tell where first to look, to locate the cause of troubles that may be observed.

1 - METER STOPS REGISTERING

After making sure that liquid is actually flowing through the line when the meter fails to register, the first step is to investigate whether the difficulty is in the register or in the submerged works. Remove the register box or lift a vertical register off its seat and see whether the drive shaft passing upward from the meter body turns when liquid is flowing. If it does turn the trouble is then located in the register. If it does not turn, this locates the trouble inside

the meter body, which must then be opened.

In a cold water meter the most common cause of internal stoppage is swelling of the hard rubber disc piston as a result of heat. In any meters which are relatively new, clogging by dirt is a common cause of stoppage and usually requires only a careful cleaning.

If the trouble is located as being in the register, the most likely difficulty is that the set screw of one of the change (calibrating) gears has come loose, and needs only to be retightened on the flat spot of the shaft.

2 - METER RUNS INACCURATE BY A FAIRLY CONSTANT PERCENTAGE.

If this percentage of error is not more than about 5% and the meter is not too old, this may indicate either an error of original calibration, or an error resulting from slight wear or change of viscosity of liquid being measured. These can be corrected by following instructions for correcting accuracy. Note, however, that once an error due to wear has started to develop, the meter may show a further error within a relatively short time and should be watched.

3 - METER OVER-REGISTERS ERRATICALLY

If the meter registers substantially more than the true quantity of liquid passing through it and particularly if the amount of the over-registration is erratic, this indicates that air, steam or other gases are being passed through the meter along with the liquid. These would register like the liquid. The remedy is to keep the air or gas out at its source or in certain cases to install an air release valve ahead of the meter. Changing the calibration of the meter cannot correct this kind of trouble. Once a meter has been correctly calibrated it cannot of itself start to over-register except that a slight and consistent over-registration, of perhaps 1%, may result if a film of scale forms inside a water meter.

4 - METER UNDER-REGISTERS BY A SUBSTANTIAL OR ERRATIC AMOUNT.

This may be caused either by severe wear or by partial clogging of the meter due to foreign matter. It is usually advisable to open the meter to see if cleaning will correct the trouble or if the needed repair is something that can be done on the job. Unless adequate repair facilities are available locally, it may be advisable to return the meter to the factory for repairs.

5 - METER OPERATES BUT DIAL HAND DOES NOT TRAVEL SMOOTHLY.

If the dial hand alternately stops and jumps ahead, this indicates difficulty with the meshing of the gearing, usually in the change gears. The gears may be worn to the point that the tops of the teeth strike on each other or the gears may be adjusted so they mesh too tightly. In either case, adjust the change gears so they mesh smoothly with just enough clearance to prevent binding, and replace gears if worn.

6 - LEAKAGE OF METERED LIQUID IS OBSERVED.

If leakage of liquid is noticed at the point where the register is attached to the meter body, this indicates either (a) that the stuffing box packing has become loose and needs retightening. Proceed as directed in instructions for repacking stuffing box, tightening the stuffing box nut only just enough to stop the leak. (b) Temperature may be too high for the packing used. All meters built before 1952 have composition cork packing for temperatures under 150° and for higher temperatures have graphite asbestos packing. Since that date, a small number of meters have o-ring stuffing box packing of materials depending upon liquid and temperature. In repairing, be sure to use only genuine packings procured from the factory and change to a high temperature packing, if needed. (c) Shaft may show score marks. If it does, a new top intermediate gear and shaft is required.

Leakage around the main flange of meter indicates usually that the operating pressure is above that for which the gasket was intended; or that the temperature is too high for the gasket causing it to burn out; or that the meter was not correctly assembled after repair. In bronze case meters it is also possible that excessively high pressure may warp the outer casing permitting leakage midway between the bolts. Leakage at the couplings on the ends of threaded meters indicates that the coupling washer is not holding tight or is missing. Pipe must be correctly aligned to permit the washers to hold tight. Leather washers used for cold liquids will burn out at high temperatures and should be replaced with resilient asbestos washers.

INSTRUCTIONS FOR CLEANING AND REPAIRING METERS

GENERAL INSTRUCTIONS

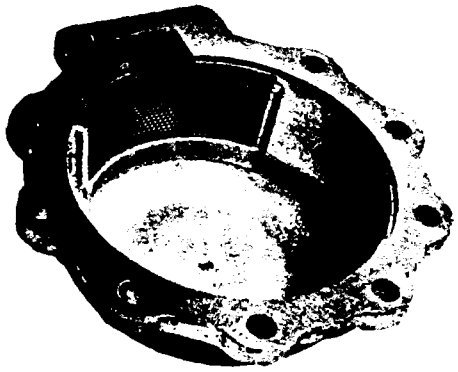
Keep all parts of a meter together and do not allow parts to be interchanged. While machining dimensions are such that the parts are physically interchangeable, any interchange of measuring disc piston, measuring chamber or change gears may change the accuracy of registration of the meter. Keep the register box with the meter body to avoid mixup of serial numbers. Remember that the meter is a precision instrument and all parts must fit perfectly after repairing. Do not expect to do a real repair job by mere cleaning, for worn parts must be replaced. Meters used on slow flows must be kept in especially good condition.

Use the procedure below for standard inspection and repair supplementing it with detailed instructions following:

Unbolt the main flange and lift off the entire top half of the casing. Lift out the chamber in which the nutating piston moves and separate the two halves, removing any screws which hold the two halves together. Lift out the measuring piston and inspect this for wear or for dirt or chips embedded in it. These must be completely and carefully removed as directed in detailed instructions for disc pistons, page 5.

Next inspect the measuring chamber for wear in the lower ball seat or for rubbing of the edge of the piston on vertical chamber wall. If wear at either point, or evidence of rubbing on the vertical wall is found, the chamber should be returned to the factory for remachining, otherwise clean out any dirt and reassemble the piston in the chamber.

Most meters contain an internal strainer inside the inlet port in the top casing. Clean this if necessary and replace so that when viewing it with the top casing upside down, the space between strainer and casing is closed at the bottom, open at the top as illustrated.



Try the register by turning the gearing inside the top casing. If the register hand fails to move or moves irregularly, remove the register of the meter and inspect the calibrating or change gears located just beneath the register base plate. Tighten the set screws of these gears if necessary and see that they mesh squarely but with a little clearance between the teeth to avoid binding.

Replace the measuring chamber with piston into the bottom casing of the meter. Replace the flange gasket or use a new one obtained from the factory. (Flange gasket material must not be more than 3/64" thick.) Then carefully set the top casing onto the assembled unit. Be careful to obtain a proper mesh of the gearing when replacing the top casing to avoid damage to the internal gears. After reassembly, a meter of 1 1/2" or smaller size should operate when held to the mouth and air blown through it. If the stuffing box has been leaking, or if the top intermediate gear has been removed, repack the stuffing box as instructed on page 6.

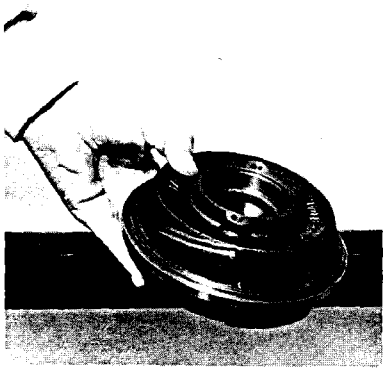
When repairing 3" IV, 4" JV or 6" LV sizes, note the top casing cover plate in the center of the top casing. This should be removed before opening the main casing, as the intermediate gearing is mounted on the underside of it. If the top main casing needs to be removed, the cover plate opening provides a convenient place to grasp the main casing. In these meters also there is a measuring chamber cover plate mounted on the disc chamber enclosing the disc pin and the disc pin opening in the chamber top in the same manner that the gear plate does in small sizes.

After repairing meters dispose of the worn parts removed. Do not allow any collection of junk parts to accumulate. They would cause confusion with parts which are still useable.

DETAILED REPAIR INSTRUCTIONS

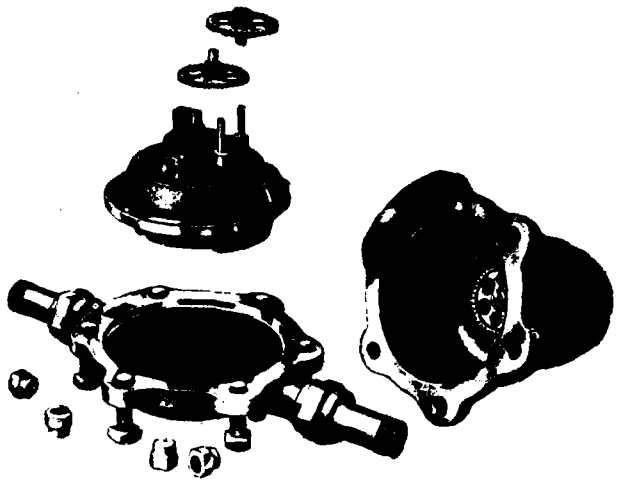
1 - Disc Pistons

Clean off foreign matter avoiding the removal of any of the piston material. If wire brushing by hand fails to put the piston in perfect condition, note the following: If made of hard rubber, extra-fine emery paper or cloth may be used but be careful not to reduce the diameter nor to round the edges nor roughen the central ball. If made of metal, carefully scrape off any embedded specks of foreign matter but do not use emery or other abrasives on the central ball if the meter is to be run at slow rates of flow. If the metal disc portion of a piston used in hot water is corroded, clean off any loose products of corrosion but it is not necessary in such a case that the disc be perfectly smooth. On non-metallic discs test the flatness of the disc portion with a straight edge. If it is warped, the entire piston (if one piece) or the disc (if three-piece construction is used) must be replaced. If any portion is swollen so that it does not run freely in the chamber, this must be replaced, for it cannot be remachined. The disc must move freely in the chamber after reassembling, and the ball must be very smooth. In small size meters if there is any doubt about the perfect fit of the disc, replace it. Accurate measurement cannot be obtained with a poor disc piston.



To separate the halves of an old chamber, remove the screws, if any, then tap diagonally on a wooden surface, holding the chamber bottom up.

In hot water meters if the disc portion of the piston is broken, this indicates that the meter has been run at excess speed probably by passing steam through it. Such breakage is especially likely with carbon disc. If one or both carbon half balls of a hot water piston are cracked this indicates (a) if the disc is made of dark gray color non-metallic composition that the temperature has been too high causing swelling. (Remedy) Replace the disc portion with carbon or spauldite, or (b) if the disc is aluminum alloy, that corrosion has worked in between the disc and



half ball. In alkaline water an aluminum alloy disc may show some corrosion even though the alloy is selected to minimize this. If the corrosion works between the disc and half ball, the increased bulk which it produces may crack the carbon half balls. (Remedy: Use carbon disc in 3" size or smaller meters and in other cases consult the factory for recommendations.)

2 - To Test for Wear on Piston Ball or Measuring Chamber.

If the edge of the disc, or the vertical wall of the measuring chamber, shows marks of scuffing or rubbing on the wall of the chamber at any point (other than obvious grit scratches), this proves that the piston or its ball needs replacing. Wear usually occurs about equally on both items so both probably need replacement if either does. This test discloses severe trouble but other wear may be checked by placing the piston in the chamber tightly. Grasp the disc pin in one hand and move the piston up and down to ascertain the amount of clearance. In meters for low temperature service, the vertical clearance should be not more than about .01". In meters for higher temperature the clearance will be slightly higher when tested cold but any clearance greater than about .02" indicates wear to require repairs. By inserting a new piston and repeating this test, it can be ascertained whether the wear was in the piston or the chamber seat or both.

3 - To Assemble the Two Halves of a Measuring Chamber.

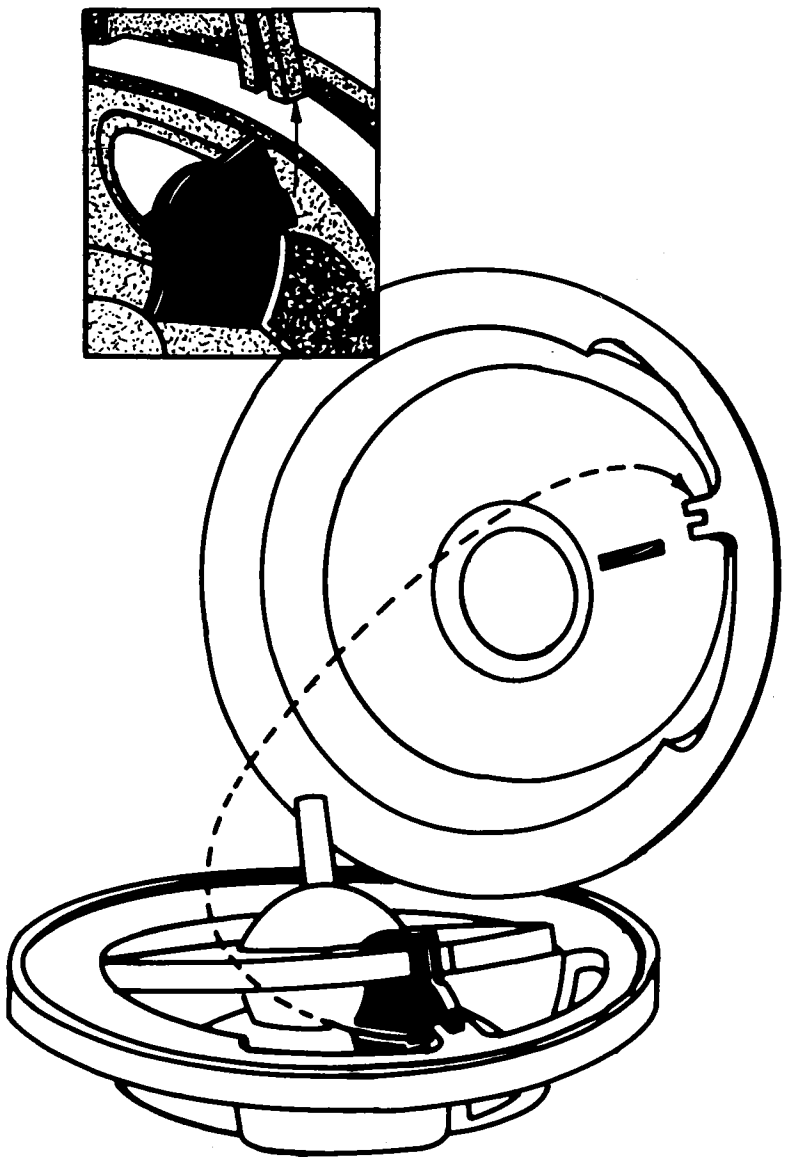
The diaphragm serves as the guide to hold the two halves of the chamber in alignment with each other. Using a wooden block or mallet lightly tap the diaphragm in place in the chamber bottom, then place the piston in the bottom chamber, then place the top half on without the gear plate, in such position that the slots engage the projections on the diaphragm. Tap sharply on the upper edge of the chamber, over the diaphragm to make sure the chamber top is fully in place. See illustration.

4 - Diaphragm.

If this is worn to the point where the surface is roughened, this would interfere with the accuracy of a meter operated below about 25% of maximum capacity. Try turning the disc in the chamber by grasping the disc pin. If it catches or sticks momentarily on the diaphragm at some point, this indicates that the diaphragm needs attention. As wear always occurs on the side toward the outlet port of the chamber (the port in the bottom half), sometimes the diaphragm can be reversed to present a new clean surface on the outlet side, otherwise it must be replaced. If meters are regularly run at fast flows, a small amount of diaphragm wear will not have so much effect on accuracy. The diaphragm must fit tightly in its slots in the chamber, otherwise slippage will occur and the meter will be very noisy. Excess clearance between the diaphragm and the slot in the disc will also create noise but a little excess clearance does not affect accuracy except at slow rates of flow.

5 - Intermediate Gear Plate.

The shaft with its driver block and pinion must revolve very freely, but without much wear in shaft or bushing. In cold water meters and most hot water meters, the bushing can be replaced if worn. (Write the factory for special instructions.) In most oil meters the bushing is integral with the gear plate so the entire unit must be replaced. The



roller also must revolve freely but must not be worn, for wear on this or the disc pin would permit the disc pin to make an incomplete stroke, displacing less than the proper volume of liquid and so causing over-registration. If the roller is worn, other parts of the gear plate are likely also to be worn making complete replacement advisable, but the roller may be replaced separately by removing the driver block, shaft and pinion. In 3/4", 1" and 1 1/4" sizes the pinion is pressed onto the knurled shaft of the driver and can be pressed or knocked out. In larger sizes the driver block is screwed onto the shaft and held in place with a nut. Pins carrying the intermediate gears, and the holes in the gear hubs must not be worn appreciably.

If the intermediate gear train is of the oil-enclosed type having the gears running in a grease filled chamber, the resilient gasket around the top of the grease chamber must be in good condition to retain the grease inside the chamber. When reassembling the meter use only one teaspoonful of semi-fluid waterproof graphite grease, which can be procured from the factory.

6 - To Repack Stuffing Box.

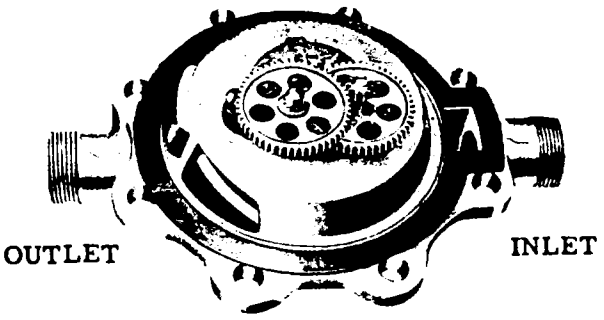
After removing the stuffing box nut, take out the old packing. Check shaft to see whether there are score marks. If the shaft is scored the top intermediate gear and shaft must be replaced, for packing cannot be kept tight on a scored shaft. If the hole passing through the top casing is worn, the top casing of a small meter should be replaced. Large ones can be rebushed at the factory or we can supply for iron case meters, new bronze stuffing box plugs. After insertion, the bottom of the plug must be faced off level with the inner surface of the top casing in a lathe.

(a) For water meters, for temperature under 150°F., the meter was probably fitted with cork stuffing box packing. Place one chamois on the stuffing box shaft, then three composition cork washers each 1/8" thick by 7/16" diameter above it, then a top chamois washer, lubricating the corks with a little water proof graphite grease which we can supply without charge, helps. (b) For oil and gasoline meters at temperatures under 150°F., use three 1/8" corks without the chamois or else two corks 1/4" thick. (c) For water or oil above 150°F., use one formed asbestos-graphite packing. (d) Most chemical meters for corrosive liquids have formed graphite-asbestos packing. A single thin Teflon washer 1/4" O.D. is placed beneath this, if necessary. Instructions concerning such cases will be given by the factory on request, stating the serial number of the meter. (e) Some high pressure oil meters built since 1952 and water meters built since 1953 have "O" ring stuffing box packing, of varying compounds depending upon the liquid to be measured and the temperature. Only one "O" ring is used and the nut is then tightened only finger tight. Be sure that parts orders for "O" ring casing gaskets specify the serial number of the meter so the correct "O" ring material can be furnished.

Have the stuffing box shaft in place and on this shaft place the new packing, then the stuffing box nut, and tighten it, preferably using the special wrench supplied for the purpose. This wrench permits a downward pressure to be exerted at the same time as the nut is rotated. If this is not available and the packing to be replaced is cork, it will be necessary to use some device to exert a downward pressure to compress the cork at the same time that the nut is rotated, until the threads have caught sufficiently to hold. Tighten the nut just enough to stop leaks. The nut for "O" ring packing should only be tightened finger tight and no wrench should be used in its assembly. Excess tightening will impose a drag on the measuring parts that will interfere with accuracy of measurements, and cause rapid wear of the submerged gears. If upon opening a meter there is more wear observed on the top intermediate gear and the pinion meshing with it than on the 1st or 2nd gears or the gear plate drive pinion, this usually indicate stuffing-box drag. Test of packing tension can be made by turning the gear inside the meter casing. The gear should turn with some friction but not too tightly.

7 - Position of Gear Plate on Measuring Chamber

Most meters of 2 1/2" and smaller sizes have the gear plate mounted directly on the chamber. In 1" and smaller sizes it is necessary and in other sizes it is preferable to place the gear plate on the measuring chamber in such position that the arms carrying the pivots point generally in the direction of the open inlet port in the top half of the measuring chamber.



8 - Position of Measuring Chamber in the Meter Body.

The measuring chamber should be so placed in the bottom casing of the meter that the outlet port in the bottom half of the chamber is directly in line with the outlet port on the meter casing. In small sizes this position must be strickly observed, otherwise the internal gears may strike against the strainer inside the meter inlet. If the meter does not assemble readily, check this point to make sure that the intermediate gears are clear of the strainer and its supporting lugs.

9 - Cleaning Scale or Deposit Off Bronze Parts.

On the measuring chamber and other bronze parts, if a brushing does not remove the deposit it is usually loosened by a quick acid dip in the solution of sulphuric and nitric acids described below, followed by careful rinsing. Do not allow the bronze parts to become roughened by the acid. In extreme cases it may be necessary to boil the parts in a caustic solution first to loosen the deposit, then follow with the acid dip and rinse.

10 - Cleaning Scale or Deposit Off Iron or Steel Casings.

Do not use any acid. Usually a dry scraping is suffi cient but, if further cleaning is required, boil the part in caustic soda solution then brush with a wire brush and rinse. Or, if sand blasting equipment using very fine grit is available. parts may be lightly sand blasted (this may also be done on bronze casing if grit is very fine). Suitable paints are sometimes used inside old case iron casings for further protection, the choice of paint depending upon the liquid to be measured. This may help minimize further deposits or rustings but should not be used on new casings as the paint would not stick to new galvanizing.

EQUIPMENT FOR SERVICING METERS

The amount of equipment required depends upon the extent of repair work to be undertaken. The minimum proper equipment would be as follows:

Three screw drivers, large, medium and small, the small one having a fine blade for change gears.

Adjustable wrenches for flange bolts.
Wire brush.
Hammer.

Extra fine emery cloth or paper.

Scraping tool.

Steel straight edge as long as the diameter of the largest meters to be serviced.

The following equipment is also desirable if the number of meters to be serviced warrants its purchase:

Motor-driven rotary wire brush for cleaning rough surfaces. (Do not use this on inside of measuring chambers or on disc piston.)

Acid bath for cleaning bronze parts consisting of a suitable container holding solution of one part sulphuric acid, one part nitric acid, one part water.

Immediately adjacent to the acid bath must be provided running water for washing castings after dipping.

Accuracy testing equipment.

Supplies that should always be on hand include gaskets and stuffing box packings for all sizes of meters in use. These should be kept on hand in advance to save time in cutting gaskets or errors of using packing of incorrect material or design. Experience will dictate what other repair parts should be kept in stock or we will make recommendations.

PRESSURE TESTS

All meters are given a hydrostatic pressure test at the factory for two reasons (1) to detect porosity of castings and (2) to check the tightness of gaskets and stuffing box packing.

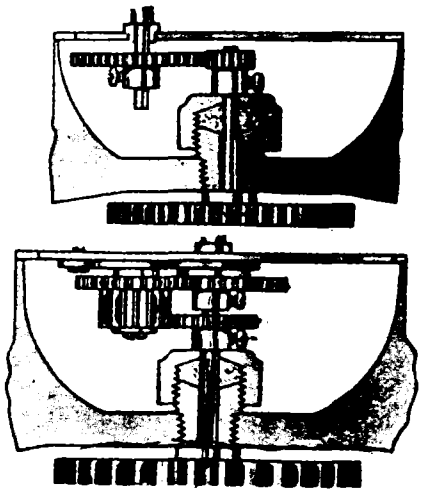
After shipment from the factory the castings need no further pressure testing against porosity unless used on corrosive applications where the metal may deteriorate. After each repair the tightness of packings should be checked. Leaks at the flange gasket are very rare if the meter is carefully assembled and testing for such leaks may usually be omitted. The tightness of the stuffing box packing should be checked either by a hydrostatic test before installation or by observing the condition of the meter after a couple of day's use when the packing has had time to seat itself in place. For detailed information on repacking of stuffing boxes, see page 6. Be careful that the packing is not unnecessarily tight, as this would cause damage because of excess friction load on the meter works.

ACCURACY TESTS AND CALIBRATION

PRINCIPLE OF ADJUSTMENT FOR ACCURATE MEASUREMENT.

Meters which are apparently identical may vary slightly in the quantity delivered per revolution of the drive shaft passing through the stuffing box. Also, substantial variations of speed of the register shaft are required for different units of registration and different types of registers. Each meter is, therefore, equipped with a set of gears known as change gears located immediately beneath the register. These are made with varying numbers of teeth so the different combinations of gears give different speed ratios as needed. There are two types of sets of change gears as illustrated.

In the lower illustration an idler change gear is used between the others to give greater flexibility of gear ratios. This is found in the larger sizes of meters and in most vertical dial meters. The number of teeth of register and meter change gears vary for calibrating purposes but usually the number of teeth of the idler change gear is constant for a given size of meter and type of register. The idler change gear pinion always has 15 teeth and the gear may have any of several numbers of teeth between 15 and 47. This variation in number of teeth necessitates giving the factory the serial number of the meter, and the number of teeth on each change gear, when accuracy is to be adjusted or new gears purchased.



TO CORRECT ACCURACY BY CHANGE GEARS

First ascertain the exact amount and direction of error. Unless such tests are accurately run, it cannot be determined whether there is any real error of measurement in the meter. After ascertaining the exact amount registered for a given amount of true quantity of liquid delivered through the meter, make sure that this registration is consistent. An erratic error or a very large error cannot be corrected by change gears and indicates other troubles as suggested under "Factors Affecting Accuracy."

Unless a stock of change gears for the particular size of meter involved, is kept on hand, new change gears must be procured from the factory so the calculation of them should be left to the factory. Notify the factory telling the serial number of the meter, the amount registered and the true quantity delivered on the accuracy tests as well as the number of teeth on each of the change gears now on the meter. At the factory the new set of gears required to correct the reported error will be calculated and mailed.

If a considerable number of meters of the same size

and dial are in use, we will supply a change gear chart showing the various combinations used on that meter and dial. To use such a chart, calculate the percentage of error and note the number of teeth of gears now on the meter. Then, from the chart select a new set which will give as closely as possible the desired percentage of change. If your meter is registering less than the true quantity delivered, select a set of gears further down the chart to make it register more. If it already registers too much, select gears further up the chart to make it register less. See chart below.

Chart of change gear combinations for 1" (B) size oil or hot water meter fitted with horizontal register, showing percentage of intervals between gear combinations.

Change gear selection table for meter with dial making one revolution of test hand for:					
1 CU. FT.			10 U. S. GAL.		
Number of Teeth		Change Gear Intervals %	Number of Teeth		Change Gear Intervals %
Register Gear	Meter Gear		Register Gear	Meter Gear	
41	14	2.2	41	11	1.7
43	15	2.0	44	12	2.4
45	16	0.5	43	12	2.4
42	15	1.8	42	12	2.5
44	16	0.6	41	12	5.7
41	15	1.7	42	13	2.4
43	16	2.4	41	13	0.4
42	16	0.9	44	14	2.3
39	15	1.1	43	14	2.4
36	14	1.5	42	14	2.3
38	15	1.3	44	15	0.2
35	14	1.4	41	14	2.2
37	15	1.2	43	15	
39	16				

FACTORS AFFECTING ACCURACY

Wear. This causes a meter to register less than the true quantity delivered. The effect shows up first at low rates of flow. A meter which is somewhat worn may still run almost perfectly at fast flows yet be inaccurate at slow flows. If the wear is not bad, a temporary correction can be made by fitting the meter with new change gears to bring the registration close to 100% at the average flow rates. If the error due to wear is more than 3%, replacement of chamber and disc piston is usually necessary.

Air or vapor. Passing any gas through a meter including air or steam causes over-registration because the meter registers the volume of gas as well as the liquid. The only remedy is to keep out the gas at its source or to protect the meter in certain cases by an air release. Change gear compensation is not satisfactory.

Foreign solids. Any solid matter in the measuring chamber of the meter will impede the movement of the piston and cause under-registration. The course of the liquid through a meter is such that the meter will tend to flush itself clean but if foreign matter comes through the line repeatedly with the liquid, the only way to obtain successful metering is to trap out this foreign matter by a filter or strainer.

Change of viscosity. Meters are shipped calibrated for the average viscosity of liquid specified in the order. In general, it may be said that if the viscosity decreases, (the liquid becomes thinner and more free flowing), the registration in the meter will decrease slightly and if the viscosity increases, the registration will increase slightly. Consult the factory for more detailed information concerning the amount of change to be expected in any given set of circumstances. Viscosity changes resulting from temperature changes of plus or minus 25°F. can almost always be disregarded.

Change of temperature. Any Niagara meter registers by volume and is calibrated to register the volume at the specified operating temperature. If the temperature changes substantially, the registration in the meter may change slightly, but this is due to the change in viscosity and properties of the liquid. The effects of minor changes of temperature, amounting to less than plus or minus 25°F., may usually be disregarded. For the effect of the difference between hot water and cold water, see page 10 under "Methods of Making Accuracy Tests."

If it is desired to convert reading into gallons as of some different base temperature, the meter readings should be multiplied by a factor representing the difference between the volume at the base temperature and the volume at the metering temperature. For example, #6 fuel oil expands approximately 1% for 27°F. rise in temperature. If oil is measured at 180°F. by a meter ordered for such use and the readings are to be converted into gallons as of 60°F., the expansion between 60° and 180° would be approximately 4 1/2% so that meter reading should be reduced by 4 1/2% to obtain the equivalent volume as of the base temperature.

Change of rate of flow. As with all meters the curve of accuracy of Niagara Meters when plotted, is a slight curve, not a perfectly straight line. Meters are calibrated at the factory so the registration at varying flows averages as close to 100% as possible. At full flow the meter usually registers slightly less than the true quantity delivered and the proportionate registration increases with decrease in flow rate until at about 5% to 10% of maximum cold water

or oil capacity, the meter registers slightly more than the true quantity. At still slower flows the registration starts to decrease until at very slow flows the meter again registers less than the true quantity delivered.

The characteristics of this curve of accuracy vary with meters for different liquids and vary slightly for different meters of the same size and class. If meters are to be used for exacting measurement where accuracy within fractions of 1% is important, consult the factory for details.

Note that when a meter registers slightly high at some flows and slightly low at others, the errors over a period of time at varying flows will tend to cancel out. The total accumulated error may thus be only a small fraction of 1% when the maximum error at certain rates of flow is as much as 1%. Note also the "accuracy tolerance" means the maximum error permissible at any one rate of flow which is usually greater than the maximum error actually existing and is far greater than the usual accumulated error in operation.

