Operations and Maintenance Manual

Ground Water Remediation System

Former Accurate Die Casting Site
Fayetteville, New York

Revised December 2000

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Emergency response

In the event of an emergency condition, shut-off power to the system by opening the main disconnect switch located in the incoming electric service panel located to the right after entering the personnel door of the water treatment building.

Emergency spill response.

In the event of an audible alarm or a potential or actual overflow/spill condition at the ground water treatment facility, the following procedures should be followed:

- Audible alarm: push "silence alarm" button located next to office inside main facility and assess situation/correct problem before depressing the reset button located on the control panel and restarting the system.
- Overflow/spill condition: Switch RW-1, RW-2, sump, and groundwater interceptor trench pumps to "off".

The person reporting the emergency should then immediately call the following emergency coordinators in the order shown until one is reached:

Name	Title	Work phone	Home phone
~~Jerry Born~~	~~Supervisor~~	~~637-0109~~	~~668-3942~~
Al Farrell	Project Engineer	~~437-6100~~ 956-6316	

The emergency coordinator shall obtain the following information from the person reporting the emergency.

- The exact location and nature of the emergency.
- The extent of the release, if any.
- The nature and extent of damage caused.
- Corrective actions taken.

- Persons and agencies contacted.

Once the emergency is discovered and reported to the emergency coordinator, the coordinator shall assess the urgency of the situation and determine if the system should be shut down and if the New York State Department of Environmental Conservation (NYSDEC) needs to be contacted.

Personal injury.

If a personal injury occurs, it should be reported to the emergency coordinator.

Toxic exposures.

If a toxic exposure occurs, it should be reported to the emergency coordinator as well as outside agencies which may include the fire department, hospital, or ambulance as necessary.

Public notification.

Public notifications will be provided by the appropriate agencies (e.g., NYSDEC, fire department, police department) when necessary to make the general public aware of conditions off Site.

1. Introduction

1.1. General

This manual has been prepared for the Operator as a means of providing guidelines, procedures, and objectives for operating and maintaining the Ground Water Recovery and Treatment System constructed at the former Accurate Die Casting Site in Fayetteville, New York (Figure 1). The Ground Water Recovery and Treatment System was constructed in 1995 and added to in 1999 by the inclusion of a ground water interceptor trench and pump for the purpose of remediating ground water on Site which was found during a Remedial Investigation (RI) to contain volatile organic compounds (VOCs) in excess of established New York State Department of Environmental Conservation (NYSDEC) ground water quality standards.

To obtain maximum benefit from the System, it must be operated as efficiently as possible to minimize operation and maintenance costs and down-time. This section of the manual presents information regarding why the System was constructed, and presents a description of how the System is intended to operate. Subsequent sections provide information regarding Operator responsibilities, System components, disposal of wastes, and emergency actions.

This document is intended to supplement information contained in the various manufacturer's operation and maintenance publications, shop drawings, and record drawings that have been provided. These publications are referred to in this manual and have been included as exhibits to this manual or separate documents. This manual, the record drawings, and the manufacturers' literature should be used together.

1.2. Background

Presented below is general background information regarding the history of the Site, the two ground water recovery wells constructed on Site, the ground water collection sump outside the northeast corner of the building, the ground water interceptor trench, and information regarding the ground water treatment system itself. For convenience, the topics are addressed separately.

Site history

During the RI and subsequent investigations, 24 ground water monitoring wells and 2 piezometers were constructed on Site in the locations shown on Figure 2. Ground water level measurements have been periodically taken using these monitoring wells and piezometers. Well construction details and the resulting ground water levels are summarized in Table 1. Periodically, water samples were also collected and analyzed for VOCs in order to evaluate ground water quality. Table 2 presents a summary of the resulting ground water quality data. This data is also presented in the New York State Department of Environmental Conservation (NYSDEC) approved Sampling and Analysis Plan dated March 1996 (O'Brien & Gere).

Based on the ground water quality results, it was concluded that ground water on Site had been impacted by the prior activities of the former owners and operators of the facility. This impact includes a plume of ground water exhibiting trichloroethylene (TCE) extending into the overburden aquifer from the Northeast of the facility north towards Bishop Brook. TCE was also detected, among other places, in the bedrock ground water on Site and in the unsaturated soils outside the Northeast corner of the facility.

Prior to initiating the RI, sludge from an abandoned TCE degreasing system was removed and the system was decontaminated. A TCE free product pool, which was discovered adjacent to and outside the Northeast corner of the facility, was also recovered to the extent practicable until no TCE free product was detected in water samples collected from that location.

Soils Remediation. The area outside the Northeast corner of the facility was also addressed as part of an Interim Remedial Measure (IRM) between May 24, 1994 and June 22, 1994. During that period, soils exhibiting TCE above the clean-up objective of 0.7 mg/kg were removed, to the extent practicable, and mechanically processed on site for subsequent use as backfill in the excavation once the clean-up objectives were achieved. A description of the soil remediation activities completed in this area is provided in the NYSDEC

approved Soil Remediation Activities Summary Report dated October 1994 (O'Brien & Gere).

In a separate area in the northwest portion of the site (Area "1"), unsaturated soils exhibiting concentrations of PAHs, PCBs and VOCs above remedial action objectives (RAOs) were excavated during September and October 1995. After excavating approximately 600 cy of soil, grab samples were collected from the excavations and analyzed for PAHs, VOCs and PCBs to evaluate if further action was required. Based on the results of the sampling and analyses, it is concluded that the unsaturated soils containing PAHs, PCBs and VOCs above the RAOs had been removed to the extend practicable.

In 1997, approximately 350 cy of the 600 cy of excavated soil was removed from the site and transported to the ESMI facility in Fort Edward, New York for low temperature thermal destruction and subsequent off-site disposal. The remaining 250 cy of soil was mechanically processed on-site to enhance volatilization of VOCs in accordance with the ROD amendment issued in October 1997.

In April 1998, following analyses that indicated that the RAOs had been achieved, the 250 cy of mechanically processed soils were spread on-site in the Corrective Action Management Unit (CAMU) identified in the ROD amendment. In accordance with the NYSDEC requirements, approximately 1 foot of general fill, topsoil, and grass seed was placed on top of the processed soils.

Ground water recovery points. In connection with the soil remediation activities conducted outside the Northeast corner of the facility as part of the IRM, a ground water collection sump was constructed on top of the clay layer at the base of the excavation prior to backfilling. This sump is being utilized as one of the ground water recovery points for the Ground Water Recovery and Treatment System constructed at the Site.

Also, an overburden recovery well designated as RW-1 (Figure 2) was constructed on site as part of the IRM. A 24-hour aquifer performance test was conducted using this recovery well on September 28 and 29, 1994 to evaluate the overburden aquifer characteristics and assess the influence of pumping on the overburden aquifer. The results of the performance test are provided in the NYSDEC approved Basis of Design Report for the Ground Water Recovery and Treatment System dated December 1994 (O'Brien & Gere). This recovery well is being utilized to provide capture of ground water containing TCE in the overburden aquifer.

A second ground water recovery well designated as RW-2 is being utilized on site to remediate the ground water from the bedrock fractures. This well was installed between September 5 and 18, 1995, in accordance with the NYSDEC approved Remedial Design/Remedial Action (RD/RA) Work Plan dated March 1996 (O'Brien & Gere) and the letter from O'Brien & Gere dated May 26, 1995, as amended on July 17, 1995. Its approximate location is shown on Figure 2. An aquifer performance test was conducted using this recovery well between November 7 and 13, 1995. The results of the performance test were provided to the NYSDEC in a letter report dated January 12, 1996.

Pursuant to an Explanation of Significant Differences (ESD) Notice dated October 1998, a ground water collection trench was also constructed to intercept ground water containing VOCs present in the sand lenses observed in Area 1. Construction plans for the installation of a ground water interceptor trench in Area 1 were submitted to the NYSDEC for review in August 1998. Construction of the trench was completed in July 1999 following the placement of approximately 300 cubic yards of soil, excavated during construction of the interceptor trench, into the CAMU as approved by the NYSDEC by the letter dated July 14, 1999. The location of the collection trench is shown on Figure 2. Collected ground water is treated by the existing on-site treatment system.

The construction details for each of these ground water recovery points are provided in subsequent sections of this manual. It is the intent that ground water be recovered from these points (sump, RW-1, RW-2, and the ground water interceptor trench) until the ground water on site exhibits VOC levels below NYSDEC ground water quality standards, or until such a time that asymptotic levels have been achieved and further remediation of the ground water is not practicable.

Ground water treatment system. The ground water recovered from the sump, interceptor trench, and the two recovery wells is being treated by passing the water through two 1,500 lb granular activated carbon (GAC) filters, connected in series, in accordance with the NYSDEC approved Basis of Design Report dated December 1994 (O'Brien & Gere). Prior to being pumped through the GAC filters, the ground water recovered from each of the individual recovery wells is combined in a 2,000 gallon flow stabilization tank and pumped through two bag filters connected in parallel.

A flow meter for each recovery well is provided on the influent header to the stabilization tank. The stabilization tank is also equipped with a header for the addition of one additional ground water recovery well, and is equipped

to be used as an aeration tank, if necessary, to pretreat the recovered ground water for VOCs prior to GAC filtration.

Following GAC filtration, the treated ground water is discharged to the bank of Bishop Brook, as shown on Figure 2, to promote aeration of the effluent. Discharge of treated ground water to Bishop Brook shall be in compliance with the conditions of the State Pollutant Discharge Elimination System (SPDES) Permit issued for operation of the System, as discussed in subsequent sections of this manual.

Figure 3 provides a process schematic of the ground water treatment system. Also provided in subsequent sections of this manual is a schematic of the control circuits and information about key system components.

1.3. Operation precautions

All components of the Ground Water Recovery and Treatment System must be installed, operated, and maintained in accordance with the manufacturers' guidelines. This document is not intended to be used instead of manufacturer literature, but rather as a supplement to it. Improper use of any component may result in injury to individuals or damage to the equipment. The operator should not work on any component or device that he/she is not technically qualified to work on, and until he/she has first referred to and is familiar with this manual and the manufacturers' instructions.

2. Operator responsibilities

2.1. General

The purpose of this section is to provide the operator a general description of operator responsibilities and duties.

The operator of the Ground Water Recovery and Treatment System is responsible for monitoring and keeping records of the System performance, for performing preventative maintenance and repair of equipment, for collecting performance monitoring samples, and for completing and submitting monthly State Pollutant Discharge Elimination System (SPDES) permit compliance monitoring reports to the NYSDEC. Each of these items are discussed herein. Also, a summary of the operator responsibilities and a description of where these responsibilities are discussed in this report is presented in Table 3.

2.2. Operator responsibilities

2.2.1. System performance monitoring and record keeping

It is the responsibility of the operator to monitor the operation of the Ground Water Recovery and Treatment System and to record data associated with the system performance on a daily basis (except Saturdays, Sundays and holidays). For convenience, an inspection/maintenance report form is provided in Appendix A. This form is to be filled out when maintenance is performed to establish a record of this activity. A Daily Operations Log Sheet is provided as Appendix B. Each day the operator will complete the Daily Operations Log Sheet. The operator is responsible for reviewing these records for any short or long term changes in the system performance (e.g., flow rate, volume treated or recovered, pressure gauge readings), since these

may be indicators of a need for repair or maintenance. To aid the operator in monitoring the system, system gauge readings at start-up are provided as Table 4. Variations from these gauge readings may be indicative of maintenance being required and should be investigated.

2.2.2. Preventative maintenance and repair

It is the responsibility of the operator to maintain equipment according to the schedule and requirements of the component manufacturer or more frequently when inspection indicates the need exists. The manufacturers' installation, operation, and maintenance manuals are provided as Exhibit A and the manufacturer's shop drawings are provided as Exhibit B.

2.2.3. Environmental monitoring sample collection

Several samples taps have been provided as part of the ground water remediation system. They are located after the bag filters, between the two GAC units, and before the discharge point from the treatment building to Bishop Brook.

Sampling of the ground water treatment system required by the NYSDEC shall be completed by the operator, following start-up, in accordance with Section 2.4 - Treatment System Performance Quality Monitoring of the NYSDEC approved Sampling and Analysis Plan dated March 1996 (O'Brien & Gere). To aid the operator in collecting samples for analysis at the proper intervals, as required by the NYSDEC, a Sampling and Analysis Checklist is provided as Appendix C. As the results of the analyses are received they should be recorded on the Sampling and Analysis Checklist for the day on which they were collected.

Flow and pH measurements required by the SPDES Permit, a copy of which is included as Appendix D, shall be recorded on the Daily Operations Log Sheet included as Appendix B.

2.2.4. SPDES Discharge monitoring reports

It is the responsibility of the operator to prepare and submit SPDES permit compliance reports for each month to the NYSDEC no later than the 28th day of the following month. The SPDES permit compliance report will include the results of discharge monitoring performed as required by the

SPDES permit (Appendix D) and describe actions taken to remedy non-compliances, if any.

3. Description and operation of system components

3.1. General

The overburden Ground Water Remediation System has the following major system components:

- Control panel
- Recovery wells (RW-1 and RW-2)
- Ground water collection sump (located outside northeast corner of main facility)
- Ground water interceptor trench (located in Area 1)
- Influent stabilization tank
- Bag filters
- Granular activated carbon (GAC) vessels
- Treated water discharge.

A table summarizing the basis of design of some of the major process components is included as Table 6.

A site plan has been included as Figure 2 which depicts the location of the recovery wells, the sump, the ground water interceptor trench, and the ground water remediation building. A process schematic showing the flow pattern and the major system components is included as Figure 3 and in the shop drawings in Exhibit B.

Appendix E is a list of the spare parts which are recommended to be kept on site.

3.2. System Controls

The ground water recovery and treatment system has been equipped with instruments and a Programmable Logic Controller (PLC) that allows it to operate continuously in an unattended mode with only occasional monitoring when the control switches are set in the "Auto" position. The PLC Ladder Logic diagram is included as Exhibit C.

The ground water recovery wells have been equipped with ground water level transducers connected to the pump controls and alarm. Two ground water elevation settings have been installed to provide the following described functions:

- Pump on setting; and
- Pump off setting.

The power circuits to the recovery well pumps have also been wired so that they are open whenever an alarm condition has been triggered. An alarm is triggered by the tank high level float switch installed inside the equalization tank and by the spill detection switch located in the building floor sump.

A flow meter with totalizer has been installed on each ground water recovery line upstream of the equalization tank. A flow meter connected to a flow circular chart recorder has also been installed between the second GAC unit and the treatment system discharge to monitor the quantity of ground water that has been recovered and treated.

A pressure sensor has been installed immediately upstream of the primary GAC vessel and has been set to trigger a high pressure alarm at a preset pressure condition of 12 psi. Such an alarm condition will disconnect power to the recovery well and equalization tank pumps.

The controls for the ground water recovery and treatment system are located inside a panel located to the left after entering the personnel door. As depicted in the following figure, the control panel is equipped with one HAND-OFF-AUTO switch for the treatment system transfer pump, and four separate OFF-ON switches for the sump pump, ground water interceptor trench pump, RW-1 and RW-2. The control panel also has blanks for two

additional wells and for the aeration tank blower if the equalization tank is converted to an aeration tank in the future.

> The system is designed to operate with the HAND-OFF-AUTO switch for the transfer pump set to the AUTO position. Operation of the system with the switch set to the HAND position will result in the bypass of control and alarm functions, and could cause damage to system components. The operator should only set the switch to the HAND position when necessary to test operation of the components. Also, setting of the recovery well, interceptor trench, or sump OFF-ON switches to ON when the HAND-OFF-AUTO switch for the transfer pump is set to OFF will result in an alarm condition and system shutdown due to a high water level in the equalization tank.

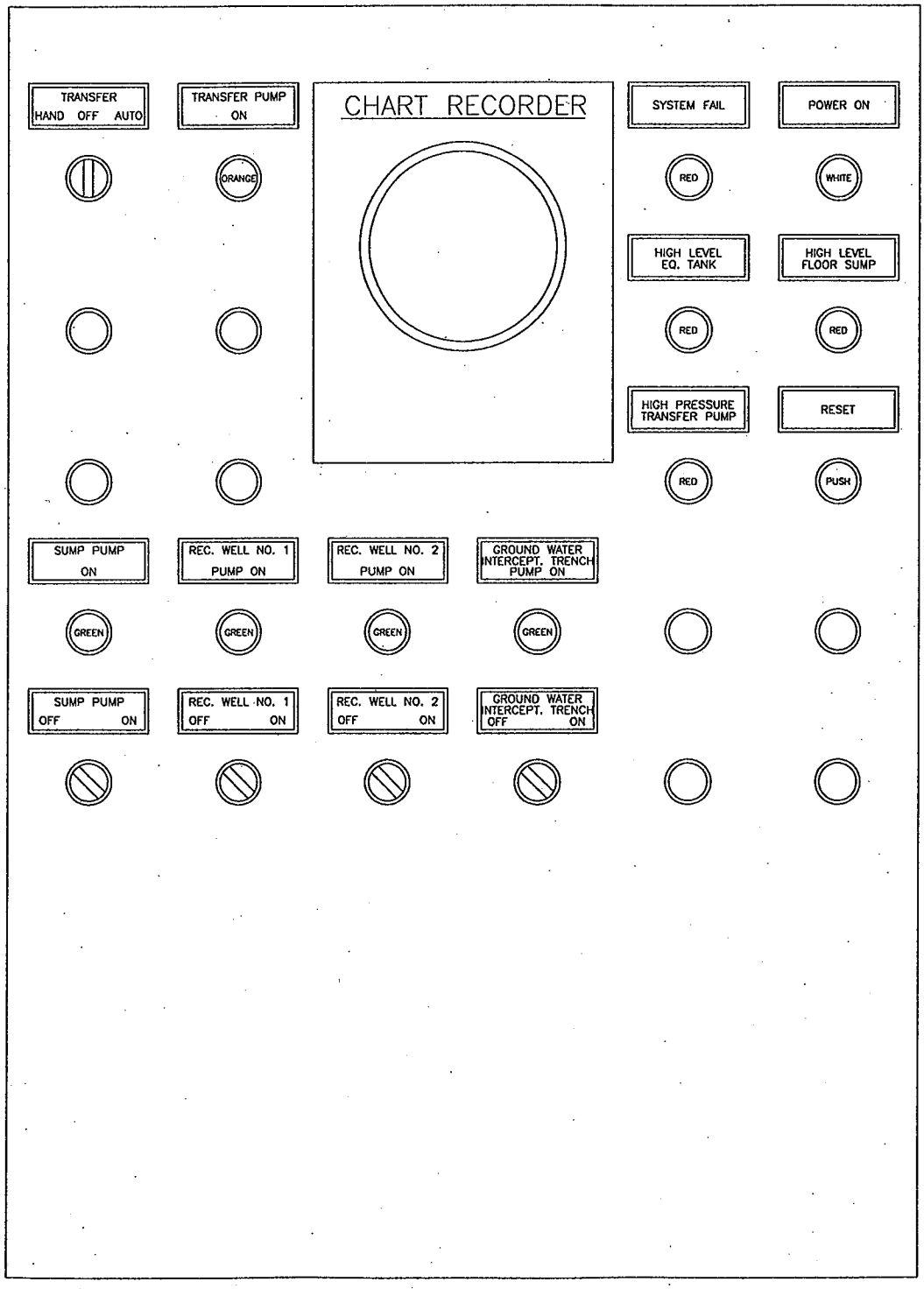
The control panel is also equipped with ten indicator lights, to apprise the operator about the ground water recovery and treatment system operation status, and a reset button, to cancel the alarm lights once the cause of the alarm has been addressed. Four of the lights indicate when the sump pump, interceptor trench pump, recovery well number one pump, and recovery well number two pump are operating. These indicator lights are green. An orange indicator light indicates when the transfer pump in operating and a white light indicates that the system power in on. The remaining four lights, which are red, identify various alarms that will cause the system to shut down (when the system is operated in the AUTO mode). When one of the red alarm indicator lights illuminates, an alarm horn will also be heard inside an occupied area of the main facility. The control panel is also equipped with five blank positions to accommodate additional controls.

Start-up of the system at the control panel, following set-up of the valves according to the valve schedule presented in Section 3.8.1, should be initiated by switching the transfer pump to AUTO and then by switching the sump pump, interceptor trench pump, and the recovery well pumps to ON.

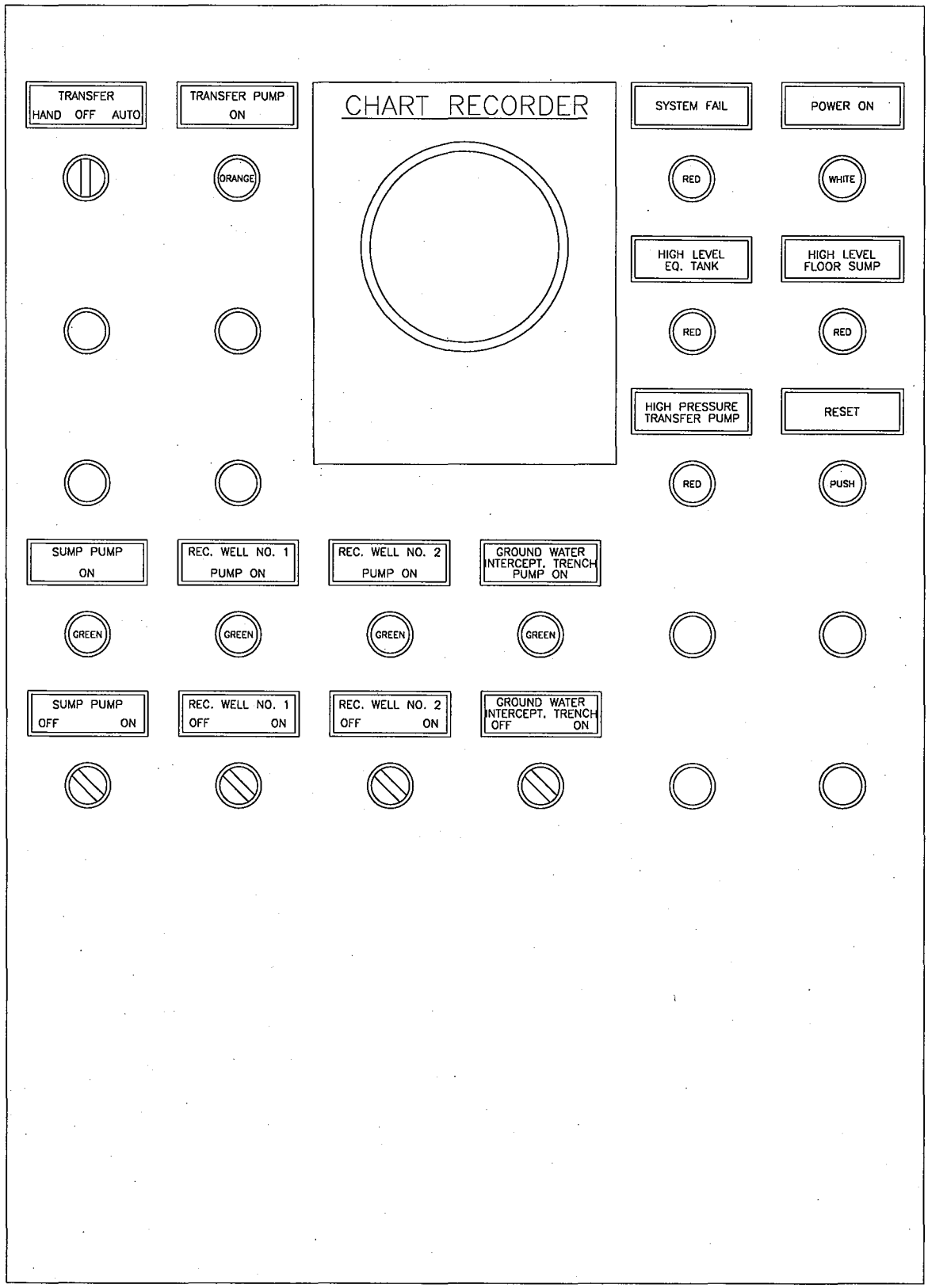
Shut-down of the system, during a non-alarm condition, should be initiated by switching the sump pump, interceptor trench pump, and the recovery well pumps to OFF and then by switching the transfer pump to OFF.

Any alarm condition encountered, once the alarm condition has been addressed, can be canceled by depressing the reset button.

Control Panel



MTW I:\2488\25463\71\60F.DWG SF:1 12/21/00



3.3. Recovery wells, trench, and sump

The ground water recovery wells (RW-1 and RW-2), interceptor trench, and sump were constructed at the locations shown on Figure 2. Details of construction are discussed in this section and summarized in the table below.

RW-1 was constructed of an eight-inch diameter carbon steel casing with an eight inch diameter 0.030 inch slotted stainless steel screen in two sections. The casing is set in various grout mixtures consisting of cement, bentonite and/or sand.

RW-2 consists of a 16 inch carbon steel casing which was advanced to a depth of 35 feet below land surface (bls), which corresponds to approximately five feet into competent bedrock. A 12 inch diameter casing was installed through and grouted within the 16 inch casing with a Portland cement/bentonite grout, which was allowed to cure for a minimum of 12 hours prior to advancing the borehole. The 12 inch diameter borehole was advanced to a final depth of 60 feet bls.

The sump was installed above the clay layer which made up the bottom of the excavation in the TCE soils excavation area. The sump was installed to collect ground water which accumulates on top of the clay layer. The sump was constructed of 24 inch HDPE slotted corrugated pipe to a depth of approximately 22 feet and is coupled with a 20 foot long horizontal 12 inch HDPE slotted corrugated pipe placed on top of three feet of clay placed in the bottom of the excavation.

The ground water interceptor trench was constructed to collect water which is present in sand lenses within and above the layer of till. The trench, having a length of approximately 250 ft, was constructed to the north of Area 1 where soils had been excavated for disposal and/or treatment in 1995. Figure 4 presents the plan and profile of the constructed trench.

	RW-1	RW-2	Sump	Interceptor Trench
Construction	- 8 inch diameter carbon steel casing. - 8 inch diameter 0.030 inch slotted stainless steel screen in two sections. - Grout mixtures consisting of cement, bentonite and/or sand.	- 16 inch diameter carbon steel casing. - 12 inch diameter casing installed through and grouted within the 16 inch casing. - Portland cement/ bentonite grout.	- 24 inch HDPE slotted corrugated pipe. - 20 foot long horizontal 12 inch HDPE slotted corrugated pipe	- 4" diameter perforated HDPE pipe located below a bed of gravel. Installed in two sections with a central water collection sump
Pump intake elevation	473 ft.	483 ft	526 ft	500 ft
Pump on elevation	475 ft.	485 ft	528 ft	502.5 ft
Pump off elevation	474 ft.	484 ft	527 ft	501.5 ft

3.4. Influent equalization tank

The influent equalization tank contains a weir approximately half as high as the height of the tank, located two thirds of the way along the length of the tank, and a 24 inch manway on top of the tank. The water from the sump, interceptor trench, and the recovery wells flows into and fills the first compartment before flowing over the weir to the second compartment. The second compartment contains three level control float switches. The two lowest float switches control operation of the transfer pump connected to the tank effluent line, and the third float switch functions as an overfilling alarm trigger. When an alarm is triggered, the circuits of the recovery well and sump pumps are opened, shutting the pumps off, and an alarm is sounded. Because of the placement of the weir, the capacity of the equalization tank is reduced from 2,000 gallons to an operating capacity of 1,000 gallons.

At some point in the future, if necessary, the stabilization tank may be converted to an aeration tank. If this happens, the spare outlet on top of the tank would be used to vent air either to the atmosphere or through vapor phase GAC units, as necessary. To enable the conversion of use, an aeration header has been installed in the bottom of the tank upstream of the weir.

3.5. Bag filters

Two ten-micron bag filters, connected in parallel, are located downstream of the equalization tank. The purpose of the bag filters is to remove suspended solids from the liquid stream prior to GAC filtration.

During normal operation, the valves on both the inlet and outlet of each bag filter will be open allowing flow through both bag filters. Flow will be directed through one bag filter when the other filter's filter bag requires changing. The procedures for directing flow through one bag filter and for changing filter bags are presented in Section 3.8.2.

3.6. Granular activated carbon (GAC) vessels

The final phase of the ground water treatment system consists of two 1,500 pound GAC vessels designed to remove VOCs from the ground water. Treatment is accomplished by adsorption of the VOCs to the carbon. Under normal operation, the ground water will run through both of the GAC units in series. The valves and piping outside the GAC units are configured so that flow can be routed through both units with either GAC unit number one or number two providing primary (lead) or backup (lag) treatment. A valve schedule for operating with either configuration is included on the flow diagram contained on the Water Treatment System Schematic in Exhibit B and on the table in Section 3.8.1. The valve schedule is also available in the treatment building.

Pressure gauges have been installed upstream of each of these GAC vessels. The operator will monitor the pressure gauge readings to determine when a filter may require servicing. The gauge readings at initial system start-up are presented on Table 4 for reference.

3.7. Treated water discharge

Following treatment by the GAC units, the ground water is discharged through a 4" PVC pipe to Bishop Creek. The treated water shall be sampled and monitored for compliance with the Effluent Limitations and Monitoring Requirements established by the NYSDEC, under the SPDES Permit Fact Sheet. A copy of the Fact Sheet is provided in Appendix D.

3.8. System start-up checklist

Presented in the following two sections are instructions for normal system operation start-up and for bag filter change-out operations.

3.8.1. Normal operation

During normal operation of the ground water collection and treatment system the numbered valves should be set up in accordance with the valve schedule below, depending on which GAC unit is selected as the lead unit. The valve numbers correspond to the numbers on the valves in the building and depicted on the process schematic. In addition to the particular valves referenced below, the valve prior to the transfer pump and the valves on either side of each bag filter must also be open during normal operation.

Valve schedule

Valve	No. 1 lead/No. 2 lag	No. 2 lead/No. 1 lag
V1	Open	Closed
V2	Open	Closed
V3	Closed	Open
V4	Closed	Open
V5	Closed	Open
V6	Open	Closed
V8	Open	Open
V9	Open	Open
V10	Open	Open

V11	Open	Open
V12	Closed	Closed
V13A	Open	Open
V13B	Open	Open
V14	Open	Open
V15	Closed	Closed
V16	Closed	Closed

Start-up and operation of the control panel should be performed according to the procedures presented in Section 3.2.

3.8.2. Bag filter change-out operation

To enable bag filter replacement, it is necessary that both the inlet and outlet valves for the bag filter being replaced be closed. The inlet valve for the filter being changed is to be closed first prior to closing the outlet valve, to avoid pressure buildup in the bag filter. Once both valves on the one bag filter are closed, the lid on the bag filter should slowly be loosened and opened, taking care to avoid being sprayed due to any pressure remaining in the bag filter. The filter bag can then be removed, allowing the water in the bag to drain. A new bag can then be installed and the lid tightened down. To put the bag filter back on line, the outlet valve should be opened first and then the inlet valve. Afterwards, check the bag filter for leaks and tighten the lid if necessary, and record the pressure gauge readings on the bag filters.

4. Disposal of spent materials

4.1. GAC

Maintenance of the GAC units will consist of periodic GAC replacement. The frequency of GAC replacement will be based on the results of VOC analyses conducted on influent and effluent samples collected at the frequency specified in Section 2.4. - Treatment System Performance Quality Monitoring of the NYSDEC approved Ground Water Monitoring Program Sampling and Analysis Plan dated March 1996 (O'Brien & Gere). Analytical results obtained from this sampling will be compared to the discharge limitations to evaluate if GAC replacement is required. The samples will be collected from the sample tap locations shown on the water treatment system schematic included in the attached shop drawings. Should water sample analysis reveal the presence of compounds above the SPDES effluent limitations, breakthrough within one or both of the GAC units is occurring and sampling to evaluate whether one or both GAC units require GAC replacement is to be performed.

The spent GAC shall be either disposed of at an off-site Treatment, Storage, and Disposal Facility (TSDF) or regenerated off site by a contracted carbon regeneration service. The spent carbon must be properly characterized for acceptance at a permitted TSDF. Proper characterization generally includes analysis for Toxicity Characteristic Leaching Procedure (TCLP) metals, TCLP VOCs, and ignitability, but individual TSDFs may have different specific requirements.

If regeneration of the carbon is selected, representatives of this service (Calgon Carbon Corporation: (800) 422-7266) should be contacted to arrange for characterization, transportation, and regeneration of spent GAC.

4.2. Bag filters

Accumulation of VOCs on the particulate matter trapped by the bag filters may occur as the collected ground water passes through the bag filter. Since the filter bags themselves are not hazardous, the filter bags should be disposed of depending on the material which is collected on the bag. A sample of the collected material from a spent filter bag should be analyzed for TCLP VOCs prior to disposal of any of the filter bags. The analytical results should be used to evaluate disposal options including disposal in a nonhazardous waste disposal facility, in a hazardous waste disposal facility, or through incineration. The disposal option selected, based on the analytical results, should be used for future disposal of filter bags from this treatment system.

5. Sampling, analysis, and reports

5.1. General

This section describes the program established to monitor and document the treatment of the collected ground water through the ground water system. The sampling procedures, location, and required analyses, as well as the reporting and record keeping requirements as described in this section.

5.2. Sampling procedures

Samples of the treated water discharge shall be collected according to the schedule and for the specific parameters listed by the SPDES Permit, presented as Appendix D.

5.3. Sampling locations and analysis

The ground water treatment system flow and pH shall be monitored on their respective meters. Other samples required by the SPDES Permit, included as Appendix D, shall be collected from the sample port on the discharge end of the system located upstream to the flow meter. Treatment system samples shall be analyzed in accordance with the SPDES Permit.

In accordance with Section 2.4. - Treatment System Performance Quality Monitoring of the NYSDEC approved Sampling and Analysis Plan dated March 1996 (O'Brien & Gere), a sample shall also be collected from between the lead and lag GAC vessels and analyzed for VOCs. These samples shall be analyzed for VOCs using EPA Method 8021. The sample collected from between the GAC vessels will be used to monitor for lead vessel VOC breakthrough.

5.4. Reporting and record keeping

The operator of the ground water recovery and treatment system shall provide to O'Brien & Gere Engineers, Inc. (O'Brien & Gere) the daily monitoring report forms, the maintenance and inspection checklists, and the sampling and analysis checklists at the completion of each month. O'Brien & Gere shall compile the daily monitoring report forms, as well as the influent - effluent analytical data, monthly for transmittal to the NYSDEC with a cover letter.

An annual report will also be prepared by O'Brien & Gere Engineers and submitted to the NYSDEC and New York State Department of Health each year. The annual report will include a summary of data and a discussion of trends observed. The annual report will include:

- Information regarding treatment system operation including the volume of water recovered, system operation up-time, summary of influent and effluent sampling and analyses, and discussion of maintenance activities performed.

- Recommendations for modification to the remedial system operation and ground water sampling frequency.

Former Accurate Die Casting Facility
Fayetteville, New York

Table 5. Project Contacts and Phone Numbers

Name	Title	Company	Work Phone	Home Phone
~~Jerry Born~~ Al Farrell	~~Supervisor~~	O'Brien & Gere Technical Services, Inc.	~~637-0109~~ 956 6316	~~668-3942~~

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O'BRIEN & GERE ENGINEERS, INC.

Table 1
Former Accurate Die Casting Site
Fayetteville, New York
Ground Water Elevation Summary Table

WELL #	Ground Elevation (ft)	Well Casing Elevation (ft)	Screened Interval Elevation (ft)	Ground Water Elevation (ft) 05/28/1992	Ground Water Elevation (ft) 06/26/1992	Ground Water Elevation (ft) 08/07/1992	Ground Water Elevation (ft) 09/26/1994	Ground Water Elevation (ft) 09/27/1994	Ground Water Elevation (ft) 10/18/1994
MW-01	99.36	101.11	75.4 - 85.4	DRY	DRY	79.69	---	---	DRY
MW-02	91.80	94.68	76.6 - 86.6	83.21	82.81	84.32	83.10	83.28	80.12
MW-03	97.65	99.63	73.7 - 83.7	80.44	80.09	81.63	AB	AB	AB
MW-04	65.62	68.52	46.6 - 56.6	51.08	49.95	50.81	47.22	52.21	46.79
MW-05	88.21	90.42	49.2 - 59.2	60.71	63.76	61.22	59.87	59.91	59.45
MW-06	77.46	79.38	46.4 - 56.4	60.50	60.49	60.46	59.51	59.52	59.05
MW-07 (B)	75.66	78.34	34.3 - 44.3	54.59	54.55	54.47	53.90	53.97	53.55
MW-08	88.21	91.78	53.9 - 63.9	66.38	66.38	66.83	61.59	61.65	60.99
MW-09	102.44	104.03	49.7 - 59.7	60.46	60.51	61.83	59.57	59.59	59.08
MW-10 (B)	97.51	97.27	43.0 - 53.0	61.15	61.99	61.69	---	---	56.02
MW-11 (B)	91.48	93.80	43.1 - 53.1	62.34	63.70	63.66	58.41	58.39	57.47
MW-12	93.62	94.14	51.9 - 61.9	62.24	60.74	62.77	59.77	59.79	59.31
MW-13	98.80	98.70	77.7 - 87.7	DRY	80.62	80.92	---	---	78.70
MW-14	98.76	100.62	74.6 - 84.6	75.11	79.07	81.54	---	---	86.18
MW-15 (B)	96.10	98.90	32.7 - 42.7	NI	NI	NI	---	---	53.47
MW-16 (B)	98.50	100.85	50.8 - 60.8	NI	NI	NI	---	---	61.67
MW-17	66.90	69.24	53.7 - 63.7	NI	NI	NI	54.61	54.61	54.08
MW-18	76.50	78.29	61.5 - 71.5	NI	NI	NI	NI	NI	NI
MW-19	69.50	71.27	46.5 - 56.5	NI	NI	NI	NI	NI	NI
MW-20	70.98	72.89	51.9 - 61.9	NI	NI	NI	NI	NI	NI
MW-21	69.90	71.87	59.5 - 64.5	NI	NI	NI	NI	NI	NI
MW-22	71.50	73.34	60.9 - 65.9	NI	NI	NI	NI	NI	NI
MW-23 (B)	89.80	91.72	17.3 - 22.3	NI	NI	NI	NI	NI	NI
MW-24			-	NI	NI	NI	NI	NI	NI
PZ-01	81.80	83.95	49.8 - 59.8	NI	NI	NI	59.56	59.57	59.10
PZ-02	80.60	83.06	42.8 - 52.8	NI	NI	NI	59.35	59.36	58.89
RW-01	78.40	80.28	29.4-39.4 - 45.4-50.4	NI	NI	NI	56.88	56.89	58.22
RW-02 (B)	91.58	95.18	NA - NA	NI	NI	NI	NI	NI	NI
SUMP	NA	97.93	NA - NA	NI	NI	NI	NI	NI	NI

NOTES: NI-Well not installed at time of monitoring, NA-Data not available, AB-Well was abandoned, --- Water level not monitored, (B)-Bedrock ground water monitoring well, * - Measurement relative to top of well casing. Elevations based on assumed datum. MW-01 through MW-16 installed during Remedial Investigation (Stearns & Wheler). MW-03 was removed as part of the TCE Soils Interim Remedial Measure (IRM) completed in September 1994. System start-up 02/06/96; System shutdown 02/15/96; System restored 02/20/96. MW-13 casing elev. changed 06/06/96. MW-04 and MW-20 were abandoned and replaced by MW-21 and MW-22 on 01/20/97.

O'BRIEN & GERE
ENGINEERS, INC.

Table 1
Former Accurate Die Casting Site
Fayetteville, New York
Ground Water Elevation Summary Table

WELL #	Ground Water Elevation (ft) 11/02/1994	Ground Water Elevation (ft) 11/17/1994	Ground Water Elevation (ft) 11/30/1994	Ground Water Elevation (ft) 12/15/1994	Ground Water Elevation (ft) 12/27/1994	Ground Water Elevation (ft) 01/13/1995	Ground Water Elevation (ft) 01/25/1995	Ground Water Elevation (ft) 02/09/1995	Ground Water Elevation (ft) 02/23/1995
MW-01	---	---	---	---	---	---	---	---	---
MW-02	---	---	---	---	---	---	---	---	---
MW-03	AB	AB	AB	AB	AB	AB	AB	AB	AB
MW-04	---	---	---	---	---	---	---	---	---
MW-05	---	---	---	---	---	---	---	---	---
MW-06	---	---	---	---	---	---	---	---	---
MW-07 (B)	---	---	---	---	---	---	---	---	---
MW-08	---	---	---	---	---	---	---	---	---
MW-09	---	---	---	---	---	---	---	---	---
MW-10 (B)	55.07	55.19	54.94	55.19	55.02	54.94	54.95	54.52	54.36
MW-11 (B)	50.01	56.68	55.59	56.63	56.55	55.63	55.63	56.13	55.63
MW-12	---	---	---	---	---	---	---	---	---
MW-13	82.92	78.21	78.21	80.92	78.34	78.25	77.83	77.84	77.75
MW-14	80.12	80.54	80.54	80.20	80.54	80.62	80.45	78.95	79.54
MW-15 (B)	---	---	---	---	---	---	---	---	---
MW-16 (B)	---	---	---	---	---	---	---	---	---
MW-17	---	---	---	---	---	---	---	---	---
MW-18	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-19	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-20	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-21	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-22	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-23 (B)	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-24	NI	NI	NI	NI	NI	NI	NI	NI	NI
PZ-01	---	---	---	---	---	---	---	---	---
PZ-02	---	---	---	---	---	---	---	---	---
RW-01	---	---	---	---	---	---	---	---	---
RW-02 (B)	NI	NI	NI	NI	NI	NI	NI	NI	NI
SUMP	76.04	74.83	75.00	75.17	74.83	75.00	75.00	74.88	75.00

NOTES: NI-Well not installed at time of monitoring, NA-Data not available, AB-Well was abandoned, --- Water level not monitored, (B)-Bedrock ground water monitoring well, * - Measurement relative to top of well casing. Elevations based on assumed datum. MW-01 through MW-16 installed during Remedial Investigation (Stearns & Wheler). MW-03 was removed as part of the TCE Soils Interim Remedial Measure (IRM) completed in September 1994. System start-up 02/06/96; System shutdown 02/15/96; System restored 02/20/96. MW-13 casing elev. changed 06/06/96. MW-04 and MW-20 were abandoned and replaced by MW-21 and MW-22 on 01/20/97.

O'BRIEN & GERE ENGINEERS, INC.