FACTORS NOT AFFECTING ACCURACY.

Sudden starting or stopping of a meter does not affect accuracy as there is no lag in the movement of the measuring piston.

Pulsating flows do not of themselves affect accuracy. The rate of flow at which the meter operates varies during the time cycle of the pulsation and the meter will register with the usual accuracy for such rates of flow. As pulsating flows reach full rate very quickly, the effect of reduced accuracy at point of slow flow in the cycle of a pulsation can usually be disregarded.

Variations in operating pressure do not affect accuracy as liquids are incompressible and the volume to be measured is unchanged at different pressures. Note, however, that an increase in pressure may speed up the rate of flow causing the meter to register with whatever accuracy would be expected at such different flow.

METHODS OF MAKING ACCURACY TESTS.

Types of Test Equipment. There are three types of test equipment, each having its own advantages as follows:

1 - The weigh tank is the most flexible testing equipment and is generally recommended for industrial use. This consists of a drum or tank of desired capacity mounted on a scale. The tank is weighed before and after each test run and the difference in weights represents the weight of metered liquid put into the tank. The exact weight per gallon of the liquid has to be computed separately or in the case of water taken from standard tables for the prevailing temperature and the weighed quantity reduced to gallons, then compared with the meter reading. Advantages of this method are that tests can be made on viscous liquids which would not completely drain out of the tank; tests can be made on widely varying quantities without change of physical equipment and that meters for different liquids can be tested. A movable platform beam scale carrying a 55 gallon drum fitted with means for emptying is most commonly used. The drum is replaced with a smaller container for testing 3/4", 1" or 1 1/4" sizes.

2 - Volume tanks. These may be of several types. Various companies such as Ford Meter Box Co., Wabash, Indiana, manufacture complete test benches consisting of volume test tanks, orifices for controlled rates of flow, connections for installing the meter to be tested and supporting base. These are widely used for testing water meters and could be used for other liquids, provided the liquid is such that the tank will drain completely. They are not useful on heavy oils, etc. For maximum accuracy a separate tank is required for each quantity such as 1 cubic foot, 10 gallons, 100 gallons, etc., as the tank should have a narrow neck with gauge glass to show small deviation from correct quantity. When properly used these test benches give excellent accuracy but are generally not flexible for a wide variety of conditions or liquids.

Variations of the volume tank take many forms. The simplest is the 10 quart or 12 quart pail used to make a rough check to see if a meter is registering somewhere near accurate. Errors in pail capacity and reading the meter makes this method unreliable for results closer than 5%.

Large meters used for delivering petroleum products are sometimes checked against calibrated compartment of a tank truck. This is acceptable provided the calibration has been carefully made, and that tests are always made in the compartment under the same operating conditions. Adjacent compartments in the truck must always be empty. Delivery into the truck must be by a hose or pipe of such length that the delivery is made beneath the surface of the liquid, otherwise an error up to 1/2% may be created by evaporation as the liquid splashes into the compartment. If tests made on two different compartments appear to vary the cause is probably due to error in calibration of one compartment.

3 - A test meter gives results with reasonable accuracy subject to whatever error may exist in the test meter. It is simple to use and permits service meters to be tested without removing them from their fitting. It is usable only on the liquid and under the operating conditions for which it was purchased.

GENERAL RULES FOR ACCURACY TESTS.

1. For maximum accuracy, test against a standard such as a calibrated volume tank or weigh tank rather than another meter. However, a portable test meter specially purchased for the purpose will give close results subject to any error within the test meter. Do not use another service meter or a meter of a different brand for testing.

2. Tests should be run at the normal rate of flow at which the meter will be used. A meter used on fast flows should be tested on quantities not less than one minute's running. If used on slow flows it should be tested on 10 gallons or 1 cubic foot or one revolution of the test hand, whichever is the greatest amount. Always make tests for complete revolutions of the test hand. On vertical dial meters set the hand back to zero for each run.

3. The control valve must be as close as possible to the end of the line and in any event on the outlet side of the meter. When a test meter is used it makes no difference whether the service or test meter is ahead of the other. If the liquid is volatile like hot water, gasoline, alcohol or solvents the discharge into the measuring tank should be beneath the surface of the liquid.

4. To make a test, run liquid through the meter and piping until all air is surely flushed out, then continue to run the meter until the test dial hand is at zero, or set a vertical dial hand to zero. Then run through the meter the desired quantity of liquid, stopping the test according to the meter reading rather than according to any indication in the testing device. Then measure the amount delivered and compare this amount with the indicated amount on the meter dial to ascertain the percentage of error, if any. Make three tests to be sure that the meter runs uniformly. If variations on tests are small, average the three runs. If large variations are found, investigate and correct the cause, then start the test again. Correct an error by change gears as described on page 9.

If a portable test meter is used as the testing method, flush out the air, run the dial hand of the service meter to the zero point, then set the adjustable hand of the test meter to zero and commence the test. On a test of 100 gallons indicated by the service meter, the number of gallons difference between the service meter reading and the test meter reading gives directly the percent of error in the service meter.

COLD WATER METER DETAIL INSTRUCTIONS.

Test only on cold water. The standard accuracy tolerance allowed by water works on new meters is plus or minus 1 1/2% to 2% throughout the total range of flow shown in the table on page 8.

At 1 1/2% of maximum flow a repaired meter should register 90% or more. A repaired meter has to be in very good condition to run accurately. If tests cannot be made at full capacity it is satisfactory if the meter runs accurately at intermediate rates, for such a meter will then also run accurately at full flow.

HOT WATER METER DETAIL INSTRUCTIONS.

For convenience, hot water meters usually are tested on cold water. As the temperature of the water increases, the lubricity and viscosity of the water decreases. When a hot water meter is tested with cold water, the meter will register less than the actual quantity of water passing through it. Hot water meters having a carbon ball in the measuring piston should register 3% to 4% less than the true quantity of cold water passing through it during the test. Meters having the piston ball made of non-metallic composition other than carbon and intended for use on temperature under 180° F should register 1% to 2% less than the true quantity of cold water delivered. Tests should be run at the rate of flow at which the meter will be used and care should be taken that this is within the recommended range of capacity as shown in the Niagara Selection Guide. If the meter reads in pounds, compensation must be made not only for the water characteristics mentioned above but also for the decrease in specific gravity that occurs with heating.

OIL, GASOLINE METER DETAIL INSTRUCTIONS

Meters for petroleum products must not be tested on water. For maximum accuracy they must be tested on the actual product to be measured and at the normal operating flows. If gasoline meters cannot be tested on gasoline by reason of fire hazard and must be tested on some other petroleum product, the factory will on request give a calibration factor which can be used to compensate for the difference in the two products.

Meters for #6 or Bunker C. fuel oil may, however, be tested on medium oil such as #3 fuel oil and the following factors of correction applied to give correct volumetric readings on #6 oil at the normal operating temperature. If the #6 oil will be at temperature under 120°F. test the meter on #3 oil to register 2% less than the true quantity delivered. If the #6 oil temperature will be 160° test to read 1% less than true quantity. If the #6 oil will be at 200° or higher temperature no correction factor is needed. Meters to be used on kerosene or diesel oil but tested on #3 oil should register 1% more than the true quantity of #3 oil delivered on the test.

TEST COMMENTS FOR OTHER METERS

For detail test standards for any other liquids, consult the factory. The following may be noted as general guides. Unheated water-base products having low viscosity may be tested the same as cold water meters. This includes many chemicals including dilute sulphuric acid, etc. Oils other than petroleum would be considered the same as petroleum products having equal viscosity. Raw linseed oil would thus be considered substantially the same as #3 fuel oil. Alcohol meters may be tested on cold water to cold water standards. Other solvents would be considered more comparable to gasoline meters and require testing either on the solvent itself or on oil with a correction factor. For other liquids such as molasses, syrups, etc., consult the factory.

FOR REGISTER SERVICE INSTRUCTIONS SEE:

SR 10 MECHANICAL TOTALIZING REGISTER
SR 20 6" MECHANICAL AND ELECTROMECHANICAL BATCH REGISTER
SR 21 10" MECHANICAL AND ELECTROMECHANICAL BATCH REGISTER
SR 22 DIGITAL RESET MECHANICAL BATCH REGISTER
SR 34 ELECTRIVOLUME BATCH REGISTER

Hersey Representative:

Hersey MEASUREMENT COMPANY
150 Venture Blvd.
P.O. Box 4585
Spartanburg, SC 29305
A Miller Industries Company
(803) 574-8960 1-800-845-2102 (except in SC)
Fax 803-578-7308

Specification Sheet

Kent Turbine Meters Model T-3000 Bronze, Magnetic Drive, Round Flanged Ends

Sizes 1 1/2" , 2" & 3"

T3000CP

T3000CB

Description

Operation. The T-3000 Turbine Meter is designed for installation where occasional low and moderate to high sustained flows are demanded. Water passes through the meter without a change in flow direction, driving a helix rotor in direct proportion to the quantity of water passing through the meter. Rotor revolutions are transferred to a register by appropriate reduction gearing and a magnetic drive.

Compliance to Standards. The T-3000 Turbine Meter complies with all performance and material requirements of the American Water Works Association Standard C-701, Class II In-Line (High-Velocity) Type, as most recently revised.

Installation. The meter must be installed in a clean pipeline, free from any foreign materials. Install the meter with direction of flow as indicated by the arrow cast in the meter case. The meter may be installed in horizontal or inclined lines. It is recommended that a Kent Plate Strainer be used to protect the turbine and help reduce the effects of turbulence.

Application. *The meter is for use in POTABLE COLD WATER up to 120 ° F (50 ° C) and working pressures up to 150 psi.* The meter will perform with accuracy registration of 100% ± 1 1/2% within the

Specifications

Size:	1 1/2"	2"	3"
95%-101% Accuracy GPM	2.88	2.99	4
*98.5%-101.5% Accuracy GPM	4-200	4-200	5-750
Continuous Flow GPM	160	160	600
Maximum Flow GPM	200	200	750
Operating Pressure psi	150	150	150
Operating Temperature°F	120	120	120
Sweep Hand Registers			
US Gallons	100	100	100
Cubic Feet	10	10	10
m^3 - Cubic Meters	1	1	1
Imperial Gallons	100	100	100
Capacity of Register			
US Gallons (millions)	100	100	100
Cubic Feet (millions)	10	10	10
m^3 Cubic Meters (millions)	1	1	1
Imperial Gallons (millions)	100	100	100
Register Type	Permanently sealed direct reading register.		
Materials			
Main Case	Bronze		
Top Cover Plate	Bronze or Polymer		
Body O-Ring	Neoprene Rubber		
Case Bolts	Stainless Steel		
Measuring Element	Polyphenylene Oxide		
Rotor	Polypropylene		
Rotor Bushings	PTFE Compound		
Rotor Thrust Bearing	Ceramic Jewel		
Rotor Spindle	Tungsten Carbide		
Undergearing	Polyacetal Resin		
Register Lens	Tempered Glass		
Register Housing and Lid	Synthetic Polymer or Bronze		
Register Can	90% Copper Alloy		

Kent Meters, Inc.
An ABB Kent Meter Division Company

ABB

normal flows". Both pressure loss and accuracy tests are made before shipment. No adjustments need be made before installation.

Construction. The meter consists of a main case, a measuring element, a case cover and a magnetically driven register assembly. The main case is cast in bronze with raised characters showing model, size and direction of flow. The case has a throated inlet. A case dowel pin is inserted for locating the top cover plate. The measuring element assembly consists of the rotor, straightening vanes, accuracy regulator, spindles and gears, filters and undergear assembly. The measuring element is attached to the underside of the cover with four stainless steel screws and washers, one insert of which is placed eccentrically in the cover. The internal regulator assembly is interconnected with an external regulator shaft located on top of the cover allowing meter calibration without depressurizing the test bench or meter service. The regulator is protected by a tamperproof device. The main case and cover are assembled with an O-ring gasket and stainless steel bolts. The register assembly is secured to the main case with a tamperproof screw and is hinged over the inlet throat. However, the register can be rotated and locked in any 360 degree position therein.

Register. The register is contained within a 90% copper seamless can which is vacuum purged then filled with a dry nitrogen gas to eliminate condensation. The 1/4" true tempered glass lens is secured in an "L" shaped gasket, then roll sealed to produce a permanent sealed design. To assure easy reading, the totalizer wheels are large and color coded. The applicable size, model, registration, part number and date code are printed on the calibrated dial face. Moving clockwise during operation, the extra thin sweep hand does not interfere with meter reading, and the flow indicator will detect plumbing leaks.

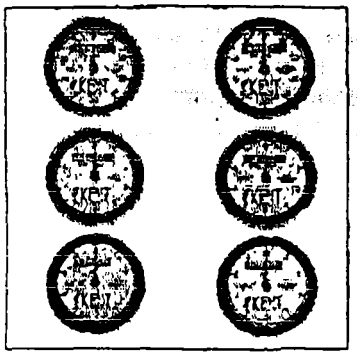
Magnetic Drive. The magnetic drive design eliminates miscoupling associated with right angle drives. Torque is absorbed in the undergear assembly below the driving magnet. Consequently, the driving magnet at all flows is turning slowly, assuring magnetic coupling with the register assembly. The undergearing is protected by an encasement appropriately filtered.

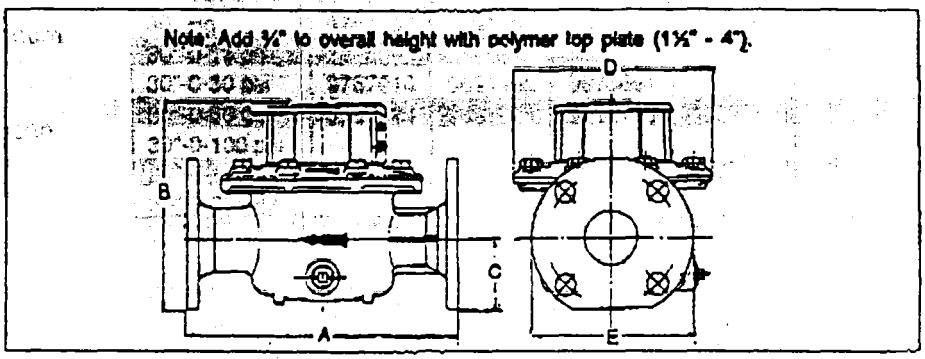
Connections. The 1 1/2", 2" & 3" meters are available with 4-bolt round flanged end connections. The flanged connections conform to ANSI B16.1 cast-iron pipe flange, Class 125. Both bronze and cast-iron companion flanges are available. The companion flanges are faced, drilled and tapped with ANSI B2.1 internal taper pipe thread and conform to ANSIB16.1 cast-iron pipe flange, Class 125.

Pulsers. See Specification Sheet #LRP/HRP-T3000.
LRP (2-wire) Reed Switch, 4 Watt (50V AC/DC Max.)
HRP (3-wire) Slotted Disc, 6-15 VDC
Both units require power from an external source.

Dimensions and Net Weights

Meter Size	Dimensions (inches)					Weight (lbs)
	A	B	C	D	E	
1-½" Oval	10	7-3/4	2-7/16	7-3/8	5-5/8	19-1/2
1-½" Round	10	7-3/4	2-7/16	7-3/8	5-1/16	20
2" Oval	10	7-3/4	2-7/16	7-3/8	6-1/8	21-1/2
2" Round	10	7-7/8	2-9/16	7-3/8	6-1/16	22
3"	12	9-3/8	3-13/16	7-3/8	7-1/2	33-3/8





The company's policy is one of continuous product improvement and the right is reserved to modify the specifications contained herein without notice. These products have been manufactured with current technology in accordance with applicable AWWA Standards.

IND73-BZ-215/12-95/2M

Kent Meters, Inc.
P.O. Box 1852
Ocala, Florida 34478-1852
Local Florida 352-732-4670
Outside Florida TOLL FREE 800-874-0890
Inside Florida TOLL FREE 800-356-6829
FAX: 352-368-1950

Kent Meters, Inc.
1200 Aerowood Drive-#35
Mississauga, Ontario
Canada L4W 2S7
Tel: 905-238-9622
FAX: 905-238-5640

An ABB Kent Meter Division Co.
Distributed by:

A-10

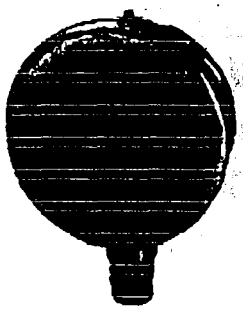
Pressure Gauges (Liquid Filled, Differential)

WIKA

Liquid-Filled Gauges

Type 213.53 2½" & 4"

- COPPER ALLOY WETTED PARTS
- STAINLESS STEEL CASE
- GLYCERINE-FILLED



WIKA Type 213.53 gauges feature a stainless steel case for protection in harsh environments. The glycerine filling helps dampen the effects of vibration and pulsation. It also lubricates the movement which extends the life of the gauge.

STANDARD FEATURES

Size: 2½" (63 mm)
4" (100 mm)
Case: Stainless steel
Ring: Polished SS, crimped
Wetted Parts: Copper alloy
Window: Polycarbonate (2½")
Acrylic (4")
Pointer: Black aluminum
O-ring: EPDM
Liquid Filling: Glycerine
Accuracy: ± 1.5% of span

Options Available from Inventory
Stainless steel front flange (FF)
Stainless steel rear flange (RF)
U-clamp bracket for panel mounting (UC)
Brass restrictor

ABBREVIATIONS
LM - Lower Mount
CBM - Center Back Mount
LBM - Lower Back Mount

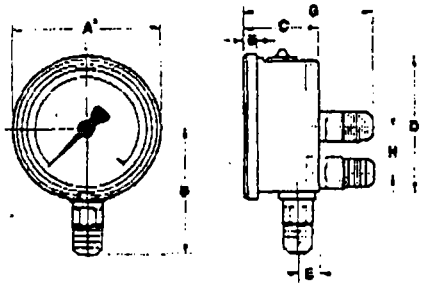
* Items shown with part numbers are available from stock (subject to prior sale).
* Items shown without part numbers are available on special order. Minimum order quantities may apply.

STANDARD RANGES AND PART NUMBERS

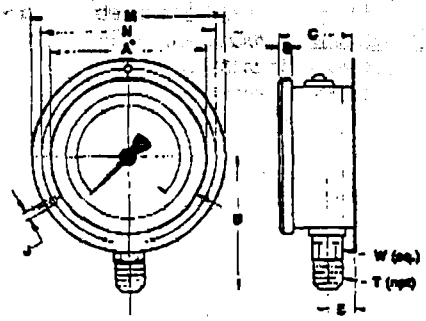
Type	213.53					
	Liquid-Filled					
Size	2½"					
Connection	LM			CBM		
Conn. Size	1/4" NPT					
Press. Scale	PSI	BAR	PSI/KG/CM²	PSI	PSI/BAR	PSI/KG/CM²
30 "Hg	9767002	9691957	9693683	9767185	9692139	9693881
30"-0-15 psi						
30"-0-30 psi	9767010	9691965	9693691			
30"-0-60 psi	9767029	9691981	9693705			
30"-0-100 psi						
30"-0-160 psi						
30"-0-200 psi						
15 psi	9767037	9691990	9693713			
30 psi	9767045	9691990	9693721	9767193	9692147	9693879
60 psi	9767053	9692007	9693739	9767202	9692155	9693887
100 psi	9767061	9692015	9693747	9767215	9692164	9693895
160 psi	9767070	9692023	9693755	9767223	9692172	9693909
200 psi	9767088	9692032	9693764	9767231	9692180	9693917
300 psi	9767096	9692040	9693772	9767240	9692198	9693925
400 psi	9767100	9692058	9693780			
500 psi	9767118	9692066	9693799	9767258	9692201	9693933
600 psi						
1,000 psi	9767126	9692074	9693802	9767455	9692210	9693941
1,500 psi	9767134	9692083	9693810	9766165	9692228	9693950
2,000 psi	9767142	9692091	9693829	9766939	9692236	9693968
3,000 psi	9767150	9692105	9693836	9767266	9692245	9693976
5,000 psi	9767169	9692113	9693845	9767274	9692253	9693985
10,000 psi	9767177	9692121	9693853	9767282	9692261	9693993
15,000 psi						

STANDARD RANGES AND PART NUMBERS

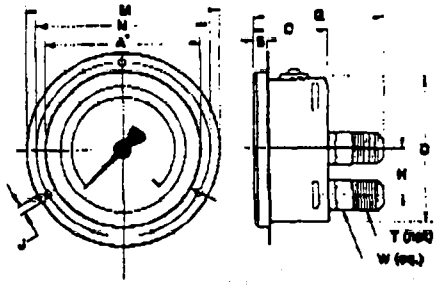
Type	213.53				
	Liquid Filled				
Size	4"				
Connection	LM			LBM	
Conn. Size	1/4" NPT	1/2" NPT	1/4" NPT	1/2" NPT	1/4" NPT
Press. Scale					
30 "Hg	9699028	9734427	9694000	9734533	9694239
30"-0-30 psi	9699045		9694026		
30"-0-100 psi	9699061		9694043		
30"-0-200psi	9699087		9694069		
30 psi	9699109	9734338	9694085	9734444	9694247
100 psi	9699125	9734355	9694107	9734460	9694264
200 psi	9699134		9694124		9694280
400 psi	9699150		9694140		9697743
800 psi	9699176				
1,500 psi	9699193	9734401	9694175	9734516	9694328
3,000 psi	9699215	9734419	9694191	9734525	9694345
10,000 psi	9699231		9694213		9694361



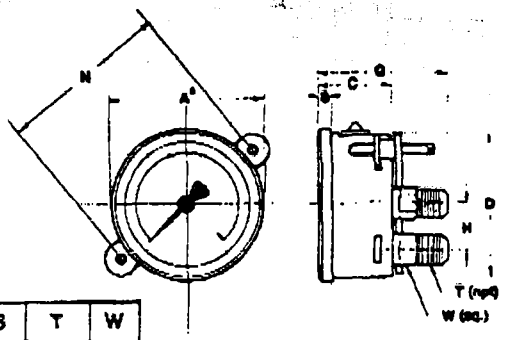
213.53 2 1/2-4" LM/CBM/LBM



213.53 2 1/2-4" LM/RF



213.53 2 1/2-4" CBM/LBM/FF



213.53 2 1/2-4" CBM/LBM/UC

A" - NOMINAL SIZE

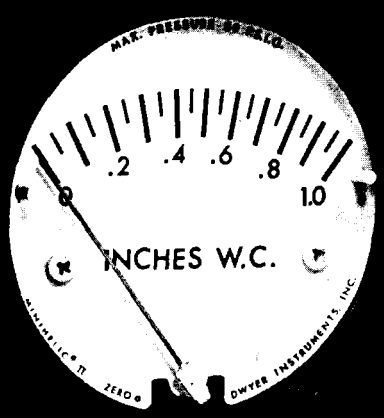
2XX.53	WEIGHT	KEY	A"	B	C	D	E	G	H	J	M	N	S	T	W
2½" LM/CBM/ FF/RF	0.50 lbs.	mm	63	53	31	62	14	56	0	3.5	85	75	7.5	--	14
		in	2.48	2.09	1.22	2.44	0.55	2.2	0	0.14	3.35	2.95	0.3	1/4"	.55
2XX.53 4" LM/LBM/ FF/RF	1.72 lbs.	mm	100	80	46	100	16.5	80	32	4.6	132	114	8	--	22
		in	3.94	3.15	1.81	3.94	0.65	3.15	1.26	0.18	5.2	4.48	0.31	1/4" or 1/2"	0.87

2XX.53	KEY	A"	C	D	G	H	N	S	T	W
2½" UC	mm	63	31	62	56	0	72	7.5	--	14
	in	2.48	1.22	2.44	2.2	0	2.83	0.3	1/4"	.55
2XX.53 4" UC	mm	100	46	100	80	32	110	8	--	22
	in	3.94	1.81	3.94	3.15	1.26	4.33	0.31	1/4" or 1/2"	.87

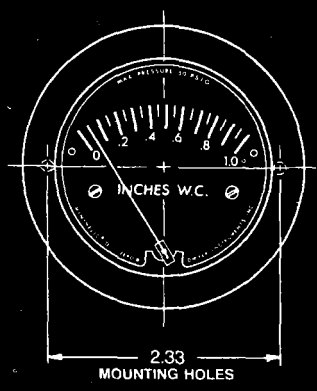
Dwyer®

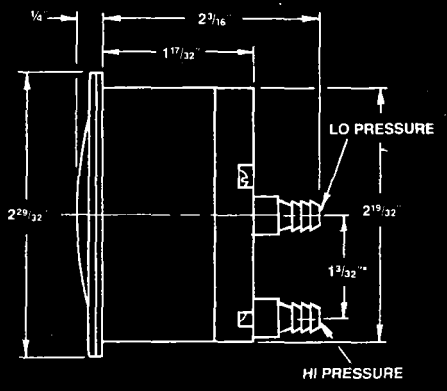
SERIES 2-5000

Minihelic II® Differential Pressure Gages



The Series 2-5000 Minihelic II® low differential pressure gage provides excellent readability in a compact size.





Dimensions, Series 2-5000 Minihelic II® Gage.

Combining clean design, small size and low cost with enough accuracy for all but the most demanding applications our Minihelic II® gage offers the latest in design features for a dial type differential pressure gage. It is our most compact gage but is easy to read and can safely operate at total pressures up to 30 PSIG. The Minihelic II is designed for panel mounting in a single 2⅝" diameter hole. Standard pressure connections are barbed fittings for 3/16" I.D. tubing; optional ⅛" NPT male connections are also available. Over-pressure protection is built into the Minihelic II gage by means of a blow-out membrane molded in conjunction with the diaphragm. Accidental over-ranging up to the rated total pressure will not damage the gage. With removable lens and rear housing, the gage may be easily serviced at minimum cost.

With the housing molded from mineral and glass filled nylon and the lens molded from polycarbonate, the gage will withstand rough use and exposure as well as high total pressure. The 5% accuracy and low cost of the Minihelic II gage make it well-suited for a wide variety of OEM and user applications. OEM applications include cabinet air purging, medical respiratory therapy equipment, air samplers, laminar flow hoods, and electronic air cooling systems. As an air filter gage, the Minihelic II finds many end use applications on large stationary engines, compressors, ventilators, and air handling units. The Minihelic II gage is suitable for many of the same applications as the Magnehelic gage where the greater accuracy, sensitivity, and higher and lower differential pressure ranges of the Magnehelic gage are not required.

Physical Data:

Ambient Temperature Range: 20° to 120°F.

Rated Total Pressure: 50 PSIG surge, 30 PSIG continuous to either pressure connection.

Accuracy: plus or minus 5% of full scale at 70°F.

Connections: Barbed, for 3/16" I.D. tubing (standard); male ⅛" NPT (optional)

Housing: Glass filled nylon; polycarbonate lens

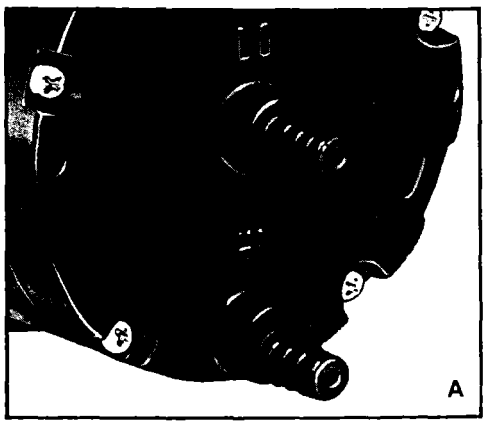
Standard Ranges: See model-range chart

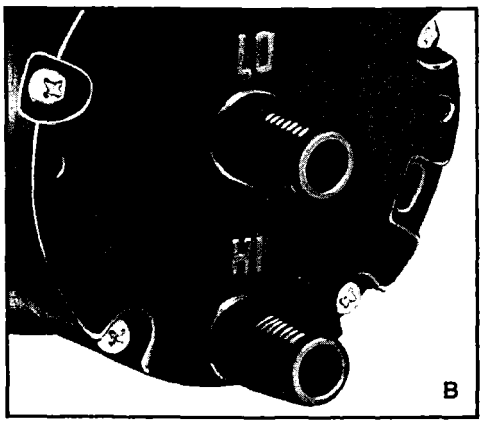
Finish: Black

Weight: 6 ozs.

CAUTION: FOR USE ONLY WITH AIR OR COMPATIBLE GASES.

PRESSURE CONNECTIONS





A The standard Minihelic II gage is supplied with two barbed pressure taps molded into the rear housing of the gage. These connections allow easy, fast connection to the gage using 3/16" I.D. rubber or plastic tubing.

B For applications in systems having higher total operating pressures, optional male ⅛" NPT pressure connections can be supplied.

Note the oblong over-pressure vent hole on the back of the gage at the right of the connections. This vent is sealed by a membrane molded in conjunction with the diaphragm and will blow out at approximately 75 PSI.

Simplicity of Design Ensures Reliable Operation

Housing is molded from strong mineral and glass filled nylon.

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

Full view lens is removable and molded of tough polycarbonate.

Aluminum scale litho-printed black on white, enhances readability.

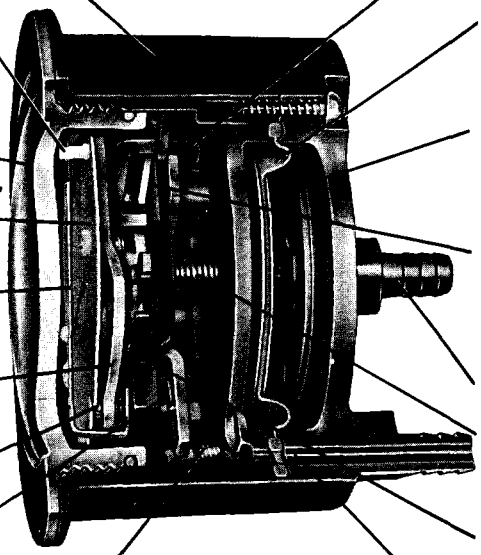
Red tipped aluminum pointer, rigidly mounted to helix is easy to see.

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

Jewel bearings provide virtually friction-free helix motion.

Helix is free to rotate in jewel bearings. It aligns with magnetic field of magnet to transmit pressure indications to pointer.

Zero adjustment screw, located behind the removable lens, eliminates tampering.



Range spring calibration clamp fixes live length of spring for proper gage calibration and is factory set and sealed.

Silicone rubber diaphragm allows accurate response to a broad range of temperatures and at extremely low pressure. Incorporates blow out area for overpressure protection.