Table 1
Former Accurate Die Casting Site
Fayetteville, New York
Ground Water Elevation Summary Table

WELL #	Ground Water Elevation (ft) 03/09/1995	Ground Water Elevation (ft) 04/26/1995	Ground Water Elevation (ft) 07/25/1995	Ground Water Elevation (ft) 10/17/1995	Ground Water Elevation (ft) 02/05/1996	Ground Water Elevation (ft) 02/07/1996	Ground Water Elevation (ft) 02/15/1996	Ground Water Elevation (ft) 02/16/1996	Ground Water Elevation (ft) 02/20/1996
MW-01	---	DRY	DRY	DRY	77.06	76.64	75.30	DRY	DRY
MW-02	---	83.28	82.42	84.22	84.04	83.87	83.41	83.34	83.15
MW-03	AB	AB	AB	AB	AB	AB	AB	AB	AB
MW-04	---	51.44	45.94	50.05	53.60	52.06	55.39	54.43	52.46
MW-05	---	60.34	58.78	---	61.26	61.01	60.80	60.73	60.50
MW-06	---	60.02	58.52	58.10	60.86	60.44	60.41	60.11	59.80
MW-07 (B)	---	54.51	53.27	52.71	55.16	54.67	55.03	54.52	54.45
MW-08	---	63.41	59.82	60.76	66.61	66.40	65.93	65.84	65.47
MW-09	---	60.10	58.56	58.16	60.95	60.70	60.48	60.35	60.07
MW-10 (B)	55.02	57.49	54.60	54.61	62.00	59.88	62.11	60.42	59.96
MW-11 (B)	56.55	58.86	55.72	55.31	62.63	60.37	62.67	60.88	60.35
MW-12	---	60.30	58.76	58.35	61.11	60.83	60.65	60.50	60.21
MW-13	77.67	DRY	DRY	DRY	80.00	79.98	79.91	79.90	79.88
MW-14	80.12	80.61	80.61	80.72	79.91	80.02	80.28	80.29	80.35
MW-15 (B)	---	54.71	51.60	50.47	59.24	59.37	59.79	59.63	59.56
MW-16 (B)	---	63.86	59.41	58.06	67.14	67.17	66.90	66.79	66.57
MW-17	---	59.02	57.71	DRY	60.29	60.17	59.75	59.70	59.52
MW-18	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-19	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-20	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-21	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-22	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-23 (B)	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-24	NI	NI	NI	NI	NI	NI	NI	NI	NI
PZ-01	---	60.08	58.58	58.16	60.92	60.61	60.46	60.28	59.99
PZ-02	---	59.88	58.37	57.97	60.70	60.30	60.26	59.97	59.66
RW-01	---	59.14	57.60	57.11	59.64	55.04	59.22	54.71	54.40
RW-02 (B)	NI	NI	NI	56.05	63.80	59.98	63.83	60.67	60.09
SUMP	78.00	75.09	75.25	76.94	74.67	74.68	74.64	74.63	74.63

NOTES: NI-Well not installed at time of monitoring, NA-Data not available, AB-Well was abandoned, --- Water level not monitored, (B)-Bedrock ground water monitoring well, * - Measurement relative to top of well casing. Elevations based on assumed datum. MW-01 through MW-16 installed during Remedial Investigation (Stearns & Wheler). MW-03 was removed as part of the TCE Soils Interim Remedial Measure (IRM) completed in September 1994. System start-up 02/06/96; System shutdown 02/15/96; System restored 02/20/96. MW-13 casing elev. changed 06/06/96. MW-04 and MW-20 were abandoned and replaced by MW-21 and MW-22 on 01/20/97.

O'BRIEN & GERE
ENGINEERS, INC.

Table 1
Former Accurate Die Casting Site
Fayetteville, New York
Ground Water Elevation Summary Table

WELL #	Ground Water Elevation (ft) 02/22/1996	Ground Water Elevation (ft) 02/29/1996	Ground Water Elevation (ft) 03/07/1996	Ground Water Elevation (ft) 03/21/1996	Ground Water Elevation (ft) 04/04/1996	Ground Water Elevation (ft) 04/10/1996	Ground Water Elevation (ft) 04/18/1996	Ground Water Elevation (ft) 05/02/1996	Ground Water Elevation (ft) 06/06/1996
MW-01	DRY	75.36	75.17	77.34	DRY	DRY	DRY	77.73	DRY
MW-02	83.32	83.67	83.50	84.24	83.68	83.68	84.86	85.35	83.17
MW-03	AB	AB	AB	AB	AB	AB	AB	AB	AB
MW-04	60.37	58.14	55.10	59.26	52.66	54.43	60.28	59.70	51.63
MW-05	60.40	60.14	59.73	58.85	58.32	58.14	58.20	58.71	60.54
MW-06	59.75	59.45	58.96	58.02	57.48	57.28	57.41	58.17	59.91
MW-07 (B)	54.58	54.46	54.32	54.29	54.17	54.15	54.32	54.75	55.02
MW-08	65.42	65.12	64.68	64.76	64.10	63.83	64.08	65.43	67.07
MW-09	60.02	59.71	59.22	58.30	57.78	57.59	57.73	58.46	60.18
MW-10 (B)	59.91	59.64	59.43	59.07	58.81	58.72	58.61	59.72	62.25
MW-11 (B)	60.29	59.99	59.78	59.38	59.10	59.01	58.94	60.35	62.68
MW-12	60.16	59.86	59.37	58.44	57.93	57.74	57.86	58.59	60.33
MW-13	79.87	79.86	79.77	79.68	79.60	79.57	79.52	79.44	79.28
MW-14	80.38	80.44	80.45	80.49	80.52	80.55	78.14	79.29	80.56
MW-15 (B)	59.56	59.46	59.40	59.14	59.07	59.04	58.84	59.87	62.62
MW-16 (B)	66.52	66.39	66.17	65.99	65.99	65.90	65.84	67.02	68.40
MW-17	59.64	59.42	59.28	59.30	59.27	59.14	59.30	59.95	59.22
MW-18	NI	NI	NI	NI	NI	NI	NI	NI	72.95
MW-19	NI	NI	NI	NI	NI	NI	NI	NI	DRY
MW-20	NI	NI	NI	NI	NI	NI	NI	NI	DRY
MW-21	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-22	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-23 (B)	NI	NI	NI	NI	NI	NI	NI	NI	NI
MW-24	NI	NI	NI	NI	NI	NI	NI	NI	NI
PZ-01	59.93	59.63	59.14	58.21	57.67	57.47	57.60	58.34	60.09
PZ-02	59.61	59.33	58.83	57.90	57.39	57.19	57.30	58.04	59.77
RW-01	54.35	54.05	53.58	52.76	52.24	52.03	52.11	52.69	53.82
RW-02 (B)	59.97	59.63	59.41	58.95	58.63	58.52	58.41	59.63	62.56
SUMP	75.30	74.90	74.65	74.87	74.69	74.99	75.89	75.76	74.73

NOTES: NI-Well not installed at time of monitoring, NA-Data not available, AB-Well was abandoned, --- Water level not monitored, (B)-Bedrock ground water monitoring well, * - Measurement relative to top of well casing. Elevations based on assumed datum. MW-01 through MW-16 installed during Remedial Investigation (Stearns & Wheler). MW-03 was removed as part of the TCE Soils Interim Remedial Measure (IRM) completed in September 1994. System start-up 02/06/96; System shutdown 02/15/96; System restored 02/20/96. MW-13 casing elev. changed 06/06/96. MW-04 and MW-20 were abandoned and replaced by MW-21 and MW-22 on 01/20/97.

O'BRIEN & GERE
ENGINEERS, INC.

Table 1
Former Accurate Die Casting Site
Fayetteville, New York
Ground Water Elevation Summary Table

WELL #	Ground Water Elevation (ft) 07/16/1996	Ground Water Elevation (ft) 09/05/1996	Ground Water Elevation (ft) 10/21/1996	Ground Water Elevation (ft) 11/19/1996	Ground Water Elevation (ft) 01/16/1997	Ground Water Elevation (ft) 02/04/1997	Ground Water Elevation (ft) 04/15/1997	Ground Water Elevation (ft) 07/08/1997	Ground Water Elevation (ft) 10/22/1997
MW-01	DRY	DRY	DRY	76.60	75.15	---	75.64	DRY	DRY
MW-02	83.32	82.57	83.18	84.22	83.56	---	83.81	83.09	82.84
MW-03	AB	AB	AB	AB	AB	AB	AB	AB	AB
MW-04	52.45	DRY	55.91	55.91	53.12	---	AB	AB	AB
MW-05	58.98	56.33	55.40	56.49	59.15	---	59.83	59.16	58.34
MW-06	58.13	54.95	53.71	55.61	58.39	---	59.34	58.58	57.97
MW-07 (B)	53.95	52.44	51.22	52.68	54.28	---	54.70	52.93	50.63
MW-08	64.50	59.05	59.56	63.61	64.67	---	65.15	61.65	58.90
MW-09	58.38	55.38	54.24	56.64	58.65	---	59.60	58.76	58.00
MW-10 (B)	59.11	53.88	51.06	54.95	59.61	---	58.11	53.44	50.75
MW-11 (B)	59.53	54.72	52.88	55.85	60.15	---	58.59	55.20	52.50
MW-12	58.54	55.48	54.30	56.18	58.81	---	59.72	58.92	58.21
MW-13	79.35	79.15	79.07	80.68	80.49	---	80.33	79.84	79.53
MW-14	80.66	80.59	80.61	80.08	80.59	---	80.53	80.55	80.58
MW-15 (B)	59.24	54.83	51.58	51.99	58.83	---	59.83	56.63	50.48
MW-16 (B)	65.57	63.31	60.09	61.06	66.13	---	66.89	64.43	58.45
MW-17	58.46	57.89	55.96	58.02	59.33	---	59.64	58.33	DRY
MW-18	72.32	70.81	70.77	73.04	73.31	72.78	73.60	71.34	69.71
MW-19	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
MW-20	50.26	DRY	DRY	DRY	DRY	---	AB	AB	AB
MW-21	NI	NI	NI	NI	NI	63.69	63.74	63.06	62.93
MW-22	NI	NI	NI	NI	NI	63.69	67.92	67.35	65.96
MW-23 (B)	NI	NI	NI	NI	NI	NI	37.71	35.61	32.29
MW-24	NI	NI	NI	NI	NI	NI	NI	NI	NI
PZ-01	58.31	55.13	53.90	55.83	58.57	---	59.51	58.70	58.01
PZ-02	57.97	54.90	53.53	55.25	58.23	---	59.13	58.34	57.65
RW-01	51.94	48.05	41.80	47.33	50.74	---	50.30	43.34	42.03
RW-02 (B)	59.14	51.01	42.02	55.39	60.03	---	55.69	44.07	42.89
SUMP	74.78	74.56	74.85	74.77	74.71	---	74.94	75.01	74.75

NOTES: NI-Well not installed at time of monitoring, NA-Data not available, AB-Well was abandoned, --- Water level not monitored, (B)-Bedrock ground water monitoring well, * - Measurement relative to top of well casing. Elevations based on assumed datum. MW-01 through MW-16 installed during Remedial Investigation (Stearns & Wheler). MW-03 was removed as part of the TCE Soils Interim Remedial Measure (IRM) completed in September 1994. System start-up 02/06/96; System shutdown 02/15/96; System restored 02/20/96. MW-13 casing elev. changed 06/06/96. MW-04 and MW-20 were abandoned and replaced by MW-21 and MW-22 on 01/20/97.

O'BRIEN & GERE ENGINEERS, INC.

Table 1
Former Accurate Die Casting Site
Fayetteville, New York
Ground Water Elevation Summary Table

WELL #	Ground Water Elevation (ft) 01/29/1998	Ground Water Elevation (ft) 04/15/1998	Ground Water Elevation (ft) 10/20/1998	Ground Water Elevation (ft) 04/28/1999	Ground Water Elevation (ft) 10/19/1999	Ground Water Elevation (ft) 04/06/2000	Ground Water Elevation (ft) 11/07/2000
MW-01	DRY	DRY	DRY	DRY	DRY	80.92	DRY
MW-02	83.47	83.52	83.54	83.38	84.44	86.58	83.06
MW-03	AB	AB	AB	AB	AB	AB	AB
MW-04	AB	AB	AB	AB	AB	AB	AB
MW-05	60.86	61.05	60.04	59.91	55.35	60.52	59.83
MW-06	60.46	60.57	59.69	59.11	53.34	60.36	59.40
MW-07 (B)	52.90	53.82	51.76	54.57	51.73	54.87	DRY
MW-08	64.98	67.17	59.86	64.21	62.37	66.41	61.45
MW-09	60.51	60.56	59.71	59.68	54.25	60.62	59.42
MW-10 (B)	55.78	61.08	51.88	57.97	51.32	57.60	52.73
MW-11 (B)	56.75	61.73	53.98	58.36	53.31	59.39	54.66
MW-12	60.67	60.80	59.89	59.53	54.09	60.71	59.62
MW-13	78.87	78.67	78.31	78.08	80.75	80.89	80.53
MW-14	80.78	80.78	80.64	80.54	80.67	80.60	80.75
MW-15 (B)	56.34	62.10	52.58	58.94	50.95	58.81	54.32
MW-16 (B)	65.71	68.03	61.84	65.99	59.81	66.92	63.57
MW-17	59.70	59.51	57.93	58.76	57.47	60.28	58.33
MW-18	73.50	73.29	70.74	72.46	70.78	75.08	71.61
MW-19	DRY	DRY	DRY	DRY	DRY	DRY	DRY
MW-20	AB	AB	AB	AB	AB	AB	AB
MW-21	63.82	63.54	63.23	63.31	62.69	64.42	62.59
MW-22	68.51	68.39	67.83	68.05	67.69	68.52	66.42
MW-23 (B)	34.95	37.95	33.57	36.76	32.48	36.69	33.97
MW-24	NI	NI	NI	-7.38*	-10.22*	-9.96*	-10.43*
PZ-01	60.50	60.61	59.70	59.30	53.65	60.51	59.44
PZ-02	60.22	60.34	59.46	59.03	52.71	60.17	59.16
RW-01	43.13	32.60	32.36	54.69	---	50.73	40.88
RW-02 (B)	52.74	59.94	44.33	56.74	---	54.52	42.86
SUMP	74.89	74.96	75.20	75.26	---	78.49	74.91

NOTES: NI-Well not installed at time of monitoring, NA-Data not available, AB-Well was abandoned, --- Water level not monitored, (B)-Bedrock ground water monitoring well, * - Measurement relative to top of well casing. Elevations based on assumed datum. MW-01 through MW-16 installed during Remedial Investigation (Stearns & Wheler). MW-03 was removed as part of the TCE Soils Interim Remedial Measure (IRM) completed in September 1994. System start-up 02/06/96; System shutdown 02/15/96; System restored 02/20/96. MW-13 casing elev. changed 06/06/96. MW-04 and MW-20 were abandoned and replaced by MW-21 and MW-22 on 01/20/97.

O'BRIEN & GERE
ENGINEERS, INC.

Table 2
Former Accurate Die Casting Site
Fayetteville, New York
Ground Water Trichloroethylene Concentrations

Date Sampled: / WELL #	08/1989 TCE ug/L	12/1989 TCE ug/L	05/1990 TCE ug/L	05/1992 TCE ug/L	07/1994 TCE ug/L	10/1994 TCE ug/L	02/1995 TCE ug/L	04/1995 TCE ug/L	07/1995 TCE ug/L
MW-01	112	ND	2	ND	---	---	---	DRY	DRY
MW-02	ND	ND	1	ND	---	ND	ND	ND	ND
MW-03	Product	>55000	440000	340000	AB	AB	AB	AB	AB
MW-04	---	7	43	6	270	23	13	16	---
MW-05	---	340	344	110	330	410	290	280	---
MW-06	---	700	454	510	390	360	330	280	270
MW-07 (B)	---	ND	ND	ND	ND	ND	ND	ND	ND
MW-08	---	ND	ND	ND	---	ND	ND	ND	ND
MW-09	---	109	106	60	72	74	74	84	75
MW-10 (B)	---	---	---	4500	1600	1300	1400	1200	900
MW-11 (B)	---	---	---	5200	5500	5300	4300	3900	4000
MW-12	---	---	---	36	44	35	33	30	25
MW-13	---	---	---	110	740	510	---	DRY	DRY
MW-14	---	---	---	67	150	120	79	95	140
MW-15 (B)	---	---	---	NI	---	14	11	10	17
MW-16 (B)	---	---	---	NI	---	6	17	7	18
MW-17	---	---	---	NI	260	140	200	130	160
MW-18	---	---	---	NI	NI	NI	NI	NI	NI
MW-19	---	---	---	NI	NI	NI	NI	NI	NI
MW-20	---	---	---	NI	NI	NI	NI	NI	NI
MW-21	---	---	---	NI	NI	NI	NI	NI	NI
MW-22	---	---	---	NI	NI	NI	NI	NI	NI
MW-23 (B)	---	---	---	---	---	---	---	---	---
MW-24	NI	NI	NI	NI	NI	NI	NI	NI	NI
PZ-01	---	---	---	---	---	---	---	---	120
PZ-02	---	---	---	---	---	---	---	490	400
RW-01	---	---	---	NI	---	---	---	---	---
RW-02 (B)	---	---	---	NI	NI	NI	NI	NI	NI
SUMP	---	---	---	NI	NI	NI	---	---	---

NOTES: ND - Not detected above method detection limit, --- - Not analyzed, NI - Not installed at time of monitoring, AB - Well was abandoned.
MW-01 through MW-16 installed during Remedial Investigation (Stearns & Wheler).
MW-03 removed as part of TCE Soils Interim Remedial Measure (IRM) completed in September 1994. Data was collected by Stearns & Wheler prior to 07/22/94.
MW-04 and MW-20 were abandoned and replaced by MW-21 and MW-22 on 01/20/97.

O'BRIEN & GERE
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Table 2
Former Accurate Die Casting Site
Fayetteville, New York
Ground Water Trichloroethylene Concentrations

Date Sampled: / WELL #	10/1995 TCE ug/L	01/1996 TCE ug/L	04/1996 TCE ug/L	05/1996 TCE ug/L	07/1996 TCE ug/L	10/1996 TCE ug/L	01/1997 TCE ug/L	04/1997 TCE ug/L	07/1997 TCE ug/L
MW-01	DRY	---	---	---	---	---	---	---	DRY
MW-02	ND	---	---	---	---	ND	---	---	---
MW-03	AB	AB	AB	AB	AB	AB	AB	AB	AB
MW-04	15	---	---	---	---	62	---	AB	AB
MW-05	---	---	---	---	---	180	---	---	---
MW-06	180	170	110	---	98	71	75	52	---
MW-07 (B)	ND	---	---	---	---	ND	---	---	---
MW-08	ND	---	---	---	---	ND	---	---	---
MW-09	68	100	64	---	65	50	95	83	66
MW-10 (B)	890	900	820	---	960	1700	1900	1200	---
MW-11 (B)	2600	2500	1500	---	1400	1600	1500	800	---
MW-12	29	---	---	---	---	17	---	---	---
MW-13	DRY	---	---	---	---	370	---	---	---
MW-14	78	84	250	---	230	170	390	400	260
MW-15 (B)	7	---	---	---	---	20	---	---	---
MW-16 (B)	20	---	---	---	---	11	---	---	---
MW-17	---	180	350	---	460	300	450	220	150
MW-18	NI	NI	NI	1200	---	2900	850	410	1800
MW-19	NI	NI	NI	---	DRY	DRY	DRY	DRY	DRY
MW-20	NI	NI	NI	70	---	---	---	AB	AB
MW-21	NI	NI	NI	NI	NI	NI	NI	520	310
MW-22	NI	NI	NI	NI	NI	NI	NI	1	3
MW-23 (B)	---	---	---	---	---	---	---	ND	ND
MW-24	NI	NI	NI	NI	NI	NI	NI	NI	NI
PZ-01	---	---	---	---	---	32	---	---	---
PZ-02	---	---	---	---	---	540	---	---	---
RW-01	---	---	---	---	---	---	---	---	---
RW-02 (B)	---	---	---	---	---	---	---	---	---
SUMP	---	170	180	---	1000	---	320	180	---

NOTES: ND - Not detected above method detection limit, --- - Not analyzed, NI - Not installed at time of monitoring, AB - Well was abandoned.
MW-01 through MW-16 installed during Remedial Investigation (Stearns & Wheler).
MW-03 removed as part of TCE Soils Interim Remedial Measure (IRM) completed in September 1994. Data was collected by Stearns & Wheler prior to 07/22/94.
MW-04 and MW-20 were abandoned and replaced by MW-21 and MW-22 on 01/20/97.

O'BRIEN & GERE
ENGINEERS, INC.

Table 2
Former Accurate Die Casting Site
Fayetteville, New York
Ground Water Trichloroethylene Concentrations

Date Sampled: / WELL #	10/1997 TCE ug/L	01/1998 TCE ug/L	04/1998 TCE ug/L	10/1998 TCE ug/L	11/1998 TCE ug/L	04/1999 TCE ug/L	10/1999 TCE ug/L	04/2000 TCE ug/L	11/2000 TCE ug/L
MW-01	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
MW-02	ND	---	---	ND	---	---	ND	---	ND
MW-03	AB	AB	AB	AB	AB	AB	AB	AB	AB
MW-04	AB	AB	AB	AB	AB	AB	AB	AB	AB
MW-05	220	---	---	200	---	---	78	---	110
MW-06	ND	---	140	92	---	63	72	30	48
MW-07 (B)	ND	---	---	ND	---	---	ND	---	---
MW-08	---	---	---	ND	---	---	ND	---	ND
MW-09	61	140	120	80	---	120	46	69	60
MW-10 (B)	1300	---	930	880	---	720	700	530	690
MW-11 (B)	1600	---	920	1100	---	740	900	670	840
MW-12	19	---	---	22	---	---	15	---	17
MW-13	760	---	---	480	---	---	430	---	790
MW-14	560	560	460	400	---	460	260	250	280
MW-15 (B)	18	---	---	21	---	---	13	---	7
MW-16 (B)	14	---	---	4	---	---	15	---	3
MW-17	---	270	800	250	---	280	180	160	220
MW-18	3100	1000	1100	3600	---	620	1800	360	1900
MW-19	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
MW-20	AB	AB	AB	AB	AB	AB	AB	AB	AB
MW-21	450	120	1300	180	---	510	90	42	73
MW-22	8	5	10	14	---	10	9	13	12
MW-23 (B)	ND	ND	---	ND	---	---	ND	---	ND
MW-24	NI	NI	NI	NI	6000	4300	4300	690	2400
PZ-01	48	---	---	85	---	---	410	---	29
PZ-02	420	---	---	250	---	---	18	---	160
RW-01	---	---	---	---	---	---	---	---	---
RW-02 (B)	---	---	---	---	---	---	---	---	---
SUMP	2600	---	560	850	---	400	---	490	1100

NOTES: ND - Not detected above method detection limit, --- - Not analyzed, NI - Not installed at time of monitoring, AB - Well was abandoned.
MW-01 through MW-16 installed during Remedial Investigation (Stearns & Wheler).
MW-03 removed as part of TCE Soils Interim Remedial Measure (IRM) completed in September 1994. Data was collected by Stearns & Wheler prior to 07/22/94.
MW-04 and MW-20 were abandoned and replaced by MW-21 and MW-22 on 01/20/97.

Former Accurate Die Casting Facility
Fayetteville, New York

Table 3. Operator responsibility summary

Activity	Reference Location
Operate treatment system	Section 3.
Maintain equipment	Sections 2.2.2., 3.8.2., 3.8.3., and Exhibits A and B
Record maintenance activities	Section 2.2.1. and Appendix A
Record system operations data	Section 2.2.1. and Appendix B
Perform sampling for analysis	Section 2.2.3. and 5., and Appendicies C and D
Prepare SPDES Discharge Monitoring Reports	Section 2.2.4. and Appendix D
Review records for changes in system performance	Section 2.2.1.
Evaluate performance of GAC	Section 5.3.
Maintain spare parts inventory	Section 3. and Appendix E
Arrange for disposal of waste materials	Section 4.
Notify proper individuals of untreated water release	Section 2.2.4. and Table 5
Compile report forms	Section 5.4.

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Former Accurate Die Casting Facility
Fayetteville, New York

Table 4. Startup system gauge readings

System Component	Gauge Reading
East bag filter pressure gauge	12 psi
West bag filter pressure gauge	12 psi
Pressure gauge prior to GAC No. 1	9.5 psi
Pressure gauge after GAC No. 1	9 psi
Pressure gauge prior to GAC No. 2	7 psi
Pressure gauge after GAC No. 2	6.5 psi
Flow meter prior to discharge	29.5 gpm

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Former Accurate Die Casting Site
Fayetteville, New York

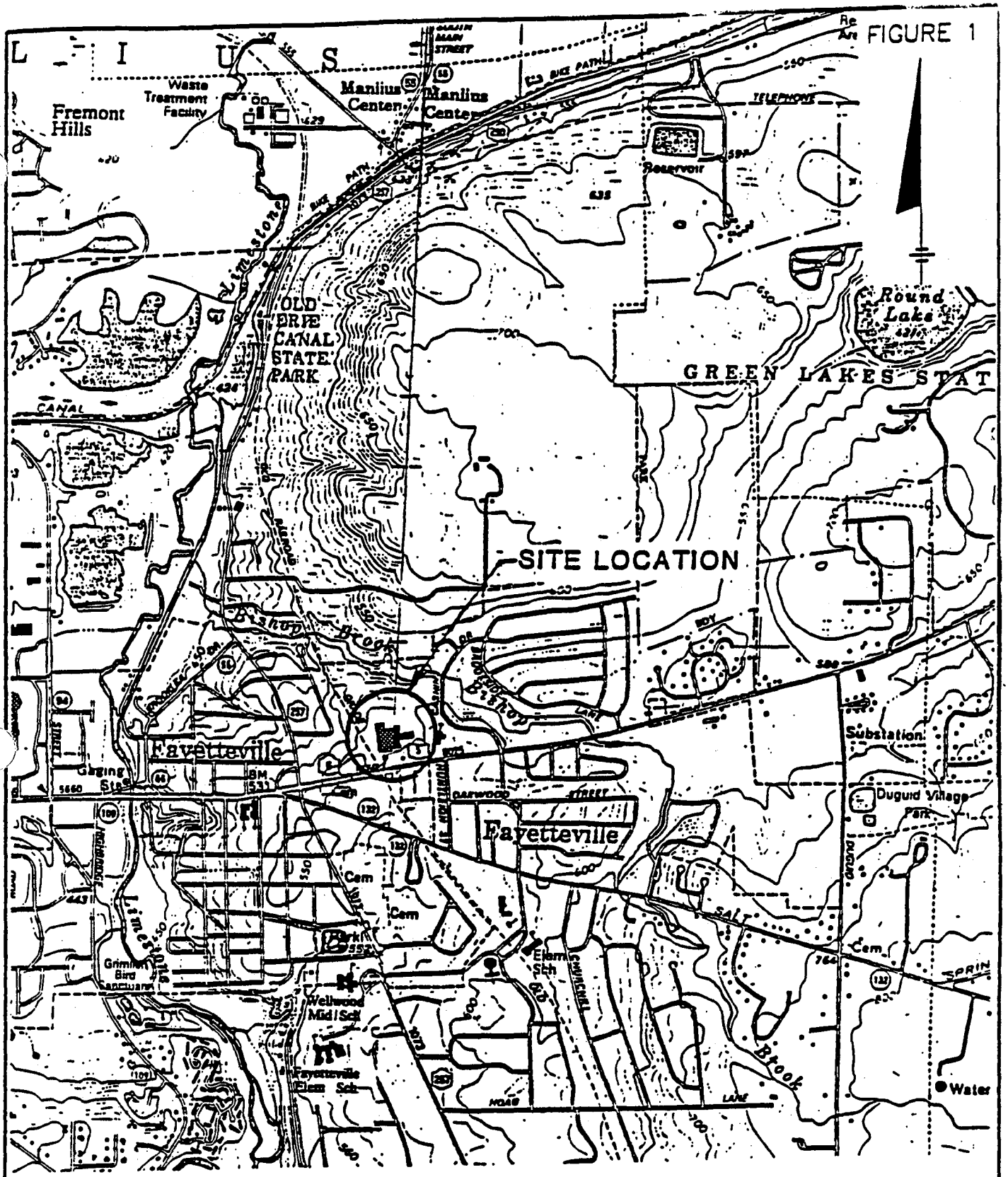
Table 6. Basis of Design of Major Process Components

System Component	Model Number	Description	Design Considerations
Ground Water Recovery Pumps	Grundfos (Redi-Flo4 25E3)	Located inside RW-1 (overburden) at a depth of 50±ft below ground surface.	15 gpm at 70 ft 25 gpm at 58 ft head design 30 gpm at 45 ft
	Grundfos (Redi-Flo4 5E8)	Located inside RW-2 (bedrock) at a depth of 57±ft below ground surface	2 gpm at 200 ft 4 gpm at 160 ft 7 gpm at 80 ft head design
	Aurora (Hysdromatic SP40)	Located inside sump (former TCE soils area) at a depth of 27±ft below ground surface.	10 gpm at 26 ft 25 gpm at 23 ft head design 35 gpm at 21 ft
Transfer Pump	Gould (NPO)	Transfer water from the equilization tank through the bag filters.	40 gpm at 27 ft 50 gpm at 23 ft head design 60 gpm at 20 ft
Bag Filters	Filtration Systems (NS-122)	Filter housings to contain filter bags.	Rated for a pressure of 150 psi.
	Filtration Systems (Accufit Welded Liquid Filter Bags)	Filter bags to remove suspended solids from the water stream.	Designed to filter water at a flow rate of 50 gpm.
Carbon Vessels	OBG Manufacturing	Each carbon vessel is capable of containing 1500 lb of granular activated carbon.	Designed for a service pressure of up to 150 psi.
	Calgon (Dry Screened Reactive Carbon-Type C Mesh Size: 8x30)	Granular activated carbon installed in each 1500 lb carbon vessel.	Designed to remove VOCs from water stream with a loading of up to 27 ppm at a flow rate of 50 gpm.

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MHB H:\DIVISION\71\ACCURATE\SITE S 04/15/94

FIGURE 1



ACCURATE DIE CASTING
FAYETTEVILLE, NEW YORK

SITE MAP

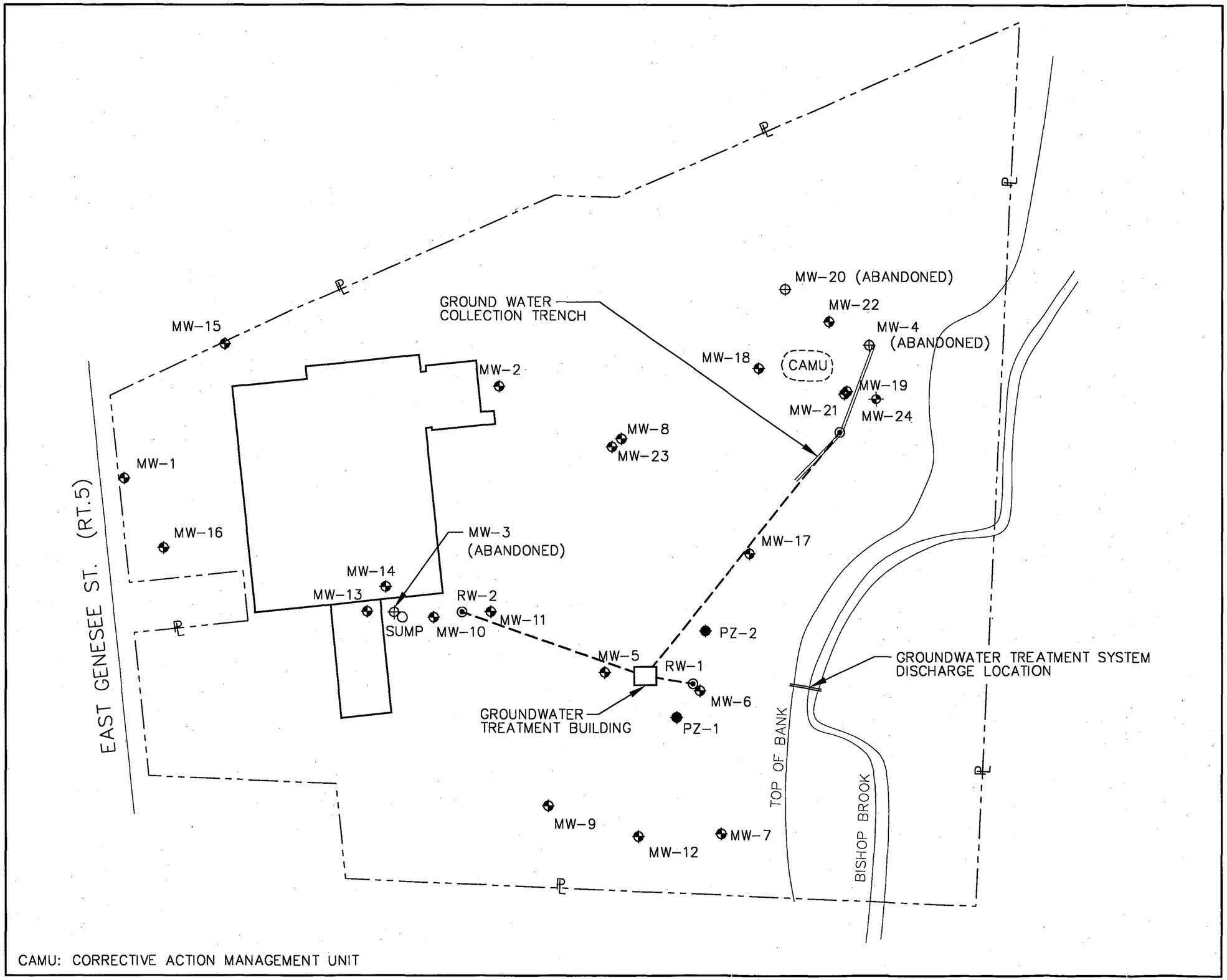
SCALE: 1" = 2,000 FT.

USGS TOPOGRAPHIC 7.5 MIN. QUAD
SYRACUSE EAST, N.Y. QUADRANGLE

FILE NO. 2488.396-

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FIGURE 2



CAMU: CORRECTIVE ACTION MANAGEMENT UNIT

LEGEND

- PROPERTY LINE
- MW-4 — MONITORING WELL LOCATION
- MW-3 — FORMER MONITORING WELL LOCATION
- RW-1 — OVERBURDEN AQUIFER RECOVERY WELL
- RW-2 — BEDROCK GROUND WATER RECOVERY WELL
- PZ-1 — PIEZOMETER LOCATION
- FORCEMAIN

NOTE: MW-24 LOCATION IS APPROXIMATE

ACCURATE DIE CASTING
FAYETTEVILLE, NEW YORK

SITE PLAN

0 150 300
SCALE IN FEET

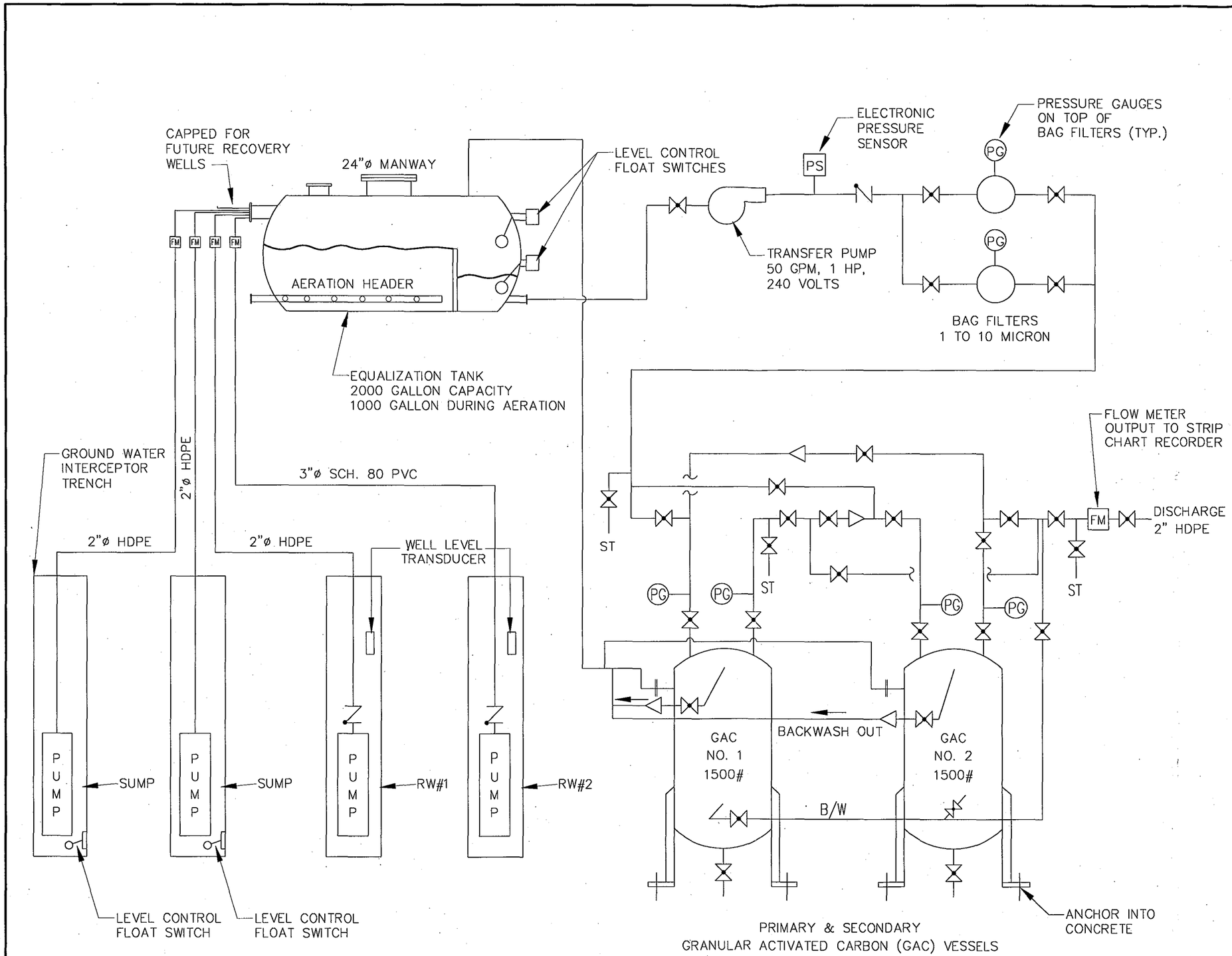
DATE: DECEMBER 2000

FILE NO. 2488.23123.002

O'BRIEN & GERE
ENGINEERS INC.

PLOT DATE: 12/22/00

FIGURE 3



LEGEND

- PG — PRESSURE GAUGE
- ST — SAMPLE TAP
- RUPTURE DISK
- BALL VALVE
- CHECK VALVE
- REDUCER

ACCURATE DIE CASTING
FAYETTEVILLE, NEW YORK
OPERATION AND
MAINTENANCE MANUAL

PROCESS SCHEMATIC

NOT TO SCALE

DECEMBER 2000
FILE NO. 2488.25463-62F

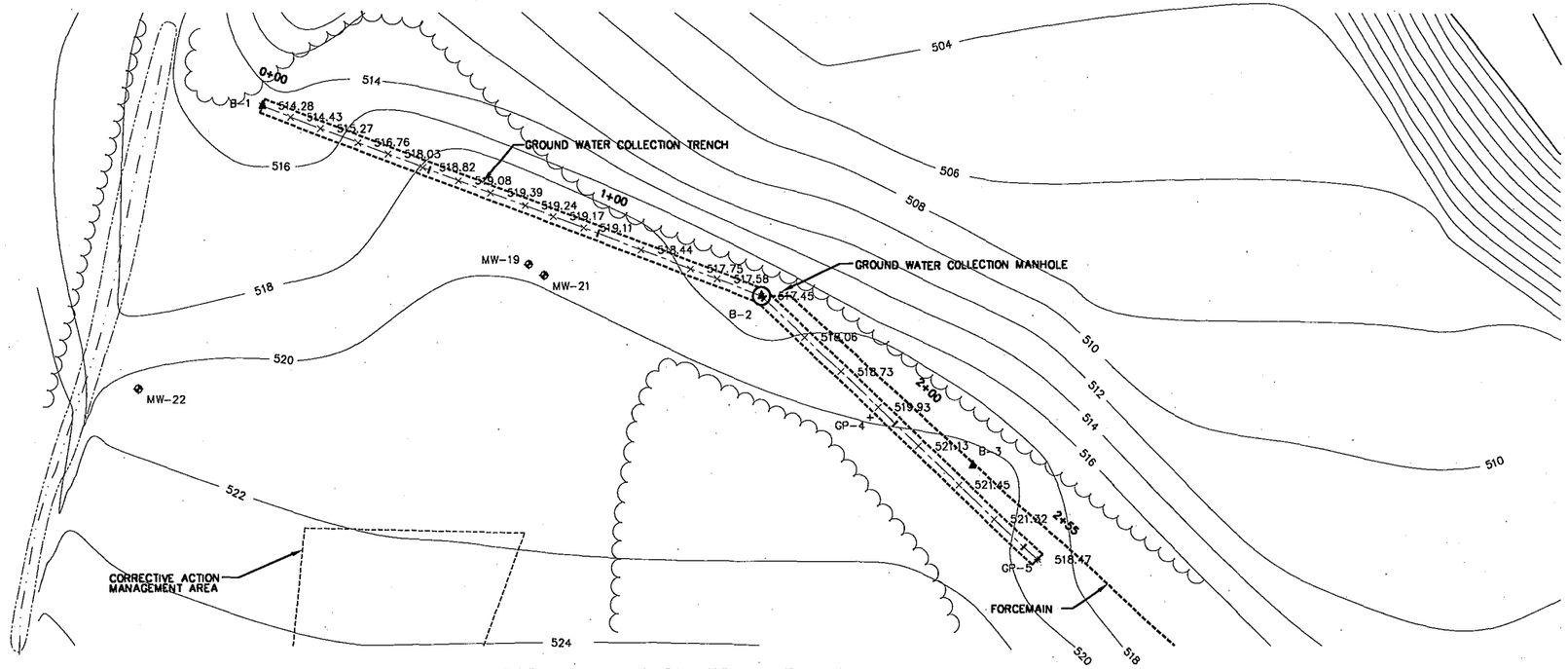
O'BRIEN & GERE ENGINEERS INC.

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PLOT DATE: 12/27/00 MTW

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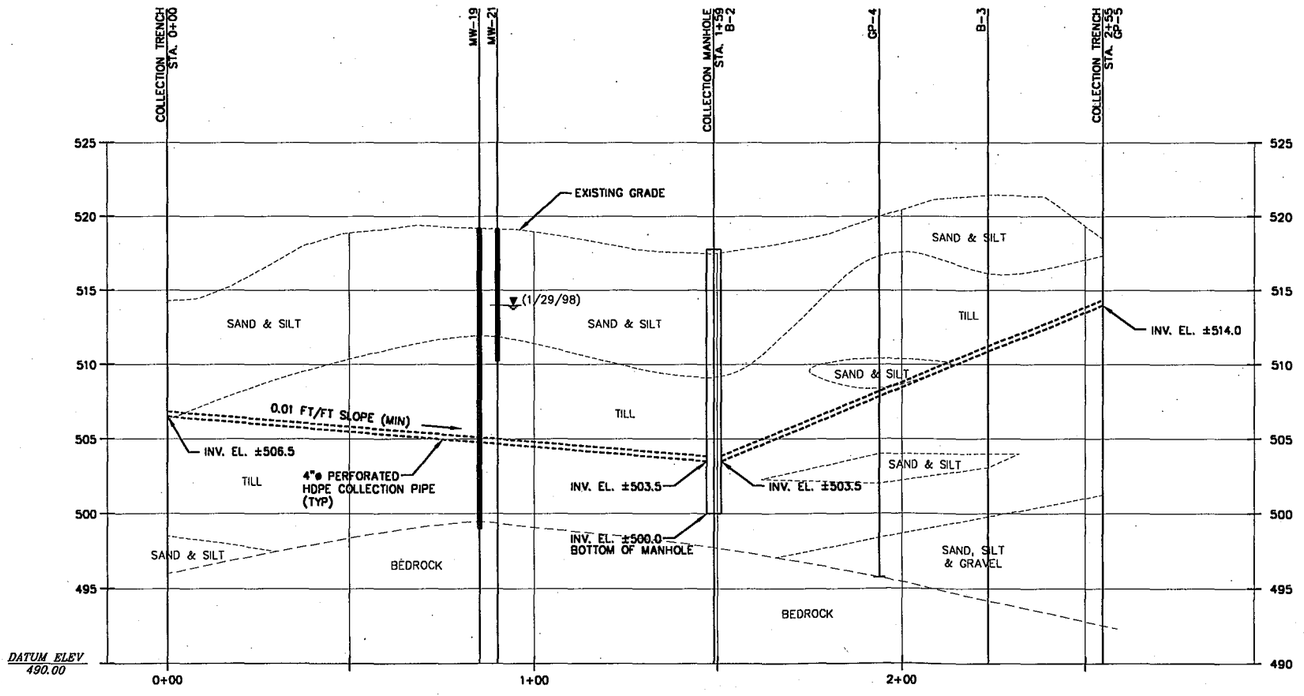
PLOT DATE: 12/27/00 MTW

FIGURE 4



GROUND WATER COLLECTION TRENCH PLAN

SCALE: 1"=20'



GROUND WATER COLLECTION TRENCH PROFILE

SCALE: HORIZ. 1"=20'
VERT. 1"=5'

LEGEND

MW-17 ⊕	MONITORING WELL
B-2 ▲	SOIL BORING
GP-4 +	GEOPROBE
——524——	ELEVATION CONTOUR
× 521.32	SPOT ELEVATION
⌒⌒⌒	APPROX. TREE LINE

ACCURATE DIE CASTING
FAYETTEVILLE, NEW YORK
OPERATION AND
MAINTENANCE MANUAL

GROUND WATER COLLECTION TRENCH PLAN & PROFILE

FILE NO. 2488.25463.005
DECEMBER 2000

O'BRIEN & GERE
ENGINEERS INC.

EXHIBIT A

MANUFACTURERS' OPERATION AND MAINTENANCE MANUALS

MANUFACTURERS' OPERATION AND MAINTENANCE MANUALS INDEX

Manufacturer	Product
Allen-Bradley Co.	Controller
Allen-Bradley Co.	Pressure switch
Ametek	Pressure gauge
Aurora	Sump ground water recovery pump
B/W Controls	Well level transducers
Carboline	Interior coating on equalization tank
Dayton Electric Mfg. Co.	Electric unit heater
Dayton Electric Mfg. Co.	Fractional HP motor for fan
Dayton Electric Mfg. Co.	Intake guards for fan
Dayton Electric Mfg. Co.	Motorized damper for fan
Dayton Electric Mfg. Co.	Swivel bracket
Dayton Electric Mfg. Co.	Torque arrestor
DuPont	Exterior coating on carbon vessels and equalization tank
Filtration Systems	Filter bag housings and filter bags
GEMS	Level switches
Gould	Transfer pump
Grundfos	RW-1 and RW-2 ground water recovery pump
Hevi-Duty Electric	Boost Transformer
Honeywell	Chart recorder
Signet	Flow meter
Signet	pH meter
Wisconsin Protective Coatings Corp.	Interior coating on carbon vessels

ALLEN-BRADLEY CO.

CONTROLLER

SLC™ 150 Programmable Controller

Processor Unit – Catalog Nos. 1745-LP151, -LP152, -LP153, -LP154, -LP156, -LP157

The SLC 150 Programmable Controller

The SLC 150 Programmable Controller is easy to program, using the familiar ladder diagram format. Functional capabilities include relay logic, timers, counters, sequencers, and shift registers. The controller can be used in a wide variety of applications, including:

- Positioning and motion control in robotics and machine tools
- High speed counting/packaging
- Material handling
- Molding and casting machines
- Energy management
- Assembly machines

The Processor Unit

Contains the processor (CPU and capacitor-backed CMOS RAM memory), a power supply, and 32 I/O circuits. It is available in six versions to meet various application requirements. Peripheral devices:

EEPROM Memory Module – Plugs into the processor unit for program loading and storage. The SLC 150 processor requires a Series B module, or a Series A module having a 28-pin chip.

High Speed Input Module – Used with the SLC 150 processor unit for high speed counting applications. Up to 4 modules can be interconnected, with 1 input circuit per module.

Pocket Programmer – Connect the programmer to the processor unit to program, monitor, edit, and troubleshoot. The nine operating modes selected with the programmer:

1: Clear Memory	**4**: Test–Single Scan	**7**: Load Program from EEPROM
2: Program	**5**: Test–Continuous Scan	**8**: Enter/Change Access Code
3: Run	**6**: Store Program in EEPROM	**9**: Diagnostic Test–Programmer

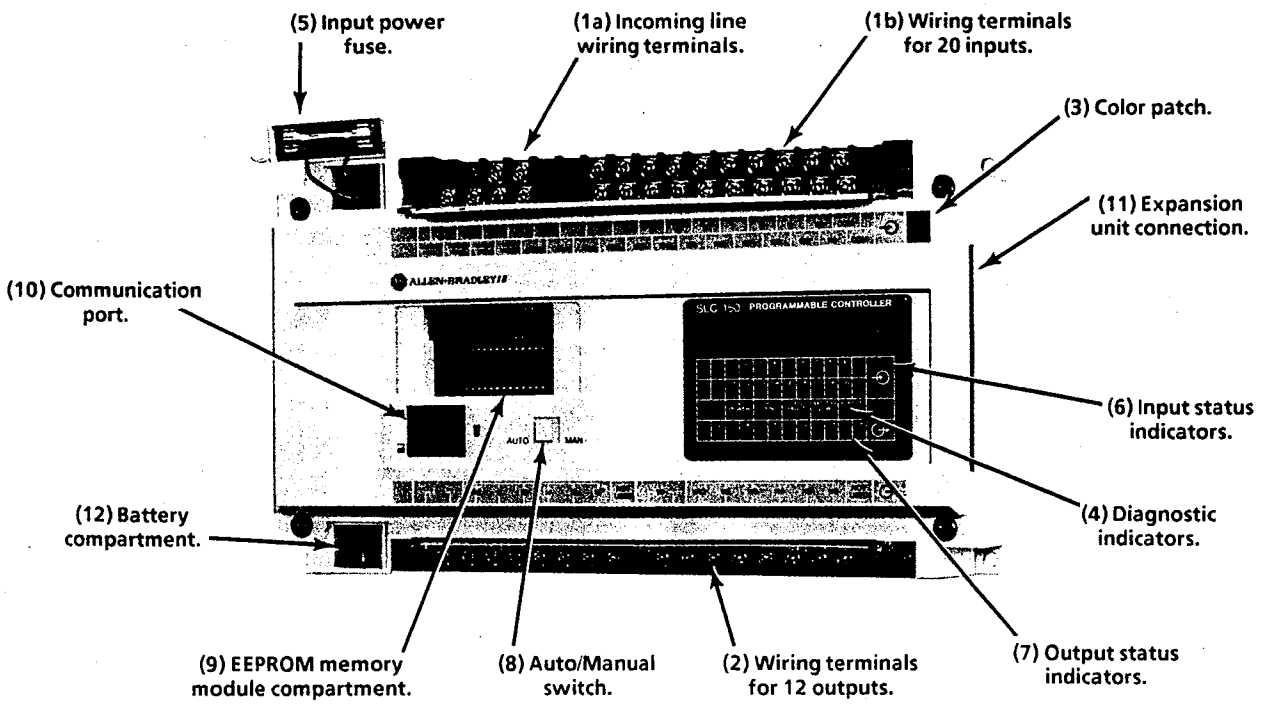
Personal Computer Software – Allows you to use an IBM or IBM-compatible personal computer in place of the pocket programmer. With the software, you can select functions equivalent to the modes defined above. Additional capabilities: off-line programming and program library development; ladder diagram display and enhancements; data display and cross reference table generation; program print-out. An RS-232-C/RS-422 interface converter is required for communication between the processor and computer.

Timer Counter Access Terminal (TCAT) – Allows production, supervisory, and maintenance people to monitor or change programmed timer, counter, and sequencer data "on-line". Connects to processor unit.

I/O Expansion Units – You can connect SLC 150 expansion units to the processor unit, increasing the number of I/O circuits in increments of 32. You can also use any of the three SLC 100 I/O expansion units – the basic expansion unit with 16 I/O, the relay output expansion unit with 12 outputs, and the analog input expansion unit with 4 analog inputs. Interconnect any combination of these units with the SLC 150 processor unit to expand the number and type of I/O circuits. 112 I/O maximum.

Publication 1745-2.5 – November, 1987
Supersedes Publication 1745-2.5 Dated June, 1987

40061-001-01(E)



Features

The following features are pointed out in the illustration above.

1. a) Incoming line wiring terminals. b) Wiring terminals for 20 inputs. Self-lifting pressure plates allow for easy wire insertion and secure connections. Terminals accept two #14 AWG wires. The hinged cover (shown in the open position) has write-on areas for identification of external circuits. The terminal block is removable for easy processor unit replacement. Terminal block removal: Page 17.
2. Wiring terminals for 12 outputs. The removable terminal block has the same construction as the line-input terminal block. Hinged cover (shown in the open position) has write-on areas.
3. Color patch. Red, black, blue, green, purple or yellow. Identifies the 6 processor unit versions. See General Specifications, Page 13.
4. Five red LED diagnostic indicators:

   DC POWER – Indicates that the processor unit is energized and DC power is being supplied.

   PC RUN – Indicates the processor unit is in the Run mode.

   CPU FAULT – Indicates the processor has detected an error in either the CPU or memory. Operation is automatically stopped.

   BATTERY LOW – An optional battery provides back-up power for the CMOS RAM memory. This LED alerts you when the battery voltage level has fallen below a threshold level.

   FORCED I/O – Indicates that one or more input or output addresses have been forced to an ON or OFF state.

Features (continued)

5. Input power fuse compartment. If line terminal voltage is present but the DC POWER LED is not lit, the fuse may be blown. Refer to Page 17 for fuse replacement procedure.

6. Input status indicators. Twenty red LEDs, identified with address numbers 1 thru 10 and 101 thru 110, corresponding to numbers below the input wiring terminals. When an input circuit is energized, the corresponding status indicator will be lit.

7. Output status indicators. Twelve red LEDs, identified with address numbers 11 thru 16 and 111 thru 116, corresponding to numbers above the output wiring terminals. When a programmed output instruction is TRUE, the corresponding output status indicator will be lit, and the corresponding output circuit will be energized.

8. Auto/Manual switch. This switch controls restarting of the processor unit after a power loss or brown-out.

   Auto – On power-up, the processor runs thru its normal diagnostic tests and then automatically enters the Run mode (if it was in the Run mode at the last power-down).

   Manual – On power-up, the processor runs thru its diagnostic tests but will not enter the Run mode. To enter the Run mode, you must move the switch to the auto position or use the pocket programmer (or personal computer).

9. EEPROM memory module compartment. The optional memory module can be plugged into the processor. (Cat. No. is 1745-M1. SLC 150 processor requires a Series B module or a Series A module having a 28-pin chip.) The pocket programmer or personal computer software allows you to store your processor RAM program in the EEPROM. You can also load a program from the EEPROM into the processor RAM. In addition, the processor unit has an Auto-Load feature.

   Further details on using the EEPROM module are found in the SLC Programmable Controller User's Manual and in Publication 1745-2.4.

   We recommend that you install an EEPROM memory module. This will provide maximum protection against user program loss or program alteration due to capacitor back-up drain, battery back-up drain, processor malfunction, or excessive noise.

10. Communication port. The pocket programmer, interface converter, or TCAT cable is plugged into this socket.

11. Socket for connecting an expansion unit or high speed input module. We've included a 20-pin to 10-pin ribbon cable with the processor unit. **Save this cable**. You will need it if you want to connect an I/O expansion unit to the processor unit or if you want to connect both a high speed input module and an expansion unit.

12. Battery compartment. An optional battery assembly can be installed in this compartment. This will provide a typical 2-3 year back-up power for the CMOS RAM memory.

    Standard back-up power (1-2 weeks) is provided by a capacitor. Under certain conditions, battery back-up is preferable. Refer to General Specifications (Page 13) for further information.

Installation Considerations

Refer to the SLC Programmable Controller User's Manual for details on the following important installation considerations:

- The enclosure should be adequate (NEMA approved) for the environmental conditions of the particular application.
- The processor unit, expansion units, and input/output device circuits should have the same power source. The processor and expansion units should be properly grounded.
- Include an electrical disconnect in the enclosure. An isolation transformer may also be required.
- A master control relay circuit should be included to permit disabling of the I/O devices independent of the processor and expansion unit power supply circuit. Emergency-stop switches should also be included.
- Follow recommendations for component spacing within the enclosure, to help keep the controller temperature within the specified limits.
- Wiring should be routed to minimize the effects of electrical noise. Surge suppressors should be used for inductive loads in series with hard contacts and for other noise-generating equipment.
- Fusing should be provided to protect loads and wiring from short circuits or overloading.

Processor Unit Start-Up

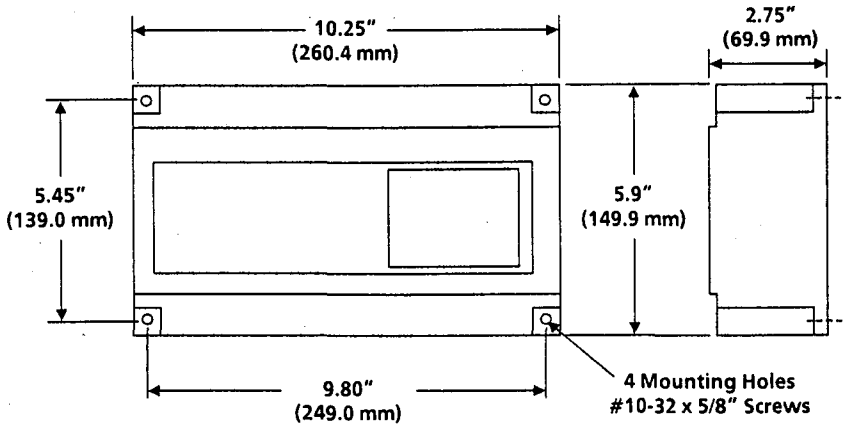
When power is applied to the SLC 150 processor unit for the first time, a processor fault will occur. The fault must be canceled and the processor RAM memory must be cleared to program and operate the processor unit. To cancel the fault and clear the RAM memory, connect the pocket programmer or a personal computer with SLC personal computer software to the processor unit.

Using the pocket programmer: The programmer will display some error codes which identify the fault. These codes must be canceled individually by pressing the CANCEL CMD key after each code appears. When all error codes have been canceled, clear the processor memory by pressing MODE, 1, ENTER, ENTER. The processor RAM memory will be cleared and the processor will be placed in the Program mode.

Using the SLC personal computer software: You will see an error message on the display and must use the program transfer function to clear the processor unit memory.

Mounting

Processor unit dimensions are shown below. Take note of the important mounting recommendations.



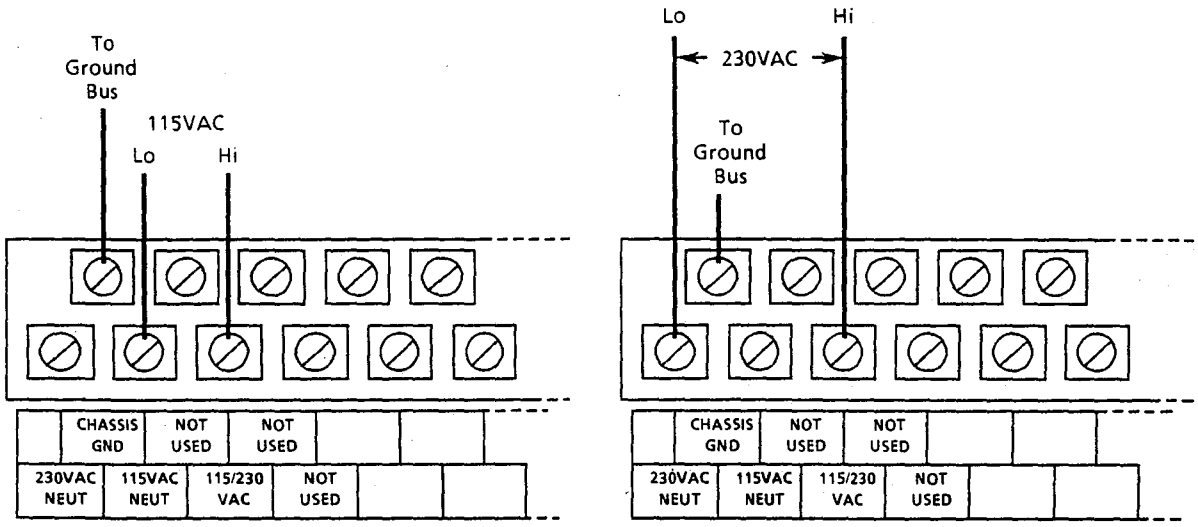
IMPORTANT: SLC 150 processor and expansion units utilize the mounting back panel as a heat sink for dissipating excess heat during operation. It is important that you mount the unit on a smooth metal back panel to provide good thermal conductivity. Back panel temperature specification: 60°C maximum.

Mounting on a sub panel – In high ambient temperatures (60°C), sub panels not exposed to air outside the enclosure could heat up beyond 60°C. In these situations, the sub panel temperature can be reduced by removing other heat generating equipment from the enclosure or by providing fans or air conditioning for cooling.

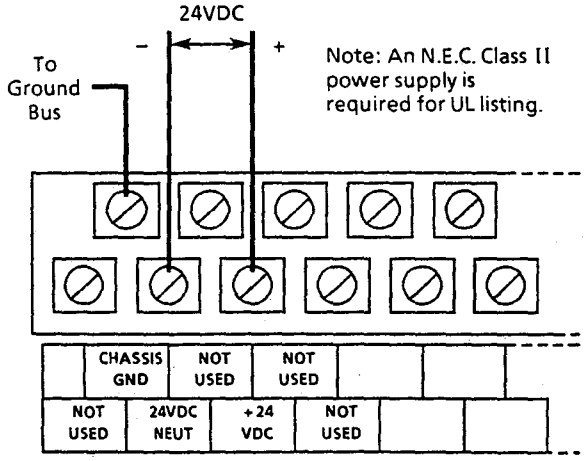
Line Wiring Connections

Make line connections to the processor unit as follows.

> **CAUTION:** Incorrect wire connections can cause damage to the processor unit power supply. **Do not** jumper 115VAC NEUT and 230VAC NEUT together. **Do not** jumper unused 115VAC NEUT or unused 230VAC NEUT to the CHASSIS GND terminal.



Catalog Nos. 1745-LP151, -LP152, -LP153, -LP156

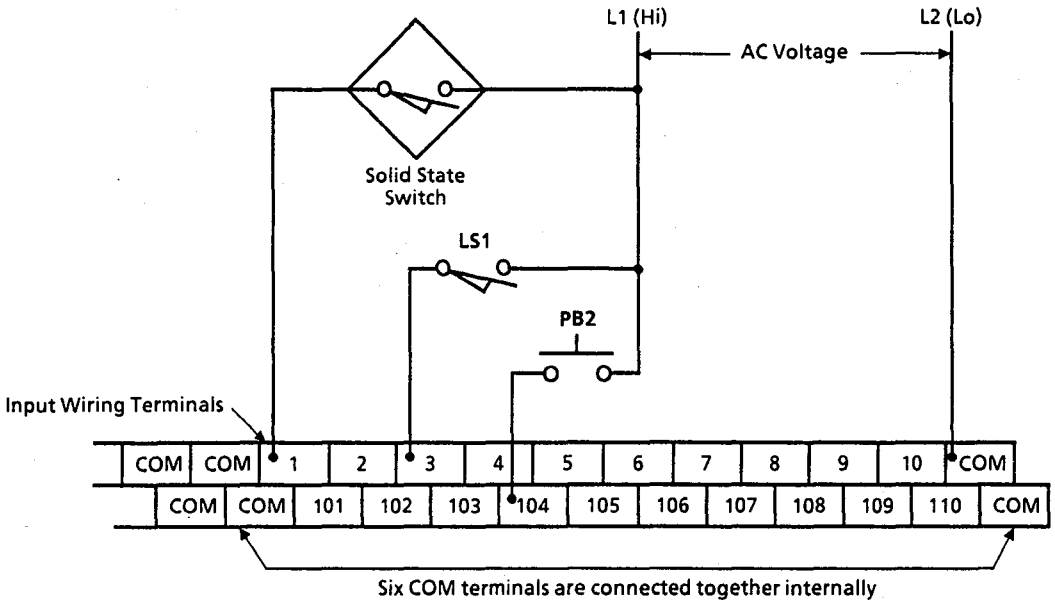


Catalog No. 1745-LP154, -LP157

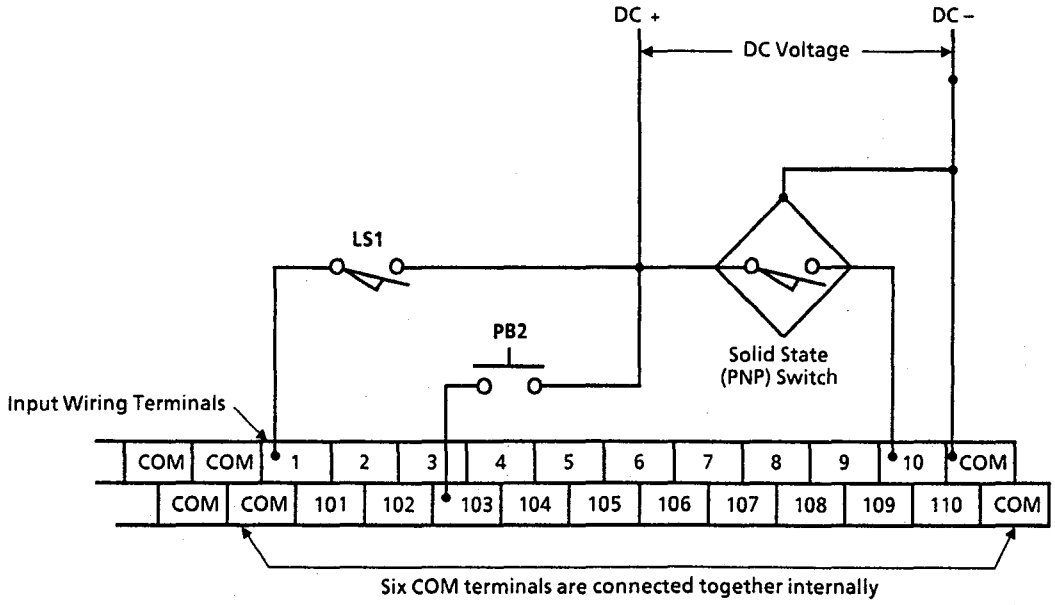
Input Wiring Connections

The diagrams below and on Page 8 show typical input devices connected to the processor unit wiring terminals.

1745-LP151, -LP152 Current sinking input circuitry



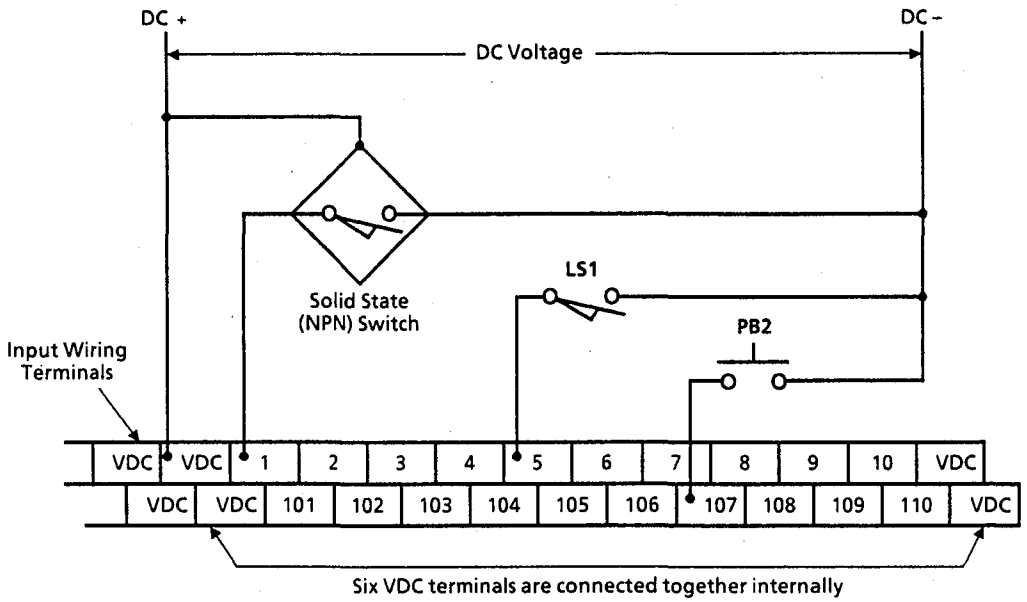
1745-LP153, -LP154 Current sinking input circuitry



Input Wiring Connections (continued)

The diagram below shows how to connect input devices to processor units 1745-LP156 and 1745-LP157. Current sourcing input circuitry is required.

1745-LP156, -LP157 Current sourcing input circuitry



Output Wiring Connections

Wiring connections are shown on Pages 10 and 11. Note that each processor unit has two isolated groups of outputs plus two additional isolated hard contact relay outputs.

Triac Outputs: Triac outputs include optical isolation as well as MOV protection to guard against possible damage by transients from external outputs. Triac output firing can be synchronized with the AC line to accomplish zero-cross turn-on and minimize noise generated when switching loads. This is accomplished by making instruction –(866)– TRUE in the user program. If this feature is used, your scan time will be 8.3 msec (or some multiple) at 60 Hz and 10 msec (or some multiple) at 50 Hz. A common power source **must be used** for the processor unit power supply and output circuits to achieve zero-cross turn on.

Since triacs turn off at AC line zero cross, it is not necessary to use external surge suppression when switching inductive loads. However, if hard contacts are connected with triacs to switch an inductive load, we recommend using varistors for external surge suppression. Do not use suppressors having RC networks, since damage to triacs could occur. Refer to Page 12 for further discussion on surge suppression.

Hard Contact Relay Outputs: Outputs at terminals 12-16 and 112-116 include arc suppression circuitry (RC networks) which protects contacts when switching inductive loads. We recommend that you also connect external surge suppression to protect the contacts from high transient voltage which occurs when an inductive device is switched off.

Hard contact relay outputs at terminals 11 and 111 do *not* include internal arc suppression. Contact protection/surge suppression: See Page 12.

Transistor Outputs: Processor unit 1745-LP154 has current sourcing (PNP) transistor outputs. Processor unit 1745-LP157 has current sinking (NPN) transistor outputs.

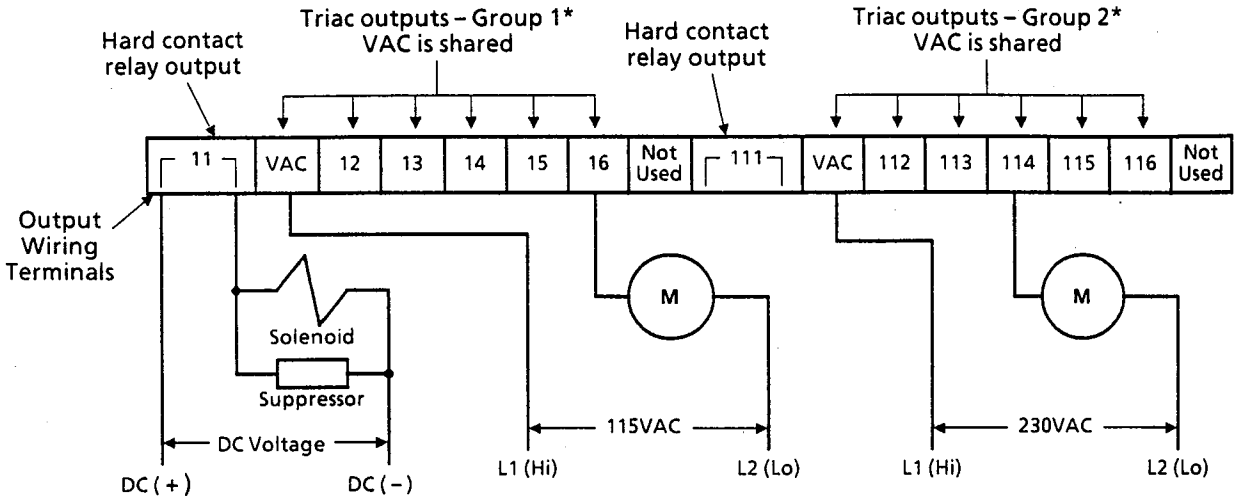
We recommend that you connect external surge suppression to protect transistors from the high transient voltage which occurs when an inductive device is turned off. An IN4004 diode is acceptable for most applications. Refer to Page 12 for further discussion on surge suppression.

Fusing: You should provide appropriate fusing to protect output devices and wiring from short circuits and overload conditions. Refer to Pages 15 and 16 for recommended fusing.

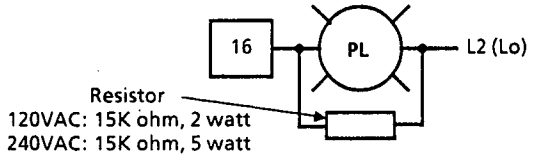
Output Wiring Connections

Wiring connections processor unit catalog numbers 1745-LP151, -LP152, and -LP154 are shown below.

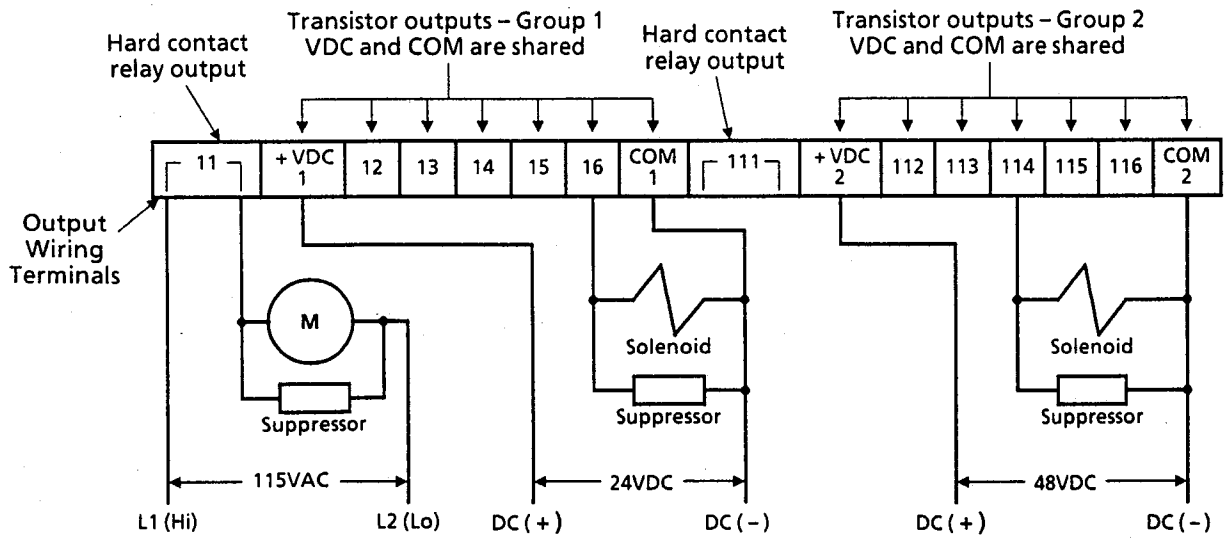
1745-LP151, -LP152



* To limit the effects of leakage current thru triac outputs, use a loading resistor across the load as shown at the right.



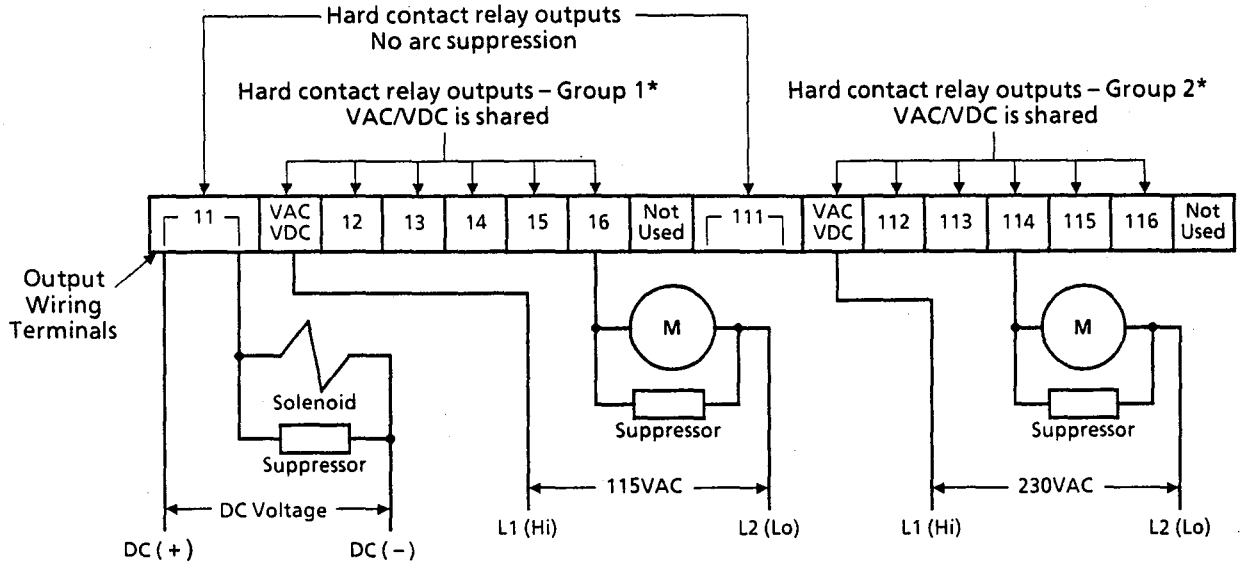
1745-LP154 Current sourcing (PNP) transistor outputs



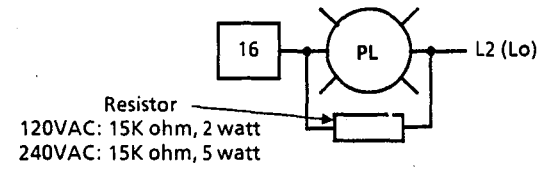
Output Wiring Connections (continued)

Wiring connections for processor unit catalog numbers 1745-LP153, -LP156, and -LP157 are shown below.

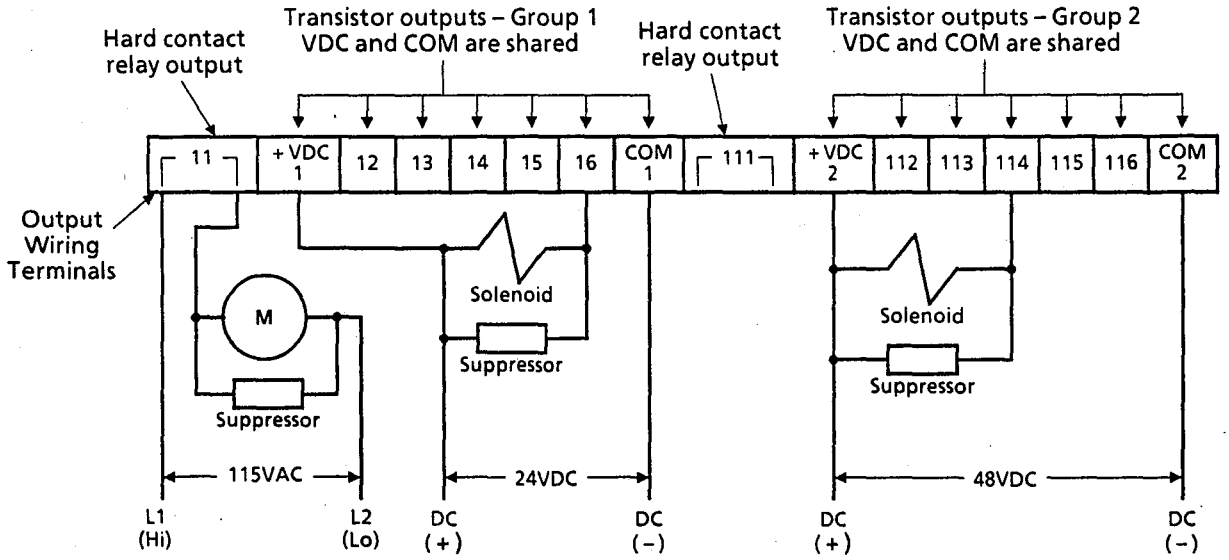
1745-LP153, -LP156



* Group 1 and 2 hard contact relay outputs have built-in arc suppression (R = 120 ohms, C = 0.022 microfarad). To limit the effects of leakage current, use a loading resistor across the load as shown at the right.



1745-LP157 Current sinking (NPN) transistor outputs



Surge Suppression

Inductive output devices such as motor starters and solenoids may require that you use some type of surge suppression to protect output contacts and minimize noise generation. Examples are shown below.

These surge suppression circuits are connected directly across the output device. The effect is to reduce arcing of the output contacts (arcing can be caused by the high transient voltage which occurs when an inductive device is switched off).

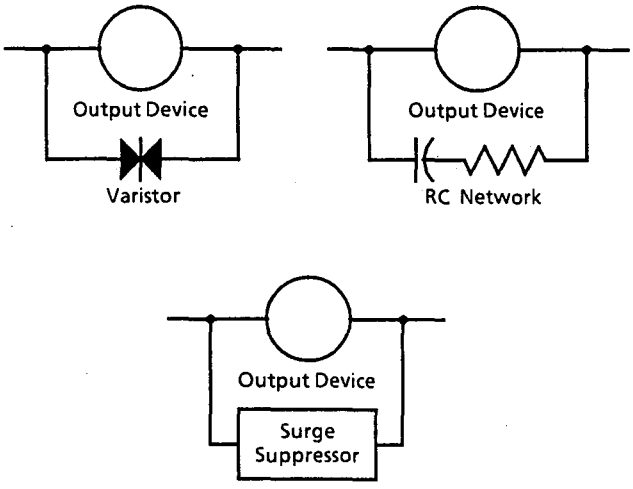
Suitable surge suppression methods for inductive AC output devices include a varistor, an RC network, and an Allen-Bradley surge suppressor. These components must be appropriately rated to suppress the switching transient characteristic of the particular inductive device.

For inductive DC output devices, a diode is suitable. A 1N4004 diode is acceptable for most applications. A surge suppressor can also be used (refer to the SLC Programmable Controller User's Manual).

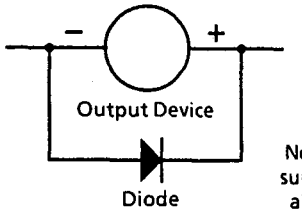
We recommend that you locate the suppression device as close as possible to the output device.

Suppressors recommended for use with Allen-Bradley relays, contactors, and motor starters are listed in the SLC Programmable Controller User's Manual.

Surge Suppression for Inductive AC Output Devices



Surge Suppression for Inductive DC Output Devices



Note: A surge suppressor can also be used.

General Specifications

Voltage Ranges (Incoming Power, Input Circuits, Output Circuits):

Catalog Number	Voltage Ranges (Incoming Power Connections)	External I/O		
		Input Circuits – 20	Output Circuits – 12	Color Patch*
1745-LP151	85-132/170-265 VAC 50/60 Hz	85-132 VAC 50/60Hz Current Sinking	10 Triac – 85-265 VAC 50/60 Hz 2 Hard Contact – 10-250VAC/10-125VDC	Red
1745-LP152	85-132/170-265 VAC 50/60 Hz	170-265 VAC 50/60Hz Current Sinking	10 Triac – 85-265 VAC 50/60 Hz 2 Hard Contact – 10-250VAC/10-125VDC	Black
1745-LP153	85-132/170-265 VAC 50/60 Hz	10-30 VDC Current Sinking	12 Hard Contact – 10-250VAC/10-125VDC	Blue
1745-LP154	18-30 VDC	10-30 VDC Current Sinking	10 PNP Transistor – 10-50 VDC 2 Hard Contact – 10-250VAC/10-125VDC	Green
1745-LP156	85-132/170-265 VAC 50/60 Hz	10-30 VDC Current Sourcing	12 Hard Contact – 10-250VAC/10-125VDC	Purple
1745-LP157	18-30 VDC	10-30 VDC Current Sourcing	10 NPN Transistor – 10-50 VDC 2 Hard Contact – 10-250VAC/10-125VDC	Yellow

* Color patch appears in the upper right corner of the unit, above the cluster of LED status indicators.

Maximum Power Requirement:
1745-LP151, -LP152, -LP153, -LP156: 25 VA.
1745-LP154, -LP157: 15 VA.

Input Power Fuse Protection:
1745-LP151, -LP152, -LP153: 315mA/250V.
1745-LP154: 1.6A/250V.
Fuse Types: SAN-O: SOC SD4.
Bussman: MDL, or GDC (miniature).

Hold-Up Time:
The processor can sustain operation for a minimum of 25 milliseconds in the event of a power interruption.

I/O Capacity:
20 inputs and 12 outputs. See table above.

Input specifications: Page 14.
Output specifications: Pages 15 and 16.

Memory Type: CMOS RAM.

Standard Capacitor Back-up: Provides memory back-up for 2 weeks at 30°C and 1 week at 60°C. No maintenance required.

Note: If the processor unit is operated in temperatures above 50°C for extended periods of time, capacitor life cannot be guaranteed beyond 2 years. For these applications, we recommend that you install the Lithium battery for memory back-up.

Optional Battery Back-up: Catalog No. 1745-B1. Lithium battery, non-rechargeable. 2 to 3 year life. Actual life may vary, depending on controller environmental conditions.
Installation: Page 18.

User Memory Size: 1200 words max. Most instructions require 1 word.

Typical Scan Time: 4 msec (1000 word program).

Internal Relay Type Instructions:
177 max. (regular or latched).

Timers, Counters, Sequencers:
32 max, any combination, retentive.

Time Base: 0.1 sec. Fine time bases down to 0.01 second can be selected.

Timer Range:
0.1 to 999.9 seconds.

Sequencer Capacity:
8 bits x 100 steps.

Shift Register:
8 bit groups.

Noise Immunity:
NEMA Standard ICS 2-230.

Vibration:
0.015 inch peak to peak displacement, 2.5g peak(max) acceleration, 1 Hr/axis.

Ambient Temperature Rating:
0° to 60° C (operating).
– 40° to 85° C (storage).

Humidity Rating:
5 to 95% (without condensation).

Wiring:
#14 - #24 AWG stranded.
3/64" insulation (max).

Input Specifications

Input specifications are shown below. All input circuits include optical isolation as well as filtering to guard against high voltage transients from external input devices.

ON State Voltage Range and Frequency:
1745-LP151: 85-132 VAC, 47-63 Hz.
1745-LP152: 170-265 VAC, 47-63 Hz.
1745-LP153, -LP154, -LP156, -LP157: 10-30VDC.