Diaphragm support plates of lightweight aluminum on each side of the diaphragm minimize position or attitude sensitivity and help define pressure area.

Flat leaf range spring reacts to pressure on the diaphragm. Live length is adjustable for calibration. Small amplitude of motion minimizes inaccuracies and assures long life.

Low pressure tap connects to rear chamber.

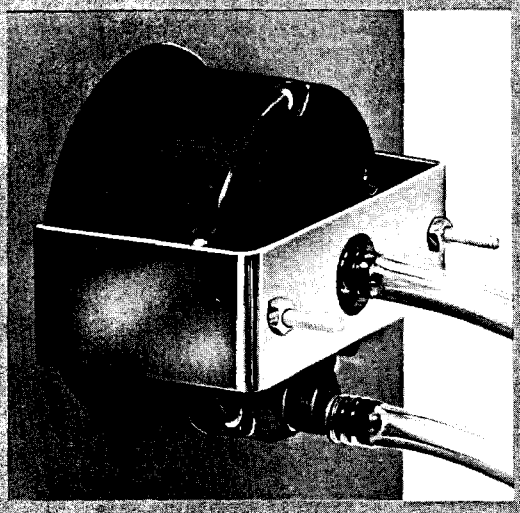
Coil spring link provides a resilient connection between the diaphragm and the range spring.

Ceramic magnet mounted on a molded bracket at the end of the range spring rotates the helix without direct mechanical linkage.

High pressure tap connects with the front chamber through passageway in the plastic case and a sealing ring molded into the edge of the diaphragm.

Patent No. 4,347,744

PANEL MOUNTING



Mounting hardware is supplied with the Minihelic II gage for panel mounting through a single hole, 2⅝" in diameter. Panel thickness up to ½" can be accommodated with the hardware supplied. If necessary, surface mounting of the gage can be accomplished by means of two 4-40 screws into the tapped mounting bracket stud holes in the rear of the gage. Surface mounting requires clearance holes in the panel for the two pressure taps.

MODEL-RANGE CHART

Model Number	Range, Inches of Water	Minor Div.
2-5000-0	0-0.5	.02
2-5001	0-1.0	.05
2-5002	0-2.0	.10
2-5003	0-3.0	.10
2-5005	0-5.0	.20
2-5010	0-10	.50
2-5020	0-20	1.00
2-5040	0-40	2.00
2-5060	0-60	2.00
2-5100	0-100	5.00

Model Number	Range, PSI	Minor Div.
2-5205	0-5	.2
2-5210	0-10	.5
2-5215	0-15	.5
*2-5230	0-30	1.0

Model Number	Range, MM of Water	Minor Div.
2-5000-25MM	0-25	1.0
2-5000-50MM	0-50	2.0
2-5000-100MM	0-100	5.0

Model Number	Range, Pascals	Minor Div.
2-5000-125 Pa	0-125	5.0
2-5000-250 Pa	0-250	10
2-5000-500 Pa	0-500	20

Model Number	Range, kPa	Minor Div.
2-5000-1 kPa	0-1	.05
2-5000-3 kPa	0-3	.10

*THIS RANGE EMPLOYS SPIRALLY WOUND BERYLLIUM COPPER BOURDON TUBE POINTER DRIVE MECHANISM.

NOTE: CONSULT FACTORY REGARDING AVAILABILITY OF ADDITIONAL RANGES.

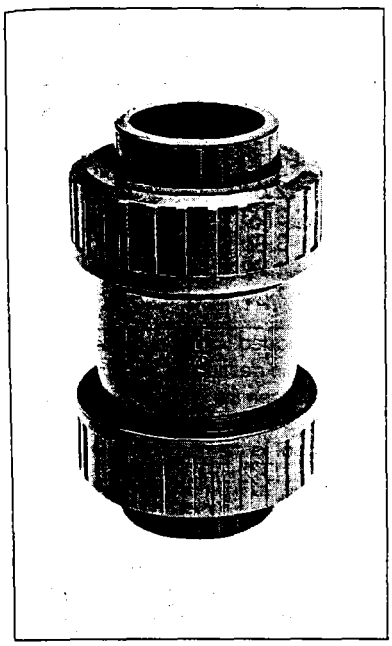
Suggested Specification:

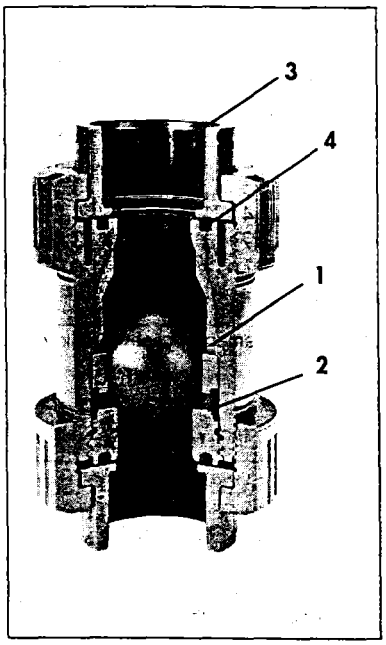
A differential pressure gage for measuring (state purpose) shall be installed. Gage shall be diaphragm actuated, round dial type, 2 29/32" O.D., black scale markings on a white background, pointer zero adjustment, and (state type) pressure connections. Gage shall be Dwyer Instruments, Inc. Minihelic II, Catalog No. ____ reading to _____" w.c. in _____" divisions.

A-11

Valves
(Flap Check, Ball Check, Ball, Butterfly, Diaphragm, Gate, Globe, Lab Cocks)

George Fischer Ball Check Valve Type 360





Flow characteristics through the Type 360 Ball Check Valve are excellent.

When combined with the George Fischer Type 050 screen, the Ball Check Valve can be converted to a Foot Valve.

The George Fischer Type 360 Ball Check Valve is used to automatically stop flow in the back direction when the fluid in the line reverses. The valve closes by the deadweight of the ball when vertically mounted.
The true union end connections (available in sizes 3/8" - 2" only) allow removal of the valve from the line for replacement of the seals. The design also eliminates the expense of a union and nipple to provide access to the valve.

Installation Note

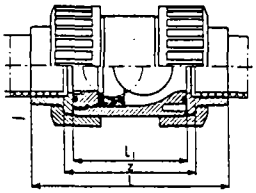
Trapped vapour from solvent cement may cause swelling of the ball and the seal. As this will affect at the proper functioning of the valve, we recommend that the line fluid velocity should not exceed 6.5 ft./second (2 m/sec.). For higher velocities the George Fischer Y-Check valve Type 304 should be used.

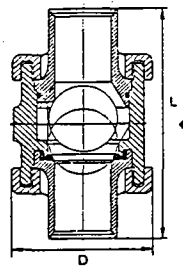
Technical Features

1. Ball cage molded into body.
2. Single elastomeric seal serves as ball seat and seal for external closure.
3. Available with solvent socket or threaded end connections in sizes 3/8" through 2" and spigot ends for the 3" size.
4. Constructed of PVC, polypropylene, or SYGEF-PVDF* with the option of EPDM or FPM (Viton) seals.

*available second half of 1993; see Type 361 on the pages following the Type 050 for current design)

Dimensions





3" valve

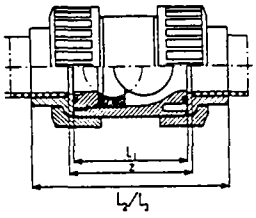
PVC

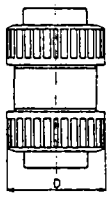
Inch size	L inch	L_1 inch	Z* inch	Z_1** inch	D inch	Weight lbs.	Metric size mm
3/8	4.41	2.48	2.91	3.53	1.81	.27	16
1/2	4.41	2.48	2.91	3.53	1.81	.27	20
3/4	5.16	2.95	3.15	3.93	2.20	.45	25
1	5.55	3.11	3.27	4.35	2.64	.70	32
1 1/4	6.54	3.50	4.02	5.25	3.23	1.16	40
1 1/2	6.69	3.74	3.94	5.20	3.86	1.85	50
2	7.91	4.53	4.92	6.36	4.72	3.30	63
3	11.81				7.09	10.8	90

Z* Solvent cement socket valve (laying length)

Z_1** Threaded valve (laying length is herein defined as the dimension between the ends of pipe when threaded into valve to a depth equal to the nominal "Handtight" plus 1/2 turn)

Polypropylene/SYGEF-PVDF





Inch size	L_2 inch	L_3 inch	L_1 inch	Z_2* inch	Z_3** inch	D inch	Weight lbs. PP	Weight lbs. SYGEF	Metric size mm
3/8	3.86	4.37	2.44	2.83	3.48	1.81	.17	.34	16
1/2	3.98	4.37	2.44	2.87	3.31	1.81	.17	.34	20
3/4	4.69	5.12	2.91	3.43	3.88	2.20	.30	.58	25
1	5.12	5.51	3.07	3.70	4.30	2.64	.45	.87	32
1 1/4	5.87	6.50	3.46	4.29	5.19	3.23	.84	1.46	40
1 1/2	6.38	6.57	3.70	4.57	5.12	3.86	1.35	2.30	50
2	7.68	7.83	4.45	5.55	6.28	4.72	2.46	4.32	63

L_2 Overall length of metric fusion socket valve

L_3 Overall length of threaded valve

Z_2* Metric fusion socket valve (laying length)

Z_3** Threaded valve (laying length is herein defined as the dimension between the ends of pipe when threaded into valve to a depth equal to the nominal "Handtight" plus 1/2 turn)

Part Numbers

Solvent cement socket

Inch inch	**PVC** EPDM	FPM		Metric size mm
3/8	161.360.561	161.360.571		16
1/2	161.360.562	161.360.572		20
3/4	161.360.563	161.360.573		25
1	161.360.564	161.360.574		32
1 1/4	161.360.565	161.360.575		40
1 1/2	161.360.566	161.360.576		50
2	161.360.567	161.360.577		63

Solvent cement spigot

Inch size	**PVC** EPDM	FPM (Viton)		Metric size mm
→ 3	150.360.013	150.360.038		90

Metric fusion socket

Inch size	**Polypropylene** EPDM	FPM (Viton)	**SYGEF-PVDF** FPM (Viton)	**SYGEF-HP** FPM (Viton)	Metric size mm
3/8	167.360.401	167.360.411	175.360.411	175.360.611	16
1/2	167.360.402	167.360.412	175.360.412	175.360.612	20
3/4	167.360.403	167.360.413	175.360.413	175.360.613	25
1	167.360.404	167.360.414	175.360.414	175.360.614	32
1 1/4	167.360.405	167.360.415	175.360.415	175.360.615	40
1 1/2	167.360.406	167.360.416	175.360.416	175.360.616	50
2	167.360.407	167.360.417	175.360.417	175.360.617	63

NPT thread

Inch size	**PVC** EPDM	FPM (Viton)	**Polypropylene** EPDM	FPM (Viton)	Metric size mm
3/8	161.360.581	161.360.591	167.360.581	167.360.591	16
1/2	161.360.582	161.360.592	167.360.582	167.360.592	20
3/4	161.360.583	161.360.593	167.360.583	167.360.593	25
1	161.360.584	161.360.594	167.360.584	167.360.594	32
1 1/4	161.360.585	161.360.595	167.360.585	167.360.595	40
1 1/2	161.360.586	161.360.596	167.360.586	167.360.596	50
2	161.360.587	161.360.597	167.360.587	167.360.597	63

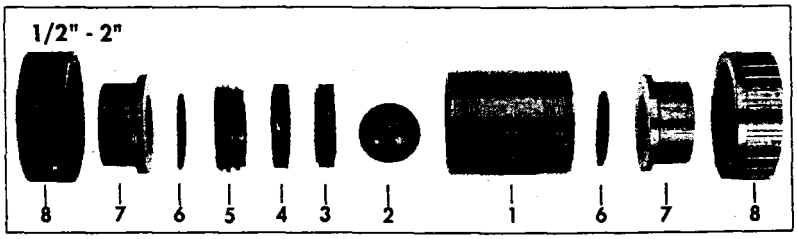
Product Specification

Type 360 Ball Check Valve, PVC only

Ball check valves 1/2" through 2" shall be of True Union design with either solvent cement socket or threaded pipe connections. Body interior to have molded ribs to serve as a cage and ball guide to assure proper seating. Valve may be equipped with a screen to create a foot valve. Solvent cement socket pipe connection dimensions shall conform to ASTM D-2467. Threaded pipe connections shall be in accordance with ASTM D-2464 which references ANSI B1.20.1 (was B2.1) for tapered pipe threads. Seat and seals may be either EPDM or FPM Viton as specified by user. PVC body and ball shall meet or exceed the requirements of Class 12454B of ASTM D-1784. The valve, Type 360, shall carry a pressure rating of 150 psi at 68°F as supplied by George Fischer Signet, Inc. Tustin, CA 92680.

Assembly Instructions

Recommendation:
Rinse PVC piping system before installing valve. Reason: The fumes produced by the solvent cement can cause a swelling of the ball and the internal surfaces of the valve, thereby considerably affecting its operation.



1/2" - 2" Style
Insert ball (2), support ring (3), and ball sealing ring (4) into body (1). Screw retaining ring (5) into body (1). Put O-ring (6) into O-ring groove on face of retaining ring (5). Place end connector (7) against face of O-ring (6) and hold in place with union nut (8), screwing union nut firmly onto body (1). Place O-ring (6) in groove on outlet end of body. Place end connector (7) against O-ring. Screw union nut (8) over end connector (7) onto body (1) until seated firmly.

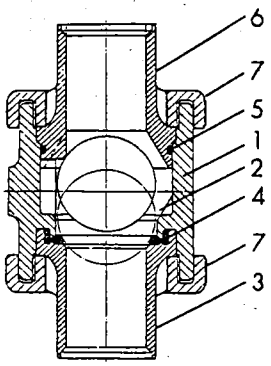
3" Style
Fit the flat side of the seal into the valve end.
Place the ball in the valve body and insert the pre-assembled valve end. Screw the valve nut into the body handtight.
Fit the body seal to the valve end. Insert the pre-assembled valve end into the body and screw on the valve nut.

Spare Parts - PVC

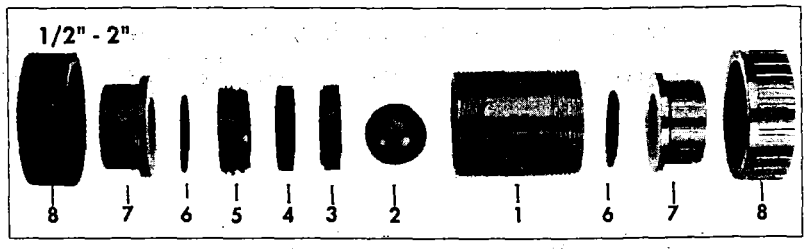
⅜" / 16 mm	½" / 20 mm	¾" / 25 mm	1" / 32 mm	1¼" / 40 mm	1½" / 50 mm	2" / 63 mm		
161.483.851	161.483.852	161.483.853	161.483.854	161.483.855	161.483.856	161.483.857	Center section consisting of: 1 Valve Body 2 Ball 3 Support ring 4 Ball sealing ring 5 Retaining ring	 PVC PVC PVC EPDM PVC
161.483.861	161.483.862	161.483.863	161.483.864	161.483.865	161.483.866	161.483.867	Center section consisting of: 1 Valve Body 2 Ball 3 Support ring 4 Ball sealing ring 5 Retaining ring	 PVC PVC PVC FPM PVC
161.340.617	161.340.617	161.340.618	161.340.619	161.340.620	161.340.621	161.340.522	8 Union nut	PVC
161.482.377 161.482.389	161.482.378 161.482.390	161.482.379 161.482.391	161.482.380 161.482.392	161.482.381 161.482.393	161.482.382 161.482.394	161.482.383 161.482.395	7 End connectors: solvent cement socket NPT thread	 PVC PVC
161.330.304	161.330.304	161.330.354	161.330.404	161.330.454	161.330.504	161.330.554	2 Ball	PVC
161.483.259 161.483.265	161.483.259 161.483.265	161.483.260 161.483.266	161.483.261 161.483.267	161.483.262 161.483.268	161.483.263 161.483.269	161.483.264 161.483.270	4 Ball sealing ring	EPDM FPM
748.410.042 749.410.042	748.410.042 749.410.042	748.410.116 749.410.116	748.410.103 749.410.103	748.410.027 749.410.027	748.410.010 749.410.010	748.410.011 749.410.011	6 O-ring	EPDM FPM

3" spigot valve, PVC only

1	Body	PVC	161.480.158
2	Ball	PVC	161.330.654
3	Inlet spigot	PVC	161.480.333
4	Ball sealing ring	EPDM	161.480.141
		FPM	161.480.149
5	Body Seal	EPDM	748.410.099
		FPM	749.410.099
6	Outlet spiigot	PVC	161.480.334
7	Valve nut	PVC	161.340.623



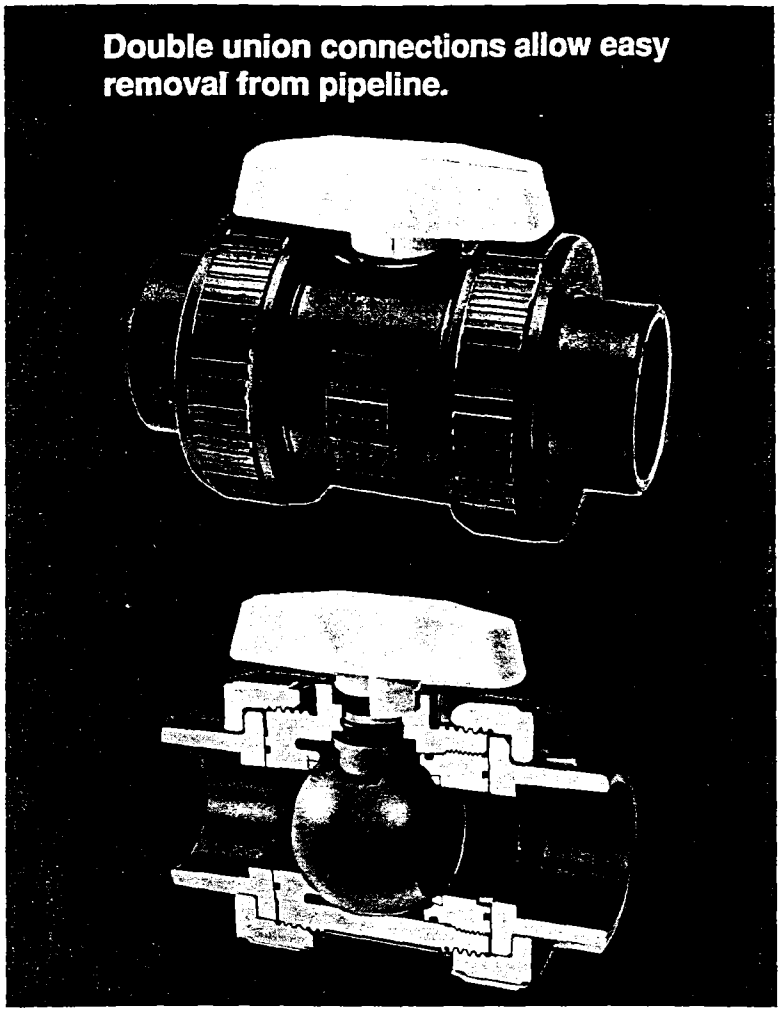
Spare Parts - Polypropylene/SYGEF-PVDF



		⅜" / 16 mm	½" / 20 mm	¾" / 25 mm	1" / 32 mm	1¼" / 40 mm	1½" / 50 mm	2" / 63 mm
Center section consisting of: 1 Valve Body 2 Ball 3 Support ring 4 Ball sealing ring 5 Retaining ring	 PP PP PP EPDM PP	167.481.125	167.481.126	167.481.127	167.481.128	167.481.129	167.481.130	167.481.131
Center section consisting of: 1 Valve Body 2 Ball 3 Support ring 4 Ball sealing ring 5 Retaining ring	 PP PP PP FPM PP	167.481.135	167.481.136	167.481.137	167.481.138	167.481.139	167.481.140	167.481.141
8 Union nut	PP	167.480.786	167.480.786	167.480.787	167.480.788	167.480.789	167.480.790	167.480.791
7 End connectors: metric fusion socket	PP PVDF	167.480.159 175.480.031	167.480.160 175.480.032	167.480.161 175.480.033	167.480.162 175.480.034	167.480.163 175.480.035	167.480.164 175.480.036	167.480.165 175.480.037
butt fusion spigot	PP PVDF	167.480.545 175.480.796	167.480.546 175.480.797	167.480.547 175.480.798	167.480.548 175.480.799	167.480.549 175.480.800	167.480.550 175.480.801	167.480.551 175.480.802
NPT thread	PP PVDF	167.480.452 175.480.727	167.480.453 175.480.728	167.480.454 175.480.729	167.480.455 175.480.730	167.480.456 175.480.731	167.480.457 175.480.732	167.480.458 175.480.733
2 Ball	PP[1] PP[2] PVDF	167.330.304 167.480.024 175.480.153	167.330.304 167.480.024 175.480.153	167.330.354 167.480.025 175.480.154	167.330.404 167.480.026 175.480.155	167.330.454 167.480.027 175.480.156	167.330.504 167.480.028 175.480.157	167.330.554 167.480.029 175.480.158
4 Ball sealing ring	EPDM FPM	161.483.259 161.483.265	161.483.259 161.483.265	161.483.260 161.483.266	161.483.261 161.483.267	161.483.262 161.483.268	161.483.263 161.483.269	161.483.264 161.483.270
6 O-ring	EPDM FPM	748.410.042 749.410.042	748.410.042 749.410.042	748.410.116 749.410.116	748.410.103 749.410.103	748.410.027 749.410.027	748.410.010 749.410.010	748.410.011 749.410.011

[1] Talc Filled ball (1.24 specific gravity)
[2] 100% polypropylene (0.9 specific gravity) (special order)

Safe Block™ True Union Ball Valve



Size: 1/4" - 6"
Material: PVC / CPVC / Polypropylene
End Conn: Threaded/Socket/Flanged

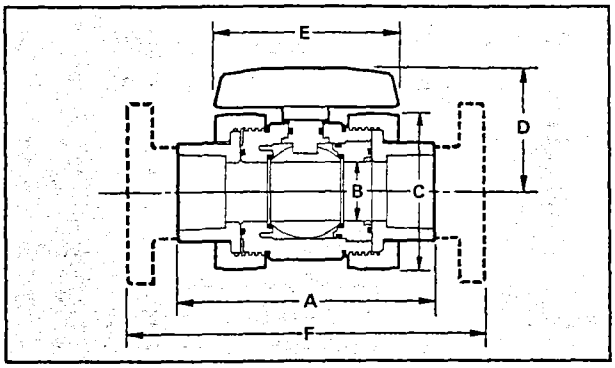
Hayward ball valves provide quick 1/4 turn on-off control for any process piping system. The Hayward True Union design allows for easy removal and disassembly of the valve or piping system.

The safest true union valves are those which are "safe-blocked", that is, valves which can be disassembled on the downstream side of the piping system, while the upstream side remains pressurized, and still be 100% bubble tight.

Some manufacturers offer true union valves which are not safe-blocked. Others offer them on select sizes or materials only. Hayward true union valves are safe-blocked in all sizes and all materials.

Other features include:

- Full-port design. Same as equivalent pipe size. No flow restriction. • EPDM or Viton O-Ring seats.
- Fully adjustable to compensate for seat wear.
- Self-lubricating TFE seats for bubble tight sealing.



DIMENSIONS – Dimensions are in inches - for reference only. For installation purposes, request certified drawings.

Size	A	B	C	D	E	F	Weight in LBS. Soc/Thd	Weight in LBS. Flanged	CV FACTORS Size	CV FACTORS GPM
1/4	4-5/8	1/2	2-1/4	1-7/8	3	–	3/4	–	1/4	1.0
3/8	4-5/8	1/2	2-1/4	1-7/8	3	–	3/4	–	3/8	8.0
1/2	4-5/8	1/2	2-1/4	1-7/8	3	6-3/4	3/4	–	1/2	8.0
3/4	4-3/4	3/4	2-5/8	2	3	7-1/8	3/4	–	3/4	15.0
1	5-1/4	1	3	2-5/8	4	7-3/4	1-1/8	2-1/8	1	29.0
1-1/4	6-7/16	1-1/4	3-9/16	2-7/8	4	9-7/16	1-3/4	2-3/4	1-1/4	75.0
1-1/2	6-3/4	1-1/2	4	3	4	9-3/4	2-1/8	3-5/8	1-1/2	90.0
2	8	2	4-3/4	3-5/8	5	11-1/4	3-3/4	6-1/4	2	140.0
2-1/2	10-9/16	3	6-9/16	5-1/2	9-1/2	14-3/8	10-1/2	16	2-1/2	330.0
3	10-9/16	3	6-9/16	5-1/2	9-1/2	14-7/16	10-1/2	16	3	480.0
4	12-7/16	4	8-9/16	6-1/2	9-1/2	17	28-1/2	37-1/2	4	600.0
6	–	4	8-9/16	6-1/2	9-1/2	19-3/16	–	45-1/2	6	600.0

PRICE

Size	PVC (Viton) Soc/Thd	PVC (Viton) Flanged	CPVC (Viton) Soc/Thd	CPVC (Viton) Flanged	PPL (Viton) Threaded	PPL (Viton) Flanged	PVC (EPDM) Soc/Thd	PVC (EPDM) Flanged
1/4	$ 24.25	—	—	—	—	—	—	—
3/8	24.25	—	—	—	—	—	—	—
1/2	24.25	$ 35.75	$ 33.50	$ 56.50	$ 37.00	$ 62.50	$ 21.50	$ 34.25
3/4	28.50	42.50	42.00	69.50	46.25	76.00	26.00	39.50
1	34.25	50.00	50.50	80.00	55.50	87.50	30.75	46.75
1-1/4	45.75	66.50	71.50	118.00	79.00	129.00	40.75	61.50
1-1/2	56.50	83.00	84.50	131.00	93.00	145.00	51.00	76.50
2	74.50	108.00	117.00	181.00	128.00	198.00	67.00	101.00
2-1/2	195.00	260.00	—	—	—	—	176.00	239.00
3	181.00	246.00	335.00	470.00	370.00	580.00	155.00	225.00
4	305.00	390.00	575.00	780.00	925.00	1235.00	275.00	360.00
6	—	720.00	—	—	—	—	—	690.00

TRU-BLOC/TRUE UNION
PVC/CPVC

Chemtrol®
A DIVISION OF NIBCO INC.

Tru-Bloc Ball Valves PVC/CPVC True Union and Single Union

150 psi at 73° water — non-shock — full port

Easy repair/replacement; interchangeability; distribution availability; technical service; reliable quality — the synergistic rationale many plants and original equipment manufacturers have embraced while standardizing on Chemtrol True Union Ball and Check Valves.

TRUE UNION

SINGLE UNION

Features:

- Double block design stops flow in either direction — upstream or downstream — when the alternate union is removed for servicing piping system.
- Heavy duty stub-acme thread for seal carrier retaining ring provides more reliability than other designs.
- Full-port design, minimum flow restriction.
- For high purity applications, manufactured and assembled without hydrocarbon lubricants.
- All PVC or CPVC thermoplastic construction with self-lubricating Teflon seats and EPDM or FPM (Viton) "O"-Ring seals.
- Distinctive orange handle not only indicates open or closed at a glance, but molded-in arrows dictate rotational direction for easy operation within 90° stops.
- Actuator mountable versions are available for pneumatic or electrical operation.

CONSTRUCTION

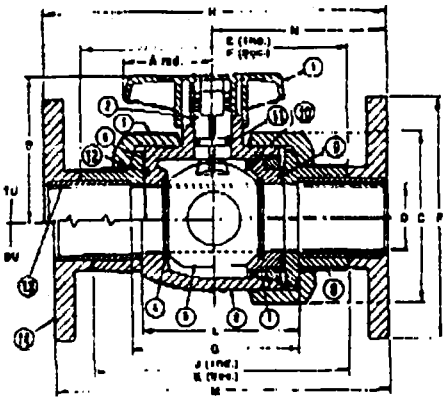
PART	MATERIAL
1. Handle — Lever‡	PVC
2. Stem	PVC or CPVC
3. Union Nut (2)	PVC or CPVC
4. Seat* (2)	TFE (Teflon)
5. Ball	PVC or CPVC
6. Body — TU	PVC or CPVC
or SU, Socket	PVC or CPVC
or SU, Thread	PVC or CPVC
7. Seal Carrier	PVC or CPVC
8. End Connector — Socket, (2) TU; (1) SU	PVC or CPVC
or Thread, (2) TU; (1) SU	PVC or CPVC
9. "O"-Ring — Carrier End (TU or SU)	FPM (Viton) or EPDM
10. "O"-Ring — Carrier O.D. (TU or SU)	FPM (Viton) or EPDM
11. "O"-Ring — Stem (TU or SU)	FPM (Viton) or EPDM
12. "O"-Ring — Body End (TU only)	FPM (Viton) or EPDM
13. Plain End Pipe Nipple — SPG x SPG (2)	PVC or CPVC
14. Flange — Socket (2)	PVC or CPVC
15. "O"-Ring — Carrier Seal Energizer (Model C)	FPM (Viton) or EPDM
16. Stem Friction Washer (4" x 6")	TFE (Teflon)
17. Handle Bolt (4" x 6")	PVC

‡ Round Safety Handle available as optional accessory in sizes ½" - 1½".
* TFE Seats are packaged in pairs as a replacement kit.

CHEMTROL FIGURE NUMBER

Valve Style	Elastomeric Trim	PVC Soc.	PVC Thd.‡	PVC Flgd.	CPVC Soc.	CPVC Thd.‡	CPVC Flgd.
TU	FPM	U45TB-V*	U45TB-V*	F45TB-V	U51TB-V*	U51TB-V*	F51TB-V
	EPDM	U45TB-E*	U45TB-E*	F45TB-E	U51TB-E*	U51TB-E*	F51TB-V
SU	FPM	S45SU-V	T45SU-V	F45SU-V	S51SU-V	T51SU-V	F51SU-V
	EPDM	S45SU-E	T45SU-E	F45SU-E	S51SU-E	T51SU-E	F51SU-E

* As original equipment, ½" - 2" True Union Tru-Bloc valve models are supplied with Universal connectors (i.e., a set of both socket and thread end connectors). For 3" - 6" sizes, replace U in the Fig. No. with 'S' or 'T' for Soc. or Thd. models respectively, as required for all SU models.
‡ Thread end connections are not available for 6" valves.