Maximum OFF State Voltage:
1745-LP151: 30V.
1745-LP152: 50V.
1745-LP153, -LP154, -LP156, -LP157: 4V.

Maximum OFF State Leakage Current:
1745-LP151, -LP152: 2 mA.
1745-LP153, -LP154, -LP156, -LP157: 1mA.

Nominal Input Current:
1745-LP151, -LP152: 8 mA.
1745-LP153, -LP154, -LP156, -LP157: 4 mA at 12VDC, 8mA at 24VDC.

Input Filter Time ON Delay:
1745-LP151, -LP152: 3 to 13 msec.
1745-LP153, -LP154, -LP156, -LP157: 4 to 8 msec.

Input Filter Time OFF Delay:
1745-LP151, -LP152: 9 to 18 msec.
1745-LP153, -LP154, -LP156, -LP157: 4 to 8 msec.

Electrical-Optical Isolation:
1500 volts between input voltage and control logic. Applies to all catalog numbers.

Output Specifications

TRIAC OUTPUTS, 1745-LP151, -LP152
(Hard contact relay outputs: Page 16)

Output Voltage Range: 85-265 VAC.

Continuous Output Current per Circuit:
1A at 30°C, linearly derated to 0.5A at 60°C.

Continuous Output Current per Chassis:
10A at 30°C, linearly derated to 5A at 60°C.

Surge Current:
10A for 25 msec. Repeat once each second at 30°C, or once each 2 seconds at 60°C.

Minimum Load Current: 10 mA.

Maximum OFF State Leakage Current: 2 mA.

OFF to ON Response Time (non-zero cross): 0.1 msec (max).

Zero-Cross Turn-on Timing Accuracy: ± 500 microseconds.

Saturation Voltage Drop: 1.5 volts at 1.0A.

Electrical-Optical Isolation:
1500 volts between output voltage and control logic.

Recommended Output Fusing for Short Circuit Protection:
San-O SOC ST4-3A or equivalent.

TRANSISTOR OUTPUTS, 1745-LP154, -LP157
(Hard contact relay outputs: Page 16)

Output Voltage Range: 10-50 VDC.

Continuous Output Current per Circuit:
1A at 30°C, linearly derated to 0.5A at 60°C.

Continuous Output Current per Chassis: 10A at 30°C. 5A at 60°C.

Surge Current:
3A for 20 msec. Repeat once each second at 30°C, or once each 2 seconds at 60°C.

Minimum Load Current: 1.0 mA.

Maximum OFF State Leakage Current: 0.1 mA.

OFF to ON Response Time: 100 microseconds.

Maximum ON State Voltage Drop:
1.5 volts at 1.0A. 0.8 volts at 0.5A.

Electrical-Optical Isolation:
1500 volts between output voltage and control logic.

Recommended Output Fusing for Short Circuit Protection:
San-O SOC ST4-2A or equivalent.

Output Specifications *(continued)*

Specifications for hard contact relay outputs are shown below. We recommend that you use some type of surge suppression when switching inductive load devices with hard contact outputs. Refer to Page 12.

HARD CONTACT RELAY OUTPUTS

Wiring Terminals, Internal Arc Suppression:

Catalog Number	Hard Contact Relay Outputs
1745-LP151 1745-LP152 1745-LP154 1745-LP157	Units have 2 hard contact relay outputs, at terminals 11 and 111. These outputs do *not* have internal arc suppression circuitry.
1745-LP153 1745-LP156	Units have 12 hard contact relay outputs. Relay outputs at terminals 12 thru 16 and 112 thru 116 have internal arc suppression circuitry. Relay outputs at terminals 11 and 111 do *not* have internal arc suppression circuitry.

Voltage Range and Frequency:
10-250 VAC (50/60 Hz), 10-125 VDC.

Contact Ratings:

Maximum Volts	Amperes		Amperes Continuous	Voltamperes	
	Make	Break		Make	Break
240VAC 120VAC	7.5A 15A	0.75A 1.5A	2.5A	1800VA	180VA
125VDC	0.22A		1.0A	28VA	
24VDC	1.2A		2.5A	28VA	

Contact Resistance: 20 mΩ (typical).

Electrical Isolation:
2000 volts between output contacts and control logic.

OFF State Leakage Current:
Outputs at terminals 11 and 111 (all catalog numbers): No leakage current.

Outputs at terminals 12 thru 16 and 112 thru 116 of 1745-LP153 and 1745-LP156: 2mA (AC voltage only). To limit leakage current, use a loading resistor across the load as shown on Page 11.

Output Fusing for Overload Protection:
Bussman 3A, 250VAC slow blow or equivalent.

Fuse Replacement

If the power supply fuse of the unit is blown, the DC Power indicator will not illuminate as it does during normal operation. The fuse could be blown because of excessive line voltage or because of an internal power supply malfunction.

After the conditions causing the malfunction have been corrected, the fuse can be replaced. The fuse compartment is located in the upper left corner, next to the incoming power wiring terminals.

> **WARNING:** Contact with AC line potential can cause injury to personnel. Remove system power before removing the fuse compartment cover.

Replacement procedure:

1. Remove the fuse compartment cover.
2. Remove the fuse holder by pushing the handle to the left, then pulling outward.
3. Remove the fuse from its holder and replace it with a recommended replacement fuse.

> **CAUTION:** Use only replacement fuses of the type and rating specified for the unit. Improper fuse selection may result in equipment damage.

4. Place the fuse holder back into its compartment by pushing inward until it locks into place. You may first have to shift the position of the wires.
5. Replace the fuse compartment cover.
6. Restore power. The DC Power indicator should now illuminate.

Terminal Block Removal

The wiring terminal blocks can be removed to allow replacement of the processor unit without removing power supply, input, or output wiring.

To remove a terminal block, back out the two screws located at the ends of the terminal block. Alternate between the two screws, backing out about five turns at a time. This will help avoid binding.

To replace the terminal block, align the terminal block screws with the holes on the chassis. Alternate between the two screws, as you did when removing the terminal block. Press on the center of the terminal block as you tighten the screws to help guard against an improper seat.

Battery Installation or Replacement

You can install or replace the battery, Catalog No. 1745-B1, without disconnecting power or disturbing normal operation of your machinery. Procedure:

1. Remove battery compartment door from the front of the processor unit.
2. If you are **installing** a battery in a new processor unit (battery never installed before), unplug the battery connector and lead wires (red and white) by inserting your finger into the compartment and pulling up on the lead wires. If this cannot be done with a finger, you may wish to use a needle nose pliers to pull out the lead wires.

2a. If you are **replacing** an old battery, remove the battery assembly stored in the compartment. To do this, first pull up on the lead wires and remove them from the compartment. The battery is held in place by a small retainer clip on the right of the battery. Apply pressure on the left of the battery with a small screwdriver or other small tool to push the battery against the clip while pulling the lead wires up at the same time. This will allow the battery to be pulled straight out of the compartment. Unplug female from male end of connector to disconnect old battery.

3. Connect a new battery making sure that the slot on the battery assembly connector aligns with the key of the processor unit socket.
4. Insert battery into compartment minus side first (white lead wire). Push the retainer clip to the side with the battery while inserting so that the battery will fall to the bottom of the compartment and stay in place with the clip.
5. Place battery connector and lead wires in compartment.
6. Replace compartment door.

ALLEN-BRADLEY
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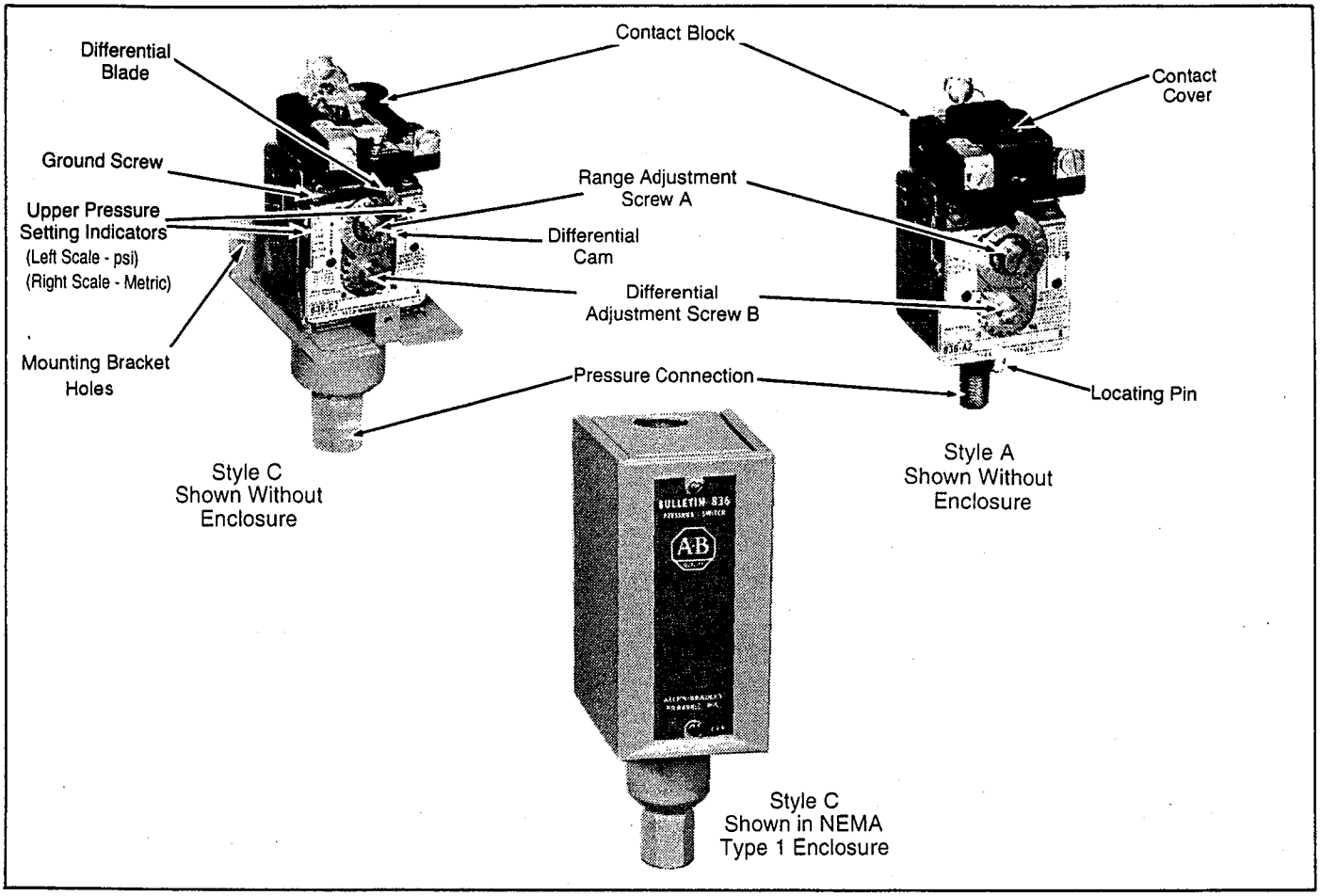
Industrial Control Group
Milwaukee, Wisconsin 53204

Printed
in
Japan

ALLEN-BRADLEY CO.

PRESSURE SWITCH

PRESSURE CONTROLS



DESCRIPTION - Bulletin 836 Pressure Controls are designed for use with air, water, oil and other noncorrosive liquids, vapors, and gases. (Type 316 stainless steel bellows are available for more corrosive liquids or gases in pressure ranges to 375 psi.)

Bulletin 836 Controls are available in NEMA Type 1, 4, 4X, 7, 9, and 13 enclosures in addition to open type. The operating range pressure and differential are adjustable. Fixed differential versions are also available. Pressure ranges available from 30 in. Hg. vacuum to 900 psi.

The standard contact block is single pole, double throw and can be wired to open or close on increasing or decreasing pressure.

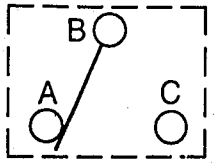
CONTACT RATINGS

Non-Inductive Ratings	Control Circuit Ratings
5 Amperes, 250 Volts	AC-125 VA 24 to 600 Volts
3 Amperes, 600 Volts	DC-57.5 VA 115 to 230 Volts

Manual reset, horsepower rated and other contact block modifications are also available on devices manufactured at the factory.

OPERATION - A low friction, straight in-line mechanism operates a snap action switch at a predetermined pressure setting. An increase in pressure causes the normally closed circuit A-B to open and normally open circuit B-C to close. This is known as the "Trip" pressure. When the pressure returns to a lower predetermined setting, the circuit A-B will close and circuit B-C will open. This is known as the "Reset" pressure. The difference between the "Trip" and "Reset" pressure is the differential.

For controls which operate in a vacuum, the following sequence occurs: 1) an increase in vacuum (lower pressure toward 30 in. Hg), causes circuit A-B to close and B-C to open. This is the "Trip" setting. 2) when the pressure returns to a predetermined lower vacuum (higher pressure toward 0 psi.), circuit A-B will open and circuit B-C will close. This is the "Reset" point. The difference between the "Trip" and "Reset" setting is the differential.



Standard Contact Arrangement For Positive Pressure

ADJUSTMENT- Generally, unless otherwise specified, controls shipped from the factory are set at the maximum operating range pressure and minimum differential. The following procedure should be used to set the control to a particular requirement:

OPERATING RANGE ADJUSTMENT- Turn range adjustment Screw "A" counterclockwise to lower the upper and lower pressure settings. To increase the upper and lower settings, turn Screw "A" clockwise. The approximate upper pressure setting is shown by indicators on the outer edges of the nameplate.

DIFFERENTIAL ADJUSTMENT- When differential blade is at the low point of the differential cam the control will function at minimum differential. To increase the differential, turn adjustment Screw "B" counterclockwise. This will decrease the lower pressure setting only. To decrease the differential, turn differential adjustment Screw "B" clockwise. This will raise the lower setting only.
Condensed instructions are supplied with open style controls and are on the inside of the cover on enclosed devices.

NOTE: The use of a pressure gauge is desirable when setting the control.

CAUTION: The range adjustment Screw "A" should not be adjusted beyond the pressure indicated on the pressure scale as this may cause the control to malfunction.

It is recommended that a periodic inspection of gauge pressure be made and the pressure control adjusted to compensate for application variables.

BELLOWS LIFE - The pressure applied to a bellows in a normal cycle of operation should not exceed the maximum rated Range Pressure. The bellows will withstand the rated Maximum Line Pressure but should not be cycled at this pressure. The control is designed to operate within published rated Range Pressure. For general applications a control used within 30% to 80% of Range Pressure will provide optimum bellows life and repeatability.

IMPORTANT: Bulletin 836 Style A pressure controls are normally supplied with a built in pulsation snubber. Bulletin 836 Style C devices are supplied with a removable snubber. The snubber can be removed for inspection, cleaning, or when using the control with high viscosity fluids. The snubber can be removed with a 1/4 inch nut wrench, or equivalent.

The pulsation snubber is designed to help reduce pressure transients. Transients can vary in amplitude, frequency, and duration and if not controlled with a snubber can reduce bellows life.

Pressure systems and lines must be maintained and kept free of foreign particles in air lines and sludge in fluid lines. A restricted or clogged pulsation snubber can cause the pressure control to become inoperative.

MOUNTING- The pressure control should be mounted securely to a firm base using two mounting screws. The mounting holes are provided either in the base of the enclosure or in a convenient mounting bracket which is provided as part of the open Style C control. Mounting brackets are available for the open type Style A control.

CAUTION: The control should not be supported by the electrical and pressure connections only. A support wrench should be used when tightening the electrical hub and pressure connections.
The enclosed device or open type control using a mounting bracket is not intended to support connecting equipment. This equipment must be secured to support weight and to reduce vibration.

CAUTION: If a liquid thread sealant is used on the pressure connection, care must be taken to avoid excess sealant from getting into bellows orifice.

PILOT LIGHT OPTION – A high intensity neon glow pilot light is available for 120 volt, 60 hertz applications. A 24 volt DC LED pilot light is also available. The pilot light is factory wired across the N.C. contacts, circuit A-B, and can easily be converted to the N.O. contacts, circuit B-C, on the standard contact block.

Unless a third wire is made available, the pilot light is connected across the load contacts which can be either the N.O. or N.C. contacts. The pilot light is on until the load is energized.

Current rating:

120 VAC high intensity neon glow --- 4 mA
24 VDC high intensity LED ---- 22 mA

WARNING: To prevent electrical shock, disconnect from power source before installing or servicing.

CAUTION: For 24 VDC LED pilot lights, polarity must be observed. Red (+) lead of pilot light should always be connected to rear terminal (B).

To order pilot light version add X9 (120VAC) or X15 (24VDC) to catalog number of the selected control.

REPAIRS – Due to the integral construction of the Bulletin 836 Pressure Control, only limited repairs can be made in the field. If returned to the factory for repairs, the condition of the control will be evaluated to determine economic feasibility. When practical, the control will be repaired, factory adjustments made for optimum performance and tested to specifications.

CONTACT BLOCK REPLACEMENT – To order the Bulletin 836 Contact Block Replacement Kit, specify Catalog No. 836-N2.

40060-217-01 (C)
Printed in U.S.A.

ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY

AMETEK

PRESSURE GAUGE

0-15 PSIG RANGE

WARNING—*Misuse of this product may cause explosion and personal injury. Do not use without first reading and understanding these instructions and the apparatus installation and operating instructions.*

AMETEK U.S. GAUGE DIVISION
HUNTER SPRING PRODUCTS
SELLERSVILLE, PENNSYLVANIA 18960

USE AND INSTALLATION OF PRESSURE GAUGES

The following information on installation and use has been excerpted from ASME B40.1-1991. The complete ASME B40.1-1991 standard which contains additional information may be obtained from the American Society of Mechanical Engineers, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300

3.3.4 Pressure Connection

3.3.4.1 Location of Connection
(a) stem mounted - bottom or back
(b) surface mounted - bottom or back
(c) flush mounted - back

3.3.4.2 Type of Connection. Taper pipe connections for pressures up through 20,000 psi (140,000 kPa) are usually 1/8-27 NPTF, or 1/2-14NPT American Standard external or internal taper pipe threads per ANSI/ASME B1.20.1, as required. Above this pressure, 1/4 high pressure taper connections, or equal, may be used. Other appropriately sized connections, employing sealing means other than tapered threads, are acceptable.

In applications of stem mounted gauges, especially with liquid filled cases and where vibration is severe, consideration should be given to the possibility of failure of the stem or associated piping caused by the vibrating mass of the gauge. A large connection (e.g., 1/2 NPT instead of 1/4 NPT) or a stronger stem material (e.g., stainless steel instead of brass), or both, should be considered.

3.4.1.10 Mounting a pressure gauge in a position other than that at which it was calibrated can affect its accuracy. Normal calibrating position is upright and vertical. For applications requiring mounting in other than this position, notify the supplier.

3.4.1.12 Caution to Users.
Pressure gauges can be rendered inaccurate during shipment despite care taken in packaging. To ensure conformance to the standard grade to which the pressure gauge was manufactured, it should be checked before use.

4 SAFETY
4.1 Scope
This Section of the Standard presents certain information to guide users, suppliers, and manufacturers toward minimizing the hazards that could result from misuse or misapplication of pressure gauges with elastic elements. The user should become familiar with all sections of this Standard, as all aspects of safety cannot be covered in this Section. Consult the manufacturer or supplier for advice whenever there is uncertainty about the safe application of a pressure gauge.

4.2 General Discussion
4.2.1 Adequate safety results from intelligent planning and careful selection and installation of gauges into a pressure system. The user should inform the supplier of all conditions pertinent to the application and environment so that the supplier can recommend the most suitable gauge for the application.

4.2.2 The history of safety with respect to the use of pressure gauges has been excellent. Injury to personnel and damage to property have been minimal. In most instances, the cause of failure has been misuse or misapplication.

4.2.3 The pressure sensing element in most gauges is subjected to high internal stresses, and applications exist where the possibility of catastrophic failure is present. Pressure regulators, chemical (diaphragm) seals, pulsation dampers or snubbers, syphons, and other similar items, are available for use in these potentially hazardous systems. The hazard potential increases at higher operating pressure.

4.2.4 The following systems are considered potentially hazardous and must be carefully evaluated:
(a) compressed gas systems
(b) oxygen systems
(c) systems containing hydrogen or free hydrogen atoms
(d) corrosive fluid systems (gas and liquid)
(e) pressure systems containing any explosive or flammable mixture or medium
(f) steam systems
(g) nonsteady pressure systems
(h) systems where high overpressure could be accidentally applied
(i) systems wherein interchangeability of gauges could result in hazardous internal contamination or where lower pressure gauges could be installed in higher pressure systems
(j) systems containing radioactive or toxic fluids (liquids or gases)
(k) systems installed in a hazardous environment

4.2.5 When gauges are to be used in contact with media having known or uncertain corrosive effects or known to be radioactive, random or unique destructive phenomena can occur. In such cases the user should always furnish the supplier or manufacturer with information relative to the application and solicit his advice prior to installation of the gauge.

4.2.6 Fire and explosions within a pressure system can cause pressure element failure with very violent effects, even to the point of completely disintegrating or melting the pressure gauge. Violent effects are also produced when failure occurs due to:
(a) hydrogen embrittlement
(b) contamination of a compressed gas;
(c) formation of acetylides;
(d) weakening of soft solder joints by steam or other heat sources;
(e) weakening of soft soldered or silver brazed joints caused by heat sources such as fires;
(f) corrosion;
(g) fatigue;
(h) mechanical shock;
(i) excessive vibration.

Failure in a compressed gas system can be expected to produce violent effects.

4.2.7 Modes of Pressure Gauge Failure

4.2.7.1 Fatigue Failure. Fatigue failure caused by pressure induced stress generally occurs from the inside to the outside along a highly stressed edge radius, appearing as a small crack that propagates along the edge radius. Such failures are usually more critical with compressed gas media than with liquid media.

Fatigue cracks usually release the media fluid slowly so case pressure buildup can be averted by providing pressure relief openings in the gauge case. However, in high pressure elastic elements where the yield strength approaches the ultimate strength of the element material, fatigue failure may resemble explosive failure.

A restrictor placed in the gauge pressure inlet will reduce pressure surges and prevent fluid flow into the partially open Bourdon tube.

4.2.7.2 Overpressure Failure. Overpressure failure is caused by the application of internal pressure greater than the rated limits of the elastic element and can occur when a low pressure gauge is installed in a high pressure part or system. The effects of overpressure failure, usually more critical in compressed gas systems than in liquid filled systems, are unpredictable and may cause parts to be propelled in any direction. Cases with pressure relief openings will not always retain expelled parts.

Placing a restrictor in the pressure gauge inlet will not reduce the immediate effect of failure, but will help control flow of escaping fluid following rupture and reduce potential of secondary effects.

It is generally accepted that solid front cases with pressure relief back will reduce the possibility of parts being projected forward in the event of failure.

The window alone will not provide adequate protection against internal case pressure buildup, and can be the most hazardous component.

Short duration pressure impulses (pressure spikes) may occur in hydraulic or pneumatic systems, especially when valves open or close. The magnitude of the spikes may be many times the normal operating pressure, and may not be indicated by the gauge. The result could be immediate failure, or a large upscale error. A restrictor (snubber) may reduce the magnitude of the pressure transmitted to the elastic element.

4.2.7.3 Corrosion Failure. Corrosion failure occurs when the elastic element has been weakened through attack by corrosive chemicals present in either the media inside or the environment outside it. Failure may occur as pinhole leakage through the element walls or early fatigue failure due to stress cracking brought about by chemical deterioration or embrittlement of the material.

A chemical (diaphragm) seal should be considered for use with pressure media that may have a corrosive effect on the elastic element.

4.2.7.4 Explosive Failure. Explosive failure is caused by the release of explosive energy generated by a chemical reaction such as can result when adiabatic compression of oxygen occurs in the presence of hydrocarbons. It is generally accepted that there is no known means of predicting the magnitude or effects of this type of failure. For this mode of failure, a solid wall or partition between the elastic element and the window will not necessarily prevent parts being projected forward.

4.2.7.5 Vibration Failure. The most common mode of vibration failure is that where the movement parts wear because of high cyclic loading caused by vibration, resulting in gradual loss of accuracy, and ultimately failure of the pointer to indicate any pressure change.

4.2.7.6 Vibration-Induced Fatigue Failure. In addition to its effect on the gauge movement and linkage (see para. 4.2.7.5) vibration may, in some instances, result in high loading of various parts of the pressure element assembly. This loading could cause cracks in the element itself, or in joints. Case pressure buildup may be slow, but it is possible that a large hole may suddenly develop, with a high rate of case pressure rise, which could result in a failure similar to an explosive failure.

4.2.8 Pressure Connection. See recommendations in para. 3.3.4.

4.3 Safety Recommendations
4.3.1 Operating Pressure. The pressure gauge selected should have a full scale pressure such that the operating pressure occurs in the middle half (25 to 75%) of the scale. The full scale pressure of the gauge selected should be approximately two times the intended operating pressure.

Should it be necessary for the operating pressure to exceed 75% of full scale, contact the supplier for recommendations.
This does not apply to test, retarded, or suppressed scale gauges.

4.3.2 Use of Gauges Near Zero Pressure.
The use of gauges near zero pressure is not recommended because the accuracy tolerance may be a large percentage of the applied pressure. If for example, a 0/100 psi Grade B gauge is used to measure 6 psi, the accuracy of measurement will be +/- 3 psi, or +/- 50% of the applied pressure. In addition, the scale of a gauge is often laid out with takeup, which can result in further inaccuracies when measuring pressures that are a small percentage of the gauge span.

For the same reasons, gauges should not be used for the purpose of indicating that the pressure in a tank, autoclave, or other similar unit has been completely exhausted to atmospheric pressure. Depending on the accuracy and the span of the gauge and the possibility that takeup is incorporated at the beginning of the scale, hazardous pressure may remain in the tank even though the gauge is indicating zero pressure. A venting device must be used to completely reduce the pressure before unlocking covers, removing fittings, or performing other similar activities.

4.3.3 Compatibility With the Pressure Medium
The elastic element is generally a thin walled member, which of necessity operates under high stress conditions and must; therefore, be carefully selected for compatibility with the pressure medium being measured. None of the common element materials is impervious to every type of chemical attack. The potential for corrosive attack is established by many factors, including the concentration, temperature, and contamination of the medium. The user should inform the gauge supplier of the installation conditions so that the appropriate element materials

(Excerpt from ASME B40.1-1991 continues on back)

can be selected.

4.3.4 In addition to the factors discussed above, the capability of a pressure element is influenced by the design, materials, and fabrication of the joints between its parts.

Common methods of joining are soft soldering, silver brazing, and welding. Joints can be affected by temperature, stress, and corrosive media. Where application questions arise, these factors should be considered and discussed by the user and manufacturer.

4.3.5 Some special applications require that the pressure element assembly have a high degree of leakage integrity. Special arrangement should be made between manufacturer and user to assure that the allowable leakage rate is not exceeded.

4.3.6 Cases

4.3.6.1 Case, Solid Front. It is generally accepted that a solid front case per para. 3.3.1 will reduce the possibility of parts being projected forward in the event of elastic element assembly failure. An exception is explosive failure of the elastic element assembly.

4.3.6.2 Cases, Liquid Filled. It has been general practice to use glycerine or silicone filling liquids. However, these fluids may not be suitable for all applications. They should be avoided where strong oxidizing agents including, but not limited to, oxygen, chlorine, nitric acid, and hydrogen peroxide are involved. In the presence of oxidizing agents, potential hazard can result from chemical reaction, ignition, or explosion. Completely fluorinated or chlorinated fluids or both, may be more suitable for such applications.

The user shall furnish detailed information relative to the application of gauges having liquid filled cases and solicit the advice of the gauge supplier prior to installation.

Consideration should also be given to the instantaneous hydraulic effect that may be created by one of the modes of failure outlined in para 4.2.7. The hydraulic effect due to pressure element failure could cause the window to be projected forward even when a case having a solid front is employed.

4.3.7 Restrictor. Placing a restrictor between the pressure connection and the elastic element will not reduce the immediate effect of failure, but will help control flow of escaping fluid following rupture and reduce the potential of secondary effects.

4.3.8 Specific Service Conditions

4.3.8.1 Specific applications for pressure gauges exist where hazards are known. In many instances, requirements for design, construction, and use of gauges for these applications are specified by state or federal agencies or Underwriters Laboratories, Inc. Some of these specific service gauges are listed below. The list is not intended to include all types, and the user should always advise the supplier of all application details.

4.3.8.2 Acetylene Gauge. A gauge designed to indicate acetylene pressure. It shall be constructed using materials that are compatible with commercially available acetylene. The gauge may bear the inscription ACETYLENE on the dial.

4.3.8.3 Ammonia Gauge. A gauge designed to indicate ammonia pressure and to withstand the corrosive effects of ammonia. The gauge may bear the inscription AMMONIA on the dial. It may also include the equivalent saturation temperature scale markings on the dial.

4.3.8.4 Chemical Gauge. A gauge designed to indicate the pressure of corrosive or high viscosity fluid, or both. The primary material(s) in contact with the pressure medium may be identified on the dial. It may be equipped with a chemical (diaphragm) seal, pulsation damper, or pressure relief device, or a combination. These devices are to minimize potential damage to personnel and property in the event of gauge failure. They may, however, also reduce accuracy or sensitivity, or both.

4.3.8.5 Oxygen Gauge. A gauge designed to indicate oxygen pressure. Cleanliness shall comply with Level IV (see Section 5). The dial shall be clearly marked with a universal symbol and/or USE NO OIL in red color (see para. 5.1.2.1).

4.4 Reuse of Pressure Gauges

It is not recommended that pressure gauges be moved from one application to another. Should it be necessary, however, the following must be considered.

4.4.1 Chemical Compatibility. The consequences of incompatibility can range from contamination to explosive failure. For example, moving an oil service gauge to oxygen service can result in explosive failure.

4.4.2 Partial Fatigue. The first installation may involve pressure pulsation that has expended most of the gauge life, resulting in early fatigue in the second installation.

4.4.3 Corrosion. Corrosion of the pressure element assembly in the first installation may be sufficient to cause early failure in the second installation.

4.4.4 Other Considerations. When reusing a gauge, all guidelines covered in this Standard relative to application of gauges should be followed in the same manner as when a new gauge is selected.

In addition to the ASME B40.1-1991 standard, the following additional instructions and warnings should be read and understood before using this product.

A very important aspect of selecting and installing pressure gauges is the consideration of the hazards that will result in the event the gauge fails. The primary causes of failure are misapplication and/or abuse of the gauge. Those people who are responsible for the selection and installation of pressure gauges must recognize conditions which will adversely affect the ability of the gauge to performits function or which will lead to early failure. These conditions may then be discussed with the manufacturer to obtain their recommendations.

Failure may consemate:

1. Loss of accuracy.
2. Clogging of the pressure port, or damage to the internal mechanism so that there is either:
   a. no indication when pressure is applied or
   b. there is an indication of pressure even though none is applied.
3. A leak in the pressure containing parts or joints.
4. A crack or fatigue failure of the bourdon.
5. Bursting of the bourdon due to severe overpressure.
6. An explosion within the system due to a chemical reaction of the pressure medium with contaminants causing the bourdon to explode.

When specifying, using or installing a pressure gauge, the following factors must be given attention:

1. Operating Pressure
Do not continuously operate the gauge at more than 75% of the span. Bourdon tubes are necessarily highly stressed, especially in ranges over 1000 psi and continuous operation at full scale will result in early fatigue failure and subsequent rupture.

2. Materials
Be certain the materials of the pressure containing portions of the gauge are compatible with the pressurized medium. Gauges are commonly made of copper alloys (brass, bronze, etc.) and may be subject to stress corrosion or chemical attack. Bourdons have relatively thin walls, and the accuracy of the indication is directly affected by any reduction in the wall thickness. Use of the same material for the bourdon as used for the tank or associated piping is not necessarily good practice. A material having a corrosion rate of .001"/year may be suitable for the piping, but will be entirely unsuitable for a bourdon having a wall thickness of, for example, .008 inches. It is imperative that the proper bourdon material be selected for the service on which the gauge is used. Gauges specially constructed for corrosion service are available.

3. Cyclic Pressure and Vibration
Continuous, rapid pointer motion will result in excessive wear of the internal mechanism and cause gross errors in the pressure indicated and possibly early fatigue failure of the bourdon. If the pointer motion is due to mechanical vibration, the gauge must be remotely mounted on a non-vibrating surface and connected to the apparatus by flexible tubing. If the pointer motion is due to pressure pulsations, a suitable damper must be used between the pressure source and the gauge.

4. Fatigue
As with any spring, the bourdon will fail after extended use and release the pressurized medium. The larger the number of applied pressure cycles and the greater the extent of the pressure cycle, the earlier failure will occur. The fatigue failure may be explosive. Since such a failure will be hazardous to personnel or property, precautions must be taken to contain or direct the release of the pressurized medium in a safe manner.

5. Frequency of Accuracy Evaluation
Where the pressure measurement is critical and gauge failure or gross inaccuracy will result in injury to personnel or property, the gauge should be checked for accuracy and proper operation on a periodic basis.

6. Use with Oxygen
Gauges used for measurement of oxygen pressure must be free of contamination within the pressure containing portion. Various levels of cleanliness are specified in ANSI B40.1. The gauge itself and the equipment to which the gauge is attached (pressure regulators, cylinders, etc.) must be kept clean so as not to contaminate the gauge. Filters on the equipment must be examined periodically and cleaned or replaced. The sudden in-rush of a high pressure gas will momentarily create a very high temperature which in the presence of oxygen may ignite the contaminant causing a violent explosion. Therefore, when the valve on the oxygen supply tank is opened, to admit oxygen to the regulator, the valve should be opened very slowly so as to allow the pressure to build up slowly. In order to accomplish this it is recommended that the tank valve be opened momentarily and then closed snugly but not excessively before attaching the regulator. This will not only blow out accumulated dirt in the valve, but will also place the valve in a condition that will permit it to be opened slowly rather than suddenly breaking loose as a result of being closed too tightly. When bleeding the oxygen tank prior to attaching the regulator, be certain the valve opening is directed away from any open flame and the operator. When opening the oxygen tank valve, the operator must not stand in front of or behind the gauge and must wear eye and face protection. In this position if there is an explosion due to contaminated equipment any parts as projected from the gauge will not be propelled directly at the operator.

7. Use with Hydrogen
Steel bourdons including 400 series stainless steel are subject to hydrogen embrittlement when stressed. Measurement of gas or liquids containing hydrogen (such as natural gas, sour oil) require the use of special materials for the bourdon.

8. Venting of Case
Vents provided in the pressure gauge case (clearance around pressure connection, rubber grommets, pressure relief back, etc.) must not be closed or restricted from operating. There is always the possibility that the pressure medium will be admitted to the case interior as a result of a leaking joint or bourdon tube failure. If this occurs, the pressure medium must be vented from the case so as not to build up sufficient pressure to rupture the case or window. However, venting will not prevent case rupture in the event of a violent explosion.

9. Liquid Filled Gauges
Performance of pressure gauges used in severe vibration or pulsating pressure service, can be improved by filling the gauge case with a viscous fluid. Gauges constructed in this manner necessarily require sealed cases to prevent the escape of the liquid. However, some means of venting the case must be provided. In some instances this vent is sealed to prevent loss of fluid during shipment, and must be released after the gauge is installed. Be certain to follow the installation instructions for properly venting the gauge after installation. The liquid filling most commonly used is a mixture of glycerin and water.

Glycerin can combine with strong oxidizing agents including (but not limited to) chlorine, nitric acid and hydrogen peroxide, and result in an explosion which can cause property damage and personal injury. If gauges are to be used in such service, do not use glycerin filled gauges; consult the factory for proper filling medium.

WARNING—Misuse of this product may cause explosion and personal injury. Do not use without first reading and understanding these instructions and the apparatus installation and operating instructions.

Important— Read other side for additional instructions and warnings.

Form #1421

AURORA

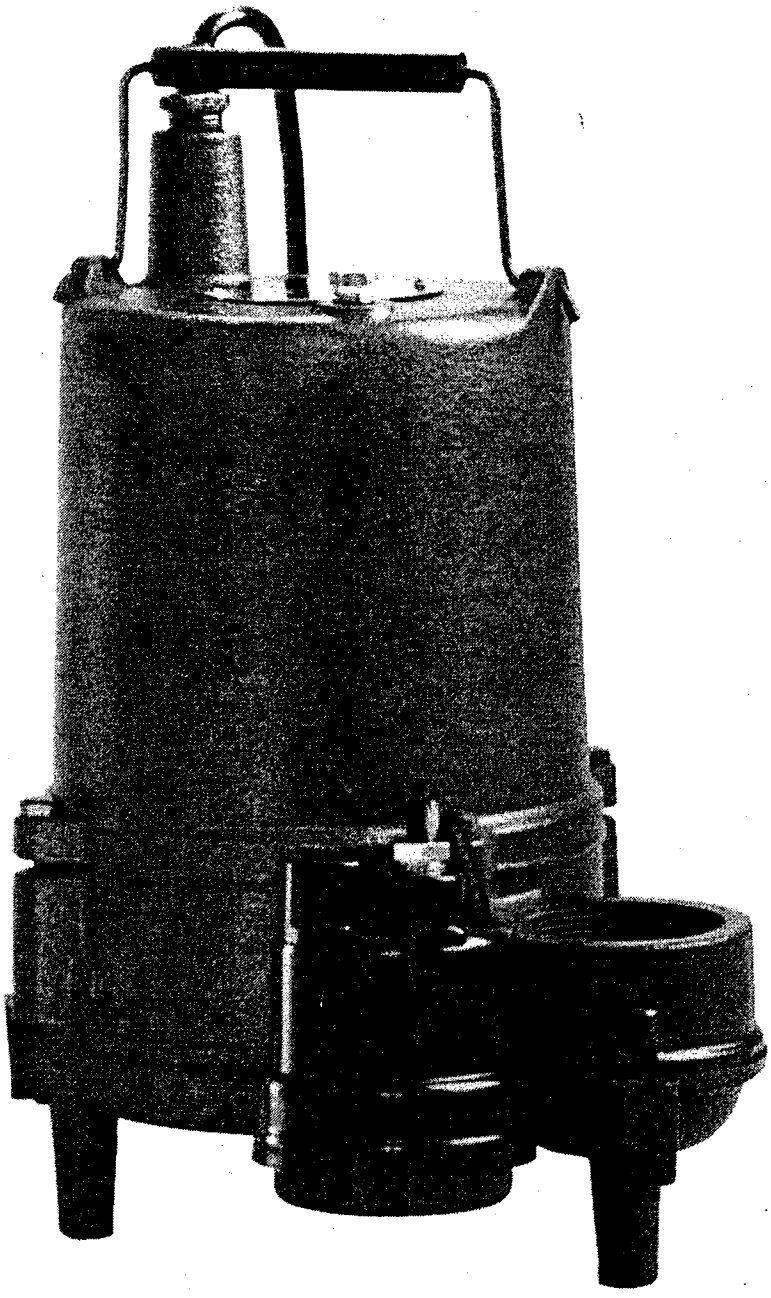
SUMP GROUND WATER RECOVERY PUMP

Installation and Service Manual

Part No.: 05625-246-1

HYDROMATIC SP40

Submersible Sewage Ejector Pump



NOTE!

To the installer: Please make sure you provide this manual to the owner of the pumping equipment or to the responsible party who maintains the system.

GS AURORA PUMP
A UNIT OF GENERAL SIGNAL

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1 Introduction

Before operation, read the following instructions carefully. Reasonable care and safe methods should be practiced. Check local codes and requirements before installation. Servicing should be performed by knowledgeable pump service contractors or authorized service stations.

Warning:
Read all instructions before starting any operation on pump. Always disconnect the pump and controls from its power source before handling or making any adjustments. Always wear rubber boots when there is water on the floor and you must unplug the pump to make any adjustments or repairs.

Warning:

Risk of Electrical Shock —
This pump has not been investigated for use in swimming pool areas.

To Reduce Risk of Electrical Shock:

1. Connect only to a properly grounded receptacle.
2. Septic tank to be vented in accordance with local plumbing codes.
3. Do not smoke or use sparkable electrical devices or flame in a septic (gaseous) or possible septic sump.
4. A septic sump condition may exist and if entry into sump is necessary, then (a) provide proper safety precautions per OSHA requirements and (b) do not enter sump until these precautions are strictly adhered to.

   Do not install pump in location classified as hazardous per N.E.C., ANSI/NFPA 70 - 1984.

Failure to heed above cautions could result in injury or death.

2 Installation

These important instructions must be followed for satisfactory performance of your pump. Before installation, check your local electrical and plumbing codes.

1. Provide proper sump size to allow the pump to operate without restrictions. A two- to five-minute run time is recommended. Also, minimum 24" diameter recommended.
2. Make sure sump is free of string, cloth, nails, gravel, etc. before installing pump.
3. Do not set pump directly on the bottom of sump pit if it is not solid. Raise the pump by placing bricks or concrete blocks underneath it.
4. Use steel or plastic pipe for all connecting lines between pump and sewer outlet.

   Note: Some city regulations do not allow installing a pump with plastic pipe. Check local regulations.
5. In applications where the pump may sit idle for months at a time, it is recommended that the pump(s) be cycled every month to insure the pumping system is working properly when needed.
6. A check valve should be installed in discharge pipe, at least 12" above the discharge outlet of the pump.
7. An audible alarm system, such as the Q Alert, for high water conditions should be installed in every pump for greater protection.

   Note: Q Alert alarm is for indoor use only. Contact your Hydromatic distributor for other panel applications.

   Warning: When using the automatic diaphragm switch the vent tube in the plug must be clear of obstructions.

   Do not bend cord. This will cause a crimp in the vent tube and switch failure will occur. Pump should be plugged into a single outlet, where vent tube can "breathe." Blocking tube or bending cord will void the warranty.
8. Connect to power source using 3-prong grounded AC receptacle. Do not remove ground pin from electrical plug. Do not use an extension cord.
9. For proper automatic operation (Model SP40A1 or SP40A2) make sure the pump power cord is plugged into the back of the piggyback receptacle on the diaphragm switch cord.
10. Use pump partially or completely submerged for pumping (temperature to 140° F). The SP40 will pump solid materials up to 1¼" (spherical) in diameter.
11. **Caution:** Do not pump flammable liquids, strong chemicals or salt water.

3 Typical Installation



4 Service

Servicing should be performed only by knowledgeable pump service contractors or authorized service stations.

1. **Remove pump from sump.** Before removing pump from sump pit for repair, check if the trouble could simply be a blown fuse, tripped circuit breaker, or a power cord not completely inserted into the receptacle.

2. **Check diaphragm switch.** If the unit is being operated by the automatic diaphragm switch, unplug the pump from the "piggyback" receptacle and plug the pump directly into the power source. If the pump starts each time it is plugged directly into the receptacle and does not start each time when plugged into the piggyback switch with the diaphragm switch pressed into a start position, replace the complete piggyback switch assembly and retest with new assembly.

3. **Check for impeller blockage.**

   Disconnect pump and switch from power source.

   Check for an obstruction in the impeller cavity by laying the pump on its side and inserting a screwdriver into impeller. Impeller should turn freely. If impeller is stuck then remove the 5 screws (27) to remove the suction base (26). If the impeller (25) does not rotate freely, clear the impeller and cavity walls before reassembling the base. Repeat Step 2.