DIMENSIONS — WEIGHTS

Valve Size	TU & SU Figures Profile A[1]	B	C	D	N	P	TU Figures End-to-End (½" thru 6") E Thd.	F Soc.	G Soc.	H Flgd.	Approx.[2] Wt. Lbs.	SU Figures End-to-End (½" thru 2") J Thd.	K Soc.	L Soc.	M Flgd.	Approx.[2] Wt. Lbs.	Fluid Flow Coefficient Cv[3] TU	SU
½	1.70	2.00	2.00	.50	3.13	3.50	4.00	4.19	2.44	6.19	.50	3.38	3.75	2.00	5.75	.32	22	24
¾	2.12	2.50	2.44	.75	3.56	3.88	4.63	5.00	3.00	7.25	.88	3.88	4.50	2.50	6.75	.58	55	61
1	2.12	2.63	2.81	1.00	4.13	4.25	5.19	5.50	3.25	8.06	1.24	4.19	4.88	2.63	7.38	.80	112	125
1¼	2.56	3.50	4.06	1.25	4.81	4.63	6.19	6.63	4.06	9.50	2.69	5.31	5.94	3.44	8.69	1.74	178	194
1½	2.56	3.50	4.06	1.50	5.06	5.00	6.19	6.88	4.06	10.00	2.84	5.31	6.19	3.44	9.19	1.82	285	310
2	2.92	4.25	5.25	2.00	5.75	6.00	7.38	8.00	5.00	11.38	5.46	7.13	7.38	4.38	10.63	3.67	540	577
3	4.00	5.56	7.19	3.00	7.25	7.50	10.38	10.38	6.57	14.63	10.21						1348	
4	8.00	6.44	8.78	4.00	8.63	9.00	12.22	12.22	7.72	17.63	16.45						2602	
6	8.00	6.44	8.78	4.00	11.91	11.00	NA	30.22	7.72	24.09	28.21						2602	

[1] Handle is not symmetrical about stem centerline. It is shown in the correct position for Single Union and 4" & 6" True Unions, but the position must be rotated 180° for the ½" - 3" True Union (ref. open body end).
[2] Weight for ½" - 2" TU Figures include both sets of end connectors or soc. end connections only for 3" - 6" sizes. Weight for SU figures is for soc. end connections. The material represented is PVC in all cases.
[3] Cv values computed for basic Valve Laying lengths (G & L)
* The 6" valve is fabricated by solvent cementing either flanges or socket couplings onto the ends of a 4" TU valve with plain-end concentric reducer pipe nipples. Threaded figure not available.

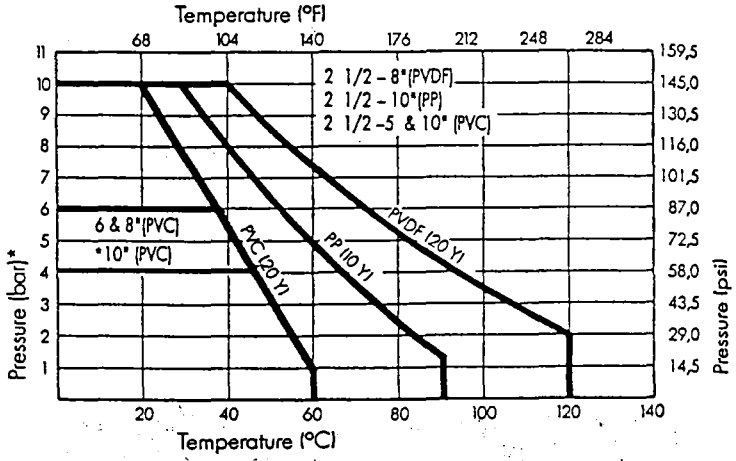
NOTES: A complete listing of optional accessories for ball valves begins on page 25. Installation and maintenance instructions for these valves appear on page 20.
For specific relationship of pressure/temperature ratings, refer to ENGINEERING DATA, page 8. And for CHEMTROL VALVE STANDARDS, see page 10.

Do not use or test the products in this catalog with compressed air or other gases. See Chemtrol Chem-Aire® literature for information about shatter resistant thermoplastic piping systems specifically designed for compressed air and other gases.

Technical Data for Butterfly Valves

Pressure/Temperature Diagram

All pressures are given in atmospheric excess pressure values. Ambient temperature max. 122°F/50°C.

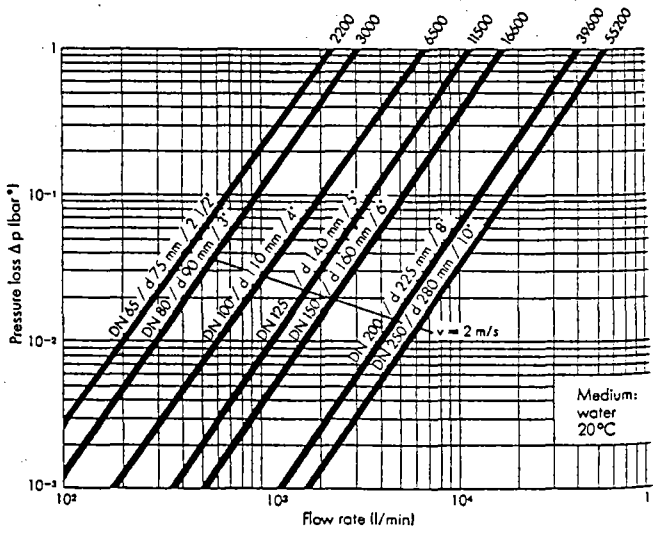


*Type 035 only

C_V/k_V Values

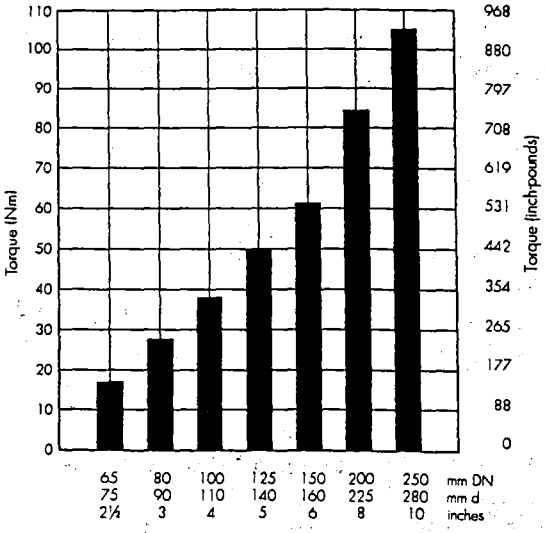
Inch size	C_V	k_V	Metric size mm d	DN
2½	154	2200	75	65
3	210	3000	90	80
→ 4	455	6500	110	100
5	805	11500	140	125
6	1162	16600	160	150
→ 8	2773	39600	225	200
10	3866	55200	280	250

Pressure Loss Characteristics

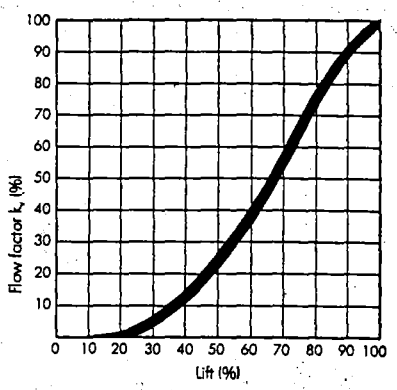


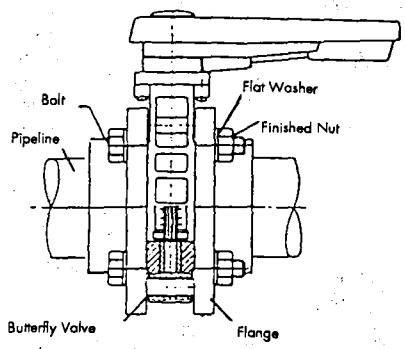
*1 bar = 0.1 N/mm² ≈ 1 kp/cm²

Closing Torque (standard values)

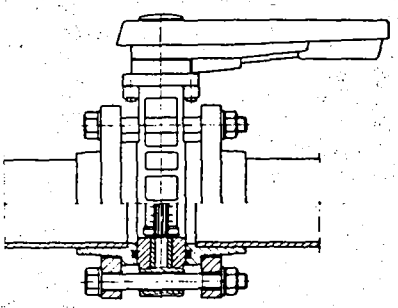


Flow Characteristics





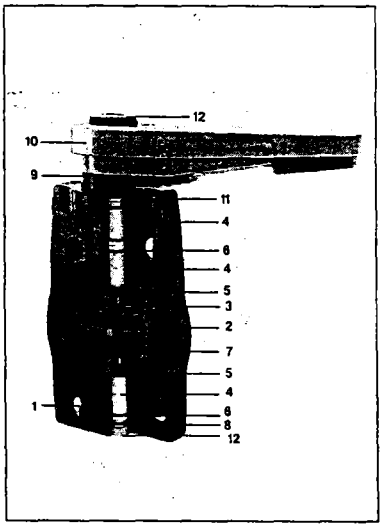
5"-10"
With Solid Flanges



2 1/2" – 4"
With Flange Adaptors and Loose Ring Flanges (Van Stone)

Valve Size inch	No. of Bolts	Bolt Size	Bolt Length: Solid Flanges	Bolt Length: Loose Ring Flanges & Adaptors	Recommended Torque (for flat gaskets)
2 1/2	4	5/8 - 11	5"	6"	26 ft. lbs.
3	4	5/8 - 11	5"	6 1/2"	30
4	8	5/8 - 11	6"	7"	33
5	8	3/4 - 10	8"	7"	33
6	8	3/4 - 10	6 1/2"	8 1/2"	44
8	8	3/4 - 10	7"	9 1/2"	55
10	12	7/8 - 9	8"	–	55

George Fischer Butterfly Valve Type 367



George Fischer butterfly valves have excellent properties, such as:

- **Corrosion resistance**
- **Maintenance free operation over a long working life**
- **Easy manual operation**
- **Optimum flow properties**
- **Easy-to-grip stream lined lever handle**
- **Light weight**

General

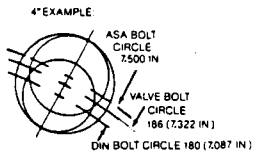
The butterfly valve Type 367 is designed for large nominal sizes of pipelines (2 1/2" thru 10"). Butterfly vales due to their design require minimum space for mounting. It is available in PVC, Polypropylene, and SYGEF-PVDF. The flow direction has no influence on the positioning of the valve. Available with lever handle or gear operator and electric or pneumatic actuators.

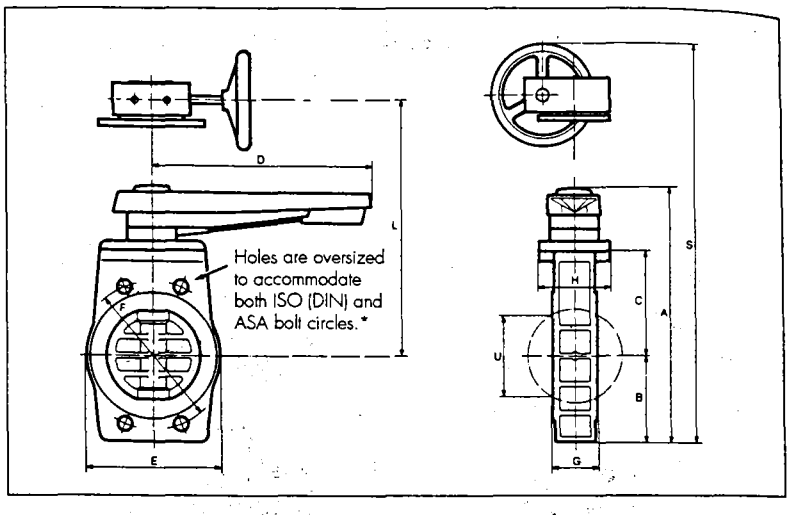
Technical Features

1. Joining: Flanged joints according to ASA, ISO, and DIN (JIS on special request).
2. Maximum waterway consistent with good plastic disc design.
3. Unique dynamic seal as primary waterway seal, captivated in an undercut groove in disc. The greater the pressure the tighter the seal.
4. Three polypropylene shaft bushings to insure accurate alignment and long life.
5. Static secondary seal isolates the shaft from fluid being transported.
6. Two dynamic O-ring seals provide secondary sealing to prevent escape of transported fluid to external environment in the event of a primary seal failure.
7. PVC, polypropylene, or SYGEF-PVDF body construction.
8. Belleville washers keep shaft, bushings, disc and dynamic seal loaded as single assembly.
9. Shaft and handle are keyed so as to insure alignment of handle with disc, indicating open when handle is parallel to pipeline.
10. Easy-to-grip streamlined heavy duty handle incorporates indexing device to position disc (at 18° intervals for 2 1/2" and 3", at 15° intervals for 4" thru 10").
11. Easily removable index plate provides for quick conversion to actuated valve use, also incorporates O-ring seal to seal out corrosive atmospheres.
12. Polyethylene caps over top of shaft and bottom protect against corrosive attack.

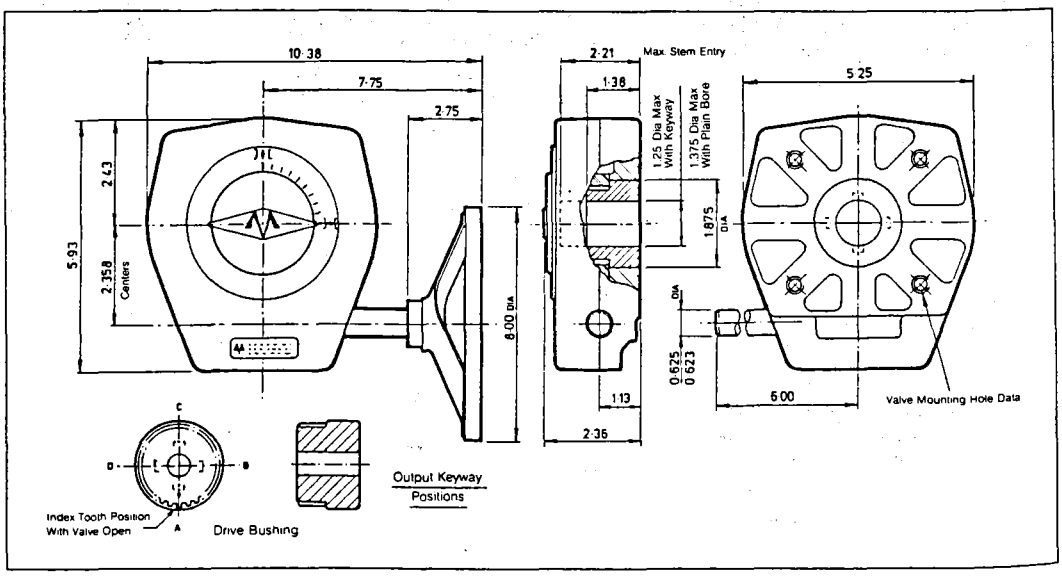
Dimensions

** Oversized holes do not cause any misalignment possibilities in installation. Disc is prevented from contact with pipe because bolt pattern in either DIN or ASA flanges still positions valve properly. Bolts will always contact one bolt hole surface or another to firmly hold valve in position (see 4" example).*





Inch size	A	B	C	D	E	F ISO (DIN)	F ASA	G	H	L	S	U	Metric size
	inch	inch	inch	inch	inch	mm	inch	inch	inch	inch	inch	inch	mm
2 1/2	10.39	3.15	4.33	7.48	4.41	142	5.50	1.81	2.91	5.78	12.93	1.93	75
3	11.41	3.62	4.72	9.01	5.20	160	6.00	1.93	3.03	6.17	13.80	2.60	90
4	13.31	4.25	5.43	10.63	6.30	186	7.50	2.21	3.62	6.88	15.14	3.35	110
5	14.72	4.72	6.14	12.21	7.48	215	8.50	2.52	4.25	7.59	16.32	4.33	140
6	16.34	5.51	6.69	13.98	8.50	240	9.50	2.76	4.57	8.14	17.66	5.32	160
8	19.57	6.89	8.46	16.14	10.71	297	11.75	2.80	5.04	9.92	20.81	7.44	225
10	21.93	8.66	9.76	16.14	16.54	350	14.25	2.99	5.67	11.89	24.55	9.37	280



Part Numbers

PVC

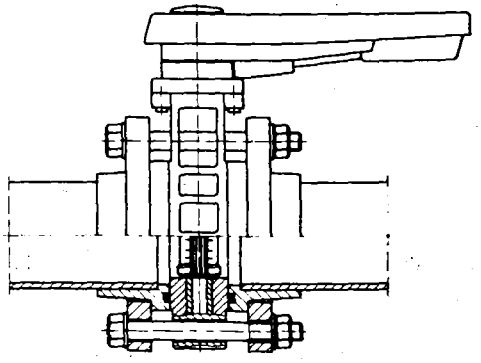
Inch size	seal material EPDM	with gear operator	seal material FPM (Viton)	with gear operator	Metric size mm
2 1/2	161.367.005	161.367.085	161.367.025	161.367.105	75
3	161.367.126	161.367.246	161.367.146	161.367.266	90
4	161.367.007	161.367.087	161.367.027	161.367.107	110
5	161.367.008	161.367.088	161.367.028	161.367.108	140
6	161.367.009	161.367.089	161.367.029	161.367.109	160
8	161.367.010	161.367.090	161.367.030	161.367.110	225
10	161.367.131	161.367.251	161.367.151	161.367.271	280

Polypropylene

Inch size	seal material EPDM	with gear operator	seal material FPM (Viton)	with gear operator	Metric size mm
2 1/2	167.367.005	167.367.085	167.367.025	167.367.105	75
3	167.367.126	167.367.246	167.367.146	167.367.266	90
4	167.367.007	167.367.087	167.367.027	167.367.107	110
5	167.367.008	167.367.088	167.367.028	167.367.108	140
6	167.367.009	167.367.089	167.367.029	167.367.109	160
8	167.367.010	167.367.090	167.367.030	167.367.110	225

SYGEF-PVDF

Inch size	seal material FPM (Viton)	Metric size mm
2 1/2	175.367.025	75
3	175.367.146	90
4	175.367.027	110
5	175.367.028	140
6	175.367.029	160
8	175.367.030	225

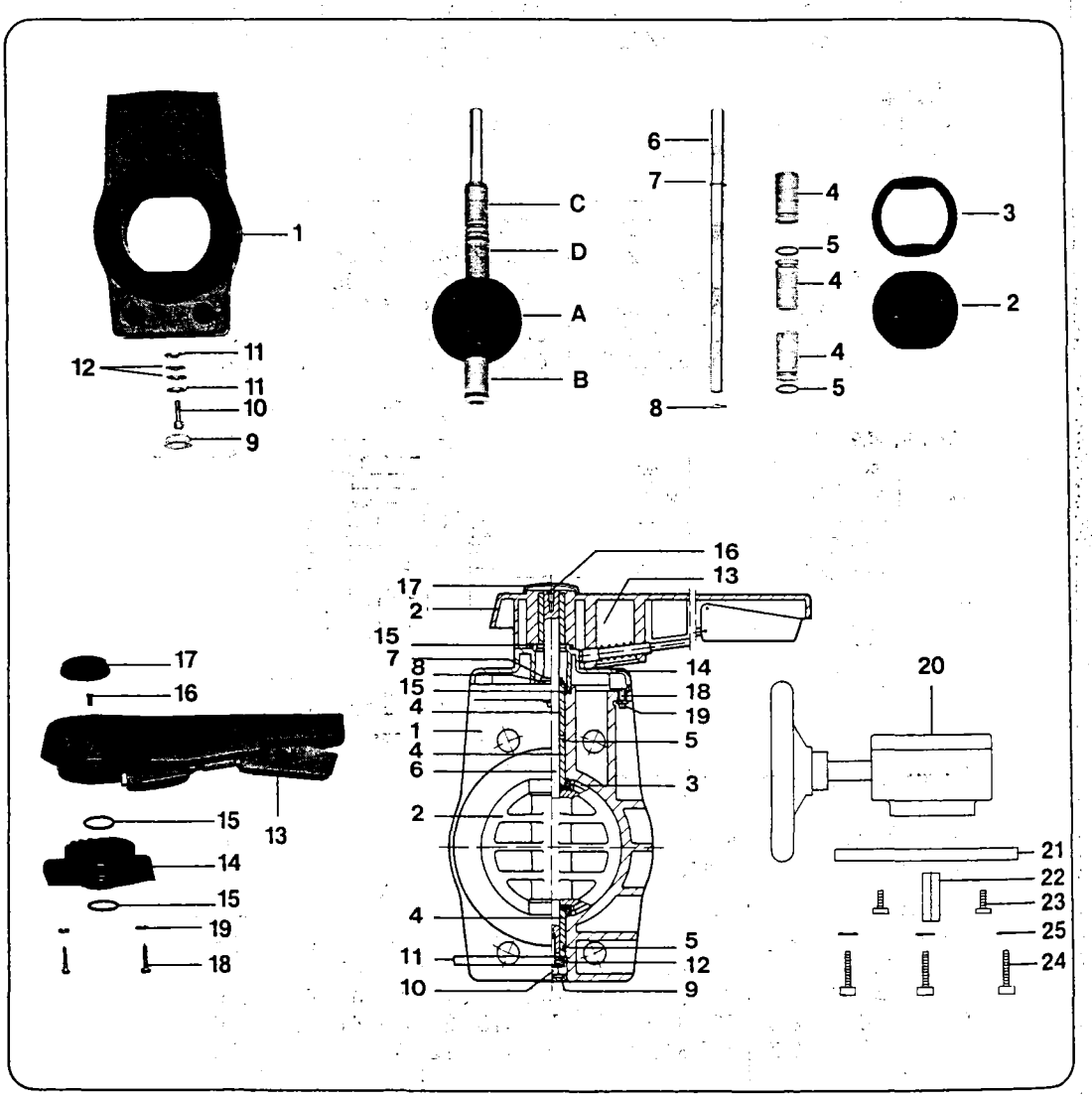


Component Parts for Flange Assembly

Inch size	flange ring FRP	flange adaptor (O-ring type) PVC	O-ring EPDM	O-ring FPM (Viton)	Metric size mm
2 1/2	740.701.812	721.810.112	748.410.014	749.410.014	75
3	740.701.813	721.810.113	748.410.015	749.410.015	90
4	740.701.814	721.810.114	748.410.020	749.410.020	110
6	740.701.817	721.810.117	748.410.021	749.410.021	160
8	740.701.820	721.810.779	748.410.022	749.410.022	225

+GF+ Butterfly Valve Type 367

Assembly / Maintenance Instructions



Disassembly

Remove polyethylene cap ⑨ from bottom of valve.

Remove socket head cap screw ⑩, two special washers ⑪ and two Belleville spring washers ⑫ from bottom of shaft. Remove two screws ⑬ and washers ⑲ from the underside of the top flange (these screws hold the index plate ⑭ in position).

There are three polypropylene bushings (B), (C) and (D), two at the top and one at the bottom. The uppermost has no O-ring seal (C). The other two engage the dynamic disc seal ③.

These polypropylene bushings must be pushed out as follows:
Pull shaft ⑥ halfway out of butterfly valve. Turn shaft with disc (A) by 45°. Push bottom polypropylene bushing (B) out of housing by pushing handle with attached shaft all the way back into the valve. Pull shaft all the way out of butterfly valve. Push shaft from lower side of butterfly valve halfway into the valve. Turn disc with shaft by 45°. Push upper two bushings (C) and (D) out of valve's body by pushing shaft all the way into the valve. Remove shaft from valve.

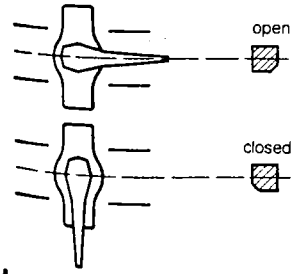
Push disc (A) out of valve.

Using small screw driver lift dynamic O-ring seals ⑤ from retaining slot of bushings and dynamic seal ③ from retaining slot of disc.

If handle is removed from shaft while shaft and disc are separated, care should be taken on reassembly that handle is oriented in the same plane as disc. Shaft and handle are keyed; shaft and disc are not keyed.

Please note

Handle position Shaft position



Assembly

Put new dynamic O-ring seals into the retaining slots of two bushings.

Put a light film of Silicon grease onto the outside surface of all polypropylene bushings. Fill the groove of the bushing without a dynamic O-ring with Silicon grease.

Push new dynamic seal ③ into retaining slot of disc. This is done easiest by starting near one end of disc (some Silicon grease may help quite a bit).

Note that one side of waterway on valve has a beveled surface at top and bottom leading to flatted area of waterway. Push disc in from this side to avoid cutting dynamic seal. (Silicon grease will help.)

Align disc visually on upperside of valve, so that polypropylene bushings could be pushed in easily.

Push in one polypropylene bushing (D) with dynamic O-ring placed away from the disc (towards the handle).

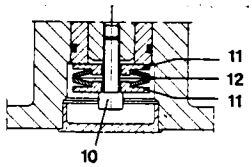
Push bushing without dynamic O-ring seal (C) into the topside of the valve housing with groove showing towards the disc. Push this second bushing all the way in, so its face is aligned with the face of the valve body.

Turn valve upside down so that large flange for the index plate is downwards. Align disc on bottomside of valve such that third bushing can easily be pushed in.

Push third polypropylene bushing (B) into the bottomside of the valve housing with O-ring seal showing away from disc.

Make sure that flat washer ⑧ is against underside of "C" clip ⑦ at upper end of shaft. Push in shaft from topside of valve into the bushing. Align bushings and disc by rotation of shaft and push shaft all the way into the valve.

Make sure that bottom bushing is pushed into final position against dynamic seal, and screw socket head cap screw ⑩ into shaft after mounting a special washer ⑪, two Belleville washers (concave sides facing each other) ⑫ and a special washer ⑪ on the screw.



Tighten screw on lower side of shaft by two turns after head of screw touches special washer.

Cover bottom opening with polyethylene cap ⑨.

Plastic Handle Kit Mounting

After placing O-ring ⑮ in position on bottom of index plate ⑭ may be mounted with the two self tapping screws ⑱ and washers ⑲ (2½" thru 5") at front and back, or the two socket head cap screws ⑱ and washers ⑲ at either side (6" and 8").

With valve in open position, beveled corner of shaft should be in 4 o'clock position in relation to notched portion on index plate as viewed from top.

Place O-ring ⑮ in position, on top of index plate ⑭. Handle should now engage shaft properly oriented in the open position and lever into the open notch. Handle is secured with screw ⑯ by inserting into and expanding shaft.

Gear Operator Kit Mounting

A sub-assembly should be assembled as step one. This will consist of the gear operator ⑳, mounting plate ㉑ and 4 bolts ㉓. Care should be taken to insure the sub-assembly will properly align the gear operator indicator with disc of valve when mounted.

Mounting the sub-assembly is accomplished by bolting the mounting plate ㉗ (with gear operator) using the four mounting holes in top of valves with bolts ㉔ and washers ㉕ provided. Shaft shims ㉒ are provided to insure proper fit for 2½" and 5" sizes.

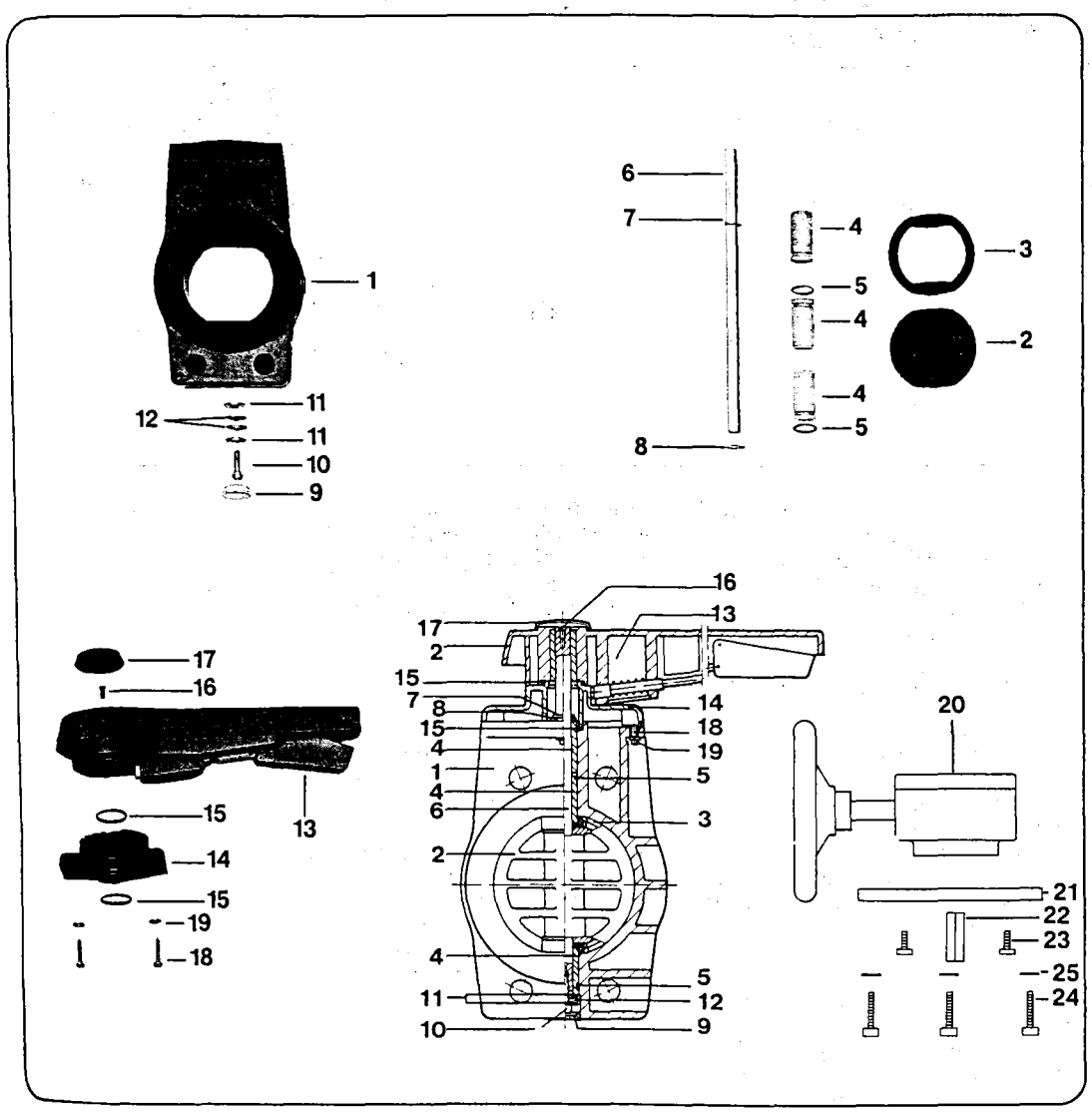
Travel adjustments for full open or full close may be accomplished by removing socket head screws on end of operator and turning internal socket head adjustment screws.

Make sure that assembly of valve has been done properly by operating valve before installation into pipe (disc seal should easily slide into waterway of body).

Component parts in accordance with part numbers

	Material	2½" 75mm	3" 90mm	4" 110 mm	5" 140 mm	6" 160 mm	8" 225 mm
1 Body	PVC ASA	161.481.292	161.481.753	161.481.294	161.481.295	161.481.296	161.481.297
	PVC ISO/DIN	161.481.292	161.481.293	161.481.294	161.481.295	161.481.296	161.481.297
	PP	167.480.383	167.480.384	167.480.385	167.480.386	167.480.387	167.480.388
	PVDF	175.480.097	175.480.098	175.480.099	175.480.100	175.480.101	175.480.102
2 Disc	PVC	161.481.298	161.481.299	161.481.300	161.481.301	161.481.302	161.481.303
	PP	167.480.389	167.480.390	167.480.391	167.480.392	167.480.393	167.480.394
	PVDF	175.480.103	175.480.104	175.480.105	175.480.106	175.480.107	175.480.108
3 Dynamic Seal	Viton	161.481.379	161.481.380	161.481.381	161.481.382	161.481.383	161.481.384
	EPDM	161.481.373	161.481.374	161.481.375	161.481.376	161.481.377	161.481.378
4 Bushing	PP	167.480.334	167.480.335	167.480.336	167.480.337	167.480.338	167.480.339
	PVDF[1]	175.480.109	175.480.110	175.480.111	175.480.112	175.480.113	175.480.114
5 Dynamic O-ring seal	Viton	749.410.136	749.410.059	749.410.059	749.410.106	749.410.116	749.410.116
	EPDM	748.410.136	748.410.059	748.410.059	748.410.106	748.410.116	748.410.116
6 Shaft	ss type 308	161.481.390	161.481.391	161.481.392	161.481.393	161.481.394	161.481.395
7 Snap Ring	steel zinc plated	161.481.410	161.481.411	161.481.411	161.481.412	161.481.413	161.481.413
8 Thrust washer	steel zinc plated	161.481.414	161.481.415	161.481.415	161.481.416	161.481.417	161.481.417
9 PE-Plug	PE	161.480.784	161.481.400	161.481.400	161.481.401	161.481.402	161.481.402
10 Socket head cap screw	steel zinc plated	161.481.351	161.481.358	161.481.358	161.481.358	161.481.358	161.481.358
11 Special washer	steel zinc plated	161.481.396	161.481.397	161.481.397	161.481.398	161.481.399	161.481.399
12 Belleville washer	steel zinc plated	161.481.406	161.481.407	161.481.407	161.481.408	161.481.409	161.481.409
13 Handle assembly	PVC	161.481.738	161.481.739	161.481.740	161.481.741	161.481.742	161.481.743
14 Index plate	PVC	161.481.304	161.481.305	161.481.306	161.481.307	161.481.308	161.481.309
	PP	167.480.395	167.480.396	167.480.397	167.480.398	167.480.399	167.480.400
	PVDF	175.480.115	175.480.116	175.480.117	175.480.118	175.480.119	175.480.120
15 O-ring	EPDM	748.410.123	748.410.137	748.410.137	748.410.138	748.410.139	748.410.139
16 Screw	ss	161.481.385	161.481.385	161.481.385	161.481.386	161.481.386	161.481.386
17 Cap	PE	161.481.387	161.481.387	161.481.388	161.481.388	161.481.389	161.481.389
18 Self tapping screw	ss	161.481.728	161.481.730	161.481.731	161.481.733	–	–
Socket head cap screw	ss	–	–	–	–	198.800.696	198.800.697
19 Washer	ss	161.481.729	161.481.729	161.481.732	161.481.732	161.481.734	161.481.735
20 Gear		198.800.832	198.800.832	198.800.832	198.800.832	198.800.832	198.800.832
Mounting kit for gear operator		150.101.612	150.101.613	150.101.614	150.101.615	150.101.616	150.101.617
21 Mounting plate	painted steel	198.800.813	198.800.814	198.800.815	198.800.816	198.800.817	198.800.818
22 Shaft shim	plated steel	198.800.819	198.800.820	198.800.820	198.800.821	–	–
23 Gear mounting bolts	ss	198.800.823	198.800.823	198.800.823	198.800.823	198.800.823	198.800.823
24 Plate mounting bolts	ss	161.481.358	161.481.358	161.481.358	198.800.826	198.800.826	198.800.771
25 Plate washer	ss	198.800.828	198.800.828	198.800.829	198.800.830	198.800.830	198.800.831

1) for PP & PVDF valves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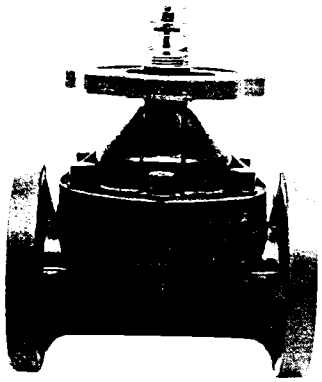
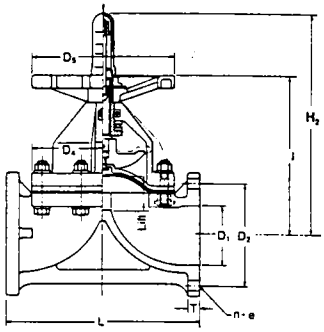
DIAPHRAGM VALVE

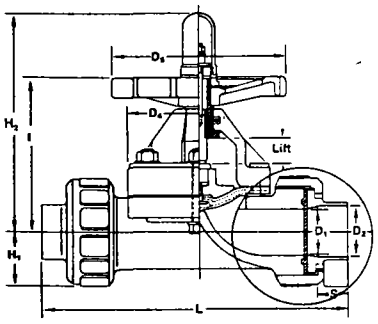
• Flanged face-to-face dimensions are equal to most commonly used lined steel diaphragm valves • Precise throttling of corrosive liquids • Large weir surface allows greater flow with less movement of diaphragm to insure long diaphragm life • Bubble-tight closure even in slurry applications • Position indicator and adjustable travel stops (to prevent overtightening) are standard • Optional 3-part Teflon/PVDF gas barrier/EPDM diaphragm • Optional vacuum service diaphragm valves



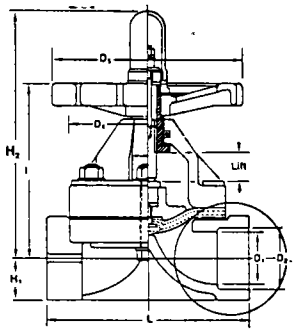
FLANGED



TRUE UNION



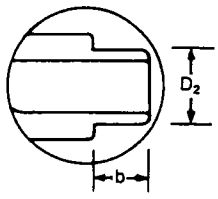
SOCKET THREADED



SPECIFICATIONS

SIZES: ½"–10"
MODELS: Flanged (ANSI—all sizes and materials)
Threaded: ½"–2" (PVC, CPVC, PVDF)
Socket: ½"–2" (PVC, PP, PVDF)
True Union: ½"–2" (PP, PVDF)
Butt: ½"–2" (PP, PVDF)
BODIES: PVC, CPVC, PVDF
DIAPHRAGMS: Teflon, EPDM (Standard)
Other elastomers such as Nitrile (Buna N), Butyl, Hypalon, Neoprene, and Natural Rubber are also available
ACTUATORS: Electric, Pneumatic

Butt



Size	b	L	D2/MM
½"	.57	4.88	20
¾"	.63	5.67	25
1"	.71	6.06	32
1¼"	.85	6.80	40
1½"	.93	7.64	50
2"	1.08	8.82	63

DIMENSIONS—FLANGED (IN INCHES—BODY BOLT HOLES ANSI)

Size	Weight (lbs.)	D_1	D_2	D_4	D_5	L	LIFT	H_2
				2.01 by				
½"	1.95	0.63	2.38	3.07	3.74	4.25	0.39	3.35
				2.48 by				
¾"	2.10	0.79	2.76	3.07	3.74	5.88	0.47	3.70
				2.68 by				
1"	2.90	0.98	3.13	3.46	4.33	5.88	0.59	3.70
1 ½"	5.00	1.61	3.88	4.72	5.91	6.94	0.87	5.31
2"	6.60	2.05	4.75	5.35	5.91	6.94	0.87	5.31
2 ½"	11.50	2.64	5.50	7.17	8.27	9.84	1.54	10.55
3"	17.00	3.07	6.00	7.48	8.27	10.38	1.89	8.27
4"	27.40	3.94	7.50	9.45	9.84	12.94	2.36	10.36
5"	41.75	4.92	8.50	12.60	11.81	16.14	2.36	16.54
6"	64.75	5.83	9.50	15.16	16.14	18.90	2.76	18.74
8"	101.00	7.72	11.75	16.93	16.14	22.44	3.74	24.69
10"	192.25	9.72	14.25	21.26	22.05	26.77	5.04	30.63

DIMENSIONS—TRUE UNION AND SOCKET/THREADED (IN INCHES)

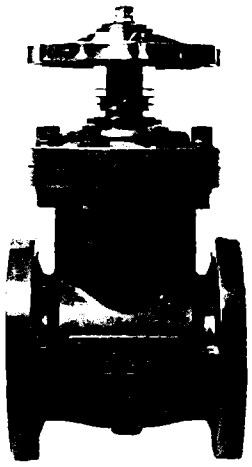
Size	Weight (lbs.)	D_1	D_2 Threaded	D_2 Socket	D_2	D_4	D_5	S Socket	L Butt	Lift	L	I	H_1	H_2	L Soc/Thd
½"	1.04	0.59	NPT ½	0.83	.54	2.13 x 2.76	3.74	0.59	6.20	0.39	3.35	3.35	.95	4.92	5.50
¾"	1.33	0.79	NPT ¾	1.05	.71	2.48 x 3.07	3.74	0.67	7.00	0.47	3.74	3.70	1.20	5.20	6.70
1"	1.83	0.98	NPT 1	1.31	.90	2.68 x 3.46	4.33	0.79	7.50	0.59	3.94	3.94	1.40	5.71	7.15
1½"	3.78	1.58	NPT 1½	1.89	1.85	4.92	5.91	0.98	10.65	0.87	6.30	5.32	1.70	7.56	10.80
2"	5.30	2.05	NPT 2	2.37	2.36	5.83	5.91	1.10	11.80	1.22	7.48	5.75	2.10	8.47	12.20

OPERATING PRESSURE VS. TEMPERATURE

	PVC				CPVC				PP				PVDF			
	Elastomer(s)		Teflon®		Elastomer(s)		Teflon®		Elastomer(s)		Teflon®		Teflon®			
Size	30°F 104°F	106°F 140°F	30°F 104°F	106°F 140°F	30°F 104°F	176°F 194°F	30°F 104°F	176°F 194°F	−5°F 104°F	176°F 212°F	−5°F 104°F	176°F 212°F	−5°F 140°F	141°F 175°F	176°F 212°F	213°F 250°F
½"	150	120	150	100	150	100	150	90	150	100	150	90	150	100	90	90
¾"	150	120	150	100	150	100	150	90	150	100	150	90	150	100	90	90
1"	150	120	150	100	150	100	150	90	150	100	150	90	150	100	90	90
1½"	150	120	150	100	150	100	150	90	150	100	150	90	150	100	90	90
2"	150	120	120	90	150	90	120	75	150	90	120	75	120	90	75	75
2½"	150	120	120	90	150	90	120	75	150	90	120	75	120	90	75	75
3"	150	120	100	75	150	75	100	60	150	75	100	60	100	75	60	60
4"	150	120	90	75	150	75	90	60	150	75	90	60	90	65	60	60
5"	100	90	75	60	100	60	75	45	100	60	75	45	75	60	45	45
6"	100	75	75	60	100	60	75	45	100	60	75	45	75	60	45	45
8"	75	60	60	45	NA	NA	NA	NA	75	50	60	45	60	45	45	45
10"	65	50	60	45	NA	NA	NA	NA	65	50	60	45	60	45	45	45

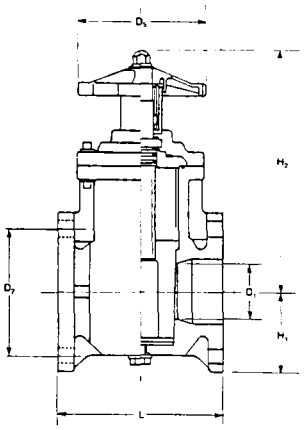
GATE VALVE

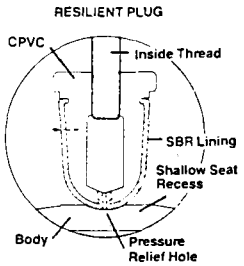
• Unique sliding plug design provides greater seating area than conventional gate valves • New plug and seat permits throttling and eliminates chatter • ANSI face-to-face dimensions on models through 8" • Non-rising stem with position indicator • Competitively priced with cast iron • Rated for full vacuum service

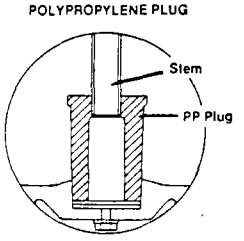


OPERATING PRESSURE VS. TEMPERATURE (PSI, WATER, NON-SHOCK)

Size	30°F–120°F
1½"	150
2"	150
3"	150
4"	150
6"	150
8"	150
10"	110
12"	70
14"	70







SPECIFICATIONS

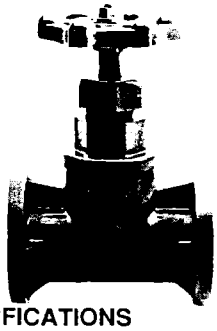
SIZE: 1½–14"
MODELS: Flanged (ANSI) Wafer Optional
BODY: PVC
PLUG: PP or CPVC-SBR lined
SEALS: EPDM

DIMENSIONS (IN INCHES)

Size	Weight (lbs.)	D_1	D_2	D_5	L	H_1	H_2	Cv Values
1½"	5.50	1.50	3.88	4.72	6.50	2.50	9.26	140
2"	7.50	1.77	4.75	5.12	7.00	3.00	10.15	230
3"	13.50	2.64	6.00	6.69	8.00	3.75	12.20	580
4"	20.00	3.46	7.50	7.68	9.00	4.50	13.78	1100
6"	40.10	5.12	9.50	10.63	10.50	5.50	17.52	2100
8"	66.20	6.61	11.75	12.20	11.50	6.75	22.72	3900
10"	115.80	8.27	14.25	14.17	14.96	8.00	27.17	6100
12"	146.70	10.04	17.00	16.14	15.75	9.50	31.50	8700
14"	187.40	11.69	18.75	17.91	16.93	10.50	35.82	12200

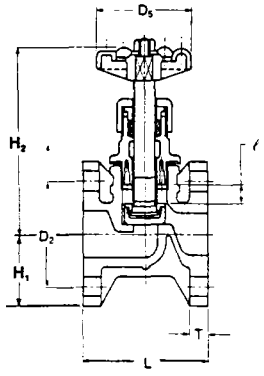
GLOBE VALVE

• Used for efficient, frequent throttling of flow with minimum erosion to the seat • Bubble-tight shut-off • Quick opening valve • All sizes rated for full vacuum service

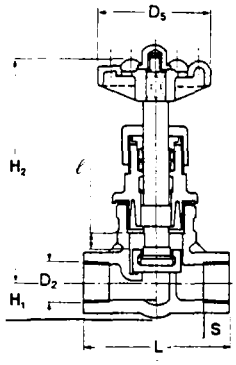


SPECIFICATIONS

SIZES: ½"–4"
MODELS: Flanged (ANSI—all sizes)
Threaded (½"–2")
Socket (½"–2")
BODY: PVC, PP
SEALS: EPDM



FLANGED



THREADED

OPERATING PRESSURE VS. TEMPERATURE (PSI, WATER NON SHOCK)

	PVC			PP		
Size	30°F 70°F	105°F	120°F	-5°F 70°F	140°F	175°F
½"	150	105	105	105	90	65
¾"	150	105	105	105	90	65
1"	150	105	105	105	90	65
1¼"	150	105	105	105	90	65
1½"	150	105	105	105	90	65
2"	150	105	90	105	70	40
2½"	105	105	90	105	60	35
3"	105	105	90	105	60	35
4"	105	80	65	105	60	35

DIMENSIONS (IN INCHES UNLESS OTHERWISE NOTED.)

	FLANGED								THREADED/SOCKET									
Size	Weight (lbs.)	D_2	L	T	LIFT ℓ	H_1	H_2 Open	D_5	Weight (lbs.)	D_2 So	D_2 Th	S So	L So	L Th	LIFT ℓ	H_1	H_2 Open	D_5
½	0.95	2.38	3.36	0.47	0.32	1.75	5.20	2.60	0.64	0.85	NPT ½	1.18	4.33	3.35	0.32	0.63	5.20	2.60
¾	1.10	2.76	3.74	0.55	0.32	1.93	5.61	2.60	1.10	1.06	NPT ¾	1.38	5.12	3.74	0.32	0.75	5.61	2.60
1	2.20	3.13	4.33	0.55	0.43	2.13	6.34	3.58	1.10	1.33	NPT 1	1.58	5.91	4.33	0.43	0.95	6.34	3.58
1¼	2.90	3.50	5.32	0.63	0.51	2.30	6.57	3.58	1.30	1.67	NPT 1¼	0.98	5.32	5.32	0.51	1.12	6.57	3.58
1½	4.50	3.88	7.48	0.63	0.79	2.50	9.06	5.31	2.70	1.91	NPT 1½	0.98	5.51	5.51	0.79	1.32	9.06	5.31
2	5.30	4.75	7.87	0.63	0.94	3.00	9.92	6.31	3.50	2.38	NPT 2	1.06	7.09	7.09	0.94	1.51	9.92	5.31
2½	13.25	5.50	8.66	0.71	1.38	3.50	13.58	7.28	–	–	–	–	–	–	–	–	–	–
3	15.00	6.00	9.45	0.71	1.38	3.76	14.13	7.28	–	–	–	–	–	–	–	–	–	–
4	22.00	7.50	11.42	0.71	1.58	4.60	16.50	7.28	–	–	–	–	–	–	–	–	–	–

A-12

Wye Strainer

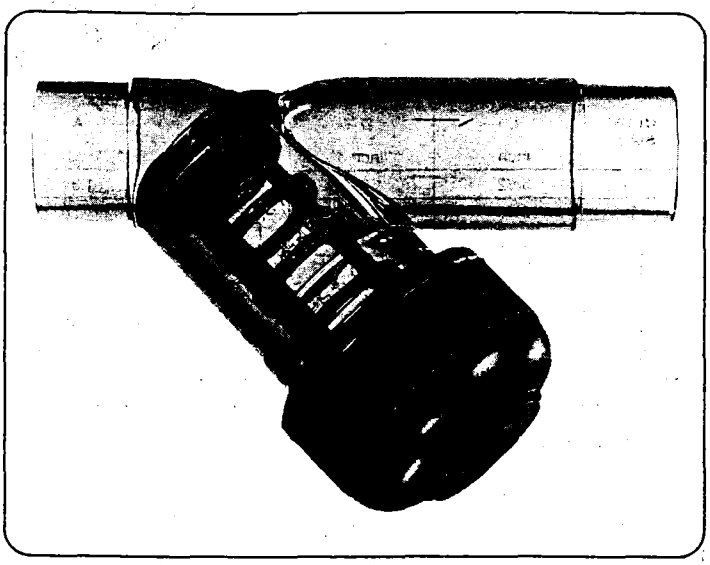
+GF+®
Line Strainer Type 306

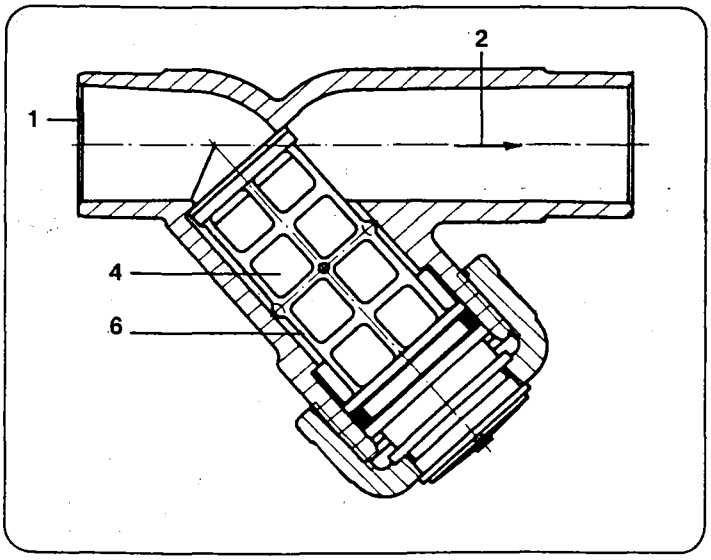
Line strainer Type 306 is suitable for protecting valves, pumps and other equipment against solid particles.

It is available in transparent PVC.

Installation position is dependent on flow direction.

Screens can be removed and cleaned without removing strainer from line.

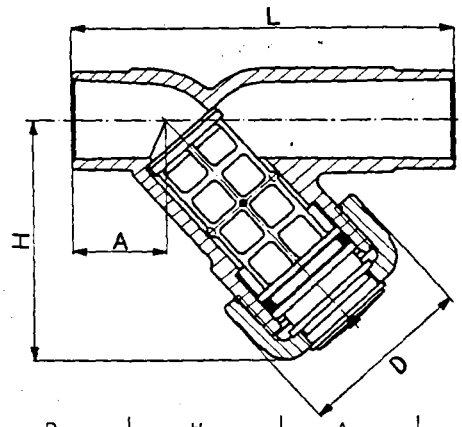




Technical Features

1. Exclusive inch size spigot ends for universal installation.
2. Flow direction clearly indicated.
3. Condition of screens clearly visible from outside.
4. Choice of four screen sizes: 8, 12, 20 & 30 mesh.
5. Screens easily removed for cleaning.
6. Screens are separate from cage providing inexpensive replacement of broken screens.

Dimensions



Inch size	L inch	D inch	H inch	A inch	Weight lbs.	Metric size mm
½	5.62	1.89	2.56	1.34	.24	20
¾	6.30	2.13	3.00	1.70	.37	25
1	6.83	2.44	3.56	1.72	.56	32
1¼	7.40	2.80	4.13	1.83	.84	40
1½	8.07	1.47	4.88	2.05	1.40	50
2	8.86	4.06	5.81	2.36	2.21	63
3	12.23	4.72	8.06	3.84	5.66	90

Types available in accordance with part numbers

Material	Inch size	Line Strainer w/20 Mesh Screen		Screens				Metric size
		Seal Material		8 Mesh, Hole ø 3/32"	12 Mesh, Hole ø 1/16"	20 Mesh, Hole ø 1/32"	30 mesh, Hole ø 1/64"	mm
		EPDM	FPM (Viton)					
Transparent PVC	½	192.306.300	192.306.349	161.305.336	161.306.337	161.305.338	161.305.339	20
	¾	192.306.350	192.306.399	161.305.386	161.305.387	161.305.388	161.305.389	25
	1	192.306.400	192.306.449	161.305.436	161.305.437	161.305.438	161.305.439	32
	1¼	192.306.450	192.306.499	161.305.486	161.305.487	161.305.488	161.305.489	40
	1½	192.306.500	192.306.549	161.305.536	161.305.537	161.305.538	161.305.539	50
	2	192.306.550	192.306.599	161.305.586	161.305.587	161.305.588	161.305.589	63
	3	192.306.650	192.306.699	161.305.686	161.305.687	161.305.688	161.305.689	90

Example of Ordering

Requirement: +GF+ Line Strainer in PVC, seal material EPDM, size 1½"
Part number: 192.306.500

Requirement: +GF+ Screen in PVC, 12 mesh, for 1½" Line Strainer
Part number: 161.305.537

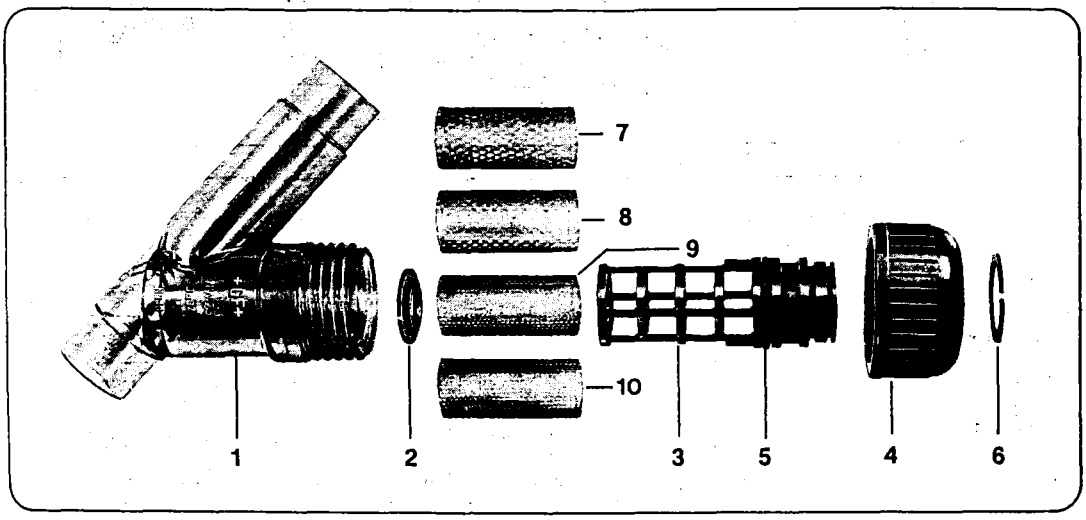
Product Specification

Type 306 Y-Strainer Valve — PVC

PVC Y-Strainer ½" through 3" shall have spigot type pipe connections. Seals shall be either FPM (Viton) or EPDM, as specified by the user. Strainer screens shall be removable for replacement without removing the body from the line. Screen perforations sizes are 8, 12, 20, and 30 mesh (3/32", 1/16", 1/32" and 1/64" respectively). Body shall be of translucent PVC to facilitate inspection. The PVC body will meet or exceed the requirements of 12454B according to the classifications and requirements of ASTM D-1784. Spigot end dimensions shall be in accordance with ASTM D1785. The strainer, Type 306, shall carry a pressure rating of 150 psi at 68°F as supplied by George Fischer Signet, Inc., Tustin, CA 92680.

+GF+ Line Strainer Type 306

Assembly Instructions



Place the body seal ⑤ in the groove on the screen cage ③.

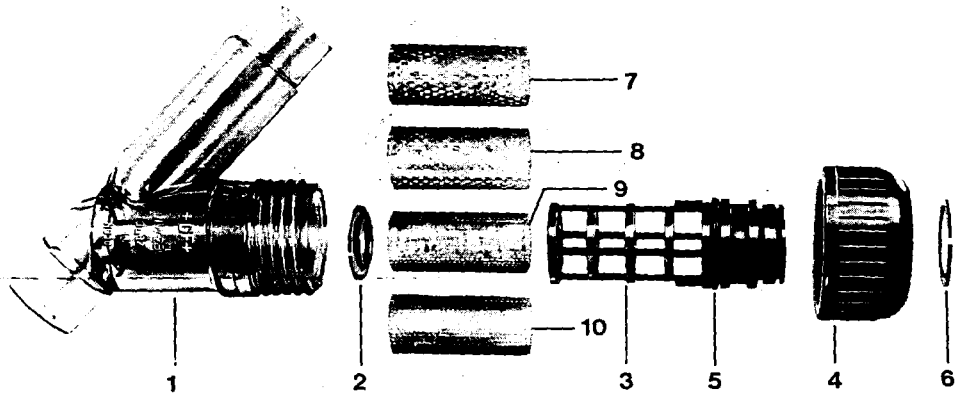
Carefully ease the screen selected (e.g. 6) into the screen cage ③.

Place the screen support ring ② in the end of the screen cage ③.

Insert the complete screen assembly into the body ①. and screw on the bonnet nut ④. Secure with circlip ⑥

For disassembly, the screen cage ③ will be pulled from body ① by the circlip ⑤. 3" size will require a pin inserted through the hole in top of screen cage.

Component parts in accordance with part numbers



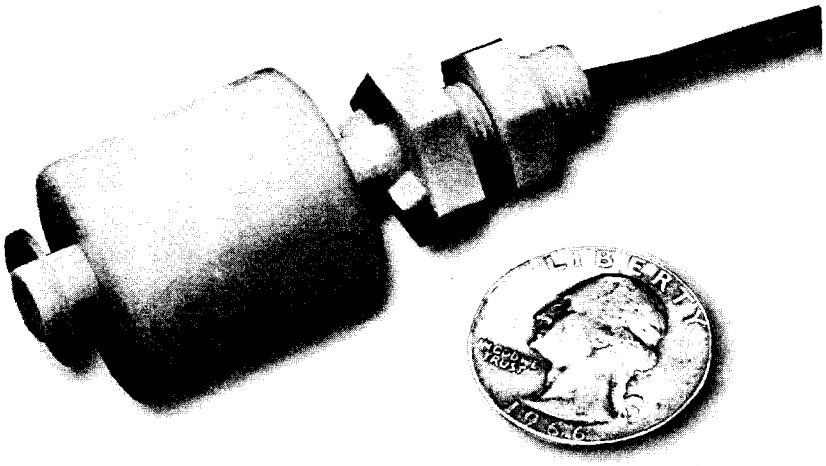
	Material	20 mm ½"	25 mm ¾"	32 mm 1"	40 mm 1¼"	50 mm 1½"	63 mm 2"	90 mm 3"
1 Body	PVC transparent	192.301.301	192.301.351	192.301.401	192.301.451	192.301.501	192.301.551	192.301.651
2 Screen Support Ring	PVC	161.305.302	161.305.352	161.305.402	161.305.452	161.305.502	161.305.552	161.305.652
3 Screen Cage	PVC	161.305.303	161.305.353	161.305.403	161.305.453	161.305.503	161.305.553	161.305.653
4 Bonnet Nut	PVC	161.300.308	161.300.358	161.300.408	161.300.458	161.300.508	161.300.558	161.305.654
5 Body Seal	EPDM	748.410.006	748.410.001	748.410.007	748.410.002	748.410.003	748.410.012	748.410.014
	FPM	749.410.006	749.410.001	749.410.007	749.410.002	749.410.003	749.410.012	749.410.014
6 Circlip	PVC	161.482.017	161.482.018	161.482.019	161.482.020	161.482.021	161.482.022	–
7 Screen perforation Ø 3/32"	PVC	161.305.336	161.305.386	161.305.436	161.305.486	161.305.536	161.305.586	161.305.686
8 Screen perforation Ø 1/16"	PVC	161.305.337	161.305.387	161.305.437	161.305.487	161.305.537	161.305.587	161.305.687
9 Screen perforation Ø 1/32"	PVC	161.305.338	161.305.388	161.305.438	161.305.488	161.305.538	161.305.588	161.305.688
10 Screen perforation Ø 1/64"	PVC	161.305.339	161.305.389	161.305.439	161.305.489	161.305.539	161.305.589	161.305.689

A-13

Level Controls
(Well, EQ and DAT Level Sensors)

OL, SH, FH Series

Miniature Liquid Level Switches



Features

- Compact size.
- Low cost.
- Reliability/long switch life.
- Can be used in a wide range of liquids.