4. **Check power cord.** If the above tests have not resolved the problem, it may be in the electrical components of the pump. Starting with the power cord (5), inspect for cuts or nicks in the insulation. If the cord is damaged – replace it!

5. **Check the oil.** Remove the pipe plug (4) in the top of the motor cover and drain oil into a clean, dry container. A milky appearance to the oil indicates that water has entered through either worn out or damaged seals (23, 24) or seal ring (20).

6. **Remove the motor cover.** Remove the four hex head cap screws (22). Use a screwdriver to pry the motor cover (19) from the volute case (21) at the fastening ears, being careful not to cut the seal ring (20) with the screwdriver or crack the motor cover. Lift the motor cover until it clears the stator (15).

7. **Check for short.** Disconnect the stator leads (7, 8) from the connector (6). Use an ohmmeter to check the continuity of the stator. If stator fails to pass the continuity test, it must be replaced.

   Ground check. Set ohmmeter scale pointer to R X 100K scale and check meter by putting both meter leads together and adjusting the needle knob until meter reads zero. If meter cannot be adjusted to zero it will indicate that batteries in meter must be replaced.

   Always make this test with the meter when scale pointer is set to a new scale before making any checks on motor.

   Now connect one meter lead to one blade terminal of stator and touch other meter lead to motor stator shell (30). If needle reads below 5 (500,000 ohms) stator must be dried out before reusing. To dry out, bake in 220° oven for 4 hours. Recheck after motor cools. If motor is new or thoroughly dry, needle of ohmmeter will not move on the ground test. This indicates a reading of 50 megohms or higher. One megohm is one million ohms.

   When making the ground test, if the needle goes clear to zero the motor probably has a wire touching the stator at some point and the stator will have to be replaced.

   Winding resistance test. If motor shows a satisfactory ground test, then the winding resistance must be checked. Use ohmmeter with scale pointer set on R X 1 scale. On this scale meter reads directly on ohms. Always check the meter with leads together as described above under ground test before making a reading of the winding.

   Connect one meter lead to the terminal with the brown wire connected underneath the terminal board. Connect the other lead to the terminal housing with the blue wire. Meter should read 1.2 to 1.4 ohms. This is the resistance of the main winding for a 115 volt stator. This reading for a 230 volt stator should be 4.8 to 5.9 ohms.

   Now connect one meter lead to the brown wire terminal and the other meter lead to the red wire beneath the terminal board. The meter should read 3.8 to 5.4 ohms for a 115 volt stator. For a 230 volt stator this reading should be 16 to 21 ohms. This is the resistance of the start winding.

4 Service Continued

Now connect the meter leads to the red wire and the blue wire and the meter reading should be the sum of the other two readings or 5.0 to 6.8 ohms for a 115 volt stator or 20.8 to 26.9 ohms for a 230 volt stator. If the readings obtained do not agree with those given, the stator is defective and must be replaced.

8. **Remove the stator.** To remove the stator, remove the four hex head screws (12) and the stator plate (13). Lift the stator off the volute case (21) and set aside.

9. **Remove the impeller.** To remove the impeller (25), hold the rotor (16) in your hand and tap the impeller with a plastic or rubber mallet so as to turn the impeller counter clockwise.

10. **Check the seal.** Remove the rotating portion of seal (24) from shaft (16) by inserting a screwdriver under the edge of the seal and lifting it off. Inspect the seal face for any nicks or an uneven seating of seal face. If any are present, replace the seal. (See Step 14.)

11. **Remove rotor and shaft.** Tap the rotor shaft (16) at the impeller end of the shaft with a plastic mallet to remove the rotor and shaft. Inspect the bearings (17). If they do not rotate freely and smoothly, they should be replaced.

    When new bearings are ready to be added onto the shaft, do not push on outer race of bearings. This will damage bearings. If a rotor and shaft is ordered from Hydromatic, the bearings will be supplied already pressed on the shaft.

12. **Remove seal.** Remove the old stationary portion of the seal (23) from the case (21) by inserting a screwdriver into the seal housing of the case from the top of the case and tapping lightly with a hammer. Clean the seal area of the case with a clean cloth.

13. **Reinstall the rotor and shaft assembly.** Push on outer race to seat bearing in volute case.

14. **Reinstall seal.** Apply a good lubricant to the new stationary portion of the seal (23) and press into the case (21). Coat the new rotating portion of seal with lubricant and press into place on the rotor shaft with the rubber ring facing the impeller.

15. **Reinstall impeller.** Add a drop of Locktite 222 to the shaft and screw the impeller on hand tight. The impeller will force the rotating portion of seal into position.

16. **Replace seal ring.** Remove the old square seal ring (20) from the volute and stretch on a new ring coated with O-ring lube.

    Do not roll the ring onto the volute or improper seating and water leakage into the motor housing will result.

17. **Reinstall the stator.** Place the stator (15) in the volute case (21) so the stator bolt holes line up. Lay the stator plate (13) on the stator (15) and line up with stator bolt holes. Put in the stator bolts (12) and tighten evenly to prevent cocking of the stator. Push the connectors of the power cord onto the stator terminals (7 and 8).

18. **Reinstall motor housing.** Tighten down the four hex head cap screws (22) evenly to prevent cocking of motor housing and achieving an uneven seal on the seal ring (20).

19. **Oil.** Fill the motor cap with high grade transformer oil just cover over (13) stator plate (.38 gallon).

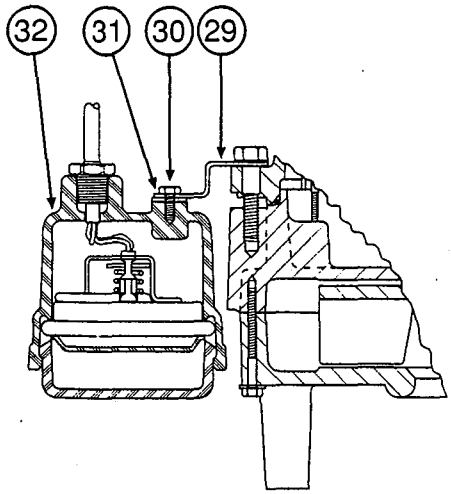
    Do not fill the motor housing completely – allow airspace for oil expansion.

20. **Reinstall oil pipe plug.** Coat pipe threads with thread sealant before installing. Plug (4) into housing (19).

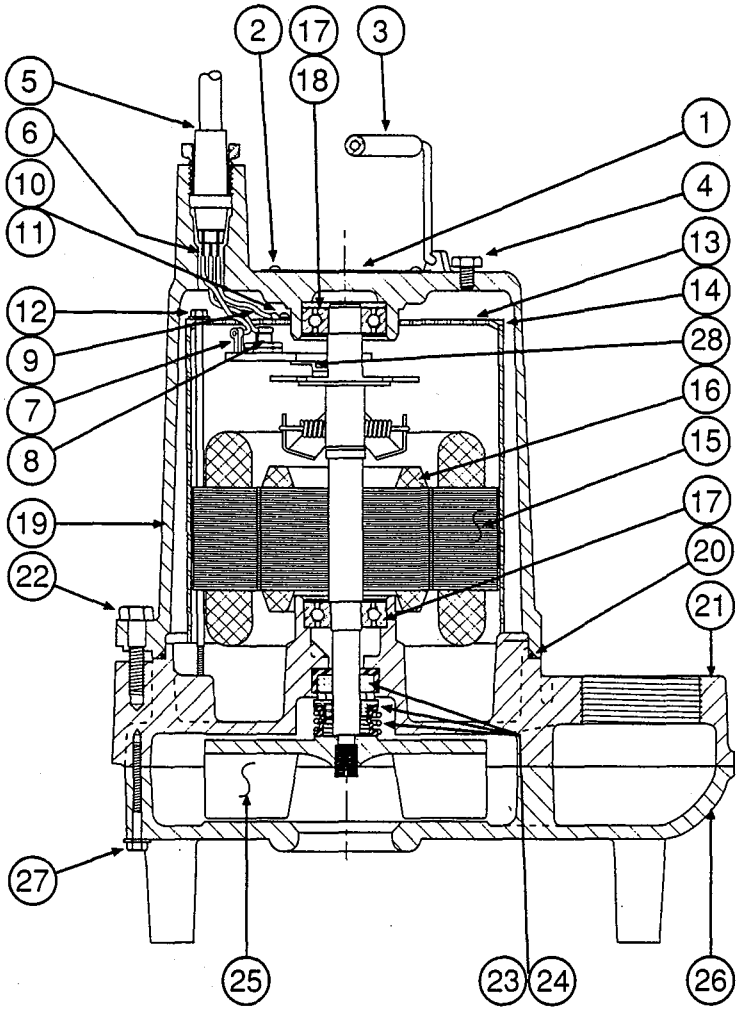
21. **Check pump.** Plug the power cord into a grounded outlet and start pump by applying pressure to the switch diaphragm (automatic only – manual should start when power is applied). Motor should run smoothly, be free of vibration and stop when pressure is removed from diaphragm switch.

*Loctite 222 is a registered trademark of Loctite Corp.

5 Parts List



AUTOMATIC MODELS



Ref. No.	Part No.	Description	Qty.	Ref. No.	Part No.	Description	Qty.
1	—	Nameplate, 115V	1	16	13349-011-5	Rotor & Shaft w/Bearings	1
1	—	Nameplate, 230V	1	17	65-001-1	Bearing	1
2	4580-001-1	Drivescrew	2	19	56-006-2	Housing, Motor (56-026-2 Emerson after 11/90)G.E.	1
3	60-000-5	Handle	1	20	77-003-1	Seal Ring	1
4	119-002-1	Pipe Plug	1	21	12328-002-2	Volute	1
5	12585-004-5	Power Cord Assembly, 115V-10'	1	22	101-008-1	Bolt, 5/16-18 x 1-1/4" Lg.	4
5	12585-005-5	Power Cord Assembly, 115V-20'	1	23	83-002-1	Seal (Stationary Seat)	1
5	12585-003-5	Power Cord Assembly, 230V-20'	1	24	83-007-1	Seal (Rotating Seat)	1
6	4209-004-5	Connector Assembly	1	25	13218-000-5	Impeller	1
7	6000-059-5	Lead Wire/Terminal Assembly (Blk, 5") B/4 11/90	1	26	311-000-2	Suction Base	1
8	6000-061-5	Lead Wire/Terminal Assembly (Blk, 6.25")	2	27	19-003-1	Screw, 10-24 x 1-1/2" Lg.	5
9	6000-060-5	Grnd Wire/Terminal Assembly (Grn, 5")	1	28	665-001-1	Switch, Motor Start	1
10	2056-003-1	Screw, #6 x 3/8 Lg.	1				
11	995-001-1	Lockwasher, #6	1			**AUTOMATIC MODELS**	
12	145-008-1	Bolt, Stator – 8-32 x 6-5/8" Lg.	4	29	5502-004-1	Bracket	1
13	70-000-3	Plate, Stator B/4 11/90	1	30	176-015-1	Screw, 1/4-20 x 3/8" Lg.	
*14		Oil	.38 gal	31	995-008-1	Lockwasher	1
15	13349-000-1	Rotor & Stator (Emerson after 11/90)		32	51752-403-7	Diaphragm Switch (8.5" Range), 115V-10'	1
15	13349-001-1	Stator, 115V if G.E. B/4 11/90	1	32	51752-404-7	Diaphragm Switch (8.5" Range), 115V-20'	1
15	13369-001-1	Stator, 230V if G.E. B/4 11/90	1	32	51752-405-7	Diaphragm Switch (8.5" Range), 230V-20'	1

*Purchase locally.



Aurora/Hydromatic, a Unit of General Signal, warrants to the original purchaser of each of Hydromatic Pump product(s) that any part thereof which proves to be defective in material or workmanship within one year from date of installation or 18 months from manufacture date, whichever comes first, will be replaced at no charge with a new or remanufactured part, F.O.B. factory. Purchaser shall assume all responsibility and expense for removal, reinstallation and freight. Any item(s) designated as manufactured by others shall be covered only by the express warranty of the manufacturer thereof. This warranty does not apply to damage resulting from accident, alteration, design misuse or abuse.

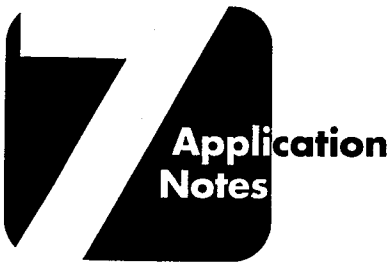
If the material furnished to the Buyer shall fail to conform to this contract or to any of the terms of this written warranty, Aurora Pump shall replace such nonconforming material at the original point of delivery and shall furnish instruction for its disposition. Any transportation charges involved in such disposition shall be for the Buyer's account. The Buyer's exclusive and sole remedy on account or in respect of the furnishing of material that does not conform to this contract, or to this written warranty, shall be to secure replacement thereof as aforesaid. Aurora Pump shall not in any event be liable for the cost of any labor expended on any such material or for any incidental or consequential damages to anyone by reason of the fact that such material does not conform to this contract or to this written warranty.

ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTY OF MERCHANT-ABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE SAME EXTENT AS THE EXPRESS WARRANTY CONTAINED HEREIN. Some States do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply.

MANUFACTURER EXPRESSLY DISCLAIMS AND EXCLUDES ANY LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF ANY EXPRESS OR IMPLIED WARRANTY ARISING IN CONNECTION WITH THIS PRODUCT. INCLUDING WITHOUT LIMITATION, WHETHER IN TORT, NEGLIGENCE, STRICT LIABILITY CONTRACT OR OTHERWISE. Some States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply.

This warranty gives you specific legal rights, and you may also have other rights which vary from State to State.

NOTE:
PUMP MUST BE REPAIRED BY AUTHORIZED AURORA/ HYDROMATIC REPAIR CENTER OR WARRANTY WILL BE VOID. IF REPAIR CENTER IS NOT AVAILABLE, RETURN PUMP TO PLACE OF PURCHASE.


Application
Notes

Application Notes

AURORA/HYDROMATIC PUMPS, INC.
800 Airport Road
North Aurora, Illinois 60542
(708) 859-7000

SSPMA Certified PUMP

A UNIT OF GENERAL SIGNAL GS

AURORA PUMP

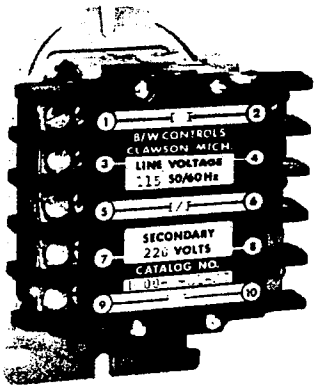
Part No.: 05625-246-1

M-SP40-1

B/W CONTROLS

WELL LEVEL TRANSDUCERS

SERIES 1500
INDUCTION CONTROL RELAYS
SERVICE BULLETIN



PRINCIPLE OF OPERATION

A BIW floatless liquid level control system consists of a relay of the proper type, a holder designed to support one or more electrodes or probes in the liquid container, and the corrosion resistant electrodes themselves. Inasmuch as all BIW induction relays are quite similar — differing only in contact arrangement, the following description of how a 1500-C Relay functions on a pump down control application will serve to explain the design, construction, and operating principles for the entire line.

As shown in diagrams below, the laminated core of the relay is **H** shaped. The primary coil is assembled to the upper bar of the core, and the secondary coil for the electrode is placed on the lower bar. An armature located below the legs of the **H** core is connected to an insulated arm carrying the movable contacts. When the armature is raised, these contacts close or open the motor and electrode circuits, depending upon whether the contacts are normally open or closed. (Contacts shown normally open in this example.)

When a source of alternating current is connected to the primary coil at terminals 3 and 4, the primary coil sets up a magnetic flux which — following the lines of least resistance — circulates through the shortest path. As shown in Figure 1, this is through the lower bar of the laminated core on which the secondary coil is mounted. This magnetic flux induces a voltage in the secondary or electrode circuit coil. No current can flow in this coil, however, until the circuit is completed between the electrodes. **Thus, the electrode circuit voltage being generated within the relay has no connection with the power line.**

The BIW 1500 induction relay utilizes the liquid as an electrical conductor to complete the secondary circuit between the upper and lower electrodes. Thus, when the liquid contacts the upper electrode, the resulting flow of current in this circuit sets up a bucking action in the lower bar of the core. This action tends to divert lines of magnetic force to the core legs and sets up an attraction that pulls the armature into contact with the legs, as shown in Figure 2. This armature movement closes the electrode and load contacts.

The lower contacts on 1500-C Relays (terminals 9 and 10) connect the secondary circuit to ground when liquid contacts the upper electrode and act as a holding circuit to maintain the relay in its closed position until the liquid falls below the lower electrode. This holding circuit provides control of the relay over any desired range in the liquid level, depending on the distance between the upper and lower electrodes.

The flow of current through the low energy secondary circuit is very small and varies with the voltage of the secondary coil. The secondary coil is selected to operate over the resistance of the liquid being controlled. Accordingly, since there is a wide range of secondary coils from which to choose, it is important that complete information regarding the nature of the liquid be furnished when ordering BIW induction relays.

1500-C RELAY USED FOR PUMP DOWN CONTROL

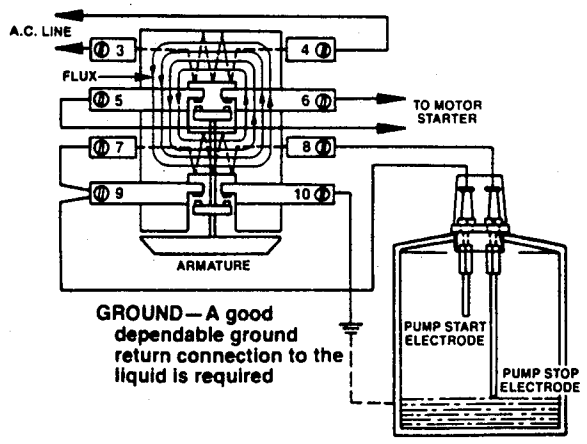


Figure 1—Secondary coil circuit open; armature down.

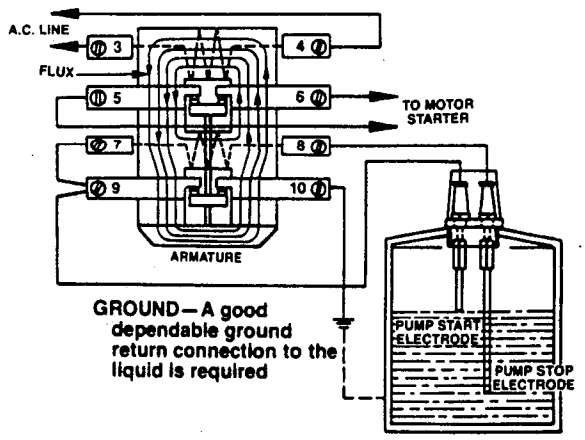


Figure 2—Secondary coil circuit closed; armature up.

Installation Instructions

Relay: Install relay in level upright position. Connect wires from AC supply to terminals #3 and #4 on relay. Make sure power is of same rated voltage and frequency as shown for connection to primary coil on relay data plate. Relays draw 9 volt amperes.

Electrodes: Install electrodes in tank or well by suspending them vertically from an electrode holder or some other suspending means. One electrode should be set at desired start level and one at desired stop level. For sewage or surface drainage sumps, make sure electrodes are hung far enough apart so that foreign matter floating on water cannot foul electrodes. Size 18 or larger Type TW or THW wire is recommended for connection to the relay.

CAUTION — Although the electrodes are connected to a low energy secondary coil output which has inherently low current, there may be up to 800 volts between the electrodes or from an electrode to ground. (See Secondary Coil Table.) Thus wiring and electrodes should be installed to protect personnel from accidental contact.

Ground: A system ground return circuit is required from the indicated relay terminal to the liquid in order to complete the secondary circuit of relay. *Conduit should not be used.* Instead, connection should be made directly to uninsulated metal tank, or to metal pipe connected to tank below normal low liquid level. In wells, connect ground to pump or metallic water pipe. For concrete, wood, or insulated tanks, use an extra common electrode extending slightly below the lowest operating electrode.

Secondary Coil: Because the secondary voltage on all BIW relays is an induced voltage generated within the relay itself, the secondary coil should never be connected to any source of power. Voltage of the secondary coil installed on a given relay is determined by conductivity of liquid to be controlled.

Load Connections: BIW relays are two-wire control devices having load contacts rated at 1 hp., single-phase, 115 or 230 volts AC or standard duty pilot rating up to 600 volts AC. In operation, load contacts act as a switch to open or close a circuit. Connecting them to an external load does not introduce a source of alternating current into the circuit.

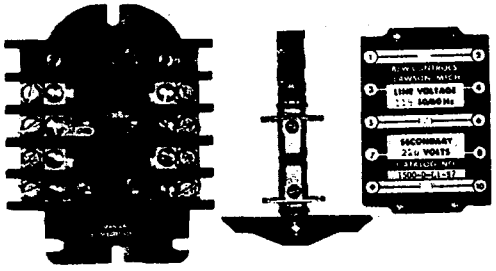
Accordingly, in making connections for direct operation of single-phase loads within rated capacity of relay, power connections must be made as shown in relay wiring diagram.

To operate higher rated single-phase loads or three-phase loads, a magnetic starter must be used. In making connections to motor starter, follow directions given on the starter wiring diagram for connecting two-wire control devices.

DISCOUNT SCHEDULE LL1
Prices Subject to Change without Notice

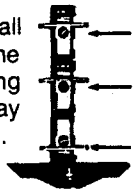
FIELD CONVERTIBLE CONTACTS PROVIDES NEW CIRCUIT VERSATILITY

The all new Series 1500 Induction Relay can have contacts easily added and/or changed from N.O. to N.C. or N.C. to N.O.



Remove cover plate and armature

For a N.O. contact, install the moveable contact in the armature assembly facing toward the top of the relay (away from the armature).



For a N.C. contact, install the moveable contact in the armature assembly facing toward the bottom of the relay (toward the armature).

CONTACT KIT PART NO. 15-000001 $13.00 LIST
LESS DISCOUNT SCHEDULE LL

N.O. CONTACT

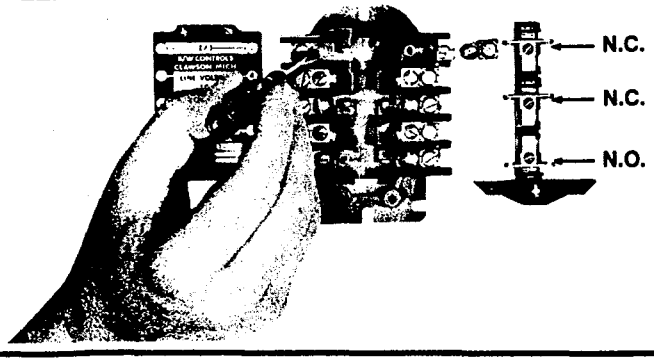


For a N.O. contact, install the stationary contacts facing toward the bottom of the relay (toward the armature).

N.C. CONTACT

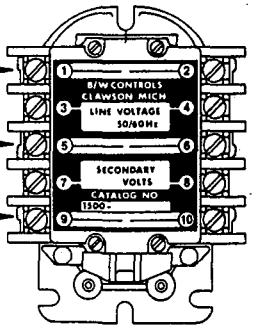


For a N.C. contact, install the stationary contacts facing toward the top of the relay (away from the armature).



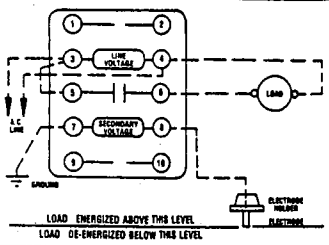
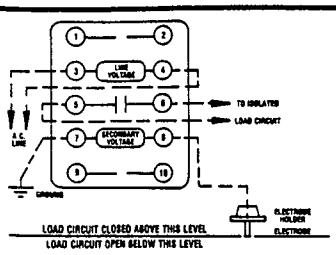
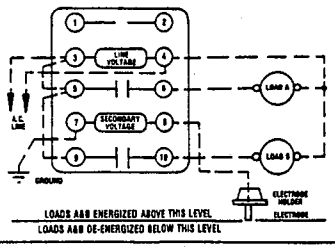
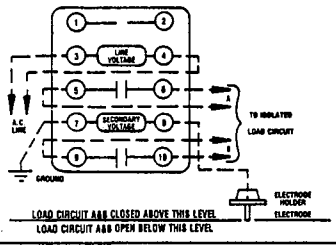
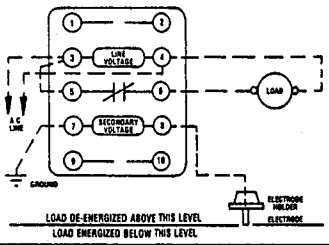
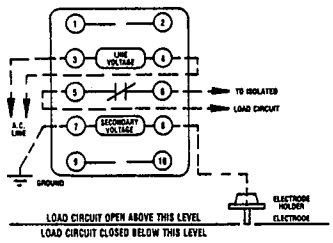
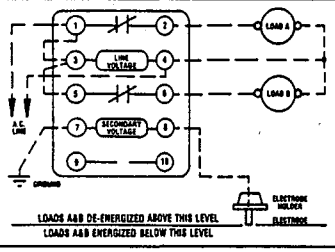
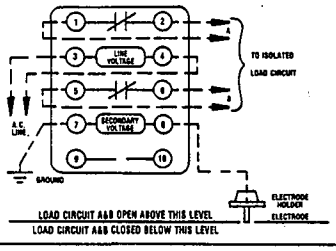
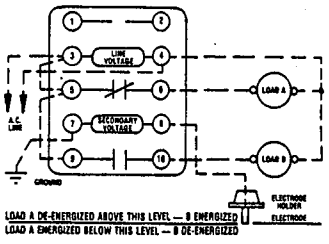
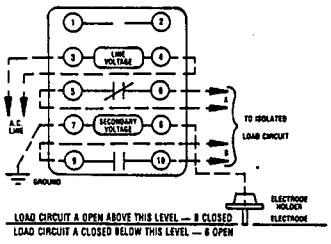
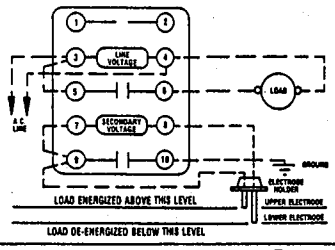
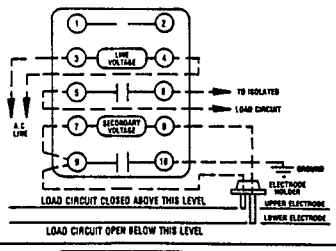
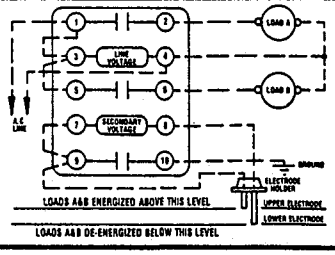
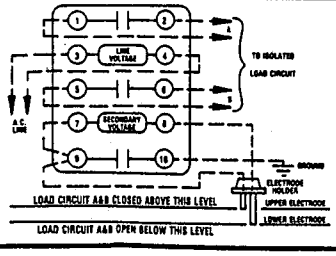
CONTACT ARRANGEMENT CODE

	A 1NO	B 1NC	C 2NO	D 1NO 1NC	E 2NC	F 3NO	G 2NO 1NC	H 1NO 2NC	J 3NC
TOP CONTACT TERMINALS 1 & 2	–	–	–	–	–	⊣⊢	⊣⊢	⊣⊢	⊣⊢
MIDDLE CONTACT TERMINALS 5 & 6	⊣⊢	⊣⊢	⊣⊢	⊣⊢	⊣⊢	⊣⊢	⊣⊢	⊣⊢	⊣⊢
BOTTOM CONTACT TERMINALS 9 & 10	–	–	–	⊣⊢	⊣⊢	–	⊣⊢	⊣⊢	⊣⊢



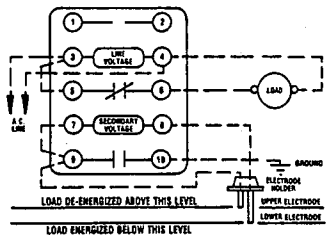
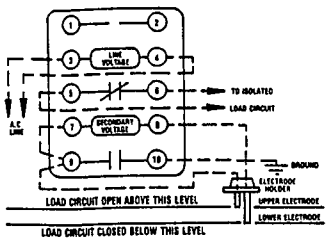
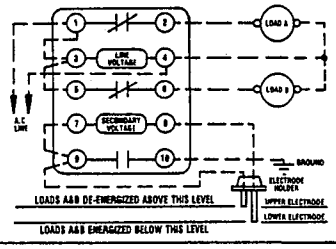
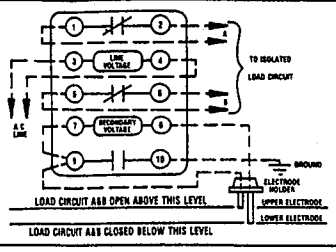
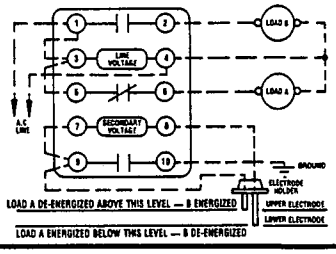
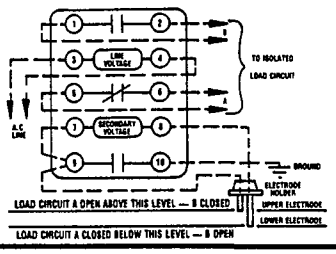
CONTACT RATINGS

25 Amp Resistive at 120, 240, or 480 VAC
1 HP Single Phase at 120 or 240 VAC
Heavy Duty Pilot 120 to 600 VAC
2 Amp Resistive at 120 VDC
10 Amp Resistive at 48 VDC

INDUCTION RELAY CONTACT ARRANGEMENT	WIRING DIAGRAM AND OPERATION		TYPICAL APPLICATIONS
	DIRECT OPERATION	PILOT OPERATION	
1500-A RELAY Contact Arrangement Normally Open: 1 — Normally Closed: 0 — Holding Circuit: 0			High Level Signal Control. Low Level Cutoff when wired in series with Stop button in 3-wire pushbutton stations. Remote, long distance and low voltage manual control applications, etc. (Similar to 1100-L)
1500-C RELAY Contact Arrangement Normally Open: 2 — Normally Closed: 0 — Holding Circuit: 0			Same as 1500-A Relay above except that an additional Normally Open contact is provided to permit simultaneous operation of different types of secondary signal devices in remote locations. (Similar to 1100-2L)
1500-B RELAY Contact Arrangement Normally Open: 0 — Normally Closed: 1 — Holding Circuit: 0			Low Level Signal Control. High Level Cutoff when wired in series with Stop button in 3-wire pushbutton stations. Remote, long distance and low voltage manual control applications, etc. (Similar to 1100-R)
1500-E RELAY Contact Arrangement Normally Open: 0 — Normally Closed: 2 — Holding Circuit: 0			Same as 1500-B Relay above except that an additional Normally Closed contact is provided to permit simultaneous operation of different types of secondary signal devices in remote locations. (Similar to 1100-2R)
1500-D RELAY Contact Arrangement Normally Open: 1 — Normally Closed: 1 — Holding Circuit: 0			High or Low Level Signal Control. High or Low Level Cutoff when wired in series with Stop button in 3-wire pushbutton stations. Can also be used to interlock various types of signal devices. (Similar to 1100-D)
1500-C RELAY Contact Arrangement Normally Open: 1 — Normally Closed: 0 — Holding Circuit: 1			Pump Down Control for sewage and sump pumps, condensate return system, etc. Low Level Cutoff for submersible pumps. Normally closed Solenoid Valve Control for discharging liquids from tanks, etc. (Similar to 1100-LH)
1500-F RELAY Contact Arrangement Normally Open: 2 — Normally Closed: 0 — Holding Circuit: 1			Same as 1500-C Relay above except that additional Normally Open contact is provided to permit simultaneous operation of second pump. Extra contact can also be used for signal purposes if desired. (Similar to 1100-2LH)

CAUTION: Electrodes are terminals of live electrical circuits and must be installed to prevent accidental contact by personnel. Control power must be disconnected before servicing.

A good dependable ground return connection to the liquid is required.

INDUCTION RELAY CONTACT ARRANGEMENT	WIRING DIAGRAM AND OPERATION		TYPICAL APPLICATIONS
	DIRECT OPERATION	PILOT OPERATION	
1500-D RELAY Contact Arrangement Normally Open: 0 — Normally Closed: 1 — Holding Circuit: 1			Pump Up Control for supply pumps on elevated tanks and towers, carbonators, etc. High Level Cutoff for pumps and valves. Normally closed Solenoid Valve Control for plating tank and boiler make-up, etc. (Similar to 1100-RH)
1500-H RELAY Contact Arrangement Normally Open: 0 — Normally Closed: 2 — Holding Circuit: 1			Same as 1500-D Relay above except that additional Normally Closed contact is provided to permit simultaneous operation of second pump. Extra contact can also be used for signal purposes if desired. (Similar to 1100-2RH)
1500-G RELAY Contact Arrangement Normally Open: 1 — Normally Closed: 1 — Holding Circuit: 1			Pump Up or Pump Down Control for same applications listed above for B\W 1500-C and 1500-D Relays. It is also suitable for use in controlling hydropneumatic tanks and motorized valve installations. (Similar to 1100-DH)

CAUTION: Electrodes are terminals of live electrical circuits and must be installed to prevent accidental contact by personnel. Control power must be disconnected before servicing.

A good dependable ground return connection to the liquid is required.

CATALOG NUMBERING SYSTEM

1500—A—L1—S7

Catalog Section

	CONTACT ARRANGEMENTS	
	NORMALLY OPEN	CLOSED
A	1	0
B	0	1
C	2	0
D	1	1
E	0	2
F	3	0
G	2	1
H	1	2
J	0	3

	LINE VOLTAGE
L1	110-120 Volts 50/60 HZ
L2	208-240 Volts 50/60 HZ
L3	440-480 Volts 50/60 HZ
L4	550-600 Volts 50/60 HZ

Consult Factory For Special Line Voltages Not Listed.

All contacts rated at:
25 Amp Resistive at 120, 240, or 480 VAC
1 HP Single Phase at 120 or 240 VAC
Heavy Duty Pilot 120 to 600 VAC
2 Amp Resistive at 120 VDC
10 Amp Resistive at 48 VDC

	SECONDARY COIL VOLTAGE	TYPICAL LIQUIDS
S1	12 Volts A.C.	Metallic circuits
S2	24 Volts A.C.	Metallic circuits
S3	40 Volts A.C.	Acid or caustic solutions: Milk; Brine and salt solutions; Plating solutions; Buttermilk; Soups.
S4	90 Volts A.C.	Weak acid or caustic solutions: Beer; Baby foods; Fruit juices.
S7	220 Volts A.C.	Sewage; Most water-except very soft; Pottery slip; Water soluble oil solutions; Starch solutions.
S8	360 Volts A.C.	Very soft water; Sugar syrup.
S9	480 Volts A.C.	Steam condensate; Strong alcohol solutions.
S11	800 Volts A.C.	Demineralized or distilled water.
S1Z	12 Volts A.C.	17 Volt D.C. Sensing Circuit
S2Z	24 Volts A.C.	34 Volt D.C. Sensing Circuit
S3Z	40 Volts A.C.	56 Volt D.C. Sensing Circuit

Service Instructions

B|W relays are designed and built to require a minimum of service in the field. Each one is tested and adjusted at the factory to insure positive operation and should not be altered or tampered with prior to installation. If a relay does not operate properly after it has been installed, the following information will be helpful in determining the probable cause.

A RELAY WILL NOT PULL IN

If relay will not pull in when liquid contacts upper electrode, failure to operate is probably caused by one of the following conditions:

1. Power Failure — A power failure to relay can be caused by broken wire, blown fuse, an open switch, loose screw, corroded connection, etc. Check for power failure with voltmeter or test light directly on relay line terminals (No. 3 and 4 on all B|W relays). Also check voltage at motor starter line terminals and overload heaters on motor starter to be sure they have not tripped.

2. Open Coils — Coils used in B|W relays very rarely fail unless struck by lightning or subjected to some severe over-voltage condition. To check coils, disconnect electrode connections from relay terminals, apply line voltage to the primary coil, and touch both ends of secondary coil with an insulated jumper wire. Relay should pull in when the jumper is connected and fall out when jumper is removed. Failure to do so indicates that one of the coils is open. If an open coil is found, contact dealer or the factory for a replacement relay.

3. Poor Ground Connections — B|W induction relays that operate from a single electrode — i.e., Types 1500-A, C, B, E and D — will not function unless a good dependable ground connection is made to complete the secondary circuit from one end of the secondary coil through the electrode and liquid, and back through ground to the other side of the secondary coil. If such a relay does not operate when liquid contacts the electrode, check ground connection to be sure it complies with Installation Instructions.

4. Broken Wires — A broken wire from relay to either electrode will prevent relay from operating. Broken wires can be checked by shorting the upper and lower electrode leads together at the electrode holder. If relay fails to pull in, one or both of the electrode leads is open. The individual leads can then be checked by running a temporary wire from the relay to holder outside conduit. If relay pulls in, it may be assumed that break is between the holder and the electrodes. This can be checked by shorting between the electrode tips with an insulated jumper.

5. Low Secondary Voltage — If the secondary coil voltage is too low for the resistance or conductivity of the liquid being controlled, the relay will not pull in — or it will buzz and chatter before pulling in. In either case, the relay should be replaced with one which has a higher voltage secondary coil. (See Table.) If in doubt about proper coil selection, furnish factory with details on liquid — or send sample for test.

6. Fouled Electrodes — Accumulation of dirt, grease or other deposits on the upper electrode will insulate it and prevent relay from pulling in. If this occurs, the electrodes should be inspected and cleaned at regular intervals as required to eliminate the difficulty. If unusual quantities of oil, grease, or sludge are encountered, the electrodes can be mounted inside a pipe that is flushed with clean water. A 4" pipe should be used — with the bottom located below the lowest water level, and vent holes provided at top so that the level inside and outside the pipe will be the same. A small flow of water entering the top of the pipe will cause an outward flow of water from the bottom of the pipe and prevent undesirable material from entering. Thus, the electrodes have a clear surface on which to operate and will stay clean.

7. Electrodes Too Short — It is possible for an installation to be completed in which the upper electrode is suspended at a point where the liquid cannot make contact. All installations should, of course, be checked to make sure that proper electrode lengths are provided.

B NOISY RELAY OPERATION

If the relay functions properly but is noisy in operation, it could be caused by the following:

1. Poor Electrode Connections — If wire suspended electrodes are used — and have either been lost or not properly connected — resultant increase in resistance is secondary circuit may cause relay to buzz or chatter in operation. This condition can be corrected by checking to see that proper electrode connections are made. Excessive accumulation of dirt, grease or other deposits on the electrodes can also result in noisy relay operation — in which case periodic cleaning will eliminate the problem.

2. Low Secondary Voltage — If resistance of the liquid being controlled is at the upper end of the sensitivity range of the relay secondary coil, noisy operation may result. Sensitivity may be increased slightly by interchanging the ground and lower electrode connections at the relay. If this does not correct the condition, the relay should be replaced with one having a higher voltage secondary coil.

C ONE LEVEL OPERATION

If a relay operates at one level only — starting and stopping at one electrode, check following:

1. Electrode Wires — If wires between relay and electrodes are interchanged, relay will not operate over range in level but from upper electrode only. To correct, simply reverse connections — either at relay or at electrodes.

2. Ground Connection — Poor ground connection will prevent holding circuit from functioning and cause relay to operate from the upper electrode only. This can be easily corrected by making sure that ground connections conform with Installation Instructions.

3. Holding Circuit — If the holding circuit is not closing, the relay will operate from the upper electrode only. Since the holding circuit contact carries only a small current, a slight film of grease or dirt can sometimes prevent proper closure. To correct, rub contact surface with a clean paper. Do not use sand paper or emery cloth.

4. Upper Electrode Lead — A ground in lead wire to the upper electrode will cause relay to operate from lower electrode only. This condition can be checked out as described below.

D RELAY WILL NOT DROP OUT

If relay will not drop out when liquid falls below lower electrode, check the following points:

1. Lower Electrode Lead — A ground in the lead wire from relay to lower electrode will prevent relay from dropping out on low liquid level. If distance from holder to relay is relatively short, the best way to check for a ground is to connect a replacement wire from relay to the electrode holder outside the conduit and test the relay for operation. If it drops out properly it is safe to assume that a ground exists in the original lower electrode lead wire.

If relay is located a considerable distance from electrode holder, check for ground as follows: Disconnect power to relay. Remove wires from terminals in electrode holder and allow them to stick up to eliminate possibility of contacting a grounded part. Then turn on power to relay. If relay pulls in, a short is indicated between the electrode leads, from both electrodes to ground, or secondary coil is shorted internally. If relay does not pull in, short secondary coil with piece of insulated wire by bridging between relay terminal connections for upper and lower electrodes. Relay should pull in when this connection is made and drop out when connection is broken. If relay does not drop out, a short to ground is indicated in lower electrode lead. This ground may not be enough to pull in relay, but it can be sufficient to hold relay in once it has been closed in normal operation.

If any of these conditions exist, disconnect power to relay and replace grounded wires.

2. Electrode Holder — Excessive dirt or moisture over insulation at electrode holder or electrodes can cause faulty relay operation. Interior of electrode holder and its underside should be kept clean and dry. Conduit connections should be made so that no condensation can enter holder. Underside of vertically mounted holders should never come in contact with the liquid. Insulated rod electrodes should be used with horizontally mounted holders.

Electrodes should be kept relatively clean and free of dirt or grease. Check them periodically to make sure they do not become fouled with floating debris or insulating deposits.

3. Length of Lead Wires — On installations with excessive distance — over 900 feet — between relay and tank, relay may tend to hold in due to capacitance in electrode lines and fail to drop out when liquid leaves lower electrode. Since there are a number of ways to achieve reliable long distance control, complete information regarding such applications should be submitted to factory for recommendations.

CAUTION

Be sure to disconnect relay control power before servicing electrodes or electrode holders.

SERIES 1500
INDUCTION CONTROL RELAYS
SERVICE BULLETIN

CONDUCTIVE LIQUIDS

With the exception of products such as oil, gasoline, animal fats and other similar products, most liquids and some moist bulk materials have sufficient conductivity to use BIW level detecting relays. The Series 1500 relay can be used on liquids with resistance up to about 90,000 ohm-cm (conductivity to 11 micromho/cm). For liquids with higher resistance the BIW Series 52 relay described in Catalog Section 5200 must be used for applications up to 12 megohms resistance. The vapor above some liquids is considered an explosive hazard and in these cases the BIW Series 53 relay with FM approved intrinsically safe sensing circuit should be used. See Catalog Section 5300.

Liquids such as milk and beer, and some pharmaceutical products will foam during processing. The liquid phase is always a better conductor than the foam, and when the interface level is to be detected, the relay sensitivity must be carefully selected and it would be well to check the factory for our recommendation.

With nearly 50 years of experience BIW has compiled a history of applications in most major industries around the world. If you have questions regarding the proper relay selection, write us, phone us, or send a sample for test. Chances are that we have the answer for you.

TYPICAL LIQUIDS

The following recommendations are satisfactory for general use, but because the conductivity of liquids varies greatly with concentration, purity, temperature and other factors, some applications may require a different selection.

A number of the products listed are produced as solids such as crystals or powders, and our relay selection is based on the normally used commercial solutions of these materials.

Liquid Description	Secondary Coil
Acetic Acid — Up to 75%	90 Volt
— 75 to 90%	220 Volt
— Glacial	Use 5200-H Relay
Acetone	Use 5200-H or 5300 Relay
Acids — General	40 or 90 Volt
— Anhydrous	Use 5200-H Relay
Alcohols	Use 5200-H or 5300 Relay
Alkalies — General	40 or 90 Volt
— Anhydrous	Use 5200-H Relay
Alum Solutions	220 Volt
Aluminum Sulphate	90 Volt
Aluminum Hydroxide	90 Volt
Amino Acids	90 Volt
Ammonia-Anhydrous Liquid	Use 5200-H Relay
Ammonium Chloride	40 Volt
Ammonium Hydroxide (Ammonia)	220 Volt
Ammonium Nitrate	Use 5300 Relay
Ammonium Sulphate	220 Volt
Baby Foods	90 Volt
Barium Chloride	40 Volt
Barium Nitrate	40 Volt
Beer	90 Volt
Black Liquor	40 Volt
Blood	220 Volt
Borax — Up to 10%	220 Volt
—.Greater than 10%	90 Volt
Boric Acid	220 Volt
Bread Dough	90 Volt
Buttermilk	24 or 40 Volt
Cadmium Chloride	40 Volt
Cake Batter	220 Volt
Calcium Chloride	40 Volt
Calcium Hydroxide	220 Volt
Carbolic Acid — Up to 90%	220 Volt
— 90 to 100%	Use 5200-H Relay
Catsup	90 Volt
Caustic Soda (Sodium Hydroxide)	40 Volt
Cement Slurry	220 Volt
Chromic Acid	40 Volt
Citric Acid	40 or 90 Volt
Coffee	90 Volt
Condensate — Ordinary Water	480 Volt
— D.I. Water	Use 5200-H Relay
Corn Syrup	480 Volt
Corn — Cream Style	90 Volt
Ethylene Glycol	Use 5200-H Relay
Ferric Chloride	90 or 220 Volt
Ferrous Sulphate	220 Volt

Liquid Description	Secondary Coil
Formaldehyde	Use 5200-H Relay
Formic Acid — Up to 75%	90 Volt
— 75 to 90%	220 Volt
Glycerine (Glycerol)	Use 5200-H Relay
Hydrochloric Acid	40 Volt
Hydrofluoric Acid — Up to 20%	220 Volt
— Above 20%	40 Volt
Hydrofluorsilicic Acid	90 Volt
Hydrogen Peroxide	Use 5200-H or 5300 Relay
Jams & Jellies	360 Volt
Juices — Fruit & Vegetable	40 or 90 Volt
Lemon Oil Essence	Use 5200-H Relay
Lignite	800 Volt
Lithium Chloride	40 Volt
Magnesium Hydroxide	90 Volt
Mayonnaise	220 Volt
Methanol	Use 5200-H or 5300 Relay
Methyl Ethyl Keystone (MEK)	Use 5200-H Relay
Milk	40 Volt
Molasses	220 Volt
Muriatic Acid	40 Volt
Mustard	40 Volt
Nitric Acid	40 or 90 Volt
Orange Juice	90 Volt
Paper Stock	220 Volt
Penicillin	220 Volt
Phosphoric Acid	40 Volt
Plating Solutions	40 or 90 Volt
Salts — Chemical	40 or 90 Volt
Sodium Carbonate (Soda Ash)	90 Volt
Sodium Chloride (Table Salt)	40 Volt
Sodium Hydroxide (Caustic Soda)	40 Volt
Sodium Hypochlorate	40 Volt
Sodium Silicate (Water Glass)	90 Volt
Soups	40 Volt
Starch Solutions	220 Volt
Sugar — Low Concentrations	220 Volt
High Concentrations	360 Volt
Sulphuric Acid	40 Volt
Vinegar	90 Volt
Water — Sea	40 Volt
— Ordinary Potable	220 Volt
— Ordinary Soft	360 Volt
— Ordinary Condensate	480 Volt
— Purified Distilled	800 Volt or 5200-H Relay
— Purified Deionized	Use 5200-H Relay
Zinc Chloride	40 Volt

B/W CONTROLS
1080 N. Crooks Road, Clawson, MI 48017-1097
Phone: 810 435-0700 Fax: 810 435-8120
For Sales & Technical Assistance Call 800 814-1578
A Product of PATRIOT Sensors & Controls Corporation

FORM 511
11/94 10M

CAT. NO. 6013-W2
PART NO. 13-020700

One Type E-1P Wire Suspended Electrode—Type 303 Stainless Steel

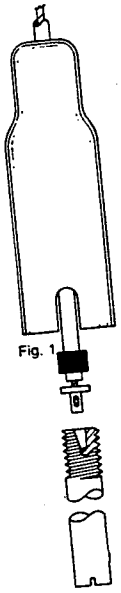


Fig. 1

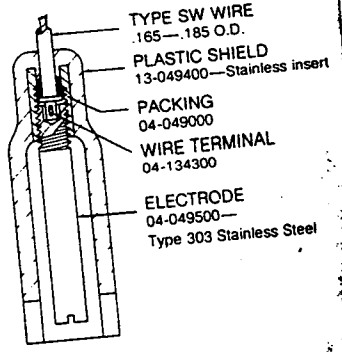


Fig. 2

Installation Instructions:

Fig. 1—Strip $^{5}/_{16}$" of insulation from end of wire. Pass wire through hole in electrode shield and packing, into the wire terminal. Crimp terminal with cutters or crimping tool so that it holds the wire tightly yet will enter hole in electrode.

Fig. 2—Pull wire back through shield and thread electrode into the shield's metal insert. Use screwdriver to fasten securely and compress the packing so that liquid will not contact bare wire.

MagneTek

1080 N. Crooks Road
Clawson, Michigan 48017

Form 308—

CARBOLINE

INTERIOR COATING ON EQUALIZATION TANK

carboline

CARBOMASTIC 15 Low Odor

VOC

SELECTION DATA

GENERIC TYPE: Two-component, high-build, modified aluminum epoxy mastic.

GENERAL PROPERTIES: CARBOMASTIC 15 Low Odor is a self-priming, high-build coating with excellent adhesion to rusted steel and most aged paints. Features include:

- Proven field performance.
- Excellent performance over minimal surface preparations.
- Low odor.
- Non-bronzing.
- Excellent application characteristics.
- Excellent film build on edges.
- Compatible with most aged coatings.
- Single coat for most applications.
- Meets the most stringent VOC (Volatile Organic Content) regulations.

RECOMMENDED USES: Particularly recommended for maintenance painting of rusty steel or upgrading old coatings. Ideal for metal buildings, piping, process equipment, highway bridges and exposed structural steel. Only a single coat is required for most applications. Hand or power tool cleaning is often acceptable. CARBOMASTIC 15 Low Odor may also be used where hand tool cleaned steel is being coated for the first time.

NOT RECOMMENDED FOR: Immersion service in acids, alkalies or solvents.

TYPICAL CHEMICAL RESISTANCE:

Exposure	Immersion	Splash & Spillage	Fumes
Acids	NR	Fair	Very Good
Alkalies	NR	Good	Excellent
Solvents	NR	Good	Excellent
Salt Water	Excellent*	Excellent	Excellent
Water	Excellent*	Excellent	Excellent

*Discolors to gray.

TEMPERATURE RESISTANCE: (non-immersion)
Continuous: 180° F (82° C)
Non-continuous: 250° F (121° C)

SUBSTRATES: Rusty steel, aged galvanized steel or others as recommended.

COMPATIBLE COATINGS: May be used over most generic types of coatings which are tightly adhering and properly prepared. A test patch is recommended over existing coatings. A mist coat may be required over inorganic zinc to minimize bubbling. A topcoat is not normally required. Most generic types of coatings are suitable as topcoat. Consult Carboline Technical Service for specific recommendations.

SPECIFICATION DATA

THEORETICAL SOLIDS CONTENT OF MIXED MATERIAL:

	By Volume
CARBOMASTIC 15 Low Odor	90% ± 2%

VOLATILE ORGANIC CONTENT:
As Supplied: 0.74 lbs./gal.(88 grams/liter)
Thinned: The following are nominal values:

Thinner	% Thinned	Fluid Ozs./Gal.	Lbs./ Gal.	Grams/ Liter
CARBOMASTIC Thinner	25	32 (1 quart)	2.02	242
CARBOLINE* Thinner #76	25	32 (1 quart)	1.93	231

RECOMMENDED DRY FILM THICKNESS PER COAT:
5 mils (125 microns) minimum (Measured excluding the rust on steel substrate).

For severe exposures including immersion, 7 mils (175 microns) minimum or 2 coats at 5 mils(125 microns) each is recommended.

Dry film thickness in excess of 10 mils(250 microns) per coat is not recommended. Excessive film thickness over inorganic zinc will increase damage during shipping and erection.

THEORETICAL COVERAGE PER MIXED GALLON:
1444 mil sq. ft. (36.0 sq. m-l at 25 microns)
289 sq. ft. at 5 mils (7.2 sq. m-l at 125 microns)

STORAGE CONDITIONS: Store indoors
Temperature: 45-110° F (7-43° C) Humidity: 0-90%

SHELF LIFE: Twenty-four months when stored at 75° F (24° C).

COLOR: Aluminum (C901) is standard. Red (M500) is available for use as a contrasting primer in multiple coat applications.

ORDERING INFORMATION

Prices may be obtained from your Carboline Sales Representative or Carboline Customer Service Department.

APPROXIMATE SHIPPING WEIGHT:

	2 Gal. Kit	10 Gal. Kit
CARBOMASTIC 15 Low Odor	25 lbs. (11 kg)	124 lbs. (56 kg)
CARBOMASTIC Thinner	8 lbs. (4 kg) in 1's	40 lbs. (18 kg) in 5's
CARBOLINE Thinner # 76	8 lbs. (4 kg) in 1's	37 lbs. (17 kg) in 5's

FLASH POINT: (Pensky-Martens Closed Cup)

CARBOMASTIC 15 Low Odor Part A	>200° F (> 93° C)
CARBOMASTIC 15 Low Odor Part B	76° F (24° C)
CARBOMASTIC Thinner	83° F (28° C)
CARBOLINE Thinner # 76	21° F (– 6° C)

March 88-N

To the best of our knowledge the technical data contained herein are true and accurate at the date of issuance and are subject to change without prior notice. User must contact Carboline Company to verify correctness before specifying or ordering. No guarantee of accuracy is given or implied. We guarantee our products to conform to Carboline quality control. We assume no responsibility for coverage, performance or injuries resulting from use. Liability, if any, is limited to replacement of products. Prices and cost data if shown are subject to change without prior notice. NO OTHER WARRANTY OR GUARANTEE OF ANY KIND IS MADE BY Carboline, EXPRESS OR IMPLIED, STATUTORY, BY OPERATION OF LAW, OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

05-12-95 10:47AM P02

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APPLICATION INSTRUCTIONS

These instructions are not intended to show product recommendations for specific service. They are issued as an aid in determining correct surface preparation, mixing instructions and application procedure. It is assumed that the proper product recommendations have been made. These instructions should be followed closely to obtain the maximum service from the materials.

SURFACE PREPARATION: Remove any oil or grease from surface to be coated with clean rags soaked in CARBOLINE Thinner #2 or Surface Cleaner #3 (refer to SC#3 instructions) in accordance with SSPC-SP 1.

Steel:

NON-IMMERSION SERVICE: Power Tool or Hand Tool clean in accordance with SSPC-SP 3 or SSPC-SP 2, to produce a rust-scale free surface. Water blasting, followed by Hand or Power Tool cleaning is acceptable to standards as defined by SSPC-SP 2. For more severe environments, abrasive blast per SSPC-SP 7 (brush-off blast) to a degree of cleanliness defined by SSPC-Sa 1 pictorial standards.

WATER IMMERSION SERVICE: Abrasive blast to a Near White Metal Finish in accordance with SSPC-SP 10 (or NACE #2) to obtain a 1-3 mil (25-75 micron) blast profile.

MIXING: Power mix separately, then combine and mix in the following proportions:

	2 Gal. Kit	10 Gal. Kit
CARBOMASTIC 15 Low Odor Part A	1 gallon	5 gallons
CARBOMASTIC 15 Low Odor Part B	1 gallon	5 gallons

THINNING: May be thinned up to 25% by volume with CARBOMASTIC Thinner. To extend pot life, may be thinned up to 25% by volume with CARBOLINE Thinner # 76 (see Pot Life information).

NOTE: Use of thinners other than those supplied or approved by Carboline may adversely affect product performance and will void product warranty, whether express or implied.

Refer to Specification Data for VOC information.

POT LIFE: Four hours at 75° F (24° C) when thinned 25%, two hours at 75° F (24° C) unthinned and one hour at 90° F (32° C) unthinned. CARBOLINE Thinner #76 may be substituted to extend pot life to 2 hours at 90° F (32° C). Pot life ends when coating becomes too viscous to use.

APPLICATION CONDITIONS:

	Material	Surfaces	Ambient	Humidity
Normal	65-85° F (18-29° C)	65-85° F (18-29° C)	65-85° F (18-29° C)	35-80%
Minimum	50° F (10° C)	50° F (10° C)	50° F (10° C)	0%
Maximum	90° F (32° C)	130° F (54° C)	100° F (38° C)	95%

Do not apply when surface temperature is less than 5° F or 2° C above the dew point.

Special thinning and application techniques may be required above or below normal conditions.

SPRAY: The following spray equipment has been found suitable and is available from manufacturers such as Binks, DeVilbiss and Graco.

Conventional: Pressure pot equipped with dual regulators, 3/8" I.D. minimum material hose, .086" I.D. fluid tip and appropriate air cap.

Airless:

Pump Ratio: 30:1 (min.)*
GPM Output: 3.0 (min.)
Material Hose: 3/8" I.D.(min.)
Tip Size: .019-.025"
Output psi: 1900-2100
Filter Size: 60 mesh

*Teflon packings are recommended and are available from the pump manufacturer.

BRUSH OR ROLLER: Use clean natural bristled brush or medium nap roller. Work coating into all irregularities.

TOUCH-UP: For small damaged areas, hand or power sand to a feather edge, then touch-up by brush.

DRYING TIMES: These times are at 5 mils (125 microns) dry film thickness. Higher film thicknesses will lengthen cure times.

Dry to touch: 5 hours at 75° F (24° C).

Temperature	Between Coats	Final Cure
50° F (10° C)	5 days	15 days
60° F (16° C)	3 days	10 days
75° F (24° C)	24 hours	5 days
90° F (32° C)	18 hours	3 days

Recommended minimum cure before immersion service is 5 days at 75° F (24° C).

VENTILATION & SAFETY: When used as a tank lining or in enclosed areas, thorough air circulation must be used during and after application until the coating is cured. The ventilation system should be capable of preventing the solvent vapor concentration from reaching the lower explosion limit for the solvents used. In addition to proper ventilation, fresh air respirators or fresh air hoods must be used by all application personnel. Where flammable solvents exist, explosion-proof lighting equipment must be used. Hypersensitive persons should wear clean protective clothing, gloves and/or protective cream on face, hands and all exposed areas.

CLEANUP: Use CARBOLINE Thinner # 2.

CAUTION: READ AND FOLLOW ALL CAUTION STATEMENTS ON THIS PRODUCT DATA SHEET AND ON THE MATERIAL SAFETY DATA SHEET FOR THIS PRODUCT.

CAUTION: CONTAINS FLAMMABLE SOLVENTS. KEEP AWAY FROM SPARKS AND OPEN FLAMES. IN CONFINED AREAS WORKMEN MUST WEAR FRESH AIRLINE RESPIRATORS. HYPERSENSITIVE PERSONS SHOULD WEAR GLOVES OR USE PROTECTIVE CREAM. ALL ELECTRIC EQUIPMENT AND INSTALLATIONS SHOULD BE MADE AND GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE. IN AREAS WHERE EXPLOSION HAZARDS EXIST, WORKMEN SHOULD BE REQUIRED TO USE NONFERROUS TOOLS AND TO WEAR CONDUCTIVE AND NONSPARKING SHOES.

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350 Hanley Industrial Ct. • St. Louis MO 63144-1599
an RPM company • 314-644-1000

DAYTON ELECTRIC MFG. CO.

ELECTRIC UNIT HEATER

INSTALLATION INSTRUCTIONS & PARTS MANUAL

ELECTRIC UNIT HEATERS

MODELS 2E635B, 2E636B, 2E637B, 2E638B, 2E639B, 2E640B, 2E669B, 2E670B, 2E805B, 2E806B, 3E341E, 3E342A, 3E343B, 3E344A, 3E345A, 3E346B, 3E347A, 3E348A, 3E349B, 3E350A, 3E351B, 3E352A, 3E353A, 3E354B, 3E355A, 3E356A AND 3E357B

FORM 5S2273
05835
1291/488/5M

READ CAREFULLY BEFORE ATTEMPTING TO ASSEMBLE, INSTALL, OPERATE OR MAINTAIN THE PRODUCT DESCRIBED. PROTECT YOURSELF AND OTHERS BY OBSERVING ALL SAFETY INFORMATION. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE! RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

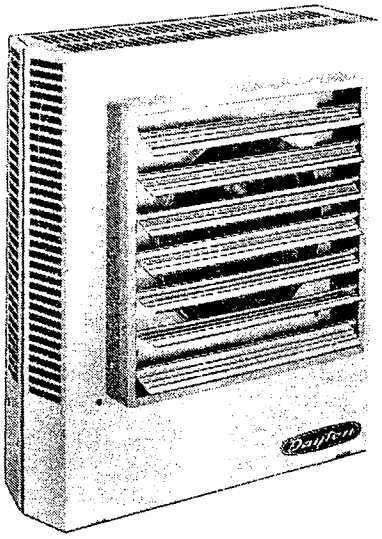


Figure 1

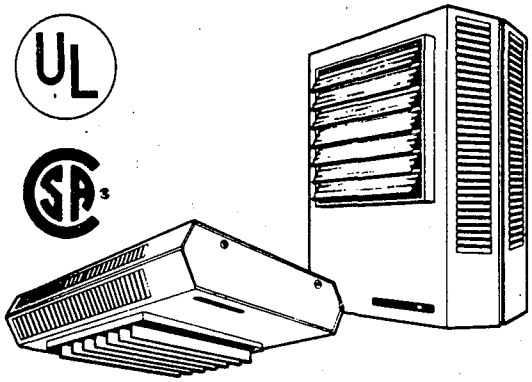


Figure 1A — Horizontal or Vertical Mounting

Description

Dayton heavy duty electric unit heaters are designed for continuous or intermittent use. They can be installed for use in downflow or horizontal applications in factories, warehouses, gymnasiums, auditoriums, farms, garages, aircraft hangars, etc. Separate thermostat (not included) is required.

FEATURES

- Forced air electric unit heater available in 208, 240/208, 277, or 480 volt as standard.
- Eight standard heating capacities of 3.3 KW/11,260 Btu thru 50.0 KW/170, 600 Btu.
- Selected 208 and 240/208 volt models are single phase field convertible to three phase on 5.0 thru 10.0 KW models.
- Specially designed inlet louver allows the fan to pull cool air evenly across the high mass all-steel element.
- Outward drawn venturi and adjustable louver assembly further directs the outlet air in a uniform pattern to meet specific air pattern requirements in either the horizontal or vertical mounting position.
- Single point terminal board wiring of optional control kits.
- 24 volt class 1 control circuit standard on all contactor transformer models.
- Roomy control box with access door locked into position by two 1/4 turn fasteners for ease of installation.
- Optional horizontal wall/ceiling or vertical mounting brackets. (As required.)
- Four weld nuts supplied in case top and back for field mounting by drill rods or eye bolt with chain. (Hardware supplied by others.)
- Optional radial or anemostat diffusers lending air pattern versatility when mounted vertically.
- Modular control kits for field installation. Disconnect switch, thermostat, summer fan switch, heat recovery thermostat. All kits with spade terminals (Except disconnect switch).

Specifications

MODEL	KW RATING	BTU/HR (1,000's)	HEATER/ MOTOR VOLTAGE	PHASE	CONTROL VOLTAGE	AMPS PER PHASE	BRANCH CIRCUIT PROTECTION SIZE (AMPS)	SUPPLY WIRE SIZE (60°C AWG)**	FAN MOTOR HP	FAN MOTOR RPM	CFM AT OUTLET	FPM AT OUTLET	AIR TEMP. RISE (°F)	AIR THROW (HORIZ.)
†2E635B	3.3	11.2	208	1	208	15.9	20	12	1/125	1550	400	1030	26	12
†2E636B	3.3/2.5	11.2/8.5	240/208	1	240/208	13.7/11.9	20/15	12/14	1/125	1550	400	1030	26	12
2E637B	3.3	11.2	480	3	24	4.0	15	14	1/125	1550	400	1030	26	12
†2E805B	3.3	11.2	277	1	277	11.9	15	14	1/125	1550	400	1030	26	12
†2E669B	5.0	17.1	208	1	208	24.1	35	8	1/125	1550	400	1030	40	12
†2E670B	5.0/3.7	17.1/12.8	240/208	1	240/208	20.9/18.1	30/25	10/10	1/125	1550	400	1030	40	12
†2E638B	5.0	17.1	208	1	208	24.1	35	8	1/125	1550	400	1030	40	12
			208	3	208	13.9	20	12	1/125	1550	400	1030	40	12
†2E639B	5.0/3.7	17.1/12.8	240/208	1	240/208	20.9/18.1	30/25	10/10	1/125	1550	400	1030	40	12
			240/208	3	240/208	12.1/10.4	20/15	12/14	1/125	1550	400	1030	40	12
2E640B	5.0	17.1	480	3	24	6.1	15	14	1/125	1550	400	1030	40	12
†2E806B	5.0	17.1	277	1	277	18.1	25	10	1/125	1550	400	1030	40	12
3E341A	7.5	25.6	208	1	24	36.1	50	6	1/50	1550	700	1000	34	22
			208	3	24	20.8	30	10	1/50	1550	700	1000	34	22
3E342A	7.5/5.6	25.6/19.2	240/208	1	24	31.3/27.1	40/35	8/8	1/50	1550	700	1000	34	22
			240/208	3	24	18.1/15.6	25/20	10/12	1/50	1550	700	1000	34	22
3E343B	7.5	25.6	480	3	24	9.1	15	14	1/50	1550	700	1000	34	22
3E344A	9.9	33.8	208	1	24	47.8	60	4	1/50	1500	700	1000	45	22
			208	3	24	27.7	35	8	1/50	1550	700	1000	45	22
3E345A	10.0/7.5	34.1/25.6	240/208	1	24	41.6/36.1	60/50	4/6	1/50	1500	700	1000	45	22
			240/208	3	24	24/20.8	30/30	10/10	1/50	1550	700	1000	45	22
3E346B	10.0	34.1	480	3	24	12.1	20	12	1/50	1500	700	1000	45	22
3E347A	15.0	51.2	208	3	24	41.7	60	4	1/20	1550	1100	1580	43	32
3E348A	15.0/11.2	51.2/38.4	240/208	3	24	36.1/31.3	50/40	6/8	1/20	1550	1100	1580	43	32
3E349B	15.0	51.2	480	3	24	18.1	25	10	1/20	1550	1100	1580	43	32
3E350A	19.5/14.6	67.2/50.5	240/208	3	24	47.8/41.1	60/60	4/6	1/20	1550	1100	1580	57	32
3E351B	20.0	68.3	480	3	24	24.1	35	8	1/20	1550	1100	1580	57	32
3E352A	30.0	102.4	208	3	24	83.4	110	2*	1/12	1550/1250	2000/1800	1300/1100	47/53	40
3E353A	30.0/22.5	102.4/76.8	240/208	3	24	72.3/62.5	100/80	2/3	1/12	1550/1250	2000/1800	1300/1100	47/53	40
3E354B	30.0	102.4	480	3	24	36.2	50	6	1/15	1550/1250	2000/1800	1300/1100	47/53	40
3E355A	49.6	169.9	208	3	24	139.0	175	2/0*	1/4	1550/1310	3100/2800	2000/1800	51/56	50
3E356A	50.0/37.5	170.6/128.0	240/208	3	24	120.5/104.3	175/150	2/0*1/0	1/4	1550/1310	3100/2800	2000/1800	51/56	50
3E357B	50.0	170.6	480	3	24	60.3	80	3*	1/4	1550/1310	3100/2800	2000/1800	51/56	50

(†) These units are wired for direct line voltage and have no contactors or transformers. (*) Use 75°C wire. (**) Use copper conductors on all heaters.
NOTES: 1) 30 & 50 KW-Models can be wired for single or two stage, low voltage control. These units also contain a two speed fan switch for HI-LO fan selection.
2) Air delivery and motor data on dual voltage units reflect higher voltage.

Unpacking

When unpacking the heater, inspect carefully for any damage that may have occurred during transit. Check for loose parts, missing parts or damaged parts.

Dimensions

KW	H	W	D
3.3-5.0	17¾"	14 15/32"	6½"
7.5-10.0	24 5/16	21½	6½
15.0-20.0	28 11/16	21½	6½
30.0-50.0	34	29¼	10 1/16

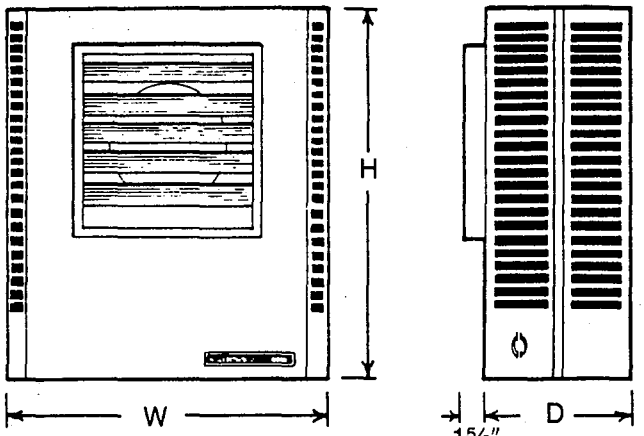


Figure 2

General Safety Information

1. Make certain that power source conforms to electrical requirements of the heater. Disconnect power before installing or servicing. If the power disconnect is out-of-sight, lock it in the open position and tag it to prevent unexpected application of power. Failure to do so could result in fatal electric shock.

WARNING: DO NOT DEPEND UPON A THERMOSTAT OR OTHER SWITCH AS THE SOLE MEANS OF DISCONNECTING POWER WHEN INSTALLING OR SERVICING THE HEATER. ALWAYS DISCONNECT POWER AT THE MAIN CIRCUIT BREAKER AS DESCRIBED ABOVE. FAILURE TO DO SO COULD RESULT IN FATAL ELECTRIC SHOCK.

2. This heater is intended ONLY for permanent installation in accordance with the National Electrical Code (NEC), all applicable local codes and ordinances, and all sections of this manual. Any variance voids the warranty and may create unsafe conditions. All wiring should be done by a qualified electrician, using copper wire only.
3. Special attention must be given to any grounding information pertaining to this heater. To prevent the risk of electrocution, the heater must be securely and adequately grounded. This should be accomplished by connecting a grounded conductor between the service panel and the green grounding screw provided on the heater. To ensure a proper ground, the grounding means must be tested by a qualified electrician.
4. Do not insert fingers or foreign objects into the heater. Do not block or tamper with the heater in any manner while it is in operation. Do not touch heater while in operation or just after it has been turned off, as some parts may be hot enough to cause injury.
5. This heater is intended for general heating applications ONLY. It must NOT be used in potentially dangerous locations such as flammable, explosive, chemical-laden or wet atmospheres.
6. Do not attach ductwork to this heater or attempt to use it as a make-up heater. Such use voids the warranty and may create unsafe conditions.
7. In cases in which property damage may result from malfunction of the heater, a backup system or a temperature sensitive alarm should be used.

WARNING: TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK, DO NOT USE THIS HEATER WITH ANY SOLID STATE SPEED CONTROL DEVICE.

Installation

LOCATION

NET JUNCTION BOX VOLUME		
KW	CUBIC INCHES	CC
3.3 - 5	74.4	1219
7.5 - 10	198	3245
15.0 - 20	198	3245
25.0 - 50	341	5592

1. Once the total heating load is calculated, the quantity and capacity of the unit heaters must be determined. Because a large number of low-capacity heaters provides more uniform heat distribution, this approach is recommended when the area will be occupied by a relatively large number of sedentary personnel, perhaps working on production lines and at benches.
2. A large number of smaller capacity unit heaters tends to prevent hot drafts, reduces noise levels, and increases diversity of load to help reduce electrical demand and operating costs.
3. In warehouse areas where even heat distribution and constant temperature are less important, a smaller number of high capacity units can be used — in many cases reducing first cost. To maintain reasonable heat distribution and reduce severe stratification even in lower bay areas, the total air volume of the space should pass through the unit heaters about three times per hour. (Take total cubic feet and divide by 20 in order to determine proper total heater CFM rating.)
4. It is important that the rated voltage of the heating equipment match the supply voltage. Supply voltage in excess of the heater rated voltage can damage equipment. Supply voltage lower than the rated heater voltage will decrease heater output as well as run the risk of damaging some components.
5. Horizontal unit heaters are recommended in low

Installation (Continued)

bay areas with maximum 15 to 18 foot ceilings. These should be concentrated along outside walls or other areas of greatest heat loss, spaced to set up a generally circular air movement, each heater supporting the air stream of the other. Additional vertical down blow unit heaters with appropriate accessory diffusers can be located to counteract ceiling heat losses.

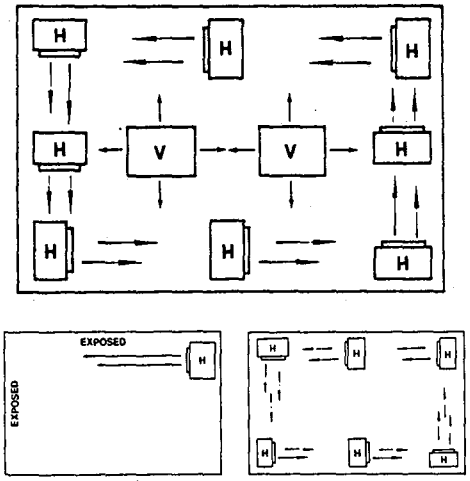


Figure 3

GENERAL MOUNTING INFORMATION

All electric unit heaters are shipped fully assembled. Installation includes hanging the unit, mounting the built-in and remote accessories, wiring of optional control devices, and electrical wiring to the unit.

1. To insure proper delivery of the heated air to desired areas, follow the mounting height and air projection tables included in these instructions. (Follow Figures 4 & 5 for minimum wall and ceiling clearances.)

Minimum Mounting Clearances

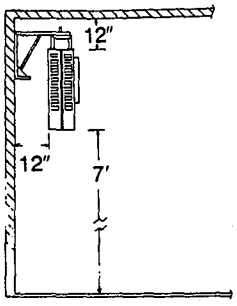


Figure 4 — Horizontal Discharge

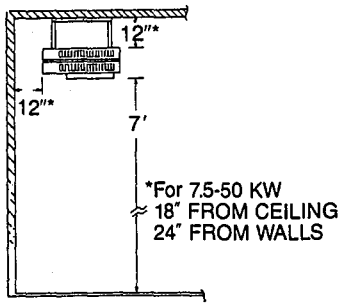
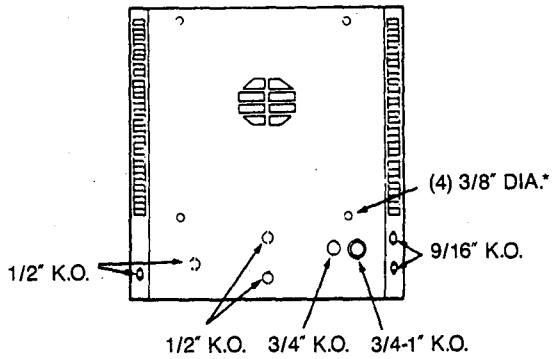


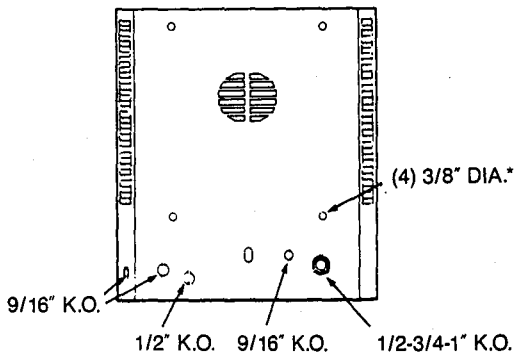
Figure 5 — Vertical Discharge

2. The wall and/or ceiling structure must be sufficient to support the combined weight of the heater and any mounting bracket and accessories.
3. Be sure power source is de-energized before installing heater. Check heater voltage and phase listed on heater data tape on back of unit. to make sure they are the same as the electrical service supplied.
4. Certain units are adaptable from single to three phase service. Follow instructions noted on the unit wiring diagram for this conversion. Units that carry a dual voltage rating require specific wiring changes when converting from 240 to 208 volt service. Carefully follow the instructions on the unit wiring diagram.
5. Open the access panel (two 1/4 turn fasteners).
6. Remove the desired knock-out(s) on back of the heater (Figures 6, 7, & 8).



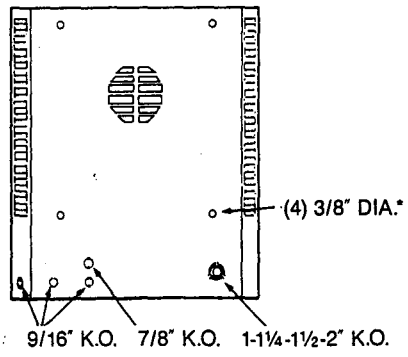
(*) For vertical discharge mounting bracket.

Figure 6 — 3.3-5KW



(*) For vertical discharge mounting bracket.

Figure 7 — 7.5-20KW



(*) For vertical discharge mounting bracket.

Figure 8 — 30 & 50KW

Installation (Continued)

7. Install any optional accessories following their installation instructions before mounting unit. Following the correct unit/accessory wiring diagram, connect the power supply, mechanical ground and accessories to the correct terminals or termination points using accepted practices.
8. Heaters may be mounted in the horizontal or vertical air discharge configuration using optional factory supplied accessory mounting equipment or using special hardware facilities supplied by others.
9. After the installation is complete, replace the access panel.
10. Set the controls (thermostat, switch) at their desired control points and apply power to the unit.
11. Check for correct operation.

HORIZONTAL AIR DISCHARGE MOUNTING

MODEL	MAX. MOUNTING HEIGHT IN FEET
2E635B thru 2E640B, 2E669B, 2E670B, 2E805B and 2E806B	9
3E341A, 3E342A, 3E343B, 3E344A, 3E345A and 3E346B	10
3E347A, 3E348A and 3E349B	11
3E350A, 3E351B, 3E352A, 3E353A and 3E354B	12
3E355A, 3E356A and 3E357B	15

1. Swivel hanger brackets may be used to suspend unit heaters from either the wall (Figure 9) or the ceiling (Figure 10).
2. Attach hanger base "A" to top of heater with the four 5/16 x 18″ capscrews and lockwashers (provided in envelope).
3. Attach main hanger frame "B" to wall or ceiling in desired location using lag screws "C" or other suitable attachments (supplied by others).
4. Lift heater into position inserting stud "D" through hole in main hanger frame and attach 5/8″ locknut (provided in envelope) "E" tightening to within two turns of being tight. (See Figures 9 & 10.)
5. Swivel heater to desired position, tighten nut (See. Figures 9 & 10).

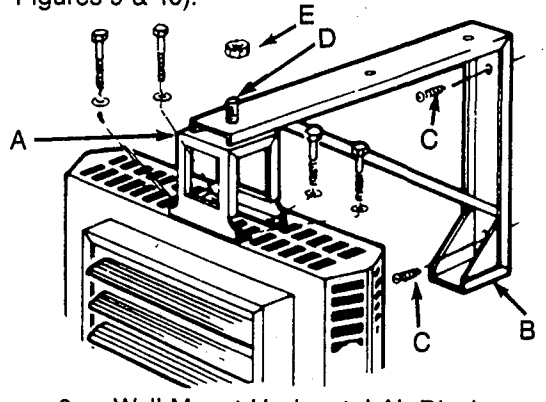


Figure 9 — Wall Mount Horizontal Air Discharge

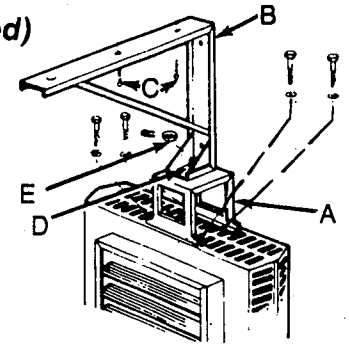


Figure 10 — Ceiling Mount Horizontal Air Discharge

VERTICAL AIR DISCHARGE MOUNTING

MODEL	MAX. MOUNTING HEIGHT IN FEET
2E635B thru 2E640B, 2E669B, 2E670B, 2E805B and 2E806B	9
3E341A, 3E342A and 3E343B	12
3E344A, 3E345A and 3E346B	14
3E347A, 3E348A, 3E349B, 3E352A, 3E353A and 3E354B	20
3E350A and 3E351B	18
3E355A, 3E356A and 3E357B	22

Refer to Figure 11

1. Attach short angle brackets "A" to back of heater with four 5/16 x 18″ capscrews "B", lockwashers "F". Be sure vertical leg of angle brackets face top and bottom of heater.
2. Attach inverted U frames "D" to short angle brackets with four 5/16 x 18″ capscrews "E", washers "F", lockwashers "G" and nuts "H".
3. Attach long angle brackets "J" to inverted frames "D" with four 5/16 x 18″ capscrews "K", lockwashers "M" and nuts "N".
4. Attach heater and bracket assembly to ceiling in desired location using customer supplied equipment sufficient to support the assembly.

NOTE: When mounting heater using 5/16″ all thread rod (by others) do not screw the rod more than 1/2″ beyond the inside of the case.