General Description

These miniature liquid level switches have been designed for reliable operation in small tanks and containers. Their rugged design and careful engineering make them the perfect solution for OEM and large volume applications.

How They Work

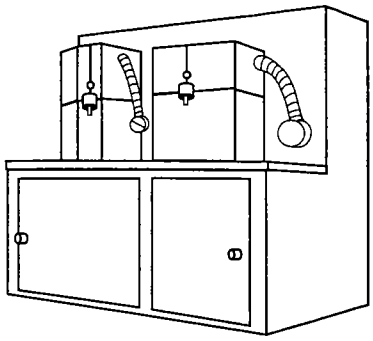
The stem of these miniature liquid level switches contains a hermetically-sealed reed switch. The float contains a permanent magnet. As the float rises or falls with the level of the liquid, the reed switch is activated by the magnet. On most models, the operation of the switch, normally open or normally closed, is easily changed by removing a retaining clip and inverting the float.

Applications

Typical applications include automatic vending machines, photocopiers, small collection tanks, miniature pumping stations, pilot plants and similar small-system applications.

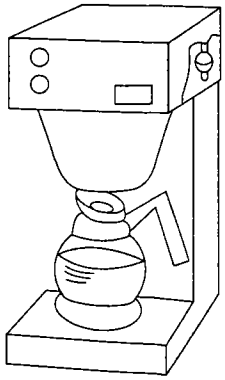
Application: Controlling delivery of plating liquid

Nickel plating liquid is used for surface treatment of electronic parts. The liquid is automatically fed into a plating bath with the OLV-2P detecting the upper and lower levels.



Application: Coffee extraction control

The OLV-5UN is mounted in the feeding water tank to detect the lower limit of the hot water. The OLV-5UN is suitable for food and pharmaceutical applications because the float joints are plasma welded and the surface is buffed smooth.



Product Summary

Plastic Float Switches

OLV-2A - Designed for water applications. 25x25mm Buna-N float with Polyacetal stem. Switch action can be reversed by inverting float.

OLV-2P - For use with chemicals, food and potable water. 25x25mm polypropylene float with polypropylene stem. Switch action can be reversed by inverting float.

OLV-2F - Designed for applications involving corrosive chemicals and solvents. 25x25mm PVDF float with PVDF stem. Switch action can be reversed by inverting float.

OLH-3 - For use in water only. Horizontal mounting. Polypropylene float with polyacetal stem. O-ring seal provided. Switch action can be reversed by inverting float.

Metal Float Switches

OLV-5UN - For use in most liquids. 28x27mm plasma-welded 316 stainless steel float with 316 stainless-steel stem. Switch action can be reversed by inverting float. UL recognized component.

OLV-5R - For use in lubricating and hydraulic oil. Similar to OLV-5UN but with 25x25mm Buna-N float.

FH30 (304SS) & FH50 (316SS) - Continuous operation at 248° F (120° C) for FH30 and at 392° F (200° C) for FH50. Both models withstand steam cleaning and sterilization. Switch action can be reversed by inverting float.

SH10 - Horizontal mounting from outside container. 316 stainless steel construction. Switch action can be reversed by changing the switch's mounting orientation. Operates at 240° F (120° C).

Plastic Floats - OL Series

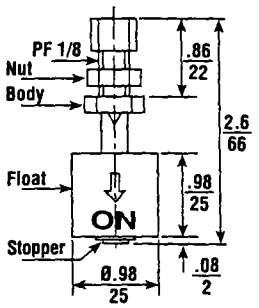
Specifications

Model	OLV-2A	OLV-2P	OLV-2F	OLH-3
Material				
Stem	Polyacetal	Polypropylene	PVDF	Polypropylene
Float	Buna-N	Polypropylene	PVDF	Polypropylene
Retainer	316SS	Polypropylene	PVDF	Polypropylene
Operating Temperature Range	14° to 194°F (–10° to 90°C)		14° to 212°F (–10° to 100°C)	14° to 194°F (–10° to 90°C)
Pressure Rating	142psi (9.8 bar)	7psi (0.5 bar)	142psi (9.8 bar)	7psi (0.5 bar)
Mounting	Vertical			Horizontal
Switch Rating	50VA AC			
Lead Wires	#22AWG, 11.8 in. (300 mm)			
Minimum SG	0.6	0.85	0.9	0.8

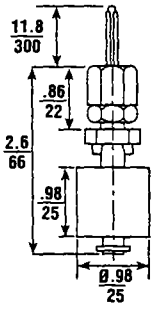
Dimensions

in / mm

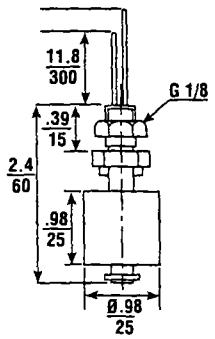
OLV-2A



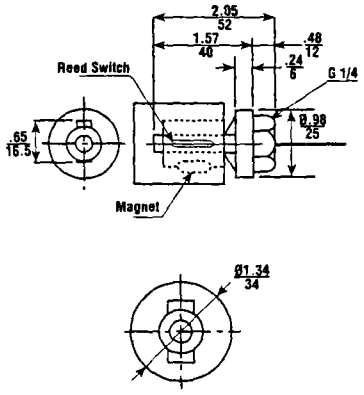
OLV-2P



OLV-2F



OLH-3



A-14

Extraction Well Pumps Electrical Receptacle Plug

ENR Dead Front Interlocked Circuit Breaking Receptacles ENP Plugs General Purpose

Ark•Gard® 2 Factory-Sealed Class I; Groups B†,C,D Class II, Groups F,G Class III NEMA 3,7BCD,9FG,12▲

Crouse-Hinds®

Application:

ENR receptacles and ENP plugs are used:
- with portable electrical equipment such as compressors, tools, lighting systems, and similar devices
- in areas made hazardous by the presence of flammable vapors and gases or combustible dusts
- wherever portable electrical equipment is likely to be transferred from hazardous to nonhazardous areas
- in damp and corrosive areas
- when power requirements do not exceed 20 amperes
- where general purpose application is required

Features:

- *Ark•Gard 2* receptacle incorporates three spring-loaded slide keys that prevent the receptacle face plate from being rotated until the ENP plug is fully inserted into the receptacle. To make the connection, the ENP plug is fully inserted; and the receptacle face moved inward by pushing the plug forward (Fig. 1). The plug is then rotated, (Fig. 2), closing the circuit. As rotation begins, the plug becomes locked in the receptacle and cannot be accidentally disengaged. In making or breaking the circuit, any resulting electrical arc is confined in the factory-sealed chamber.
- Factory-sealed chamber encloses the potential arcing components between two explosion-proof threaded joints. These threads are specially coated to guarantee freedom of movement, which ensures on-off action. No additional seals are required.
- One piece molded gasket seals cover plate and ENP plug when plug is inserted, providing full environmental protection at the receptacle face.
- Top-hinged cover design with 45° downward angle provides superior protection in damp, wet, and dirty locations.
- Molded-in contact design provides superior interior contact reliability.
- ENP plugs can be used in nonhazardous areas with standard U-ground NEMA configuration 5 and 6 receptacles eliminating the need for two separately equipped portable units of the same type. The ENR receptacle will not accept standard NEMA configuration plugs.
- ENP plug handle body is designed with an internal cord strain relief mechanism and a cable sealing grommet which will accept various cable diameters.
- Field assembly is accomplished with standard tools.

Figure 1

Figure 2

Grounding:

- NEC Article 501 requires that metal frames or exposed non-current-carrying metal parts of portable devices used in hazardous locations be grounded through an extra conductor in the portable cord. ENR receptacles and ENP plugs are provided with an extra grounding pole.

Standard Materials:

- Receptacle housing, spring door and plug body – die cast copper-free aluminum
- Interiors: receptacle – *Krydon*® fiberglass-reinforced polyester material; plugs – nylon 100
- Contacts: receptacle blade – brass; receptacle switch – silver; plug – brass
- Receptacle cover hinge pin and spring – stainless steel
- Receptacle gasket – neoprene
- Plug bushing – neoprene

Standard Finishes:

- Copper-free aluminum – aluminum acrylic paint▲
- Brass – natural

Electrical Rating Ranges:

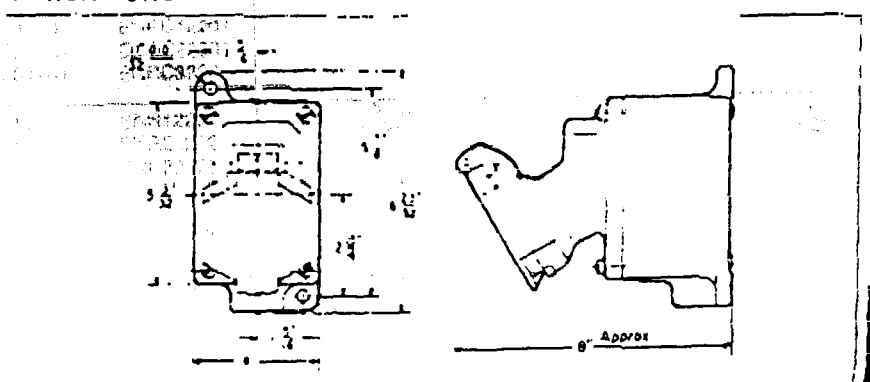
- Receptacles – 20 amperes; 125 vac and 250 vac, 50-400 hertz
- Plugs – 15 amperes; 125 vac and 250 vac, 50-400 hertz
  20 amperes; 125 vac and 250 vac 50-400 hertz

Compliances:

- NEC: Class I, Groups B† C,D
  Class II, Groups F,G
  Class III
- ANSI▲/UL Standard 1010
- NEMA 3,7BCD,9FG

CAUTION: To reduce the risk of ignition of hazardous atmospheres, do not use plugs or receptacles in Class II, Group F locations that contain metallic conductive dusts.

Dimensions



▲ Denotes revision

† Single gang receptacle units can be modified for Class I Group B usage. Add suffix B to the Cat. No. Example ENRB1201. Seals must be installed within 1½" of each conduit opening.

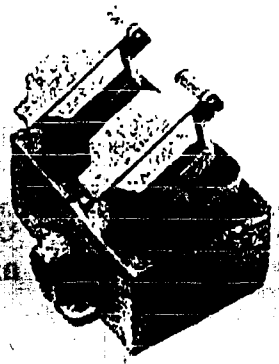
Crouse-Hinds®

ENR Dead Front Delayed Action Circuit Breaking Receptacles ENP Plugs General Purpose

Ark•Gard® 2 Factory Sealed Class I, Groups B*,C,D Class II, Groups F,G Class III NEMA 3,7BCD,9F,G,12A

ENR single gang dead end assembly

ENR single gang dead end assembly with spring door open



ENR two gang dead end assembly

ENR two gang dead end assembly with one spring door open

ENR receptacle only, with spring door open

ENP plug

Receptacle Rating	Description	Hub Size	Single Gang Receptacle Assembly Cat. # ‡	Two Gang Receptacle Assembly Cat. # ‡	Receptacle Unit Only Cat. #	NEMA Config.	15 Amp Plug Cat. #	NEMA Config.	20 Amp Plug Cat. #	NEMA Config.
20 amp, 125 volt	Dead End	½	ENR11201	ENR12201	ENR5201	5-20R	ENP5151	5-15P	ENP5201	5-20P
		¾	ENR21201	ENR22201						
		1	ENR31201	ENR32201						
	Through Feed	½	ENRC11201	ENRC12201						
		¾	ENRC21201	ENRC22201						
		1	ENRC31201	ENRC32201						
20 amp, 250 volt	Dead End	½	ENR11202	ENR12202	ENR6202	6-20R	ENP6152	6-15P	ENP6202	6-20P
		¾	ENR21202	ENR22202						
		1	ENR31202	ENR32202						
	Through Feed	½	ENRC11202	ENRC12202						
		¾	ENRC21202	ENRC22202						
		1	ENRC31202	ENRC32202						

CAUTION: To reduce the risk of ignition of hazardous atmospheres, do not use plugs or receptacles in Class II, Group F locations that contain electrical conductive dusts.

A Denotes revision.

* Single gang receptacle units can be modified for Class I, Group B usage. Add suffix B to the Cat. No. Example: ENRB11201. Seals must be installed immediately adjacent to each conduit opening.

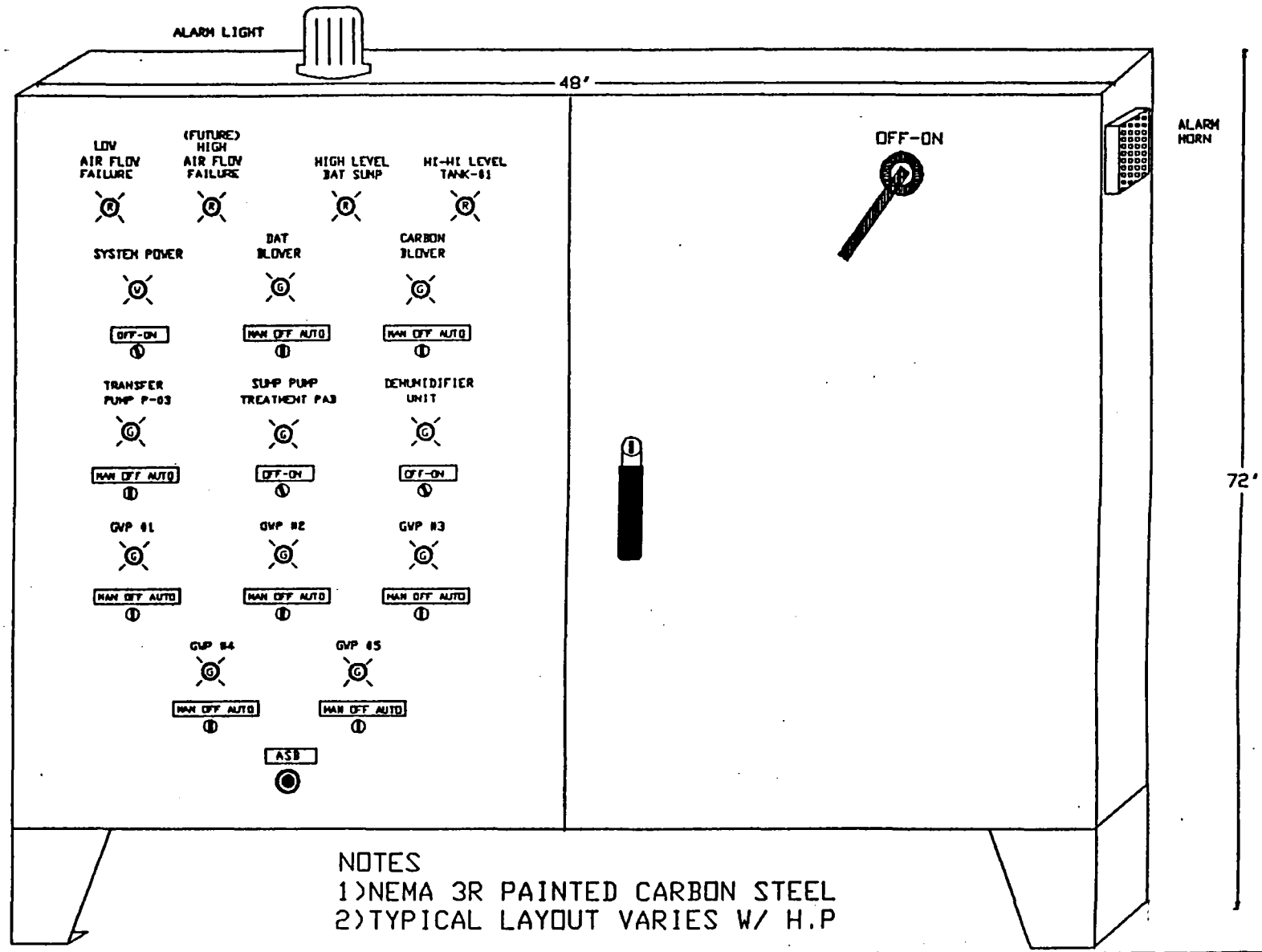
‡ With EDS, EDSC back boxes.

A-15

Control Panel Layout

CONTROL PANEL LEGEND

A/C	AIR COMPRESSOR
AST	AIR STRIPPING TOWER
C	CONTACTOR
CR	CONTROL RELAY
C.T	CURRENT TRANSFORMER
DAT	DIFFUSED AERATION TANK
DPS	DIFFERENTIAL PRESSURE SWITCH
F	FUSE
FB	FUSE BLOCK
FS	FLOAT SWITCH
GFDR	GROUND FAULT DUPLEX RECEPTACLE
GWP	GROUNDWATER PUMP
GRD.	GROUND,(EQUIPMENT ONLY)
HOA	HAND-OFF-AUTOMATIC
ISR	INTRINSICALLY SAFE RELAY
LLC	LIQUID LEVEL CONTROLLER
M	MOTOR
MB	MOTOR BREAKER
MCB	MAIN CIRCUIT BREAKER
MC	MOTOR CONTACTOR
MICRO1	SQD PROGRAMMABLE CONTROLLER
MTS	MOTOR THERMAL SWITCH
MS	MOTOR STARTER
N	NEUTRAL
O.L	OVERLOAD
PDB	POWER DISTRIBUTION BLOCK
PS	PRESSURE SWITCH
PLC	PROGRAMMABLE LOGIC CONTROLLER
R	CONTROL RELAY
SSU	SURGE SUPPRESSOR UNIT
TB	TERMINAL BLOCK
TDR	TIME DELAY RELAY
TMC	TIME MARK CONTROLLER (GWP)
TTS	THERMAL TERMINAL STRIP
TU	THERMAL OVERLOAD UNIT
XFMR	TRANSFORMER



NOTES
1)NEMA 3R PAINTED CARBON STEEL
2)TYPICAL LAYOUT VARIES W/ H.P

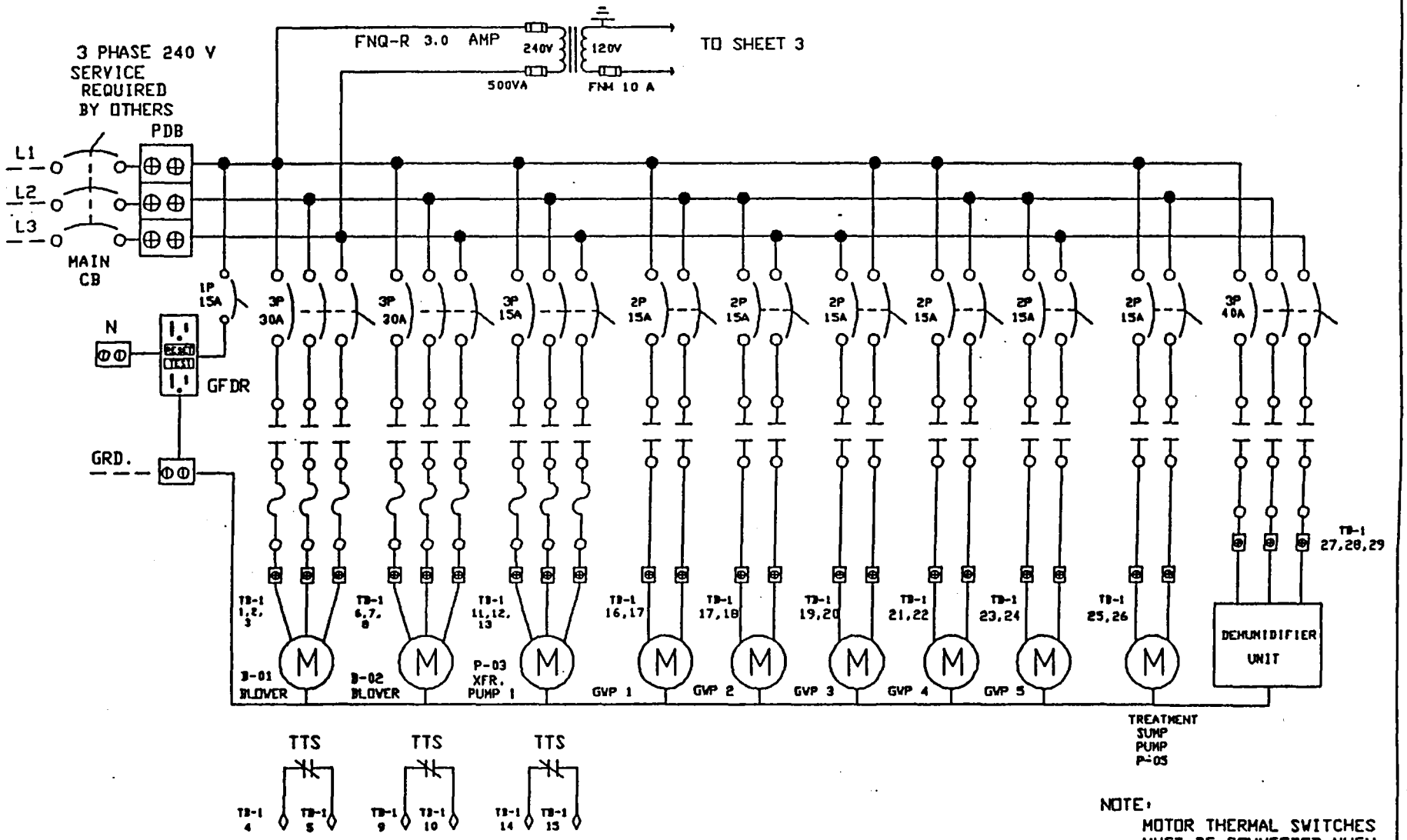
Revisions		
1	12-93	DELETE DECON SUMP PUMP DELETE HIGH LEVEL BOTH SUMPS

Diversified Remediation Southeast, Inc.

Scale: NONE
Drawn: SJS
Date: 11-17-93
Proj.# 93577PL
Approved:

ABB ENVIRONMENTAL
KING'S BAY PROJECT
CONTROL PANEL LAYOUT

1



NOTE:
MOTOR THERMAL SWITCHES MUST BE CONNECTED WHEN APPLICABLE TO MAINTAIN MANUFACTURER'S WARRANTY

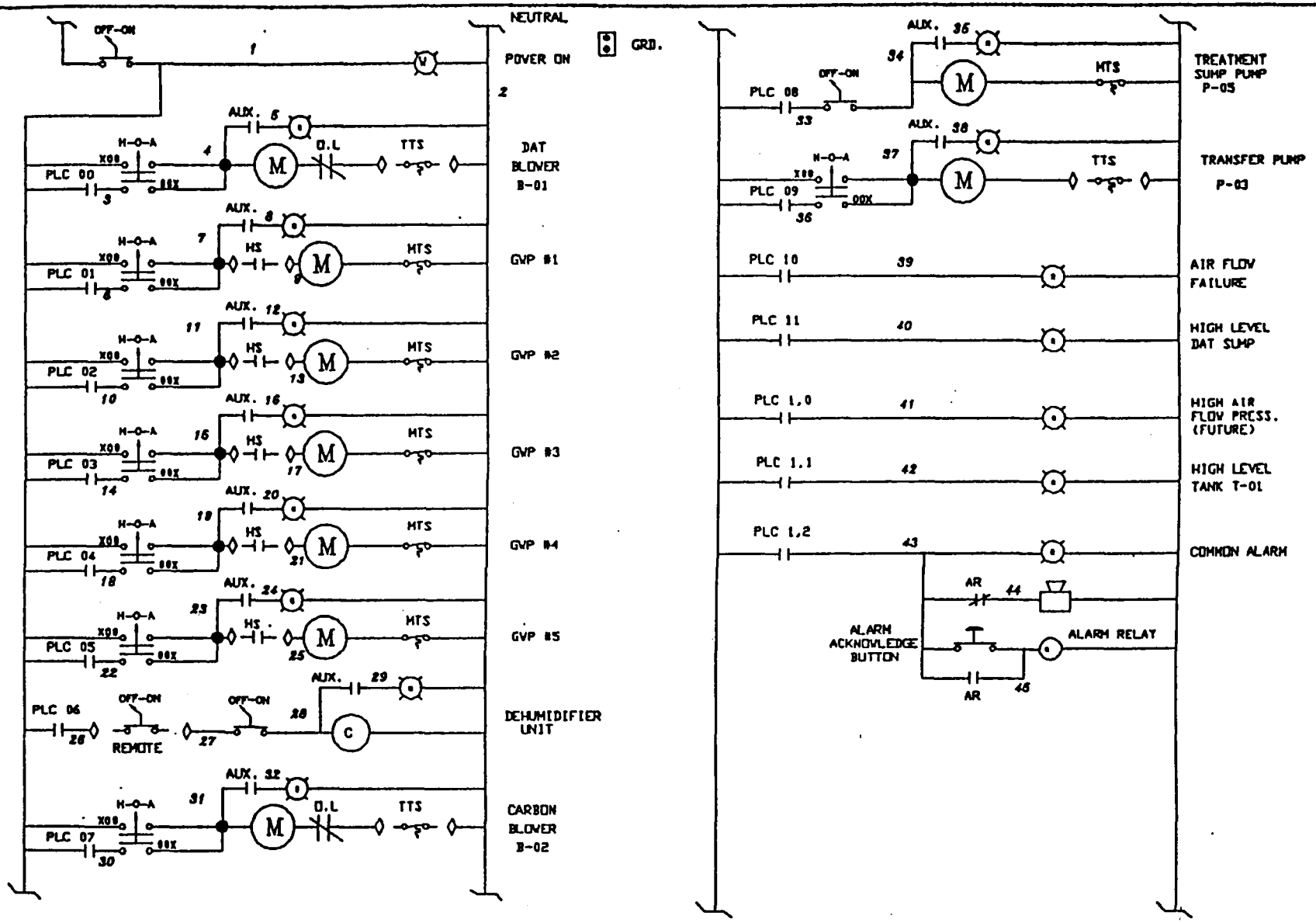
Revisions		
1	12-93	DELETE DECON SUMP PUMP DELETE HIGH LEVEL BOTH SUMPS
1	12-93	DELETE GVP 6
1	12-93	ADD DEHUMIDIFIER UNIT

Diversified
Remediation
Southeast, Inc.

Scale: NONE
Drawn: SJS
Date: 11-16-93
Proj.# 93577PT
Approved:

ABB ENVIRONMENTAL
KING'S BAY PROJECT
POWER TRAIN
DRAWING

2

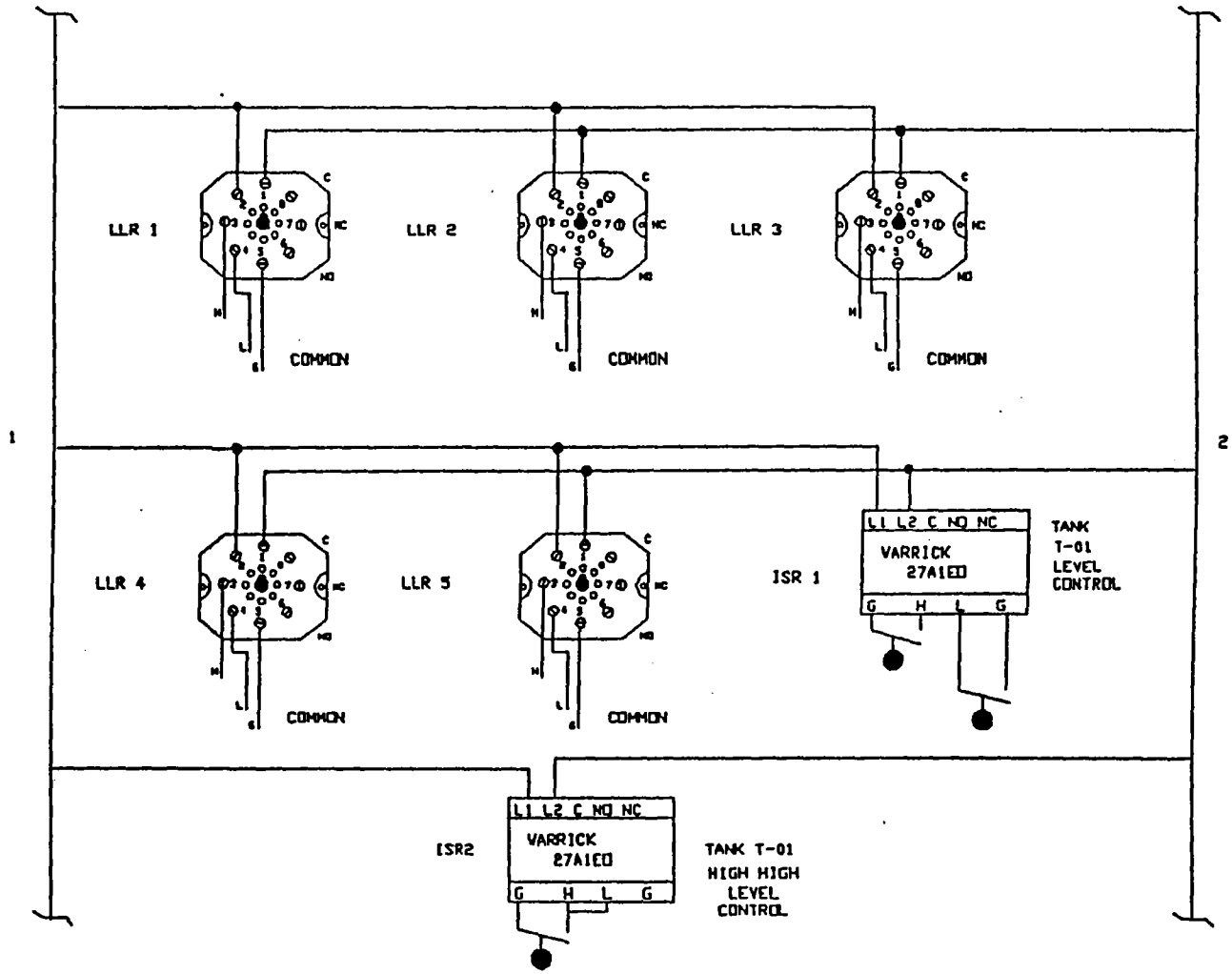


Revisions		
1	12-93	DELETED GVP 6, DELETED DECON PUMP ADDED 'HS' CONTROL TO GVP'S
1	12-93	ADDED DEHUMIDIFIER UNIT

Diversified Remediation Southeast, Inc.