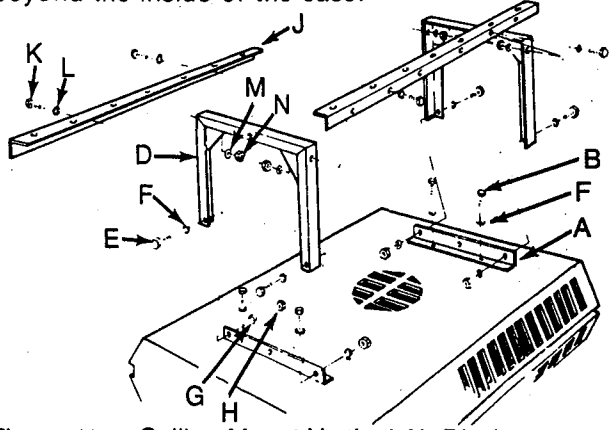


Figure 11 — Ceiling Mount Vertical Air Discharge

Installation (Continued)

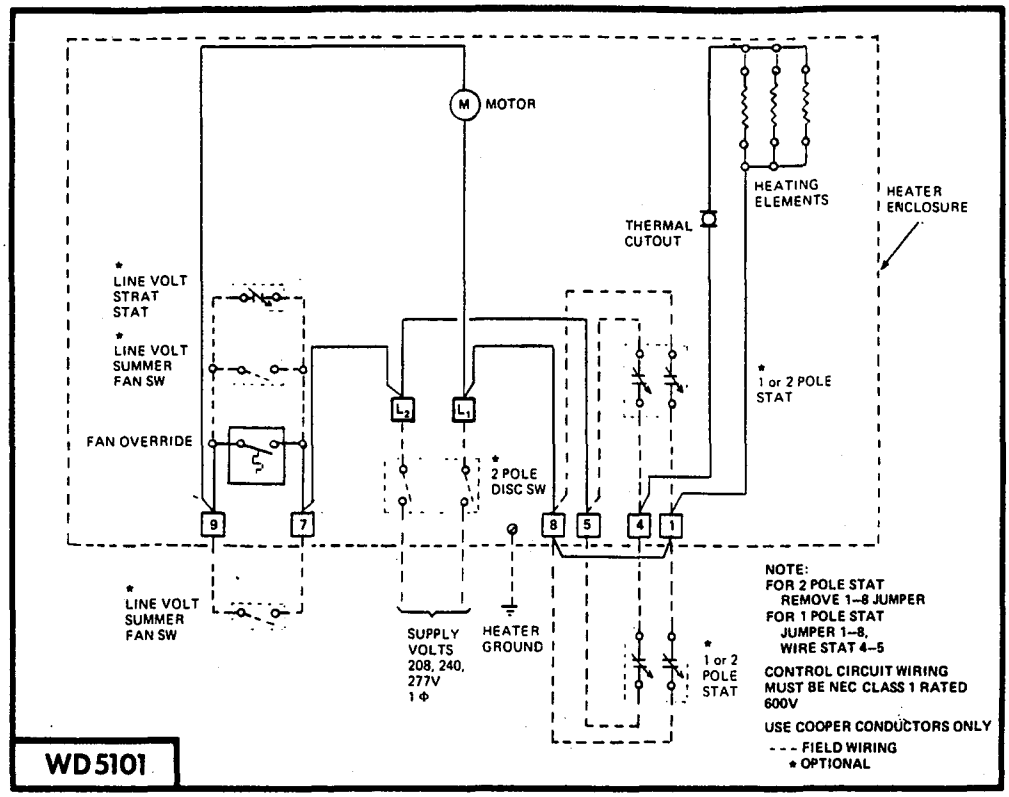
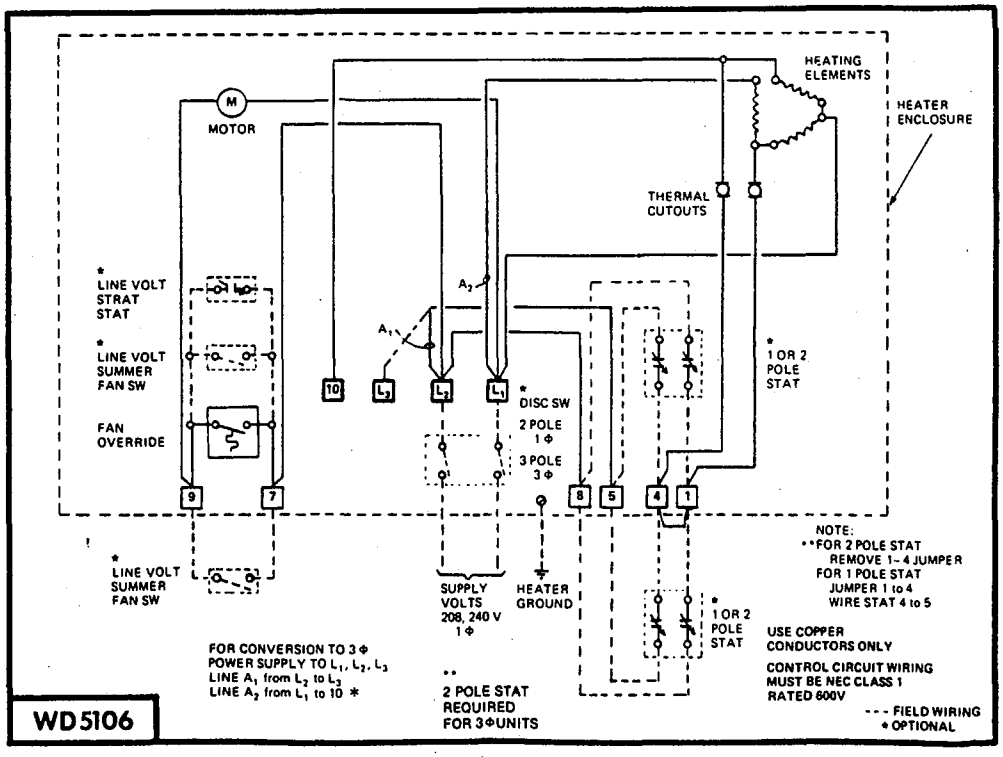


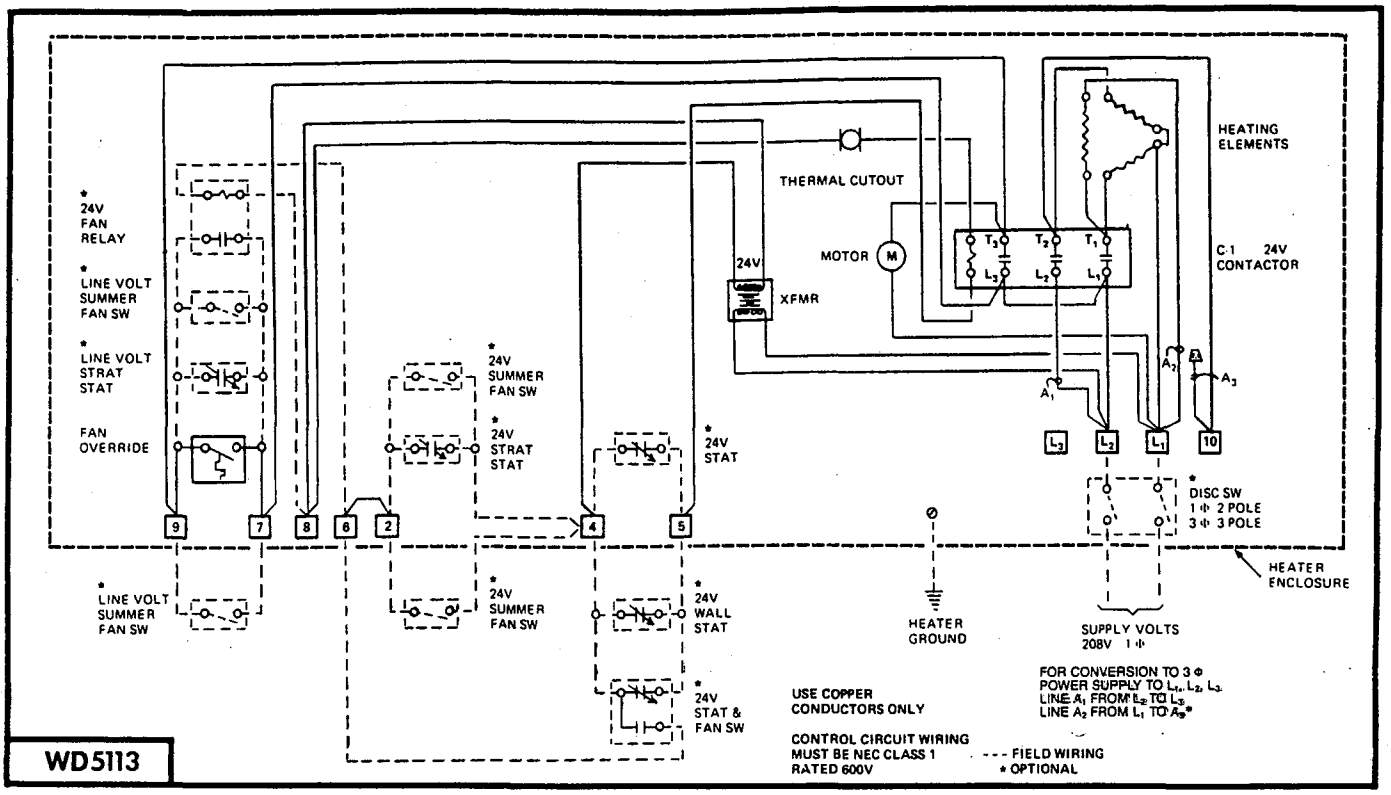
Figure 12 — Wiring Diagram for Models 2E635B, 2E636B, 2E669B, 2E670B, 2E805B & 2E806B



(*) A_2 is brown

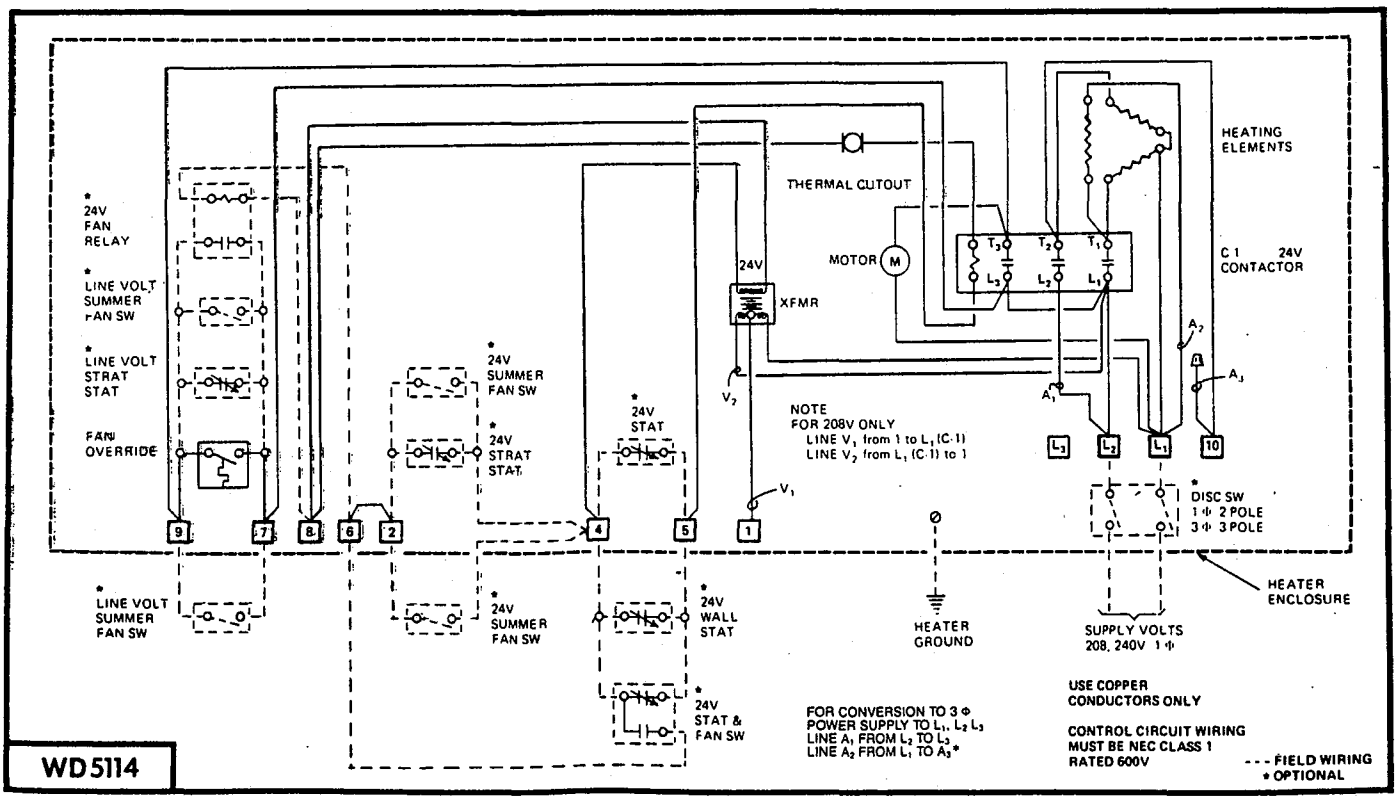
Figure 13 — Wiring Diagram for Models 2E638B & 2E639B

Installation (Continued)



(*) A_2 is brown

Figure 14 — Wiring Diagram For Models 3E341A & 3E344A



(*) A_2 is brown

Figure 15 — Wiring Diagram For Models 3E342A & 3E345A

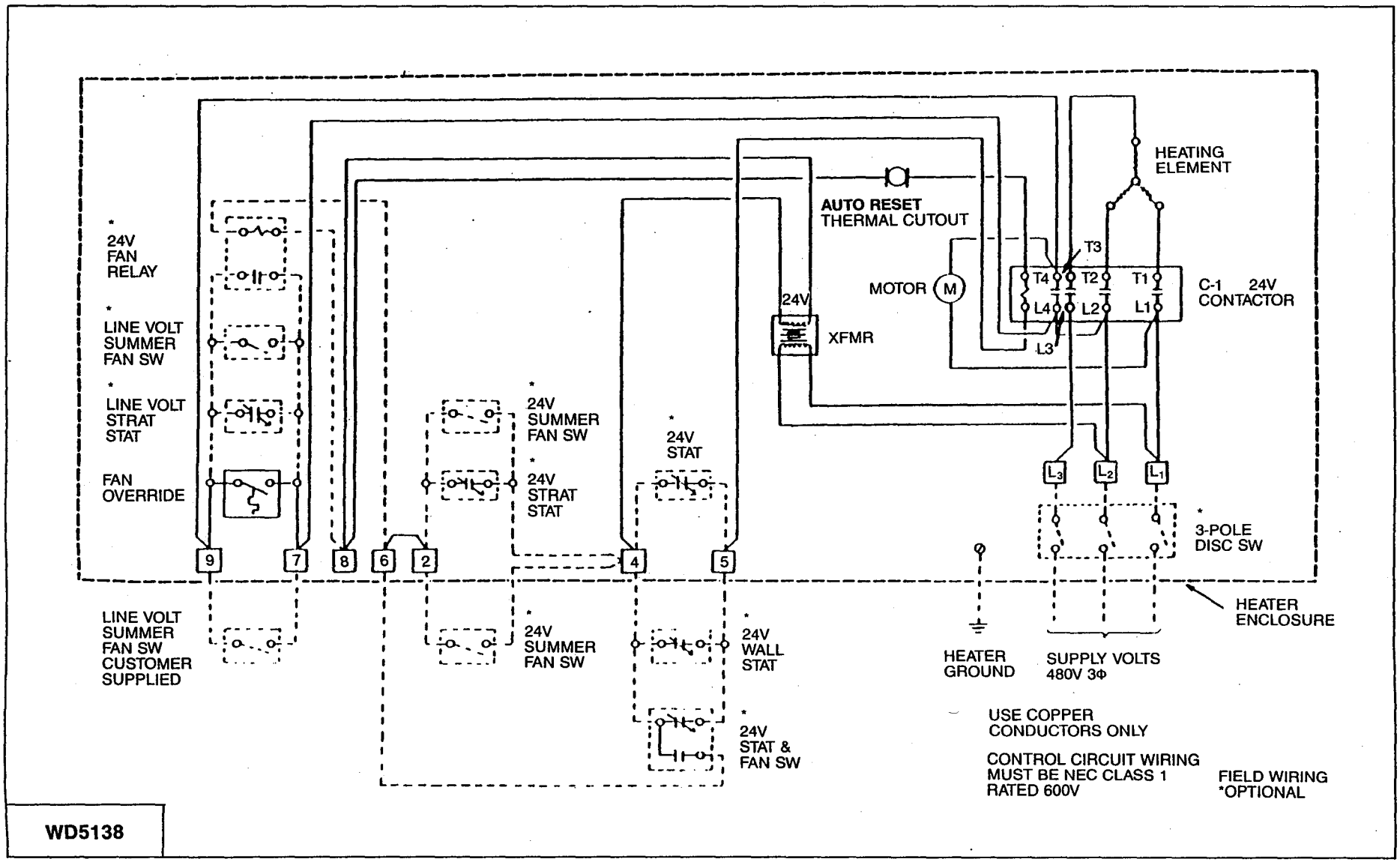


Figure 16 — Wiring Diagram for Models 2E637B, 2E640B, 3E343B, 3E346B, 3E349B & 3E351B

Installation (Continued)

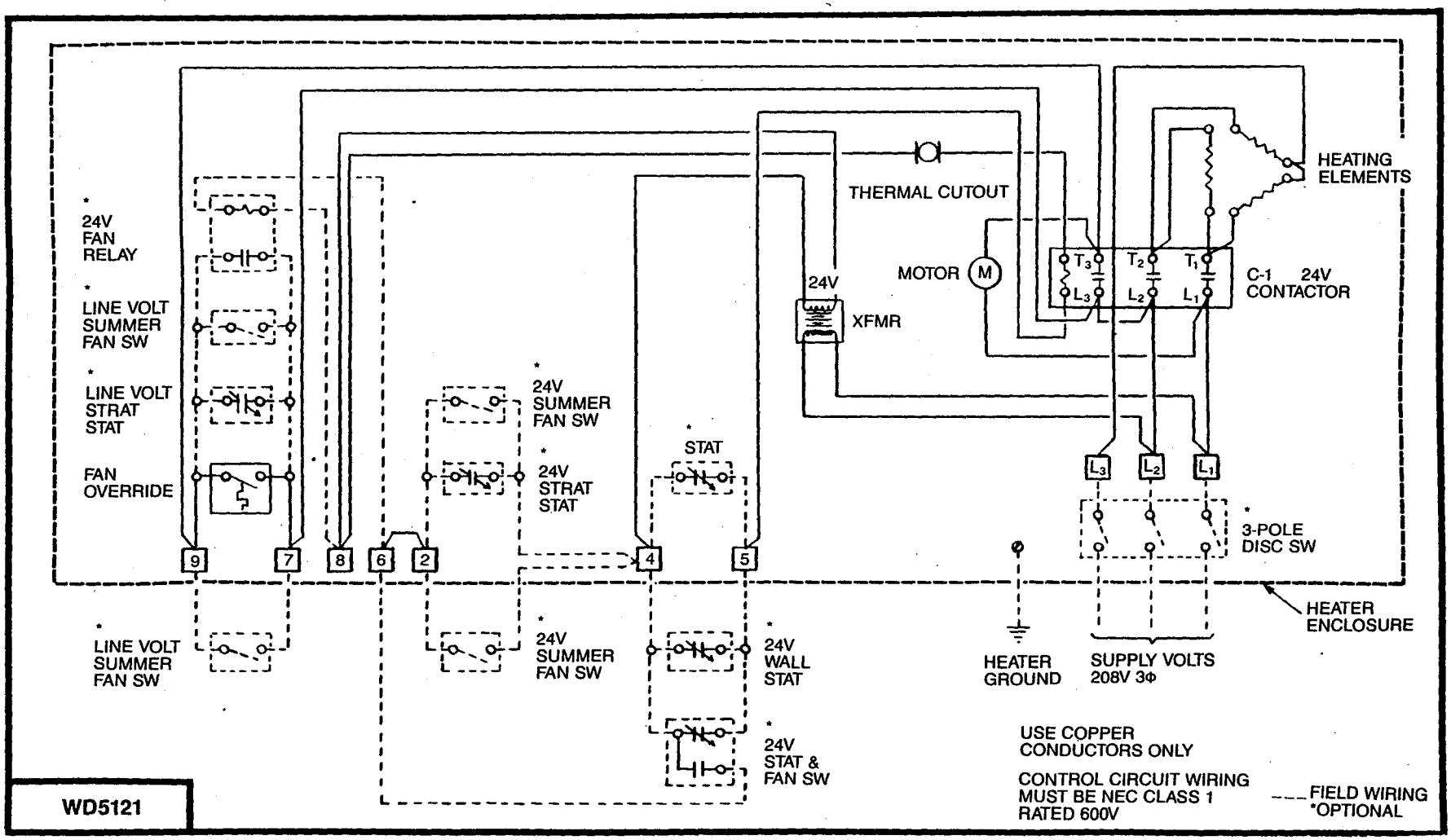


Figure 17 — Wiring Diagram For Model 3E347A

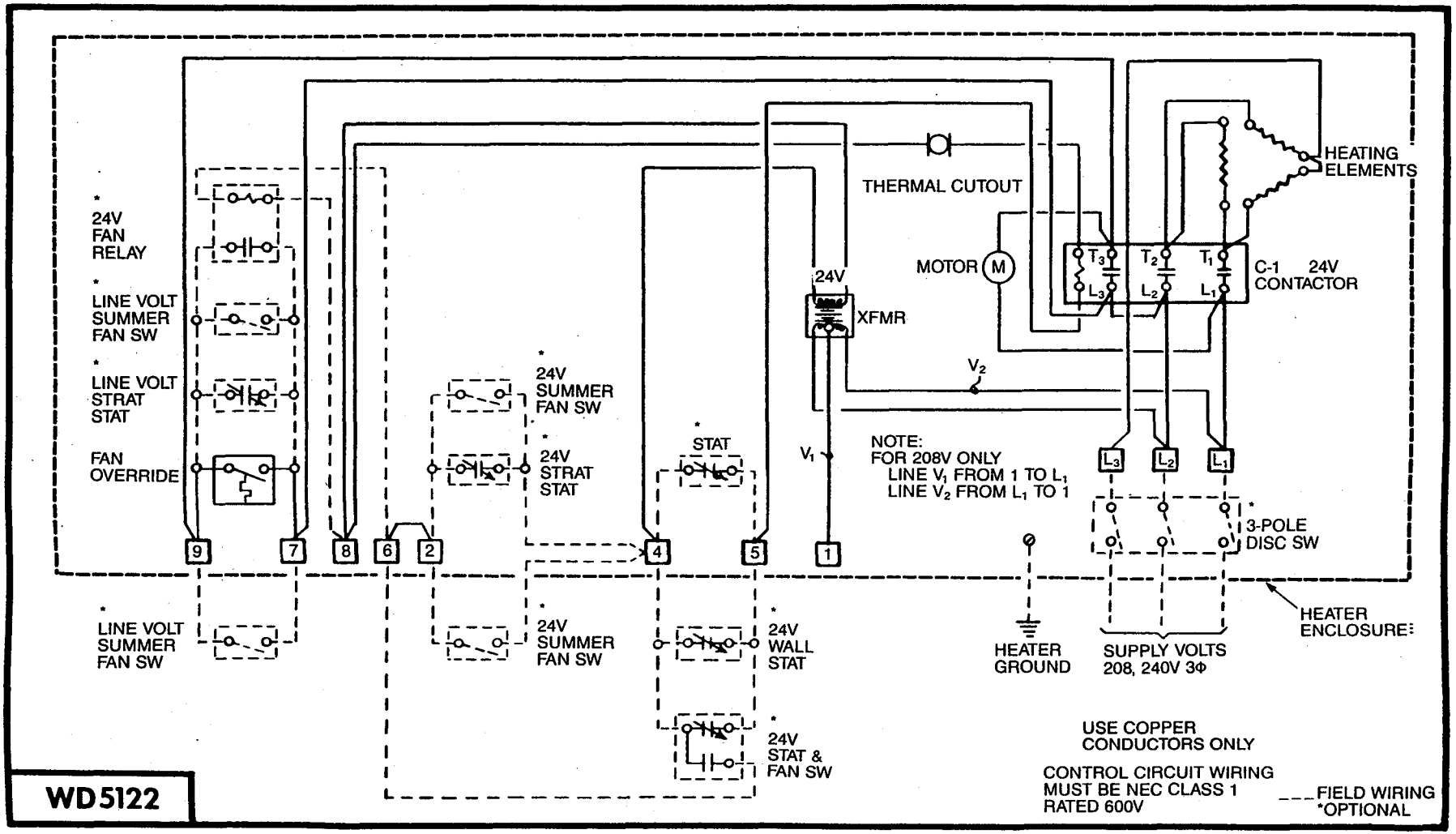


Figure 18 — Wiring Diagram For Models 3E348A & 3E350A

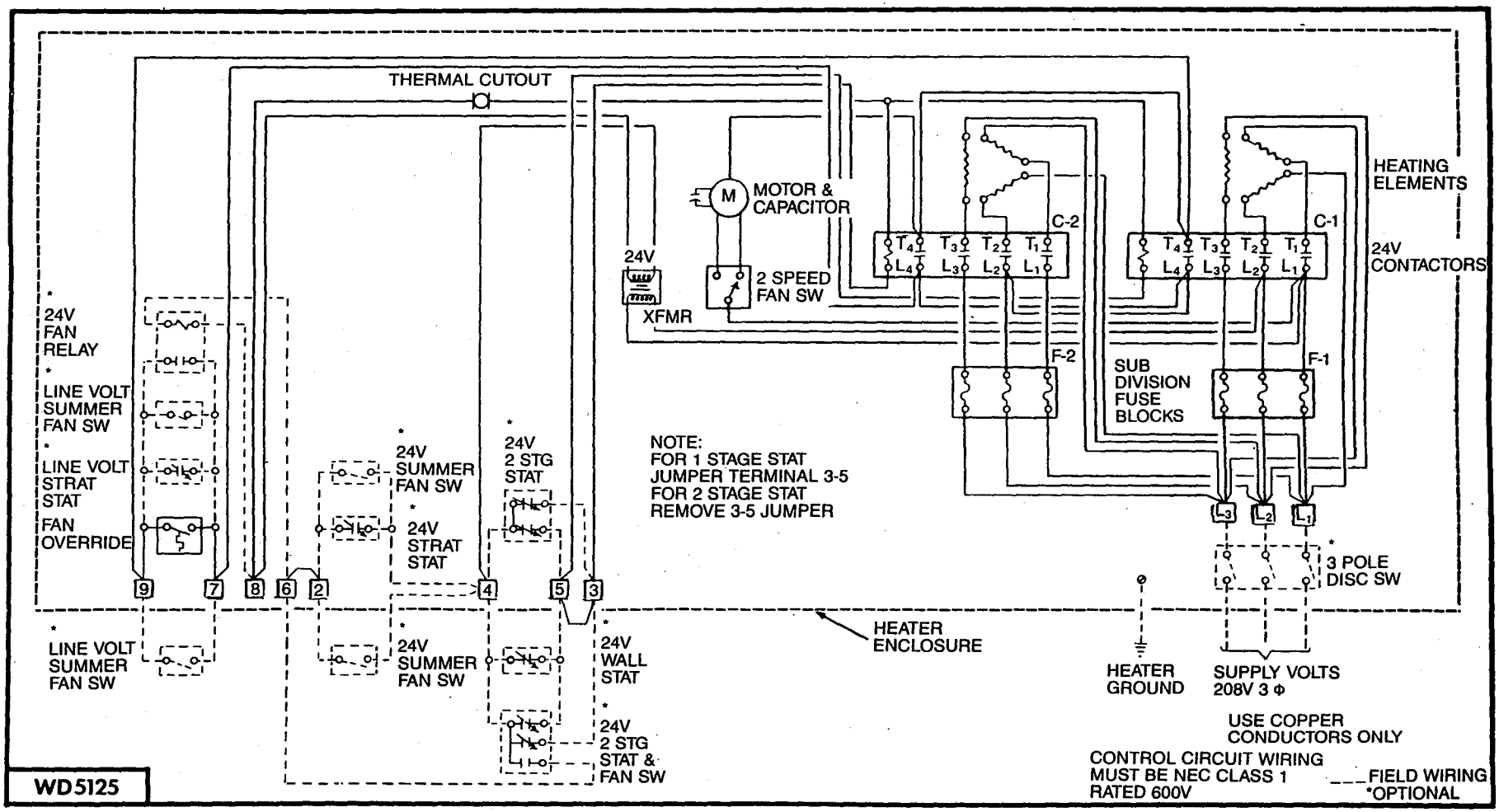


Figure 19 — Wiring Diagram For Models 3E352A & 3E355A

Installation (Continued)

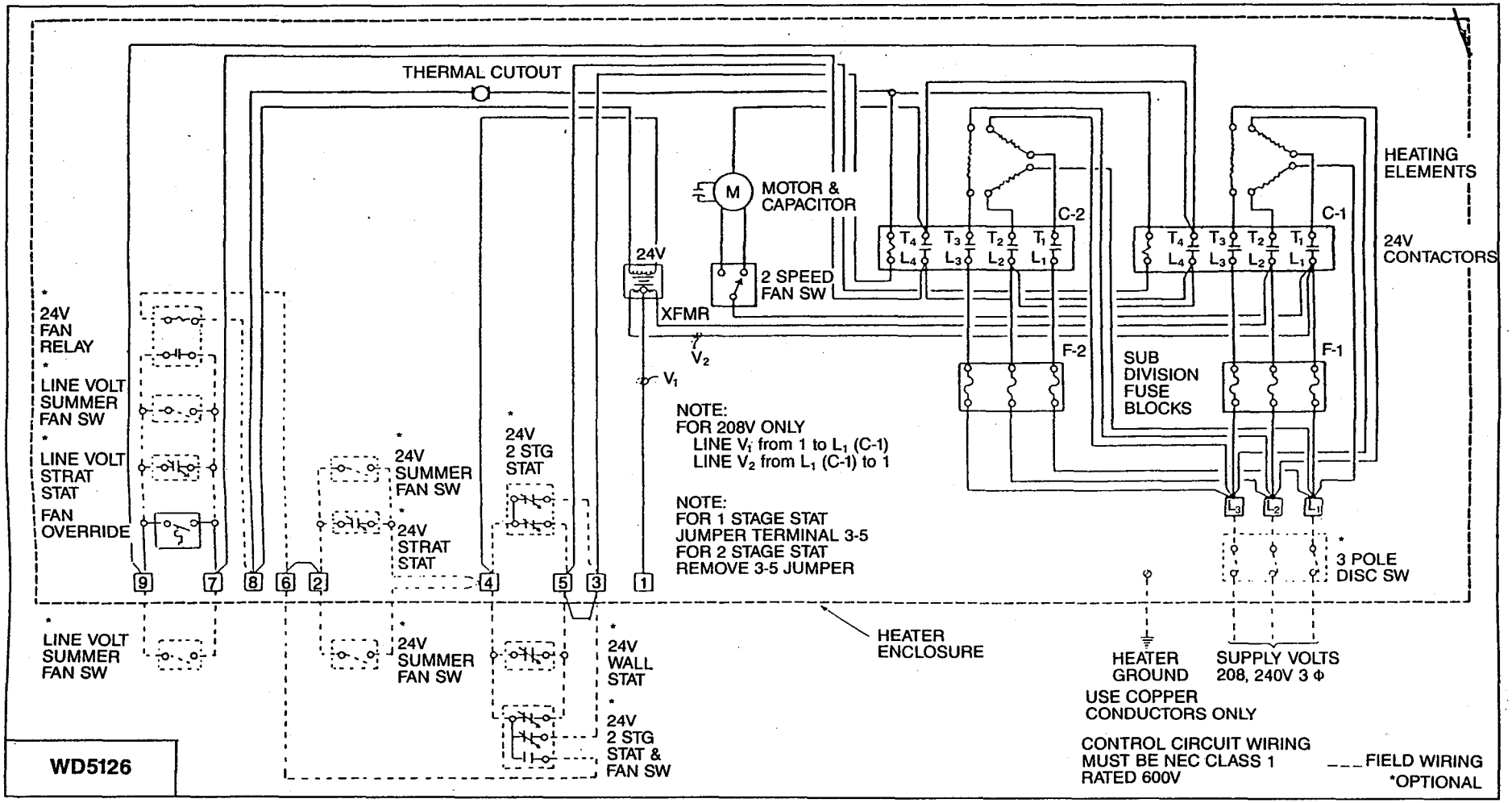


Figure 20 — Wiring Diagram For Models 3E353A and 3E356A

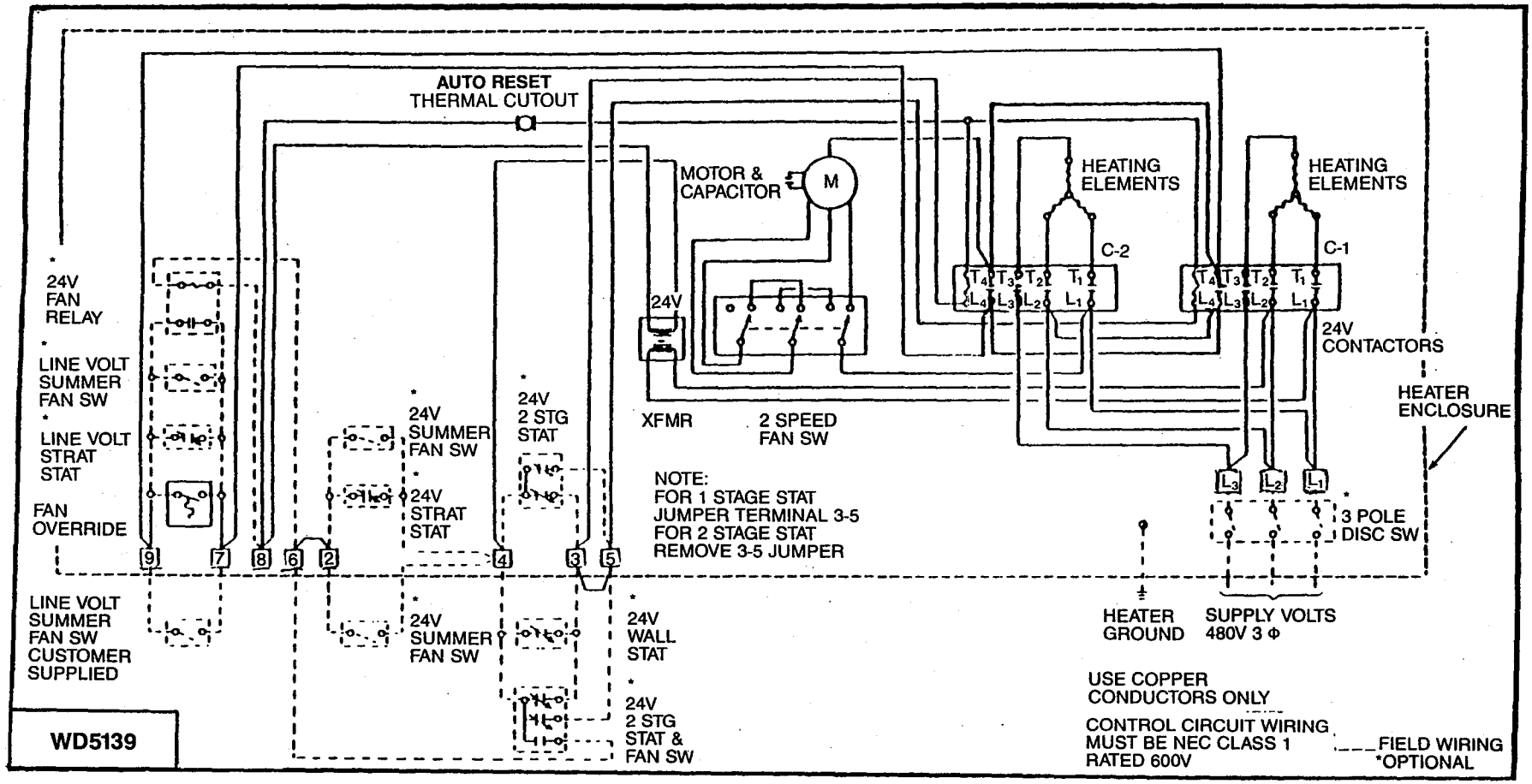


Figure 21 — Wiring Diagram For Model 3E354B

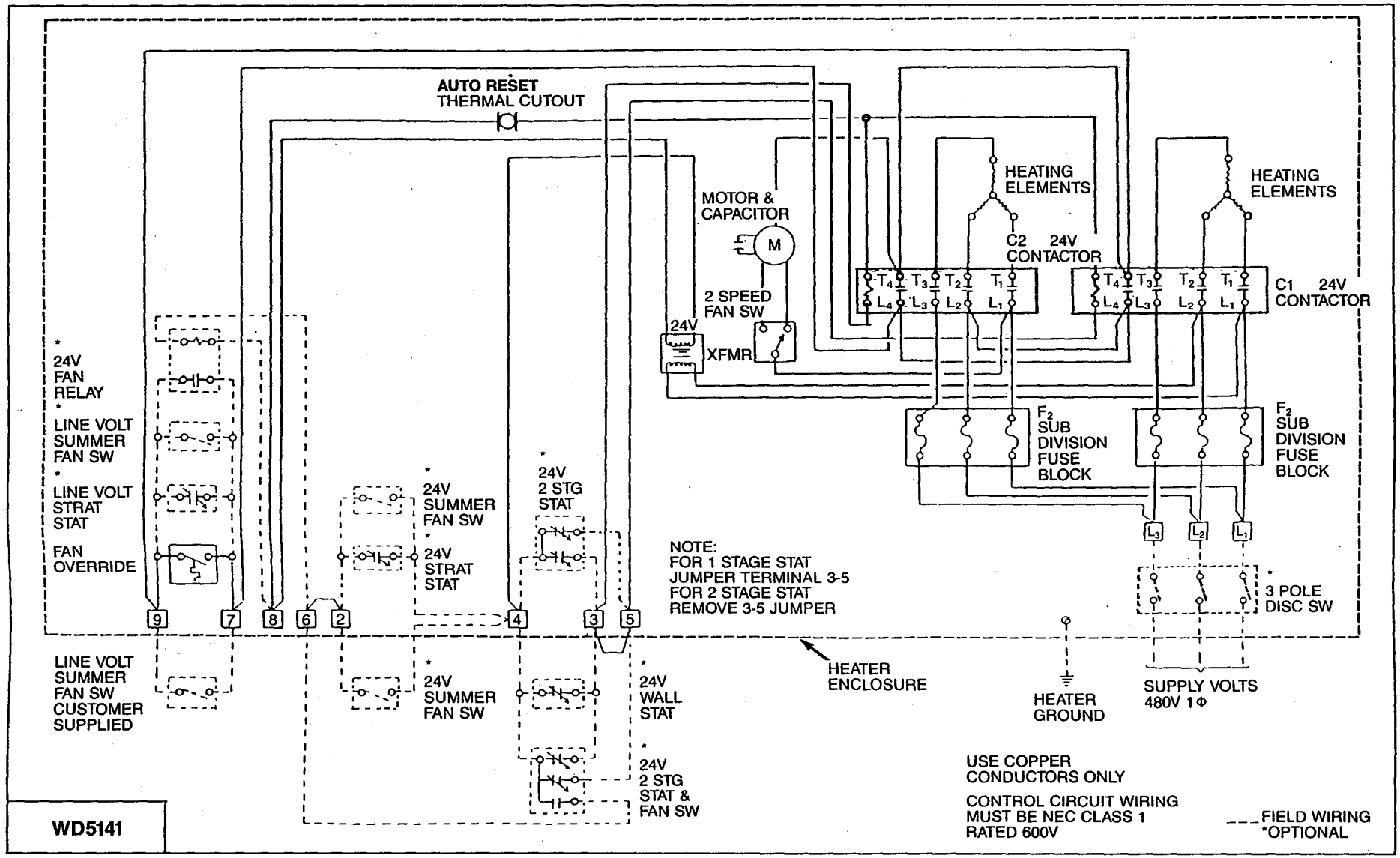


Figure 22 — Wiring Diagram For Model 3E357B

Operation

Upon a call for heat from the floor level or unit mounted optional accessory thermostat, the unit fan motor and heating elements shall be energized and remain on until temperature reaches setting of thermostat; at which time, the heating elements shall be de-energized. The fan motor shall continue to run and purge heater casing of residual heat until setting of fan override is reached, then the fan motor shall be de-energized. For those units with a factory installed two speed fan switch (30 & 50KW), the unit as shipped from the factory is set for the LOW speed fan position. Customer option to set to HIGH speed. For those units available with subdivided circuits, the accessory two stage thermostat (optional) will, upon a call for heat, energize fan motor and the first stage heating element. Should temperature continue to fall, the thermostat shall energize the second stage heating element. Upon a rise in space conditions towards setting of the thermostat, the two stages of heating elements shall be de-energized in reverse sequence. The fan motor shall continue to run and purge heater casing of residual heat until setting of fan override is reached, then the fan motor shall be de-energized.

The accessory unit mounted stratification thermostat will energize the unit heater fan motor upon a rise in temperature above its setting. When the unit mounted stratification thermostat closes on a temperature rise and at the same time the floor thermostat calls for heat, the motor shall be energized immediately and the heating element shall be energized, as previously described.

The safety high limit shall de-energize the heating elements and control circuits should the temperature exceed the setting of this device. The fan safety override shall energize fan motor any time the setting of this device is exceeded so as to purge heater casing of excess residual heat. When the accessory fan switch is placed in the ON position (for summer air circulation), the unit heater fan motor shall be energized.

NOTE: The wall thermostat is to be set to the OFF Position during this mode of operation (units with contactors).

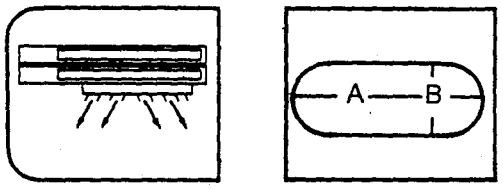
For those accessory thermostats equipped with an integral fan switch, place the switch in the HEAT, or AUTO position for operation of the fan and elements which shall then be under control of the thermostat as described above. When switch is placed in the FAN position, elements shall be de-energized and fan shall be immediately energized.

OPTIONAL DIFFUSERS

Optional diffusers lend added air pattern versatility to individual vertical down blow installations, as shown in illustrations below.

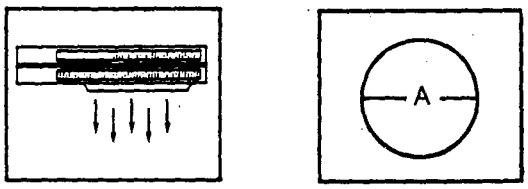
Standard Diffusers

STANDARD LOUVER DIFFUSER



USED ON	MAX. MTG. HT. (FEET)	DIM. A	DIM. B
3.3 & 5.0 KW	9	20	10
7.5 & 10.0 KW	12	40	22
15.0 & 20.0 KW	18	52	30
30.0 KW	22	75	42
50.0 KW	24	84	47

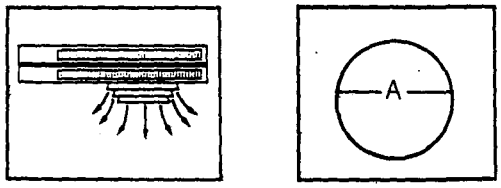
WITHOUT STANDARD DIFFUSER



USED ON	MAX. MTG. HT. (FEET)	DIM. A
3.3 & 5.0 KW	9	15
7.5 & 10.0 KW	12	30
15.0 & 20.0 KW	18	40
30.0 KW	22	55
50.0 KW	24	64

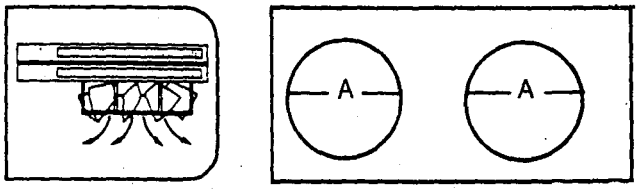
Accessory Diffusers

ANEMOSTAT DIFFUSER



USED ON	MODEL	MAX. MTG. HT. (FEET)	DIM. A
3.3 & 5.0 KW	N/A	—	—
7.5 & 10.0 KW	2E666	10	30
15.0 & 20.0 KW	2E666	15	38
30.0 KW	3E360	17	50
50.0 KW	3E360	20	60

RADIAL DIFFUSER



USED ON	MODEL	MAX. MTG. HT. (FT.)		DIMENSION A	
		45°	90°	45°	90°
3.3 & 5.0 KW	N/A	—	—	—	—
7.5 & 10.0 KW	2E664	10	14	36	30
15.0 & 20.0 KW	2E664	14	21	42	35
30.0 KW	2E665	20	30	62	44
50.0 KW	2E665	18	28	68	54

Figure 23 — Vertical Discharge Units — Air Patterns

Maintenance

WARNING: MAKE CERTAIN THAT THE POWER SOURCE IS DISCONNECTED BEFORE ATTEMPTING TO SERVICE OR DISASSEMBLE ANY COMPONENT. IF THE POWER DISCONNECT IS OUT OF THE LINE OF SIGHT, LOCK IT IN THE OPEN POSITION AND TAG IT TO PREVENT THE APPLICATION OF POWER.

ELECTRICAL

1. Once a year inspect the control panel wiring to make certain insulation is intact and all connections are tight. Inspect all heater and relay contacts. If the contacts appear badly pitted or burned, replace the contractor/relay.
2. For proper heater protection during operation, the correct size fuse must be used. The parts list contains the fuse size for all 30 and 50KW units.

CLEANING

Clean the unit casing, fan and motor once a year. A dirty motor will tend to run hot and eventually will be damaged internally. Any rust spots on the casing should be cleaned and repainted.

LUBRICATION

All units up to 20KW have fan motors that are permanently lubricated so that only occasional cleaning is required. Units above 20KW have fan motors lubricated for 5 years of continuous duty or 10 years of intermittent operation. When required, remove the oil access plug on back of heater at motor intake grill, open oil cap, fill with S.A.E. No. 10 electric motor oil, replace plugs and access plug. Ensure that power is disconnected before attempting lubrication.

Troubleshooting Chart

SYMPTOM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
Thermostat calls for heat, but heater does not function	1. Open (blown) fuse 2. Incorrect wiring 3. Thermal cut-out open, de-energizing heater element and control circuit	1. Replace fuses, check for cause (See Replacement Parts List for fuse size.) 2. Check wiring connections 3. Check for the following: Correct supply volts & phase. Correct control wiring (heater control must be thru thermostat control wiring section only) Power interruption to heater during heater operation Restriction of air around heater 1-5 minute fan purge after thermostat off
Fan motor runs "hot"	1. Dust accumulation or excessive dirt on fan motor 2. Dirt accumulation 3. Motor needs lubrication	1. Clean fan motor and casing of grease and oil accumulation 2. Clean louvers and between heating elements 3. See Maintenance
Fan motor runs, but no heat	1. Element contact not operating correctly 2. Element fuse blown	1. Check wiring for open circuit. Replace contactor if defective 2. Replace fuses, check for cause (See Replacement Parts List for fuse size.)

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. Electric heaters, Models 2E635B thru 2E637B, 2E805B, 2E669B, 2E670B, 2E638B thru 2E640B, 2E806B, 3E341A, 3E342A, 3E343B, 3E344A, 3E345A, 3E346B, 3E347A, 3E348A, 3E349B, 3E350A, 3E351B, 3E352A, 3E353A, 3E354B, 3E355A, 3E356A & 3E357B, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined by Dayton to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specific legal rights which vary from state to state.

LIMITATION OF LIABILITY. To the extent allowable under applicable law, Dayton's liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to, and shall not exceed, the purchase price paid.

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Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some states do not allow limitations on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Manufactured for Dayton Electric Mfg. Co., 5959 W. Howard St., Chicago, IL 60648

ORDER REPLACEMENT PARTS BY CALLING TOLL FREE

1-800-323-0620

Please provide following information:

- Model Number
- Serial Number (if any)
- Part Description and Number as shown in Parts List.