Scale: NONE
Drawn: SJS
Date: 11-17-93
Proj.# 93577P1
Approved:

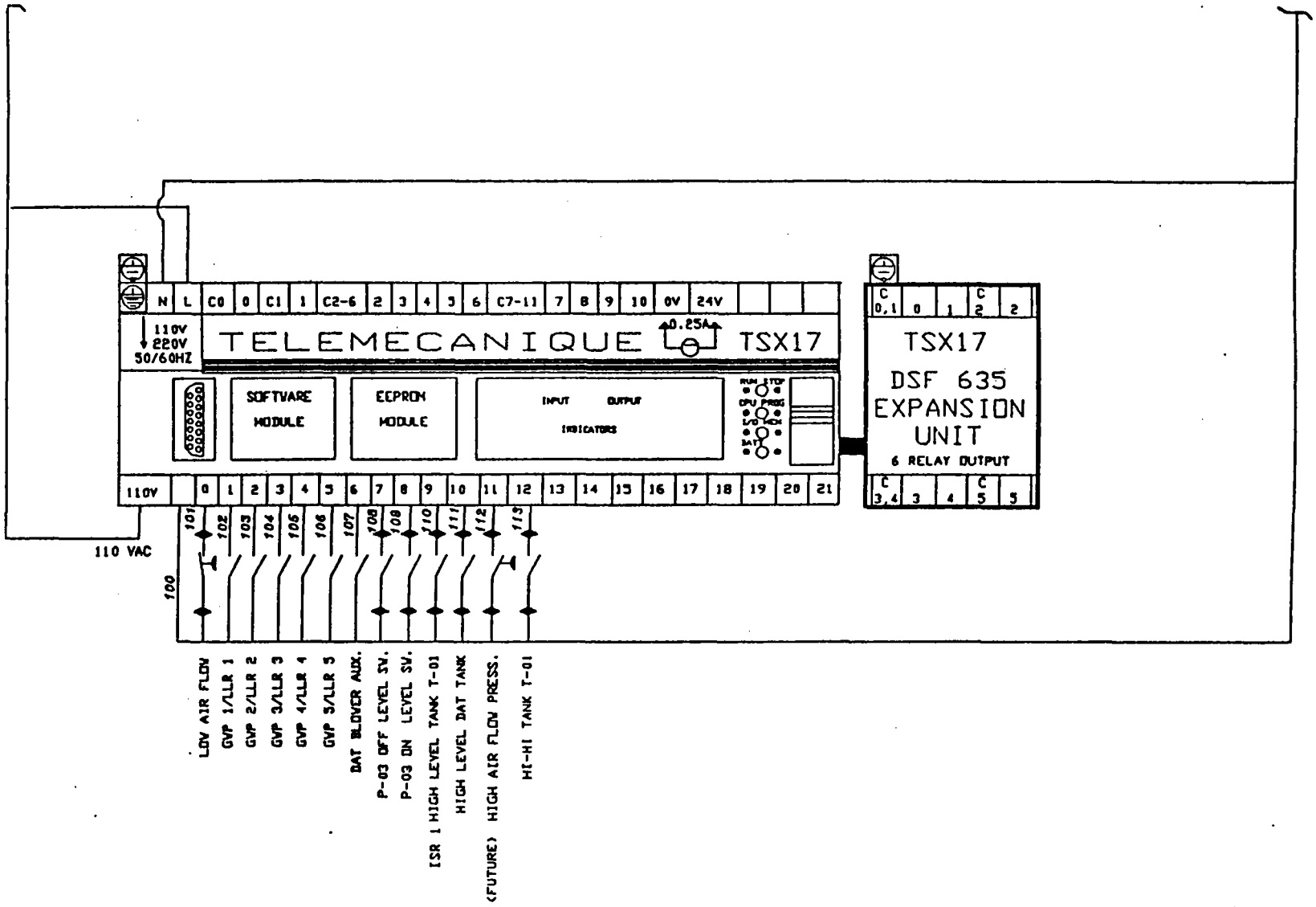
ABB ENVIRONMENTAL
KING'S BAY PROJECT
CONTROL LOGIC DIAGRAM



Revisions			

Diversified
Remediation
Southeast, Inc.

Scale: NONE	ABB ENVIRONMENTAL
Drawn: SJS	KING'S BAY PROJECT
Date: 11-17-93	CONTROL LOGIC DIAGRAM
Proj.# 93577P2	
Approved:	

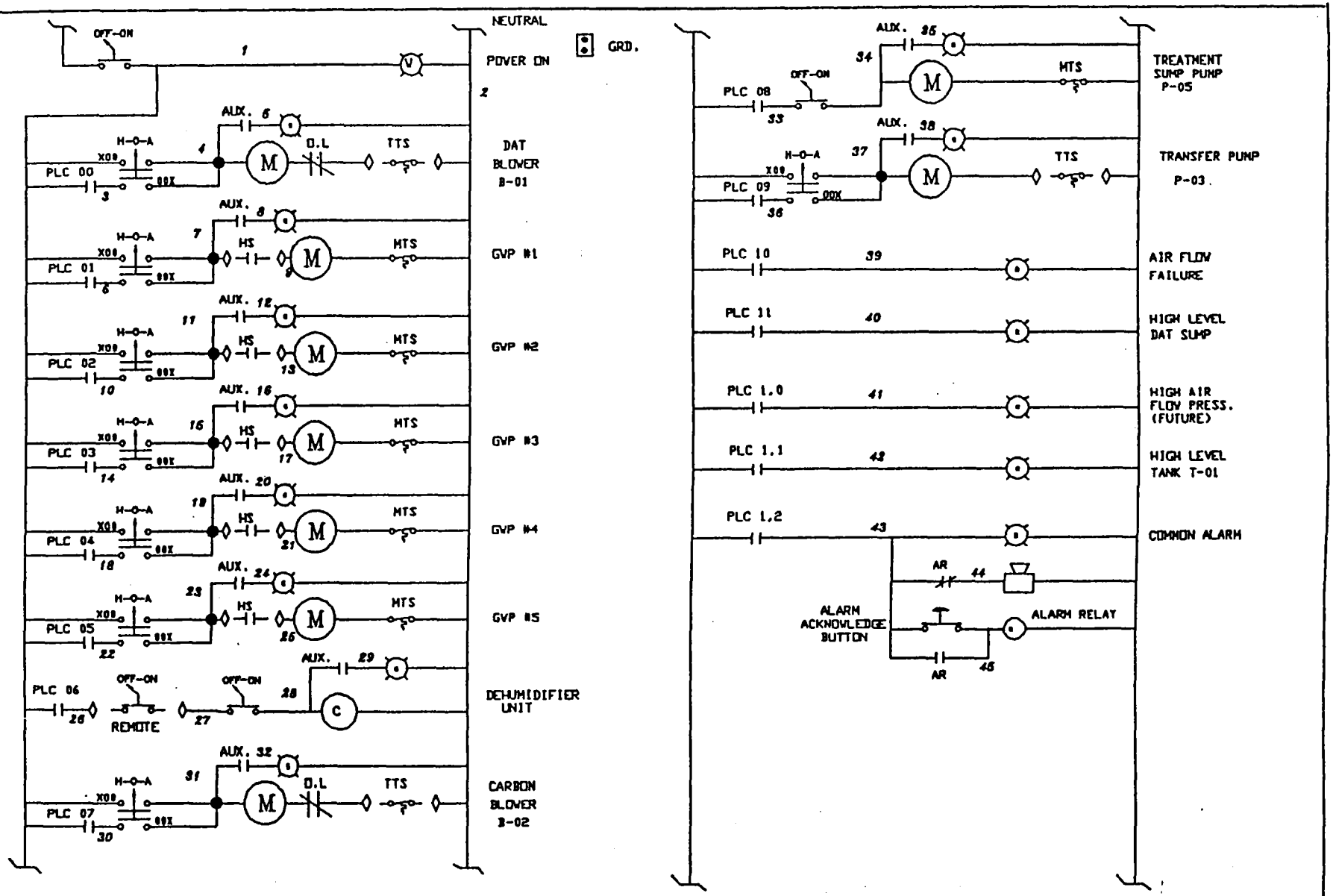


Revisions		
1	12-93	DELETED GPV 6/LLR 6; HIGH LEVEL INPUTS FOR PAD SUMP PUMP

Diversified Remediation Southeast, Inc.

Scale: NONE
Drawn: SJS
Date: 11-17-93
Proj.# 93577PLC
Approved:

ABB ENVIRONMENTAL
KING'S BAY PROJECT
CONTROL LOGIC DIAGRAM



Revisions		
1	12-93	DELETED GVP 6, DELETED DECON PUMP ADDED 'HS' CONTROL TO GVP'S
1	12-93	ADDED DEHUMIDIFIER UNIT

Diversified Remediation Southeast, Inc.

Scale: NONE
Drawn: SJS
Date: 11-17-93
Proj.# 93577P1
Approved:

ABB ENVIRONMENTAL
KING'S BAY PROJECT
CONTROL LOGIC DIAGRAM

TERMINAL LEGEND
DRS PROJECT #930577

TB 1	TB 2
1.DAT BLOWER T1	1.PLC INPUT COMMON
2.DAT BLOWER T2	2.LOW AIR FLOW
3.DAT BLOWER T3	3.PLC INPUT COMMON
4.DAT BLOWER TTS	4.P-03 START
5.DAT BLOWER TTS	5.P-03 STOP
6.CARBON BLOWER T1	6.DAT HIGH LEVEL
7.CARBON BLOWER T2	7.PLC INPUT COMMON
8.CARBON BLOWER T3	8.HIGH AIR FLOW PRESSURE
9.CARBON BLOWER TTS	9.GWP 1 COMMON
10.CARBON BLOWER TTS	10.GWP 1 START
11.TRANSFER PUMP T1	11.GWP 1 STOP
12.TRANSFER PUMP T2	12.GWP 2 COMMON
13.TRANSFER PUMP T3	13.GWP 2 START
14.TRANSFER PUMP TTS	14.GWP 2 STOP
15.TRANSFER PUMP TTS	15.GWP 3 COMMON
16.GWP 1 T1	16.GWP 3 START
17.GWP 1 T2	17.GWP 3 STOP
18.GWP 1 REMOTE SW. FEED	18.GWP 4 COMMON
19.GWP 1 REMOTE SW. RETURN	19.GWP 4 START
20.GWP 2 T1	20.GWP 4 STOP
21.GWP 2 T2	21.GWP 5 COMMON
22.GWP 2 REMOTE SW. FEED	22.GWP 5 START
23.GWP 2 REMOTE SW. RETURN	23.GWP 5 STOP
24.GWP 3 T1	24.TANK T-01 COMMON
25.GWP 3 T2	25.TANK T-01 HIGH LEVEL
26.GWP 3 REMOTE SW. FEED	26.TANK T-01 LOW LEVEL
27.GWP 3 REMOTE SW. RETURN	27.TANK T-01 COMMON
28.GWP 4 T1	28.TANK T-01 HIGH-HIGH LEVEL
29.GWP 4 T2	
30.GWP 4 REMOTE SW. FEED	
31.GWP 4 REMOTE SW. RETURN	
32.GWP 5 T1	
33.GWP 5 T2	
34.GWP 5 REMOTE SW. FEED	
35.GWP 5 REMOTE SW. RETURN	
36.TREATMENT SUMP PUMP T1	
37.TREATMENT SUMP PUMP T2	
38.DEHUMIDIFIER UNIT T1	
39.DEHUMIDIFIER UNIT T2	
40.DEHUMIDIFIER UNIT T3	
41.DEHUMIDIFIER REMOTE SW. FEED	
42.DEHUMIDIFIER REMOTE SW.RETURN	

MOTOR CONTROL PREVENTATIVE MAINTAINANCE GUIDE

1. Exterior and Surroundings:
Clean and remove any dust, grease, oil, rust, or corrosion. Inspect all gaskets for damage.

2. Interior of Enclosure:
Nuts, and Bolts: Same as #1 plus: excess vibration have loosened nuts, bolts or other mechanical connections.

3. Contacts, Relays, Solenoids:
a. General: Check control circuit voltage; inspect for excess heating of parts by discoloration of metal, charred insulation or odor ; dust ; grease ; corrosion ; and loose connections.
b. Contact Tips: Check for excessive pitting ; roughness ; copper oxide ; DO NOT FILE
c. Springs: Check contact pressure.
d. Flexible Leads: Check for frayed or broken strands ; be sure lead wires are NOT brittle.
e. Arc Chutes: Check for signs of flashover ; discolored ; charred surfaces.
f. Bearings: Check for freedom of movement, do not oil or spray with any lubricants.
g. Coils: Check for overheating. charred insulation or mechanical injury.
h. Magnets: Clean pole faces ; check shading coils ; check alignment.

4. Fuses and Fuse Clips:
Check for proper rating ; snug fit ; if copper polish ferules ; check clip pressure.

5. Overload Relays:
Check for proper heater size ; manually trip and reset ; check connections and inspect for dirt and corrosion.

6. Pushbutton Stations and Pilot Devices:
Check contacts ; inspect for dirt, grease, and corrosion.

7. Resistors:
Check for signs of overheating ; overheating ; tighten sliders.

8. Connections:
Check ALL connections for proper torque.

9. Control Operation:
Check the system for proper operation and observe relays, contactors and motor starters for arcing or bouncing when closing.

DIVERSIFIED REMEDIATION SOUTHEAST,INC.
REMEDIATION EQUIPMENT TROUBLESHOOTING GUIDE

!!!! CHECK FOR PROPER VOLTAGE,PHASE & ROTATION !!!!

AST BLOWER WON'T RUN:check the following items.
a)circuit breaker tripped
b)overload tripped
c)selector switch in "OFF" position
d)gallery high level
e)ast sump high level
f)air flow switch OR pressure sw.not functioning properly
g)foreign materials in BLOWER vanes

DAT BLOWER WON'T RUN:check the following items.
a)circuit breaker tripped
b)overload tripped
c)selector switch in "OFF" position
d)gallery high level
e)DAT sump high level
f)air flow switch not functioning properly
g)foreign materials in BLOWER vanes

SUBMERSIBLE TYPE ONLY
GROUNDWATER PUMP(S) WON'T RUN:check the following items.
a)circuit breaker tripped
b)overload tripped internally in motor (auto reset)
c)selector switch in "OFF" position
d)gallery high level
e)blower not running
f)tower or DAT sump high level
g)well probes corroded or dirty
h)well float switches dirty
i)high level OIL WATER SEPERATOR
J)high level EQ. tank
K)low water level in well
l)high level "RUSTY" tank

SUCTION LIFT TYPE
GROUNDWATER PUMP(S) WON'T RUN:check the following items.
a)circuit breaker tripped
b)overload tripped
c)selector switch in the "OFF" position
d)gallery high level
e)blower not running
f)tower or DAT sump high level
g)high level "RUSTY" tank
h)well probes corroded or dirty
i)well float switches dirty
j)high level OIL WATER SEPERATOR
k)high level EQ.tank
l)low water level in well

DIVERSIFIED REMEDIATION SOUTHEAST,INC.
REMEDIATION EQUIPMENT TROUBLESHOOTING GUIDE

TRANSFER PUMPS WON'T RUN:check the following items.
a)circuit breaker tripped
b)overload tripped
c)selector switch in "OFF" position
d)high level in gallery
e)high level in DAT sump
f)low level in DAT sump
g)low level in EQ. tank
h)high level in EQ.tank
i)high pressure in carbon system

AIR SOLENOID VALVE (ASV) WON'T ENERGIZE:check the following
a)low air flow
b)high level gallery
c)high level DAT sump
d)high level PRODUCT tank
e)high level OIL WATER SEPERATOR
f)high level EQ.tank
g)high level AST sump
h)defective coil,check resistivity

VAPOR EXTRACTION BLOWER WON'T RUN:check the following items.
a)circuit breaker tripped
b)overload tripped
c)selector switch in "OFF" position
d)high level in moisture seperator tank
e)time delay cycle after high level recedes (10min. adj.)
f)internal motor overload open (auto resets)

ABB ENVIRONMENTAL
KING'S BAY PROJECT
DRS930577 12-13-1993 X= RECOMMENDED SPARES

QTY	DESCRIPTION	MANUFACTURER	PART NUMBER	
1	CONTROL ENCLOSURE	HOFFMAN	A-604810LP	
1	ENCLOSURE PANEL	HOFFMAN	A60P48	
1	SURGE SUPRESSOR	WEIDMUELLER	EGU2/931152	X=1
1	RELAY,2POLE DPDT	A.A ELECTRIC	AAE-A201-120V	
1	RELAY BASE 8PIN OCTAL	OMRON	PF083A	
1	POWER DIST. BLOCK	GOULD	69153	
1	PUSH BUTTON, MOMENTARY	TELEMECANIQUE	ZB2 BA2	
2BX	PILOT LIGHT LAMPS	SYLVANIA	120MB	X=1BX
15	PILOT LIGHTS,22 MM	TELEMECANIQUE	ZB2 BV6	
4	LENSE,RED	TELEMECANIQUE	ZB2 BV04	
10	LENSE,GREEN	TELEMECANIQUE	ZB2 BV03	
1	LENSE,CLEAR	TELEMECANIQUE	ZB2 BV01	
3	2 POSITION SWITCH 22 MM	TELEMECANIQUE	ZB2 BD2	
8	3 POSITION SWITCH 22 MM	TELEMECANIQUE	ZB2 BD3	
8	2 N.O BLOCKS & COLLAR	TELEMECANIQUE	ZB2 BZ103	
4	1 N.O BLOCK & COLLAR	TELEMECANIQUE	ZB2 BZ101	
15	WELL PROBES	WARRICK	3W1 OR 3W2	
5	LEVEL CONTROL RELAYS	WARRICK	16MB1A0	X=1
5	RELAY BASES 11 PIN	OMRON	PF113A	
75	TERMINALS	SPRECHER + SCHUH	VU4-4	
6	END CLAMPS	SPRECHER + SCHUH	19.116,221-01	
1	MOTOR STARTER 3PH. 3 POLE	SQUARE D	8911 DPS013V02	
2	MOTOR STARTER 3PH. 3 POLE	SQUARE D	8911 DPS033V02	
5	CONTACTOR 1PH.2 POLE	SQUARE D	8910 DPA12V02	
1	CONTACTOR 3 POLE	SQUARE D	8910 DPA23V02	
9	AUXILLARY CONTACT N.O	SQUARE D	9999 D10	
1	CIRCUIT BREAKER 1 POLE	SQUARE D	FAL12015	
5	CIRCUIT BREAKER 2 POLE	SQUARE D	FAL24015	
1	CIRCUIT BREAKER 3 POLE	SQUARE D	FAL34015	
2	CIRCUIT BREAKER 3 POLE	SQUARE D	FAL34030	
1	CIRCUIT BREAKER 3 POLE	SQUARE D	FAL34040	
1	CIRCUIT BREAKER 3 POLE	SQUARE D	FAL34100	
1	ARRESTOR,LIGHTING 3 PHASE	SQUARE D	SP3650	
1	TRANSFORMER,CONTROL	SQUARE D	9070 KF500D1	
4	FUSES,PRIMARY	BUSSMAN	FNQ-R 3.0A	X=2
2	FUSES,SECONDARY	BUSSMAN	FNM 10.0A	X=1
1	G.F.C.I RECEPTACLE	LEVITON	6599I	
1	PROCESSOR 34 I/O	TELEMECANIQUE	TSX172-3444E	
1	EXPANSION UNIT 6 OUTPUTS	TELEMECANIQUE	TSX DSF 635	
1	END OF LINE ADAPTER	TELEMECANIQUE	TSX 17 ACC10	
1	EEPROM MODULE	TELEMECANIQUE	TSX MC70E38	
1	LANGUAGE CARTRIDGE	TELEMECANIQUE	TSX P17 20F	
1	ALARM HORN	WARRICK	MODEL 1200	
1	INTRINSIC RELAY	WARRICK	27A1E0	

APPENDIX B

GROUNDWATER AND AIR EFFLUENT DISCHARGE PERMITS

Air Permit

Georgia Department of Natural Resources
Environmental Protection Division, Air Protection Branch
4244 International Parkway, Suite 120, Atlanta, Georgia 30354
404/363-7000
Joe D. Tanner, Commissioner
Harold F. Reheis, Director

January 19, 1994

Commanding Officer
Naval Submarine Base
1063 USS Tennessee Avenue
Kings Bay, Georgia 31547-2606

RE: Air Sparging Pilot Study
Dated January 3, 1994

Commanding Officer:

The Air Protection Branch has reviewed the letter dated January 3, 1994 regarding the Air Sparging Pilot Study at the Naval Submarine Base, Kings Bay, Georgia.

We have determined, based on available information, that a permit will not be required at this time. On site soil decontamination can be exempted from permitting per Georgia Rule 391-3-1-.03(6)(g)2.

The letter will be placed on file for reference. Exemption from permitting does not relieve the operator from responsibility for compliance with all applicable emission regulations. Any future projects or modifications will require review and possible permitting through this office.

Thank you for your cooperation. If you have any questions, you may contact me at (404)363-7110.

Sincerely,

James Capp

James A. Capp
Environmental Engineer
Stationary Source Compliance Program

5090
Ser N56/0027
JAN 03 1994

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Georgia Department of Natural Resources
Air Protection Branch
Attn: Gene Drew
4244 International Parkway, Suite 120
Atlanta, GA 30354

Dear Mr. Drew:

This is to provide information regarding an air sparging pilot study to be performed at SUBASE Kings Bay by ABB Environmental Services (ABB-ES) under contract with the Navy. This is to conform to the requirements of Georgia Air Quality Rules.

The pilot study, part of the Interim Measure to remediate contamination at the Old Camden County Landfill site, is fully described in the Air Sparging Pilot Study, enclosure (1). This document also describes the contacts between ABB-ES and the Air Protection Branch regarding this study.

As enclosure (1) confirms that there will be attainment of the Lowest Achievable Emission Rate and that air emissions will result in a negligible impact on air quality during the air sparging pilot test, we believe that an air permit will probably not be necessary for the pilot study.

If you have questions regarding this letter or the enclosed document, please contact Mr. John Garner at 912-673-8845. Please address all correspondence to "Commanding Officer, Naval

Submarine Base, 1063 USS Tennessee Avenue, Kings Bay, Georgia, 31547-2606."

Sincerely,

L.P. SCULLION
CAPTAIN, CEC, USN
PUBLIC WORKS OFFICER
BY DIRECTION OF THE
COMMANDING OFFICER

Encl:
(1) Air Sparging Pilot Study

Copy:
SOUTHNAVFACENGCOM (Dave Dregger)
ABB-ES (Frank Cater)
GA EPD (Bruce Khaleghi)

Subject: Air Sparging Pilot Study
Naval Submarine Base, Kings Bay, Georgia

ABB Environmental Services (ABB-ES) is proposing to conduct an air sparging pilot study as part of an Interim Measure at the Naval Submarine Base (NSB) in Kings Bay, Georgia. The purpose of the Interim Measure is to prevent further migration of the contaminated groundwater plume. This letter contains information on expected air emissions and air quality impacts from the air sparging operation. Ms. Norma Gordon, air quality consultant to ABB-ES, first approached the Air Protection Branch of the Georgia Department of Natural Resources regarding the groundwater remediation through telephone calls with Mr. Kurt Churchill and Mr. Tony Curter in January of this year. More recently, on July 15, she discussed this project briefly with Mr. Ron Methier, who recommended that information regarding the pilot study be sent to you.

Additionally, at a project information meeting with Bruce Khaleghi, Unit Coordinator of the Georgia Department of Natural Resources Environmental Protection Division (EPD) Hazardous Waste Management Branch, on 12 August 1993, ABB-ES was informed that treatment of the vapors from the Air Sparger will be required. A review comment of the Interim Measure Work Plan requires attainment of the Lowest Achievable Emission Rate. Based upon these conversations, it is our understanding that an air permit will likely be unnecessary for the pilot study at the NSB. We have attempted to supply all the information you need to evaluate the air quality aspects of this project.

Description of Air Sparging Pilot Study

Groundwater will be extracted from the area beneath the Old Camden County Landfill to prevent further migration of contaminants in the aquifer. The groundwater is known to contain volatile organic compounds (VOCs) as listed in Table 1. The VOCs will be removed from the groundwater utilizing an air stripping technology before discharge of the water to a treatment works.

The Air Sparger is a diffused aeration system where air is released into the water through diffusers that produce coarse bubbles. Mass transfer occurs across the air-water interface of the bubbles. Exhaust air exits the unit and is directed to a series of activated carbon adsorbers before being discharged through a single PVC stack to be released to the atmosphere at a minimum height of 16 feet.

Design air flow through the Air Sparger is 800 cubic feet per minute for an air to water ratio of 100 to 1 at a water feed rate of 60 gallons per minute.

The pilot study will operate up to 24 hours per day, 7 days per week, for a total of 45 days.

Figure 1 shows the approximate location of the Air Sparger, carbon adsorbers and stack.

Air Emissions

Seventeen chemicals have been identified in the groundwater which may be emitted into the air during the air sparging. These chemicals are listed in Table 1. Tables 2 and 3 provide the estimated emission rates for each chemical following vapor phase carbon adsorption (Column 3). Emission rates were calculated using the maximum groundwater concentration detected at any point in the constituent plume (Table 1, Column 1) and modeling for the Air Sparger and carbon adsorbers using the following equations:

$$C_1/C_0 = [1/(1+kt)]^N$$

Where:
- C_0 = initial concentration
- C_1 = effluent concentration from the Air Sparger
- k = Henry's Law Constant
- t = residence time
- N = number of stages

And: $R/AW \times 1.203$ = vapor effluent in mg/m^3

Where:
- R = concentration transferred to the vapor stream in micrograms per liter
- AW = air to water ratio of Air Sparger

These equations have been documented to be a conservative calculation based on actual operating data of the Air Sparger unit to be used at the site.

The vapor phase activated carbon has been documented to remove a minimum of 99 percent of each constituent of concern with a retention time of 1.7 to 2 seconds. Four parallel streams of carbon adsorbers will be used to provide a retention time of 1.8 seconds in each adsorber. Two

units will be placed in series to provide a polishing stage and a sample point will be placed between the two units to monitor for breakthrough.

The maximum emission rate from the carbon adsorbers was calculated based on a 99 percent removal efficiency.

Ambient Air Quality Impacts

To estimate expected ambient air quality concentrations during the pilot test, air dispersion modeling was conducted. Maximum predicted impacts were then compared with calculated acceptable ambient concentrations to ensure public health would not be threatened during the system operation.

The United States Environmental Protection Agency (USEPA) SCREEN model was used to predict air quality impacts for each chemical of concern. SCREEN uses a number of conservative assumptions and provides conservative estimates of ambient air concentrations. This model is recommended by the USEPA for conducting dispersion modeling for air pathway analyses. Based upon discussions with staff at the Georgia Air Protection Branch, the SCREEN model is the preferred screening model for estimating air quality impacts.

The point source algorithm in SCREEN was used in the analysis. Flat terrain and rural dispersion were assumed. Concentrations were calculated for the full range of meteorological conditions available in the model. Automated receptor distances from one meter to 50 kilometers were selected for a single wind direction. One additional receptor, 200 feet from the stack, was calculated to represent the nearest public property. Because stack gas temperature is expected to be close to ambient temperature, the default ambient temperature assumed by the model, 293 Kelvin, was also used as the stack gas temperature. The stack gas velocity is based on the blower capacity (800 cubic feet per minute) and stack diameter (4 inches). To reduce the number of model runs and for ease of calculating air quality impacts for each of the chemicals, the model was conducted using a unit emission rate of one pound per hour (lb/hr).

The emission rates and modeled maximum ground level concentrations for each chemical of concern are provided in Tables 2 and 3. Table 4 presents the SCREEN model documentation for calculating the maximum ground level concentrations. Stack parameters used as input to the model are shown in Table 5.

Dimensions of the Air Sparger to be installed are approximately 14 feet long by 8 feet wide by 26 inches high. The unit on a skid will be a height of approximately 3 feet. Due to its size and the height of the stack, the Air Sparger is not expected to affect dispersion of air emissions. The tallest nearby structure to the stack is the Equalization Tank (7 feet high with a 6 foot diameter). The stack height of 16 feet follows Good Engineering Practice (GEP) for stack heights, defined as the height of a nearby structure plus 1.5 times the lesser of the height or width of the nearby

structure. Because the stack height is equivalent to the GEP stack height, building downwash is not expected to occur. The Equalization Tank dimensions were input to the model to confirm that emissions will not be subject to downwash effects.

Table 3 represents the maximum one-hour concentrations that will occur during various dispersion situations following vapor treatment. Table 4 represents the maximum concentrations for a 24-hour averaging time. The maximum predicted one-hour concentration for a 1 lb/hr emission rate was 90.37 $\mu g/m^3$ (Table 4). The maximum impact for a 1 lb/hr emission rate occurred at 421 meters for F stability and a 1 meter per second wind speed. Using a factor of 0.4 to convert this one-hour impact to a 24-hour concentration, the maximum 24-hour impact for a 1 lb/hr emission rate is 36.15 $\mu g/m^3$. The USEPA recommends this 0.4 factor to be applied to one-hour results from the SCREEN model to estimate 24-hour impacts. The 24-hour concentration was multiplied by the emission rate for each chemical to obtain the maximum ambient air concentrations as presented in the tables.

Modeling of the dispersion following the Air Sparger without vapor treatment was also performed to estimate the confidence of emissions not exceeding Acceptable Ambient Concentrations (defined below). Table 6 represents the maximum one-hour concentrations that will occur during various dispersion situations following the Air Sparger without vapor treatment. Table 7 represents the maximum concentrations for a 24-hour averaging time following the Air Sparger without vapor treatment.

Acceptable Ambient Concentrations

In the telephone conversation with Ms. Gordon, Mr. Ron Methier indicated that no more recent guidance was available than the July 1984 guidance document followed in determining the Acceptable Ambient Concentrations (AAC). The basis for the calculation of the AAC comes from the toxicity data priority schedule provided in Part III, paragraph 1 of the guidance document. The American Conference of Governmental and Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) recommendations were converted to units of mg/m^3 for each constituent of concern. These values are included in the tables. The TLV values were adjusted for operation 24 hours a day, 7 days a week by multiplying by 40 hours per week and dividing by 168 hours per week. This is required by paragraph 2, Part III of the guidance document. The values were then adjusted by a safety factor that accounts for pollutant exposure to members of the public who may be more sensitive to pollutant effects than the average citizen, as required by paragraph 3. Table 1 indicates known carcinogens as category A, and all other pollutants as category B.

As indicated on Tables 2, 3, 6 and 7, the maximum ground level concentration calculated by the SCREEN model are well below the resulting AACs. The analysis reaffirms that air emissions will result in a negligible impact on air quality during the air sparging pilot test.

Proposed Monitoring

Daily stack monitoring for vinyl chloride will be conducted during the pilot study to collect actual air emission data. The modeling shows that a concentration of 37 mg/m^3 of vinyl chloride at the stack should not exceed a maximum ground level concentration of 0.01004 mg/m^3 (Table 8) for worst case meteorological conditions. This is less than the required AAC. ABB-ES proposes to monitor the stack and to initiate corrective action if the stack concentration exceeds ~~37~~ 3.7 mg/m^3, providing a minimum safety factor of 10 times the AAC. If a stack concentration of ~~3.7~~ 3.7 mg/m^3 of vinyl chloride is exceeded, corrective measures to reduce emissions will be initiated. Corrective measures will be defined in an Operations and Maintenance Plan. The on-site laboratory that will be used initially for this stack monitoring will use a maximum detection limit of 0.1 mg/m^3. When analytical functions are transferred to an off-site laboratory, this maximum detection limit will continue to be used.

Water Permit

Georgia Department of Natural Resources

205 Butler Street, S.E., East Floyd Tower, Atlanta, Georgia 30334

Reply To:
Industrial Wastewater Program
Suite 1070
404/656-4887

Joe D. Tanner, Commissione
Harold F. Reheis, Directo
David Word, Assistant Directo
Environmental Protection Divisior
404/656-4713

December 5, 1994

J. R. Allen, P.E.
Captain, CEC, USN
Facilities and Environmental Directorate
Department of the Navy
Naval Submarine Base
1063 USS Tennessee Avenue
Kings Bay, GA 31547-2606

Re: Land Application System
Permit No. GA03-751

Dear Captain Allen:

The Georgia Environmental Protection Division acknowledges receipt of your October 6, 1994 letter requesting a five year extension of the interim pilot scale groundwater recovery operation, where no more than 86,400 gallons per day of remediated groundwater is disposed to the sanitary sewer system governed by the referenced permit. The initial approval letter was written February 4, 1994 and covered a period from February 15, 1994 to December 15, 1994. The intention of the present system is to operate it in the same interim mode until design and construction of a final remediation measure can be implemented.

We are hereby approving the addition of remediated groundwater from the present groundwater remediation to the wastewater treatment system for the period from the effective date of this letter through December 15, 1999. Operation and monitoring of the groundwater remediation will be done in accordance with the December 1993 proposal entitled "Request for Groundwater Discharge into the NSB Kings Bay Land Application System, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia, Contract No. N62467-89-D-0317." You should comply with the pertinent enforcement action by the Hazardous Waste Management Program governing groundwater remediation under the old Camden County Landfill across State Road Spur 40 from the Crooked River Plantation Subdivision. Stipulations in the referenced LAS permit will remain the same.

If you have any questions, please contact Mr. Larry Kloet at 404-656-4887.

Sincerely,

Michael S. Creason

Michael S. Creason, P.E.
South Unit Coordinator
Industrial Wastewater Program

MSC:lkk

8503-105-94

DEPARTMENT OF THE NAVY

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA 31547-5000

IN REPLY REFER TO:

October 6, 1994

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Georgia Department of Natural Resources
Attn: Mr. Larry Hedges
Industrial Wastewater Program Manager
205 Butler Street, SE, Suite 1070
Atlanta, GA 30354

Dear Mr. Hedges:

This letter is to formally request extension and modification to the authorization to allow discharge of treated groundwater to SUBASE Upper Base Wastewater Treatment Plant and Land Application System, LAS Permit No. GA 03-751. Current authorization is for the 10-month period from February 15, 1994, until December 15, 1994.

The modification includes:

- a 5-year extension,
- an updated monitoring plan, and
- future system modifications.

The 5-year extension is to allow continued operation of a groundwater treatment system as an interim measure until design and construction of a final remediation measure is implemented. The Phase I monitoring plan has been updated for the 5-year extension. Future system modifications may be associated with implementing a scaled-up interim measure needed to contain groundwater migration (Phase II).

Two documents are incorporated by reference: (1) the current Discharge Authorization dated February 4, 1994, from Georgia Department of Natural Resources (GA DNR) to Naval Submarine Base (NSB) Kings Bay, and (2) the initial *Request for Authorization for the Groundwater Discharge into the NSB Kings Bay Land Application System, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia, Contract No. N62467-89-D-0317* dated December 1993. The Request for Authorization is the document which was submitted for the initial 10-month pilot-scale study and Phase I continuance. Background information of the site, system, and operation and monitoring of the groundwater remediation is included.

The LAS facility has discharge requirements of 10 milligrams per liter (mg/ℓ) BOD_5 and 10 mg/ℓ TSS with a permitted capacity of 1.5 million gallons per day (gpd). The treated groundwater discharge to the LAS facility will not adversely affect the LAS operating and discharge parameters.

CURRENT SYSTEM OPERATIONS

Groundwater is extracted from the recovery wells installed near the Old County Landfill (Site 11) on SUBASE property. The water is then treated onsite to meet State and Federal drinking water standards and then discharged to a manhole for delivery to the LAS system. The design maximum treatment system discharge flow is 86,400 gpd.

Phase I has been effective in recovering and treating the contaminated groundwater. Current system operations meet all stipulations set forth in the discharge authorization. System discharge flows have been averaging between 50,000 and 55,000 gallons per day which is less than the authorized maximum of 86,400 gpd. Treated groundwater samples have met all State and Federal water standards as shown in Table 1. Table 1 provides influent and effluent concentrations and the discharge criteria for volatiles, semivolatiles, metals, and selected engineering treatability parameters (ETPs). The influent concentrations are the maximum values detected from influent samples collected from March 24, 1994 through August 23, 1994. The reported effluent concentration ranges are the minimum and maximum values to date which were detected from effluent samples collected from June 1994 through August 16, 1994. Discharge criteria are the maximum contaminant levels as established by the State of Georgia and USEPA.

SYSTEM MODIFICATION REQUEST

We request that the intended duration for discharge to the LAS be extended from 10 months (February 15, 1994, through December 15, 1994) to an additional 5 years (December 15, 1994, through December 15, 1999). This extended duration includes operating the treatment system as an interim measure until design and construction of a final remediation measure can be implemented.

The monitoring plan for Phase I is updated for the additional 5-year period. The sampling program outlined in the initial request includes sampling volatiles every week and metals and selected ETPs every other week. In addition to this, semivolatiles have been sampled every other week. A revision to this monitoring plan, extended over the 5-year period, is presented in Table 2. Volatiles, semivolatiles, metals, and ETPs continue to be collected and analyzed; however, the sampling frequency decreases over time as system operations mature and stabilize and as discharge criteria continue to be met.

As ABB Environmental Services is the operator of the treatment system, we request that you provide a copy of your authorization to them at:

ABB Environmental Services, Inc.
Attn: Mr. Ted Taylor
1400 Centerpoint Boulevard, Suite 158
Knoxville, TN 37932-1968

We thank you for your consideration of this request and the continuing assistance you are providing to the project. If you have questions regarding this request or the enclosed documents, please contact Mr. Mike Anderson at (912) 673-4620. Please address all correspondence to "Commanding Officer, Naval Submarine Base, 1063 USS Tennessee Avenue, Kings Bay, Georgia 31547-2606."

Sincerely,

pc: GA DNR (EPD), Bruce Khaleghi
ABB-ES, Ted Taylor
Anthony Robinson, SOUTHNAVFACENGCOM

Table 1
Phase I Treatment System
Summary of Constituents Detected in Influent and Effluent
Dissolved Aeration Tank (DAT) Samples Collected for Offsite Analysis

Constituents of Concern	Influent Concentration[1]	Effluent Concentration Range[2]	Discharge Criteria[3]
Volatile Organic Compounds[4] (µg/ℓ)			
Chloromethane	2	<2[5]	NONE
Vinyl Chloride	24	<2[5]	2
Acetone	140[6]	23 to 58[7]	NONE
1,1-Dichloroethene	1	<2[5]	7
1,1-Dichloroethane	17	<2[5]	NONE
cis-1,2-Dichloroethene	330	<2 to 8	70
trans-1,2-Dichloroethene	4	<2[5]	100
2-Butanone	92	33 to 96	NONE
Trichlorethene	78	<2[5]	5
Benzene	2	<2[5]	5
4-Methyl-2-pentanone	430	36 to 82	NONE
2-Hexanone	6	<17[5] to <23[5]	NONE
Tetrachloroethene	19	<2[5]	5
Toluene	77	<2[5]	1,000
Chlorobenzene	2	<2[5]	100
Ethylbenzene	24	<2[5]	700
Xylene (total)	27	<2[5]	10,000
1,2-Dichloroethane	13.47	<2[5]	5
Methylene Chloride	23.41	<2[5] to <3[5]	5
1,4-Dichlorobenzene	2	<2[5]	75
Semivolatile Organic Compounds[4] (µg/ℓ)			
Phenol	31	14 to 17	NONE
2-Methylphenol	5	2 to 4	NONE
4-Methylphenol	250	68 to 150	NONE
2,4-Dimethylphenol	5	<10[5]	NONE
Naphthalene	8	1 to 3	NONE
Diethylphthalate	10	7 to 8	NONE
Di-n-butylphthalate	<10	1	NONE
bis(2-Ethylhexyl)phthalate	<10	0.7 to 2	6

See notes at end of table.

Table 1 (continued)
Phase I Treatment System
Summary of Constituents Detected in Influent and Effluent Dissolved Aeration Tank (DAT) Samples Collected for Offsite Analysis

Constituents of Concern	Influent Concentration[1]	Effluent Concentration Range[2]	Discharge Criteria[3]
Metals[8] (mg/ℓ)			
Cadmium	<0.005[5]	<0.010[5]	0.005
Chromium	<0.010[5]	<0.010[5]	0.1
Iron	3.27	1.0 to 2.3	NONE
Manganese	0.0907	0.015 to 0.18	NONE
Lead	<0.003[5]	<0.003[5]	0.05
Engineering and Treatability Parameters (ETPs)[9] (mg/ℓ)			
Biochemical Oxygen Demand	32	18 to 24	NONE
Carbon, Total Organic	33.7	<17[5] to 22	NONE
Chloride	57.9	42 to 59	NONE
Hardness	140	30 to 68	NONE
Total Dissolved Solids	280	160 to 220	NONE
Total Suspended Solids	25	<10[5] to 11	NONE

[1] Influent data was collected during Phase I Activities (March 24, 1994 through August 23, 1994).

[2] Effluent data was collected during Phase I Continuance Activities (June 1994 through August 16, 1994).

[3] Discharge criteria are the maximum contaminant levels as established by the State of Georgia and U.S. Environmental Protection Agency (USEPA). Where "NONE" is indicated, these limits are not established.

[4] Effluent samples were analyzed for volatiles and semivolatiles by the USEPA Contract Laboratory Program 1990 and 1992 Statement of Work for Organic Analysis for all Target Compound List (TCL) volatile organic compounds and semivolatile organic compounds. Constituents in the TCL not shown above were non-detect.

[5] A "less-than" symbol (<) indicates that the constituent was not detected at the reported quantitation limit.

[6] The value shown is the highest concentration of acetone detected in an influent sample; however, all positive results for acetone in influent samples were qualified as undetected due to laboratory method blank contamination. The value shown is not representative of the actual influent concentration of acetone.

[7] Values may be biased high because acetone was detected in associated trip blanks at concentrations ranging from 6 to 16 micrograms per liter.

[8] Effluent samples were analyzed for metals by USEPA Methods 6010 and 7421.

[9] Effluent samples were analyzed for ETPs by USEPA Methods 325.2, 415.1, 160.2, 160.1, 130.2, and 405.1.

Notes: $\mu g/\ell$ = micrograms per liter.
mg/ℓ = milligrams per liter.
ETP = engineering and treatability parameter.

Table 2
Phase I Continuance Monitoring Plan
Dissolved Aeration Tank Sampling Frequency

Time Period	Frequency	Analysis	Analytical Method
Year 1	1 per month	Volatiles	CLP-TCL
	1 per quarter	Semivolatiles	CLP-TCL
		Metals	Methods 6010, 7421[1]
		ETPs	Parameter dependent[2]
Year 2	1 per quarter	Volatiles	CLP-TCL
	1 per 6 months	Semivolatiles	CLP-TCL
		Metals	Method 6010, 7421[1]
		ETPs	Parameter dependent[2]
Years 3 to 5	1 per 6 months	Volatiles	CLP-TCL
	1 per 6 months	Semivolatiles	CLP-TCL
		Metals	Method 6010, 7421[1]
		ETPs	Parameter dependent[2]

[1] Effluent samples for metals.

[2] Effluent samples will be collected for the following engineering and treatability parameters (ETPs) and will be analyzed by their respective analytical methods: chloride (U.S. Environmental Protection Agency [USEPA] Method 325.2), total organic carbon (USEPA Method 415.1), total suspended solids (USEPA Method 160.2), total dissolved solids (USEPA Method 160.1), hardness (USEPA Method 130.2), and biological oxygen demand (5-day) (USEPA Method 405.1).

Notes: CLP-TCL = Contract Laboratory Program - target compound list.
ETP = engineering treatability parameters.

Georgia Department of Natural Resources

205 Butler Street, S.E., East Floyd Tower, Atlanta, Georgia 30334

Reply To:
Industrial Wastewater Program
Suite 1070
404/656-4887

Joe D. Tanner, Commissioner
Harold F. Reheis, Director
David Word, Assistant Director
Environmental Protection Division
404/656-4713

February 4, 1994

L. P. Scullion
Captain, CEC, USN
Public Works Officer
Department of the Navy
Naval Submarine Base
1063 USS Tennessee Avenue
Kings Bay, GA 31547-2606

Re: LAS Permit No. GA 03-751

Dear Captain Scullion:

The Georgia Environmental Protection Division acknowledges receipt of your December 30, 1993 letter requesting to tie treated water from groundwater remediation into the sanitary sewer system governed by the referenced permit. As we understand the proposal, this is a pilot-scale testing project which is expected to last up to ten months. Maximum water generated will be 86,400 gpd. Water will be treated to EPA Maximum Contaminant Levels (MCL's).

We are hereby approving the addition of remediated groundwater to the wastewater treatment system for the specified ten month period beginning February 15, 1994. Operation and monitoring of the groundwater remediation will be in accordance with the December 1993 proposal entitled "Request for Authorization for Groundwater Discharge into the NSB Kings Bay Land Application System, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia, Contract No. N62467-89-D-0317." You should comply with the pertinent enforcement action by the Hazardous Waste Management Program governing groundwater remediation under the old Camden County Landfill across State Road Spur 40 from the Crooked River Plantation Subdivision. Stipulations contained in the referenced LAS permit will remain the same.

If you have any questions, please contact Mr. Larry Kloet at 404-656-4887.

Sincerely,

Michael S. Creason

Michael S. Creason, P.E.
South Unit Coordinator
Industrial Wastewater Program

MSC:bk
cc: Madeleine Kellam

↓ Valerie Rule f
IF City will not take our effluent it probably will go here. John G 6/21

Georgia Department of Natural Resource
205 Butler Street, S[illegible] Suite 1252, Atlanta, Georgia 3033
J. Leonard Ledbetter, Commissio
404-656-15

March 15, 1990

St. Marys
City Manager
Mike Mahaney
912-882-5516

Fe 5-2
ADVANCED COPY

Commander W. P. Pierson
Assistant Public Works Officer
Naval Submarine Base
11345 Ser N 521/3284
Kings Bay, Georgia 31547-5000

RE: Kings Bay Naval Submarine Base
Permit No. GA03-751

Dear Commander Pierson:

Pursuant to the Georgia Water Quality Control Act, as amended, and the Rules and Regulations promulgated thereunder, we have issued the attached Georgia Land Application System Permit for the specified wastewater treatment system.

Please be advised that on and after the effective date indicated in the attached LAS permit, the permittee must comply with all the terms, conditions and limitations of this permit.

Sincerely,

J. Leonard Ledbetter

J. Leonard Ledbetter
Commissioner

JLL:bk
Attachment

Valerie,
This is what I promised you. If you need more - call me at 912-673-8845.
John Garner
Subase Kingsbay

State of Georgia

Department of Natural Resources

ENVIRONMENTAL PROTECTION DIVISION

LAND APPLICATION SYSTEM PERMIT

Permit No. GA03-751

In accordance with the provisions of the Georgia Water Quality Control Act (Georgia Laws 1964, p. 416, as amended), and the Rules and Regulations promulgated pursuant thereto, this permit is issued to the following:

UNITED STATES DEPARTMENT OF THE NAVY
Naval Submarine Base
Kings Bay, Georgia 31547-5000

is authorized to operate the land application system located at

Kings Bay in the St Marys River Basin

This permit is conditioned upon the permittee complying with the effluent limitations, monitoring requirements and other conditions set forth in the permit; with the statements and supporting data submitted with the application dated December 8 1989; and with the approved plan of operation and management, all of which are filed with the Environmental Protection Division of the Department of Natural Resources.

This permit is effective on the date signed by the Director of the Environmental Protection Division and is subject to revocation on evidence of noncompliance with any of the provisions of the Georgia Water Quality Control Act or any of the Rules and Regulations promulgated pursuant thereto; or with any presentation made in the above mentioned application or the statements and supporting data entered therein or attached thereto; or with any conditions of this permit.

This permit shall expire at midnight. March 14, 1995.

Signed this 15th date of March, 1990.

J. Leonard Ledbetter

Director
Environmental Protection Division

Permit Conditions

1. The system shall be operated at maximum efficiency at all times. The average daily flow to the wastewater treatment facility shall not exceed 1.5 MGD. The following effluent standards for the discharge to the land application system apply:

   (A) Biochemical Oxygen Demand (5-Day): The monthly average shall not exceed 10 mg/l.

   (B) Suspended Solids: The monthly average shall not exceed 10 mg/l.

   (C) Fecal Coliform Bacteria: The monthly average geometric mean shall not exceed 20 per 100 milliliters.

2. Monthly operating reports shall be submitted to the Environmental Protection Division by the responsible Class II Operator. The operating reports shall be submitted no later than the 15th day of the month following the reporting period to:

   Environmental Protection Division
   Industrial Wastewater Program
   205 Butler St., S.E., Floyd Towers East
   Suite 1070
   Atlanta, Georgia 30354

   This operation report should contain the analytical results of samples taken at the treatment facility, the groundwater monitoring wells, and/or the surface streams as specified in the approved "Plan of Operation and Management." These sampling requirements may be revised if approved by the Division.

   All analysis shall be made in accordance with the latest edition of Standard Methods for the Examination of Water and Wastes, Methods for Chemical Analysis of Water and Wastes, or other required methods.

3. The wastewater and disposal system must be maintained as a no-discharge system; therefore, additional land for spraying must be utilized if the application rate cannot satisfactorily be handled by the currently approved spray field.

4. Certification Requirements (Operation)

   The permittee shall insure that the person in responsible charge of this wastewater treatment plant is a Certified Operator in accordance with the Georgia Certification of Water and Wastewater Treatment Plant Operators Act, as amended, and the Rules promulgated thereunder and holds a classification consistent with the plant classification specified by Subparagraph 391-3-6-.12 of the Rules and Regulations for Water Quality Control.

5. Certification Requirements (Laboratory)

The permittee shall insure that the person in responsible charge of the laboratory that is completing the laboratory analysis for this wastewater treatment plant is a certified Laboratory Analyst in accordance with the Georgia Certification of Water and Wastewater Treatment Plant Operators Act, as amended, and the Rules promulgated thereunder.

6. Land Application System Monitoring Requirements

(A) Pretreatment Plant Monitoring

Parameter	Frequency	Location
Flow	Daily	Influent & Effluent
Biochemical Oxygen Demand (5-Day)	One/Month	Influent & Effluent
Suspended Solids	One/Month	Influent & Effluent
pH	One/Month	Effluent
NH_3-N	One/Quarter	Effluent
NO_3-N	One/Quarter	Effluent
Kjeldahl Nitrogen	One/Quarter	Effluent
Phosphorus	One/Quarter	Effluent
Sodium	One/Quarter	Effluent
Calcium	One/Quarter	Effluent
Potassium	One/Quarter	Effluent
Magnesium	One/Quarter	Effluent

(B) Groundwater Well Monitoring

Parameter	Frequency
Depth to Groundwater	One/Month
pH	One/Six Months
NO_3-N	One/Six Months
Total Phosphorus	One/Six Months
Chloride	One/Six Months
Electrical Cond.	One/Six Months
Fluoride	One/Six Months
Metals*	One/Year
Organics**	One/Year

* These include Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium and Silver.

** These include Edrin, Lindane, Methoxychlor, Toxaphene, 2,4 Dichlorophenoxyacetic Acid and 2,4,5-TP Silvex.

(C) Soil Monitoring

5-6 92

Parameter	Frequency
pH	One/Year
Cation Exchange Capacity	If pH changes by one unit
Percent Base Saturation	If pH changes by one unit
Phosphorus Absorption	One/Four Years

(D) Surface Water Monitoring (Including Outfalls, EI, CI and KI)

Parameter	Frequency
Biochemical Oxygen Demand (5-day)	One/Month
Suspended Solids	One/Month
pH	One/Month
Fecal Coliform Bacteria	One/Month
NO_3-N	One/Month
NH_3-N	One/Month

7. Groundwater

Groundwater leaving the land application system boundaries must meet primary maximum contaminant levels for drinking water. If groundwater samples indicate contamination, the permittee will be required, upon written notification by the Division, to develop a plan which will insure that the primary maximum contaminant levels for drinking water are not exceeded. The plan will be implemented by the permittee immediately upon Division approval.

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CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Georgia Department of Natural Resources
Attn: Mr. Larry Hedges
Industrial Wastewater Program Manager
205 Butler Street, SE, Suite 1070
Atlanta, GA 30354

Dear Mr. Hedges:

This is to formally request your authorization to allow discharge of treated groundwater to SUBASE Upper Base Wastewater Treatment Plant and Land Application System, Las Permit No. GA 03-751.

We are providing for your information two copies of Request For Authorization For Groundwater Discharge into the NSB Kings Bay Land Application System, enclosure (1), and one copy of Draft Final RFI Interim Report For Site 11, Volumes I & II, enclosure (2). The RFI Interim Report has been reviewed and accepted by the Environmental Protection Division. Mr. Bruce Khaleghi and Ms. Madeleine Kellam are our contacts in EPD's Hazardous Waste Department.

Groundwater will be extracted from five recovery wells installed near the Old County Landfill (Site 11) on SUBASE property. The water will be treated on-site to meet State and Federal drinking water standards and will then be discharged to a manhole for delivery to the LAS system.

Currently, the LAS operates at approximately 64 percent of its permitted capacity of 1.5 million gallons per day (gpd). The proposed maximum treatment system discharge flow of 86,400 gpd (60 gpm, 24 hours per day) would represent approximately 5.7 percent additional flow. The Wastewater Treatment Plant, an Aerobic Facultative Process, includes two large lagoons equipped with surface aerators. This process allows aerobic and anaerobic degradation zones. The additional aerobic zone has the ability to degrade chlorinated organics more readily than a conventional system. Anaerobic degradation takes place in a "quiet zone". The process generates minimal sludge and discharges through sand filters to a land application system. This facility has discharge requirements of 10 mg/l BOD and 10 mgl TSS. The treated groundwater discharge to the facility will not adversely affect these parameters.

The intended duration for discharge to the LAS is up to ten months. This includes six weeks of pilot scale testing to begin

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February 10, 1994 and eight months of continued operation of the treatment system during the design and implementation of a full-scale Interim Measure

As ABB Environmental Services is the operator of the pilot-scale test, we request that you provide a copy of your authorization to them at: ABB Environmental Systems, Inc., Attn: Mr. Frank Cater, 1400 Centerpoint Blvd., Suite 158, Knoxville, TN 37922.

We thank you for your consideration of this request and the continuing assistance you are providing to us and to ABB-ES. If you have questions regarding this request or the enclosed documents, please contact Mr. John Garner at 912-673-8845. Please address all correspondence to "Commanding Officer, Naval Submarine Base, 1063 USS Tennessee Avenue, Kings Bay, GA 31547-2606."

Sincerely,

L.P. SCULLION
CAPTAIN, CEC, USN
PUBLIC WORKS OFFICER
BY DIRECTION OF THE
COMMANDING OFFICER

Encl:
(1) Request For Authorization For Groundwater Discharge
(2) Draft Final RFI Interim Report, Volumes I & II

Copy to:
GaDNR (EPD), Bruce Khaleghi (w/1 copy encl (1))
ABB-ES, Frank Cater (w/o encl)

Blind Copy to:
SOUTHNAVFACENGCOM, Dave Dregger (w/o encl)

APPENDIX C

AS-BUILT DRAWINGS

APPENDIX D

PERFORMANCE MONITORING AND MAINTENANCE CHECKLIST

KINGS BAY PHASE I OPERATIONS

PRESSURE READINGS (POUNDS PER SQUARE INCH)

WELL HEAD	MANIFOLD	WELL HEAD	MANIFOLD	WELL HEAD	MANIFOLD	WELL HEAD	MANIFOLD
DATE:	DATE:	DATE:	DATE:	DATE:	DATE:	DATE:	DATE:
TIME:	TIME:	TIME:	TIME:	TIME:	TIME:	TIME:	TIME:
PI-1A_____	PI-1B_____	PI-1A_____	PI-1B_____	PI-1A_____	PI-1B_____	PI-1A_____	PI-1B_____
PI-2A_____	PI-2B_____	PI-2A_____	PI-2B_____	PI-2A_____	PI-2B_____	PI-2A_____	PI-2B_____
PI-3A_____	PI-3B_____	PI-3A_____	PI-3B_____	PI-3A_____	PI-3B_____	PI-3A_____	PI-3B_____
PI-4A_____	PI-4B_____	PI-4A_____	PI-4B_____	PI-4A_____	PI-4B_____	PI-4A_____	PI-4B_____
PI-5A_____	PI-5B_____	PI-5A_____	PI-5B_____	PI-5A_____	PI-5B_____	PI-5A_____	PI-5B_____

DIFFERENTIAL PRESSURE INDICATORS (INCHES OF WATER)

DATE: TIME:	DPI-1	DPI-2	DPI-3	DPI-4	DPI-5	DPI-6	DPI-7	DPI-8
DATE: TIME:	DPI-1	DPI-2	DPI-3	DPI-4	DPI-5	DPI-6	DPI-7	DPI-8
DATE: TIME:	DPI-1	DPI-2	DPI-3	DPI-4	DPI-5	DPI-6	DPI-7	DPI-8
DATE: TIME:	DPI-1	DPI-2	DPI-3	DPI-4	DPI-5	DPI-6	DPI-7	DPI-8

FLOW INDICATORS (TOTAL GALLONS)

DATE:	DATE:	DATE:	DATE:
TIME:	TIME:	TIME:	TIME:
FQI-1 _____	FQI-1 _____	FQI-1 _____	FQI-1 _____
FQI-2 _____	FQI-2 _____	FQI-2 _____	FQI-2 _____
FQI-3 _____	FQI-3 _____	FQI-3 _____	FQI-3 _____
FQI-4 _____	FQI-4 _____	FQI-4 _____	FQI-4 _____
FQI-6 _____	FQI-6 _____	FQI-6 _____	FQI-6 _____
System Effluent	System Effluent	System Effluent	System Effluent
FQI-E _____	FQI-E _____	FQI-E _____	FQI-E _____

DATE:	DATE:	DATE:	DATE:
TIME:	TIME:	TIME:	TIME:
AIR STACK FLOW (fps)			
FI-1 _____	FI-1 _____	FI-1 _____	FI-1 _____
ESTIMATED DAT FLOW (GPM)			
_____	_____	_____	_____
TEMPERATURE INDICATORS (°F)			
DATE:	DATE:	DATE:	DATE:
TIME:	TIME:	TIME:	TIME:
TI-1 _____	TI-1 _____	TI-1 _____	TI-1 _____
TI-2 _____	TI-2 _____	TI-2 _____	TI-2 _____
TI-3 _____	TI-3 _____	TI-3 _____	TI-3 _____
ATM.TEMP _____	ATM.TEMP _____	ATM.TEMP _____	ATM.TEMP _____
IN.RAIN _____	IN.RAIN _____	IN.RAIN _____	IN.RAIN _____

COMMENTS:

O&M CHECKLIST

Date:_____

Weekly Schedule

- ☐ Record water flow measurements
- ☐ Record air pressure measurements
- ☐ Record water pressure measurements at vaults and manifold
- ☐ Record temperature measurements
- ☐ Record air flow measurements
- ☐ Check sump pumps operations
- ☐ Resolve and/or note deficiencies
- ☐ Observe operations within well vaults and at treatment pad
- ☐ Record water level reading from recovery wells

Monthly Schedule

- ☐ All weekly tasks
- ☐ Clean and check Wye strainers
- ☐ Clean and check all check valves
- ☐ General cleaning (sweep out compound)
- ☐ Water meter breakdown, cleaning, and calibration check
- ☐ DAT cleaning
- ☐ EQ tank cleaning
- ☐ Lube Blower motors

Quarterly Schedule

- ☐ All weekly and monthly tasks
- ☐ Pull pumps and level sensors. Check and clean. (Every other quarter)
- ☐ Download well sentinels
- ☐ Replace carbon drums (if necessary)
- ☐ Inspect Heat Pump

Annual Schedule

- ☐ All weekly, monthly, and quarterly tasks
- ☐ Clean out effluent line
- ☐ Electrical load checks
- ☐ Vacuum out sumps
- ☐ Vacuum out recovery well vaults
- ☐ Install weatherstripping on recovery well vaults
- ☐ Redevelop recovery wells

Other (Note)

- ☐ _____
- ☐ _____
- ☐ _____

Operator

_____

Operator's Printed Name and Signature