Address parts correspondence to:

Parts Company of America
1657 Shermer Road
Northbrook, IL 60062-5362

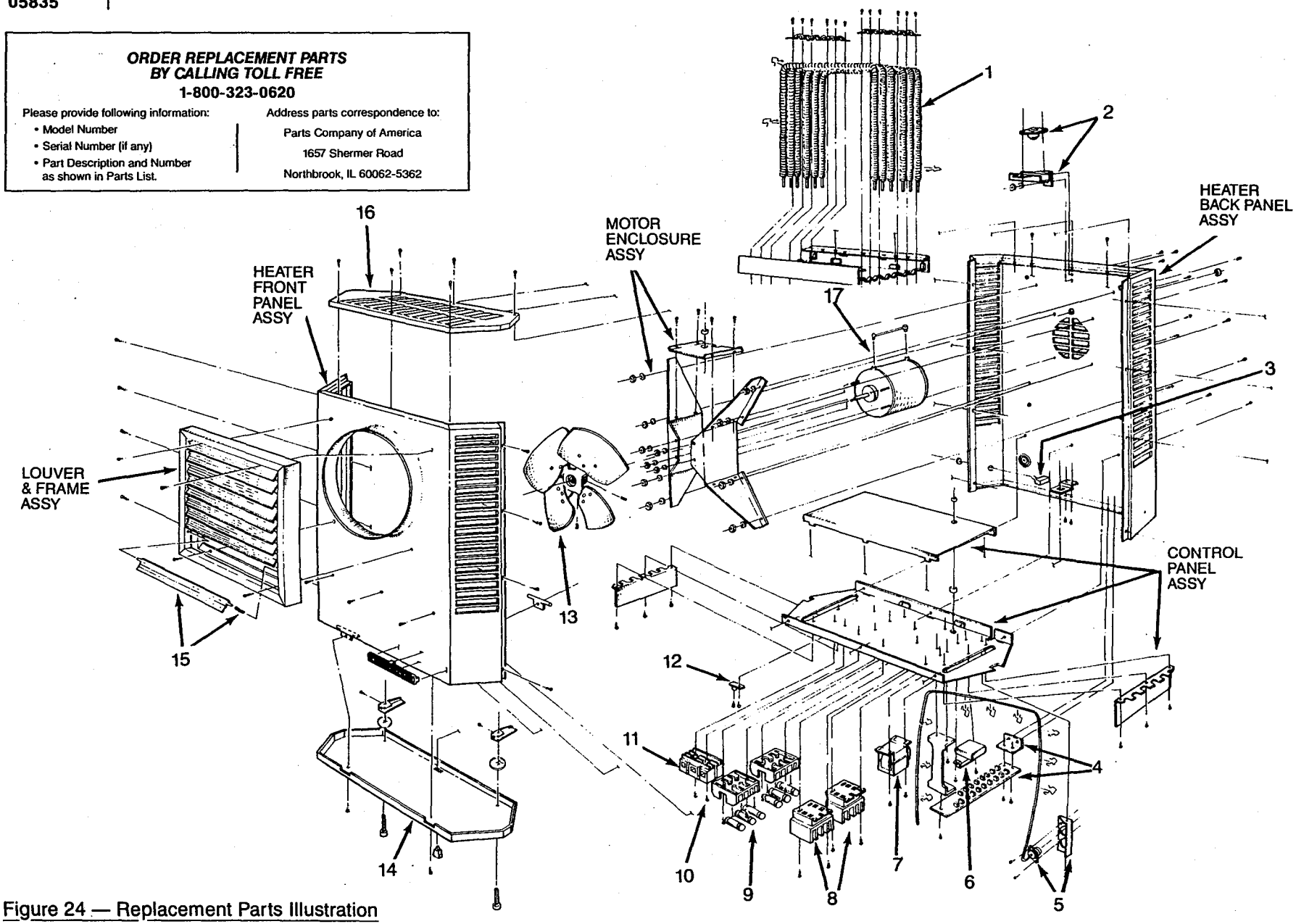


Figure 24 — Replacement Parts Illustration

Replacement Parts List

REF. NO.	DESCRIPTION	PART NUMBER FOR MODEL: 2E635B	2E636B	2E637B	2E638B	2E639B	2E805B	2E806B
1	Element assembly	60715-001	60715-002	60715-008	60715-004	60715-006	60715-007	60715-009
2	Fan override	56811-001	56811-001	56811-001	56811-001	56811-001	56811-001	56811-001
3	Fan speed switch	—	—	—	—	—	—	—
4	Terminal board	56809-001	56809-001	56809-001	56809-001	56809-001	56809-001	56809-001
5	Thermal cutout	57640-006	57640-006	57640-006	57640-006	57640-006	57640-006	57640-006
6	Motor capacitor	—	—	—	—	—	—	—
7	Transformer	—	—	60719-006	—	—	—	—
8	Contactor	—	—	50378-016	—	—	—	—
9	Fuse (6 req'd.)	—	—	—	—	—	—	—
10	Fuse block (2 req'd.)	—	—	—	—	—	—	—
11	Power terminal block	56815-001	56815-001	56815-001	56815-001	56815-001	56815-001	56815-001
12	Ground connector	1458	1458	1458	1458	1458	1458	1458
13	Fan blade	56806-001	56806-001	56806-001	56806-001	56806-001	56806-001	56806-001
14	Bottom panel	56963-001	56963-001	56963-001	56963-001	56963-001	56963-001	56963-001
15	Individual louver assy.	56986-001	56986-001	56986-001	56986-001	56986-001	56986-001	56986-001
16	Top panel	56962-001	56962-001	56962-001	56962-001	56962-001	56962-001	56962-001
17	Motor	56562-012	56562-017	56562-018	56562-012	56562-017	56562-016	56562-016

REF. NO.	DESCRIPTION	PART NUMBER FOR MODEL: 2E640B	2E669B	2E670B	3E341A	3E342A
1	Element assembly	60715-010	60715-003	60715-005	56954-004	56954-006
2	Fan override	56811-001	56811-001	56811-001	56811-001	56811-001
3	Fan speed switch	—	—	—	—	—
4	Terminal board	56809-001	56809-001	56809-001	56809-001	56809-001
5	Thermal cutout	57640-006	57640-006	57640-006	57640-003	57640-003
6	Motor capacitor	—	—	—	—	—
7	Transformer	60719-006	—	—	60719-001	60719-001
8	Contactor	50378-016	—	—	50378-022	50378-013
9	Fuse (6 req'd.)	—	—	—	—	—
10	Fuse block (2 req'd.)	—	—	—	—	—
11	Power terminal block	56815-001	56815-001	56815-001	56816-001	56816-001
12	Ground connector	1458	1458	1458	1458	1458
13	Fan blade	56806-001	56806-001	56806-001	51554-002	51554-002
14	Bottom panel	56963-001	56963-001	56963-001	56965-001	56965-001
15	Individual louver assy.	56986-001	56986-001	56986-001	56986-003	56986-003
16	Top panel	56962-001	56962-001	56962-001	56964-001	56964-001
17	Motor	56562-018	56562-012	56562-017	56823-011	56823-012

REF. NO.	DESCRIPTION	PART NUMBER FOR MODEL: 3E343B	3E344A	3E345A	3E346B	3E347A
1	Element assembly	56954-002	56954-003	56954-004	56954-008	56954-009
2	Fan override	56811-001	56811-001	56811-001	56811-001	56811-001
3	Fan speed switch	—	—	—	—	—
4	Terminal board	56809-001	56809-001	56809-001	56809-001	56809-001
5	Thermal cutout	57640-003	57640-003	57640-003	57640-003	57640-004
6	Motor capacitor	—	—	—	—	—
7	Transformer	60719-006	60719-001	60719-001	60719-006	60719-001
8	Contactor	50378-016	50378-031	50378-031	50378-016	50378-031
9	Fuse (6 req'd.)	—	—	—	—	—
10	Fuse block (2 req'd.)	—	—	—	—	—
11	Power terminal block	56815-001	56816-001	56816-001	56815-001	56816-001
12	Ground connector	1458	1458	1458	1458	1458
13	Fan blade	51554-002	51554-002	51554-002	51554-002	56813-001
14	Bottom panel	56965-001	56965-001	56965-001	56965-001	56965-001
15	Individual louver assy.	56986-003	56986-003	56986-003	56986-003	56986-003
16	Top panel	56964-001	56964-001	56964-001	56964-001	56964-001
17	Motor	56824-011	56823-011	56823-012	56824-011	56825-001

REF. NO.	DESCRIPTION	PART NUMBER FOR MODEL: 3E348A	3E349B	3E350A	3E351B	3E352A
1	Element assembly	56954-010	56954-011	56954-012	56954-013	56954-020
2	Fan override	56811-001	56811-001	56811-003	56811-003	56811-002
3	Fan speed switch	—	—	—	—	57112-001
4	Terminal board	56809-001	56809-001	56809-001	56809-001	56809-001
5	Thermal cutout	57640-004	57640-004	57640-004	57640-004	57640-005
6	Motor capacitor	—	—	—	—	57100-001
7	Transformer	60719-001	60719-006	60719-001	60719-006	60719-009
8	Contactor	50378-022	50378-016	50378-031	50378-016	50378-025 (2)
9	Fuse (6 req'd.)	—	—	—	—	41280-008 (6)
10	Fuse block (2 req'd.)	—	—	—	—	50836-003 (2)
11	Power terminal block	56816-001	56815-001	56816-001	56815-001	57097-001
12	Ground connector	1458	1458	1458	1458	3981
13	Fan blade	56813-001	56813-001	56813-001	56813-001	57114-001
14	Bottom panel	56965-001	56965-001	56965-001	56965-001	56967-001
15	Individual louver assy.	56986-003	56986-003	56986-003	56986-003	56986-004
16	Top panel	56964-001	56964-001	56964-001	56964-001	56966-001
17	Motor	56825-002	56825-003	56825-002	56825-003	56943-001

REF. NO.	DESCRIPTION	PART NUMBER FOR MODEL: 3E353A	3E354B	3E355A	3E356A	3E357B
1	Element assembly	56954-021	56954-022	56954-026	56954-027	56954-028
2	Fan override	56811-002	56811-002	56811-003	56811-003	56811-003
3	Fan speed switch	56809-001	57090-001	57112-001	57112-001	57090-001
4	Terminal board	56809-001	56809-001	56809-001	56809-001	56809-001
5	Thermal cutout	57640-005	57640-005	57640-005	57640-005	57640-005
6	Motor capacitor	57100-001	57100-001	57100-001	57100-001	57100-001
7	Transformer	60719-009	60719-012	60719-009	60719-009	60719-012
8	Contactor	50378-025 (2)	50378-016 (2)	50378-034 (2)	50378-025 (2)	50378-016 (2)
9	Fuse (6 req'd.)	41280-002 (6)	—	41280-005 (6)	41280-004 (6)	57111-008 (6)
10	Fuse block (2 req'd.)	50836-012 (2)	—	50836-003 (2)	50836-003 (2)	57110-001 (2)
11	Power terminal block	57097-001	57098-001	57097-001	57097-001	57097-001
12	Ground connector	3981	3981	3981	3981	3981
13	Fan blade	57114-001	57114-001	57115-001	57115-001	57115-001
14	Bottom panel	56967-001	56967-001	56967-001	56967-001	56967-001
15	Individual louver assy.	56986-004	56986-004	56986-004	56986-004	56986-004
16	Top panel	56966-001	56966-001	56966-001	56966-001	56966-001
17	Motor	56943-002	56944-001	56945-001	56945-002	56946-001

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Address parts correspondence to:

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1657 Shermer Road
Northbrook, IL 60062-5362

DAYTON ELECTRIC MFG. CO.

FRACTIONAL HP MOTOR FOR FAN

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Prompt Disposition. *Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom the product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date, and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.*

Manufactured for Dayton Electric Mfg. Co.
5959 West Howard Street
Niles, Illinois 60714 U.S.A.

Printed in U.S.A. ©1994 W.W. Grainger, Inc. 94/0069 8S469

Dayton Fractional HP Motors

Motor Installation and Maintenance Information

Initial Inspection and Handling

- After opening carton, look for concealed damage. If concealed damage is found, immediately file claim with carrier.
- Check the nameplate to verify that data conforms to specification of motor ordered.

⚠ DANGER High voltage and moving parts around motors and motor driven equipment can cause serious or fatal injuries. Always disconnect power source before working on a motor or its connected load. Installation must conform to all OSHA requirements, the National Electrical Code (NEC) and all local codes.

Electrical – Motor must be securely and adequately grounded by wiring with a grounded metallic conduit, or other grounding method approved by the NEC and local codes.

Insulate all connections carefully to prevent grounding or short circuits. Reinstall all conduit and terminal box covers. Do not force connections into the conduit box.

Thermal Protection – Use thermally protected motors or a motor starter incorporating thermal overload protection wherever required by safety regulations (including NEC) or Underwriters Laboratories (UL) Standards; or where overloading, jamming or other abnormal operating conditions may occur. Under low temperature conditions, manual reset protectors may reset automatically, causing motor to start unexpectedly. **Always disconnect power before working on equipment.**

Mechanical – Guard all moving parts. Remove the shaft key before running the motor without a connected load. Be careful when touching the exterior of an operating motor! Motor may be hot enough to be painful or cause injury. This condition is normal for most motors when operated at rated load and voltage. Do not use the motor in a hazardous location as defined by Article 500 of the National Electrical Code (NEC).

Storage – Motor should be stored indoors in a clean, dry location.

Location

- **Open, Dripproof Motor** – Clean dry locations with access to an adequate supply of cooling air.
- **Totally Enclosed Motor** – Harsher environments where damp and dirty conditions may exist. Totally enclosed motors are not water-proof.
- Use only UL listed **Hazardous Location** motors for service in **Hazardous Locations** as defined in Article 500 of the NEC.
- Temperature around the motor should not exceed 104°F (40°C). Minimum temperature is –20°F (–29°C).
- If the motor nameplate indicates "Air-Over, Cont. A.O.," etc., the motor must be mounted in the air stream of an air moving device.

CAUTION: Not for fans in unattended areas. Refer to below for proper thermal protection, and other motor selection information.

UL 507 STANDARD – FANS FOR USE IN UNATTENDED AREAS (PARAGRAPHS 125 & 126)

Any motor used in a fan product, such as bathroom exhaust fans, wall-insert fans, ceiling-insert fans, attic exhaust fans, whole house fans and duct fans, etc., which are built into or within the building structure and which are likely to operate unattended or in situations in which the operator may not detect a locked rotor (stalled motor) condition must have either a manual reset thermal cut-off (one-shot) device. Rangehoods, circulating fans, pedestal fans and ceiling suspended fans **are not** included. Agricultural fans are included, if they are built into the building structure and are likely to operate unattended or in situations in which the person operating the fan may not detect a locked rotor (stalled motor) condition.

Power Source

- Voltage, frequency and phase of the power supply must correspond to that shown on the motor nameplate. Low voltage can reduce performance and cause overheating.
- On three-phase power, voltages on all three lines should be balanced within 1%. Unbalanced voltages cause motor overheating and poor performance.

Motor Control Devices

- Use of a suitable motor starting device is advisable and usually required by local electrical codes.
- Power supply must have fuses or circuit breakers to provide short circuit protection for the motor and controller.
- Where a motor starter is used, follow the control manufacturer's recommendations on heater selection or setting. If an existing controller is to be used with a replacement motor, new heaters may be required.
- Any switching device used to control motor must have a horsepower rating equal to or greater than the motor.
- An electronic adjustable speed control **must not be used** unless the motor has been specifically designed for such applications.

Motor Mounting

Motor must be securely fastened to prevent vibration and minimize noise. For secure mounting use high-quality bolts of the largest possible diameter.

Where possible, sleeve bearing motors should be mounted with oil ports up and accessible.

Belt-drive sheaves must be in-line. Use a straight edge to check. Do not overtighten belts.

Direct-coupled installations require a careful check of shaft and coupling alignment. Shim motor base as necessary. Do not depend on a flexible coupling to compensate for misalignment.

Table A – Minimum Wire Sizes for Three-Phase Motors

Motor	25 to 50 Feet			100 Feet			150 to 200 Feet		
HP	200V	230V	460V	200V	230V	460V	200V	230V	460V
1/8	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14(16)*	14(16)*	14(18)*
1/6	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14	14(16)*	14(18)*
1/4	14(18)*	14(18)*	14(18)*	14(16)*	14(18)*	14(18)*	14	14	14(18)*
1/3	14(18)*	14(18)*	14(18)*	14(16)*	14(16)*	14(18)*	12	14	14(18)*
1/2	14(16)*	14(18)*	14(18)*	12	14(16)*	14(18)*	10	12	14(18)*
3/4	14(16)*	14(16)*	14(18)*	12	14	14(18)*	10	10	14(16)*
1	14	14(16)*	14(18)*	12	12	14(18)*	8	10	14(16)*
1½	12	14	14(18)*	10	10	14(16)*	6	8	14
2	12	12	14(18)*	8	10	14(16)*	6	6	12
3	10	12	14(18)*	6	8	14	4	6	12

Note: NEC Article 310-5 Minimum conductor size for General Wiring at 115-440VAC is No. 14AWG

Troubleshooting

This chart suggests common answers to electric motor problems. The information is not all-inclusive and does not necessarily apply in all cases. When unusual operating conditions, repetitive failures, or other problems occur, consult an electric motor service firm for assistance.

Trouble	Cause(s)	What to do
Motor fails to start.	Blown fuses.	Replace with time-delay fuses. Check for grounded winding.
	Tight shaft.	Occasionally during shipment a sleeve bearing motor may be received with a shaft which does not rotate freely. It may be necessary to strike the motor, at the shell/end-shield rabbet, with a rawhide or plastic mallet to align the bearings.
	Voltage too low at motor terminals due to line drop.	Consult local power company. Increase wire size (refer to Tables A & B). Check for poor connections.
	Overload in motor starter tripped.	Check and reset overload relay in starter. Check heater rating against motor nameplate current rating.
	Overload (internal thermal protector) tripped.	Check motor load. If motor has an automatic or manual reset thermal protector, check if tripped.
	Improper line connections.	Check connections against diagram supplied with motor.
	Motor may be overloaded.	Reduce load or increase motor size.
	Defective motor or starter.	Repair or replace.
	Not applied properly.	Consult motor service firm for proper type. Use larger motor.
Motor does not come up to speed or takes too long to accelerate.	Voltage too low at motor terminals.	Increase wire size (refer to Tables A & B). Check for poor connections. Check for voltage unbalance (3-phase).
	Starting load too high.	Check load motor is carrying at start.
	Excess loading; tight belts.	Reduce load; increase motor size. Adjust belts.
	Defective motor.	Repair or replace.
	Inadequate starting torque. High inertia load.	Replace with larger motor.

Troubleshooting (continued)

Trouble	Cause(s)	What to do
Motor stalls during operation.	Overloaded motor.	Reduce load or increase motor size.
	Low motor voltage.	Verify that nameplate voltage is maintained.
Motor vibrates or is excessively noisy.	Motor shaft misaligned.	Realign.
	Three-phase motor running single phase.	Check for open circuit, blown fuses or unbalanced voltages.
	High or unbalanced voltages.	Check wiring connections. Consult local power company.
	Worn, damaged, dirty or overloaded bearings.	Repair or replace motor; check loading and alignment.
	Defective winding. Bent or bowed shaft.	Repair or replace.
	Loose sheave or misaligned coupling.	Tighten setscrew(s); realign coupling.
Motor overheats while running under load.	Overloaded.	Reduce load; increase motor size; belts may be too tight.
	Dirt blocking ventilation openings.	Clean motor.
	If three-phase, one phase may be open.	Check lines for open phase. Check voltage with motor disconnected, one fuse may be blown.
	Unbalanced supply voltage.	Check for faulty connections. Voltage on all three lines should be balanced within 1%. Excessive single phase loads.
	Faulty connection.	Clean, tighten, or replace.
	High or low voltage.	Check voltage at motor, should not be more than 10% above or below rated.
	Defective motor.	Repair or replace.

Connecting Power to Motor

To connect motor for proper voltage and rotation, refer to the connection diagram on the nameplate or inside the terminal/conduit box.

Table B – Minimum Wire Sizes for Single-Phase Motors

Motor	25 Feet		50 Feet		100 Feet		150 Feet		200 Feet	
HP	115V	230V	115V	230V	115V	230V	115V	230V	115V	230V
1/8	14(18)*	14(18)*	14	14(18)*	12	14(18)*	10	14(16)*	8	14
1/6	14(16)*	14(18)*	12	14(18)*	10	14(16)*	6	14	6	12
1/4	14	14(18)*	10	14(16)*	8	14	6	12	4	10
1/3	14	14(18)*	10	14(16)*	8	14	6	12	4	10
1/2	12	14(18)*	8	14	6	12	4	10	3	8
3/4	10	14(16)*	6	12	4	10	2	8	1	6
1	10	14(16)*	6	12	4	10	2	8	1	6
1½	8	14	6	12	3	8	1	6	1/0	6
2	8	14	4	10	2	8	1/0	6	2/0	4
3	6	12	3	8	1/0	6	2/0	4	4/0	3

Note:

- NEC Article 310-5 – Minimum conductor size for general wiring at 115-440VAC is No. 14AWG.
- Above wire sizes based on approximate 5% voltage drop during starting; copper conductors; and 75°C type THHW, THW, THWN, RH, RHW insulation, etc. For aluminum wire, increase two wire size steps minimum. See NEC Article 310 for ampacities of aluminum conductors.
- Type S, SO, SJ, SJO, etc. flexible cable wire sizes. See NEC Article 400 for ampacity.

⚠ WARNING **All aspects of the installation must conform to the requirements of the NEC, including Article 430 (Motor Circuits and Controllers), and all local codes.** Wherever possible, each motor should be powered from a separate circuit of adequate capacity to keep voltage drop to a minimum during starting and running. Increase wire size where motor is located a distance from the power source. Wire size must be adequate to minimize voltage drop during starting and running. Refer to Tables A and B for suggested wire sizes. Distances shown are one-way between source and motor. Portable cords, if used, should be as short as possible to minimize voltage drop. Long or inadequately sized cords, especially on hard starting loads, can cause motor failure. All electrical connections in ≠system must be secure to prevent voltage drop and localized heating.

- Determine direction of rotation before connecting driven equipment to prevent damage.
- To prevent bearing damage, do not strike shaft with hammer or other tool.
- If the motor has been damp or wet, then have motor serviced by a qualified motor repair shop before operating.

Starting Motor

Be sure motor is properly grounded.

Connect motor to load and run briefly. Check for unusual noises and vibration (see Troubleshooting). Check motor current; it should be close to nameplate.

Visually re-inspect the installation. Make sure that the guards and other protective devices are securely in place. All covers and gaskets must be re-installed to minimize the entry of dirt and moisture.

⚠ DANGER **Before performing any maintenance, disconnect power and allow motor to come to a complete stop. Discharge capacitors, if any, for safety.**

Recommended Maintenance

Remove dirt accumulations in and around vent openings, by vacuuming. **Dirt accumulations can cause motor overheating and a fire hazard**. Enclosed motors can be cleaned with an air jet; wear eye protection.

Periodically inspect the installation. Check for dirt accumulations; unusual noises or vibration; overheating; worn or loose couplings, sheaves and belts; high motor current; poor wiring or overheated connections; loose mounting bolts or guards; and worn motor starter contacts.

Exercise caution with solvents; some solvents may attack motor insulation, finish or bearing lubricants; some are highly flammable. If solvents are used, make sure area is well ventilated.

Sleeve bearing motors require periodic reoiling. Follow reoiling instructions on the motor (See nameplate or terminal box cover). If instructions are not included, re-oil continuous duty units once a year, intermittent duty units every two years and occasional duty units every five years with 30 to 35 drops of SAE No. 20 non-detergent or electric motor oil. Do not overlubricate.

Dayton ball bearing motors are pre-lubricated at the factory and do not require relubrication.

Order Replacement Parts By Calling Toll Free 1-800-323-0620

Please provide following information:

- Model Number
- Serial Number (if any)
- Part Description and Number as shown in Parts List

Address parts correspondence to:

Parts Company of America
1657 Shermer Road
Northbrook, IL 60062-5362

DAYTON ELECTRIC MFG. CO.

INTAKE GUARDS FOR FAN

OPERATING INSTRUCTIONS & PARTS MANUAL

INTAKE GUARDS

MODELS 6D581 THRU 6D591

FORM 5S3561
05580
0594/109/VP

READ CAREFULLY BEFORE ATTEMPTING TO ASSEMBLE, INSTALL, OPERATE OR MAINTAIN THE PRODUCT DESCRIBED. PROTECT YOURSELF AND OTHERS BY OBSERVING ALL SAFETY INFORMATION. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE! RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

Description

Dayton Intake Guards are to be used with Dayton 12" thru 30" direct-drive and 24" thru 60" belt-drive exhaust fans. These guards are strongly recommended for use on fans located in any area accessible to personnel or where there is a possibility of loose objects being drawn into the fan. All intake guards comply with OSHA regulations. Each unit consists of four (4) side panels, perforated guard, and assembly hardware. All guards have a galvanized finish.

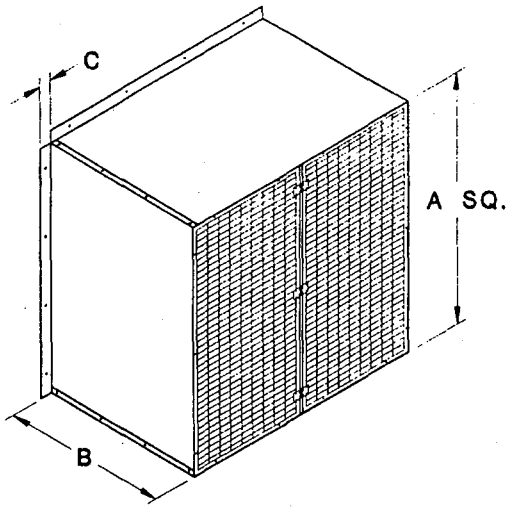


Figure 1 - Overall Dimensions

Specifications

MODEL	FAN SIZE	DAYTON STOCK NO.	DIMENSIONS			GUARD GRID SECTIONS	SIDE PANEL GAGE	TOTAL FREE AREA % OPENING
			A	B	C			
6D581	12"	4C545*	16-1/8"	13	1-1/4"	1	20	85
6D582	16	4C546*	20-1/8	13	1-1/4	1	20	85
6D583	18	4C547*	22-1/8	13	1-1/4	1	20	85
6D584	20	3C304*	24-1/8	14	1-1/4	1	20	85
6D585	24	3C305* 3CC73 5C193	28-1/8	20	1-1/4	1	20	85
6D586	30	3C378* 3CC74 5C194	34-1/8	20	1-1/4	1	20	85
6D587	36	3CC75 3CC78 3C606 3C705	40-1/8	27	2	2	20	85
6D588	42	3CC76 3C607 3C706	46-1/8	30	2	2	20	85
6D589	48	3CC77 3C608 3C707	54-1/4	32	2	2	18	85
6D590	54	3C671 3C708	60-1/4	34	2	2	18	85
6D591	60	3C609 3C709	66-1/4	37	2	2	18	85

(*) Venturi frame listed. Contact Grainger for motors and blades.

Copyright 1994, W.W. Grainger, Inc.

General Safety Information

⚠ WARNING ⚠

INTAKE GUARDS TO BE USED IN CONJUNCTION WITH EXHAUST FANS. CARE SHOULD BE TAKEN TO ENSURE THAT POWER SOURCE TO FAN IS LOCKED OFF BEFORE INTAKE GUARD IS INSTALLED SO THAT THE FAN CREATES NO HAZARD TO INSTALLER.

⚠ CAUTION ⚠

Intake guard complies with OSHA regulation. Make sure intake guard is securely in place before placing fan into operation.

Installation

INTAKE GUARD HOUSING FOR EXHAUST FANS

IMPORTANT: FAN SHOULD BE SECURELY MOUNTED TO WALL PRIOR TO INSTALLATION OF INTAKE GUARD HOUSING.

1. Bolt (4) side panels together with 1/4" dia. x 1/2" long bolts and lock nuts (supplied). Panel bolts should be hand tight only.
2. Install center channel post with #10 x 1/2" sheet metal screws (supplied) on sizes 36" or larger which have two piece guards. Post not required with 12" through 30" models which have a single grid.

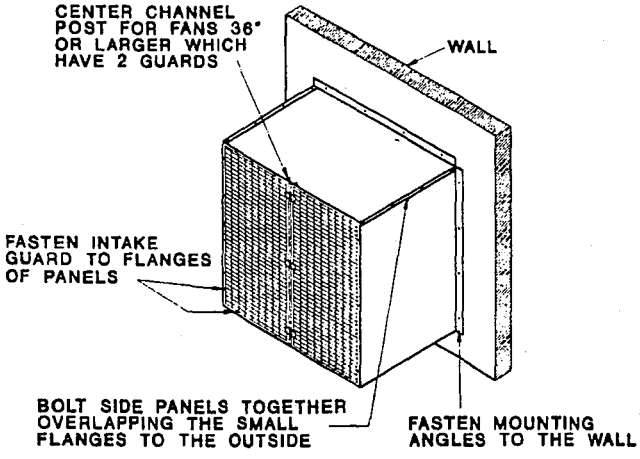


Figure 2 - Illustration

3. Fasten guard to face with hinges and #10 x 1/2" sheet metal screws (supplied)See Figure 3. Tighten side panel bolts.
4. Fasten housing to wall or directly to fan frame; hardware not supplied. a) Use 1/4" x 2" masonry anchor for masonry walls. b) Use 1/4" x 2" lag screw if fastening to a frame wall. c) If fastening directly to fan frame, which is already mounted on wall, use 1/4"-20 x 1/2" bolts and nuts.

NOTE: On sizes 12" thru 30" the housing should be mounted with the hinges on the right-hand side panel. On sizes 36" and larger the "up" arrow on the channel post should be at top (See Figure 3).

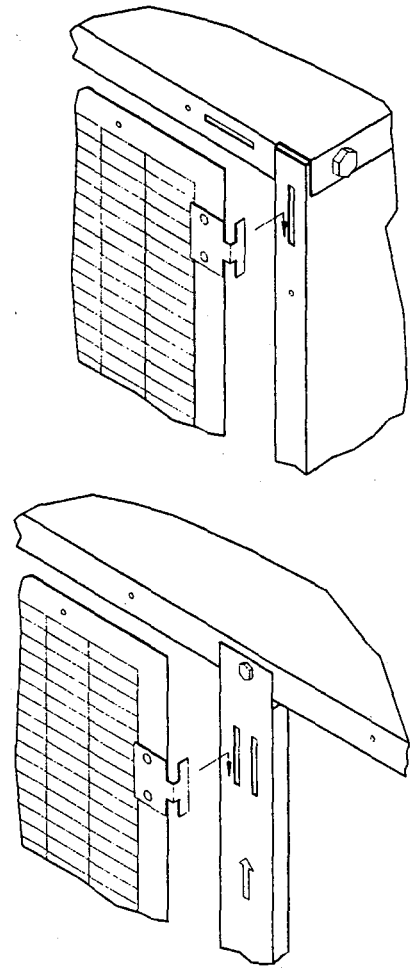


Figure 3 - Assembly of Hinges

⚠ CAUTION ⚠

Maintenance

Make certain that the power source is disconnected before attempting to service or disassemble any components! If the power disconnect is out of sight, lock it in open position and tag to prevent application of power.

CLEANING

Clean intake guard and housing of any accumulated dirt which would restrict air flow.

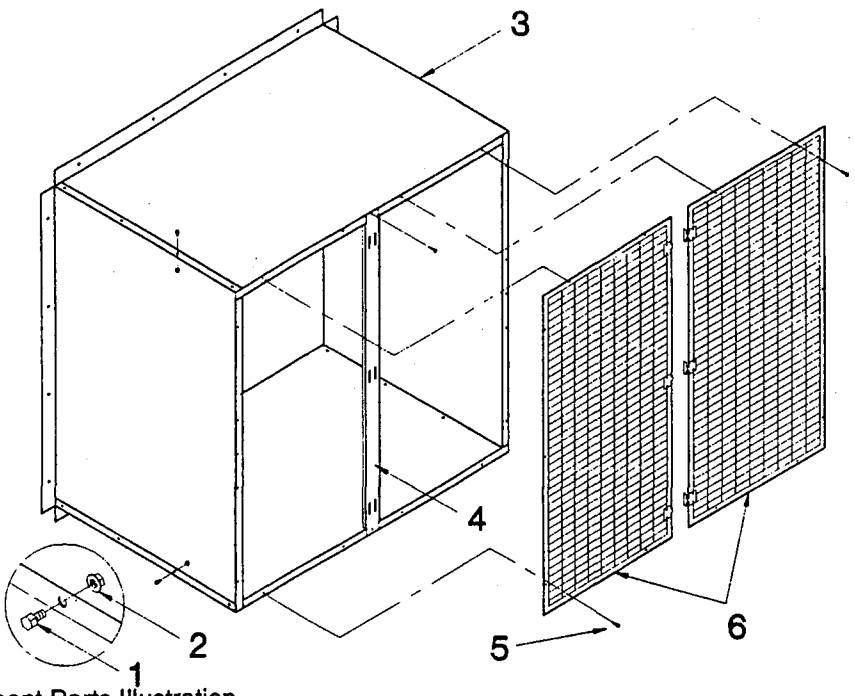


Figure 4 - Replacement Parts Illustration

ORDER REPLACEMENT PARTS BY CALLING TOLL FREE
1-800-323-0620

Please provide the following information:

- Model Number
- Serial Number (if any)
- Part Description and Number as shown in Parts List.

Address parts correspondence to:

Parts Company of America
1657 Shermer Road
Northbrook, IL 60062-5362

Replacement Parts List

REF. NO.	DESCRIPTION	PART NO. FOR MODEL: 6D581	6D582	6D583	6D584	6D585	6D586	QTY.
1	1/4-20x1/2" Bolt	*	*	*	*	*	*	12
2	1/4"-20 Locknut	*	*	*	*	*	*	12
3	Side panel	90262001	90263001	90264001	90265001	90266001	90267001	4
4	Channel support	—	—	—	—	—	—	1
5	#10x1/2 SM screw	*	*	*	*	*	*	6 to 9
6	Guard assembly	90289001	90290001	90291001	90292001	90293001	90294001	1

(*) Standard hardware item, available locally.

REF. NO.	DESCRIPTION	PART NO. FOR MODEL: 6D587	6D588	6D589	6D590	6D591	QTY.
1	1/4-20x1/2" Bolt	*	*	*	*	*	16
2	1/4"-20 Locknut	*	*	*	*	*	16
3	Side panel	90268001	90269001	90270001	90271001	90272001	4
4	Channel support	90273001	90274001	90275001	90276001	—	1
5	#10x1/2 SM screw	*	*	*	*	*	16 to 26
6	Guard assembly	90295001	90296001	90297001	90298001	90299001	2

(*) Standard hardware item, available locally.

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. Intake Guards, Models 6D581 thru 6D591, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined by Dayton to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specific legal rights which vary from state to state.

LIMITATION OF LIABILITY. To the extent allowable under applicable law, Dayton liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to, and shall not exceed, the purchase price paid.

WARRANTY DISCLAIMER. Dayton has made a diiigent effort to illustrate and describe the products in this literature accurately; however, such illustrations and descriptions are for the sole purpose of identification, and do not express or imply a warranty that the products are merchantable, or fit a particular purpose, or that the products will necessarily conform to the illustrations or descriptions. Except as provided below, no warranty or affirmation of fact, expressed, or implied, other than as stated in "LIMITED WARRANTY" above is made or authorized by Dayton. Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some states do not allow limitations on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write Dayton at address below, giving dealer's name, address, date and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Manufactured for Dayton Electric Mfg. Co., 5959 W. Howard St., Niles, IL 60714 U.S.A.

Printed in U.S.A.

DAYTON ELECTRIC MFG. CO.

MOTORIZED DAMPER FOR FAN

INSTALLATION INSTRUCTIONS & PARTS MANUAL

MOTORIZED DAMPERS

MODELS 4C560, 4C561 & 3C315

FORM
5S3106
01280

0389/107/5M

READ ALL INSTRUCTIONS CAREFULY BEFORE ATTEMPTING TO INSTALL YOUR DAYTON MOTORIZED DAMPER!
RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

Description

Dayton heavy-duty dampers are constructed of extruded aluminum frame and vanes. Dampers can be mounted horizontally or vertically. For intake or exhaust applications. Tie rod linkage is attached to vanes on fan side.

Dimensions

FAN DIA.	STOCK NUMBER	VOLTAGE	A-SQ.	B-SQ.	C-SQ.	OPENING REQUIRED
16"	4C560	115V, 60 Hz	19	16½	16	17
		220V, 60 Hz	19	16½	16	17
20"	4C561	115V, 60 Hz	23	20½	20	21
		220V, 60 Hz	23	20½	20	21
24"	3C315	115V, 60 Hz	27	24½	24	25
		220V,60 Hz	27	24½	24	25

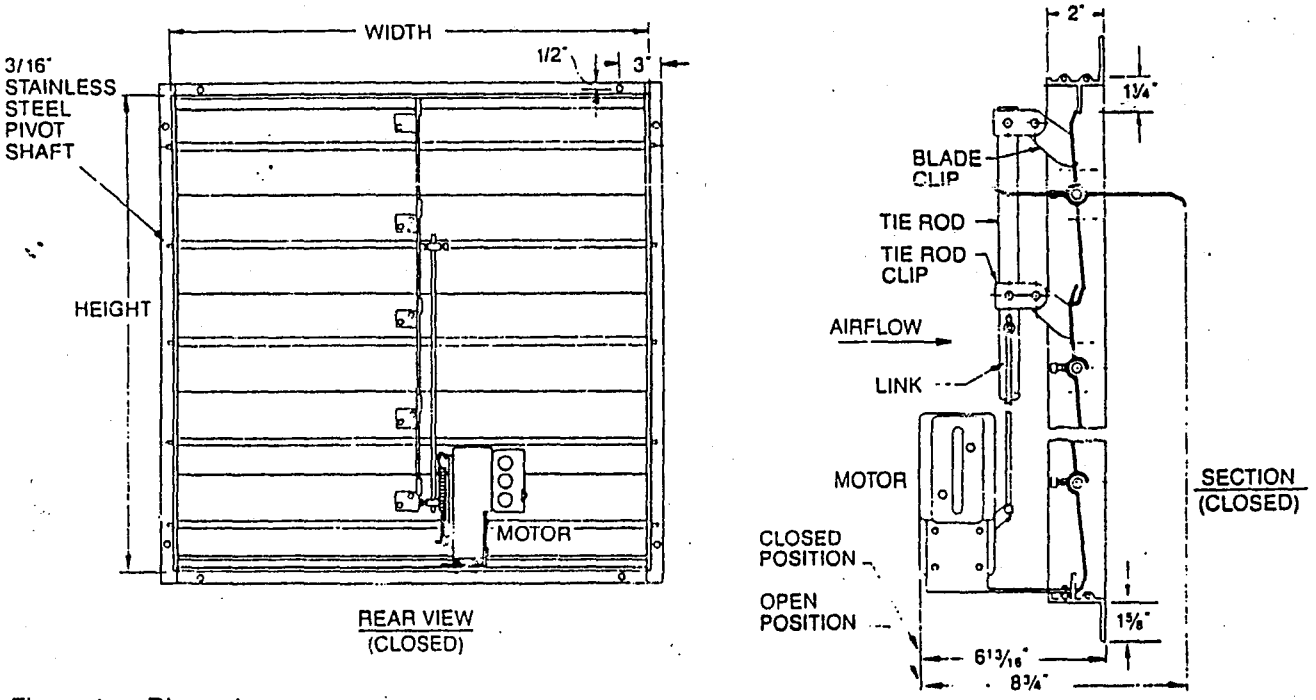


Figure 1 — Dimensions

Specifications

MODEL	MOTOR (*) POWER SUPPLY REQUIRED	RUNNING AMPS	TORQUE	LEAD LENGTH	UNIT DIMENSIONS (†) H	W	D
4C560	120V, 60 Hz	0.26	35 Inch-lbs.	6"	6⅛"	3½"	2¼"
4C561	120V, 60 Hz	0.26	35 Inch-lbs.	6	6⅛	3½	2¼
3C315	120V, 60 Hz	0.26	35 Inch-lbs.	6	6⅛	3½	2¼
4C560	240V, 60 Hz	0.15	35 Inch-lbs.	6	6⅛	3½	2¼
4C561	240V, 60 Hz	0.15	35 Inch-lbs.	6	6⅛	3½	2¼
3C315	240V, 60 Hz	0.15	35 Inch-lbs.	6	6⅛	3½	2¼

(*) Motor is single-phase continuous duty with a 40°C. (104°F) maximum ambient temperature.
(†) See Figure 1 for Operating Dimensions.

General Safety Information

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA).
2. Motor must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad raceway system, by using a separate ground wire connected to the bare metal of the motor frame, or other suitable means.
3. Always disconnect power source before working on or near a motor or its connected load. If the power disconnect point is out-of-sight, lock it in the open position and tag to prevent unexpected application of power.
4. Protect the power cable from coming in contact with sharp objects.
5. Do not kink power cable and never allow the cable to come in contact with oil, grease, hot surfaces, or chemicals.
6. Make certain that the power source conforms to the requirements of your equipment.

Installation

1. Cut opening required for correct damper size. Do not force damper into opening. Damper must operate freely.
2. Following General Safety Information and Wiring Diagram, wire damper motor as illustrated.

LIMITED WARRANTY

DAYTON ONE YEAR LIMITED WARRANTY. Dayton motorized dampers, Models 4C560 thru 4C563, 3C315 & 3CA18, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined by Dayton to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specific legal rights which vary from state to state.

LIMITATION OF LIABILITY. To the extent allowable under applicable law, Dayton's liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to, and shall not exceed, the purchase price paid.

WARRANTY DISCLAIMER. Dayton has made a diligent effort to illustrate and describe the products in this literature accurately; however, such illustrations and descriptions are for the sole purpose of identification, and do not express or imply a warranty that the products are merchantable, or fit for a particular purpose, or that the products will necessarily conform to the illustrations or descriptions.

Except as provided below, no warranty or affirmation of fact, expressed or implied, other than as stated in "LIMITED WARRANTY" above is made or authorized by Dayton.

PRODUCT SUITABILITY. Many states and localities have codes and regulations governing sales, construction, installation, and/or use of products for certain purposes, which may vary from those in neighboring areas. While Dayton attempts to assure that its products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a product, please review the product application, and national and local codes and regulations, and be sure that the product, installation, and use will comply with them.

Certain aspects of disclaimers are not applicable to consumer products, e.g. (a) some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some states do not allow limitations on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Manufactured for Dayton Electric Mfg. Co.,
5959 W. Howard St., Chicago, IL 60648

ORDER REPLACEMENT PARTS BY CALLING TOLL FREE
1-800-323-0620 (Outside Illinois)
1-800-225-7149 (Inside Illinois)
Please provide following information:
- Model Number
- Serial Number (if any)
- Part Description and Number as shown in Parts List

Address parts correspondence to:
Dayton Electric Mfg. Co.
1250 Busch Parkway
Buffalo Grove, IL 60089

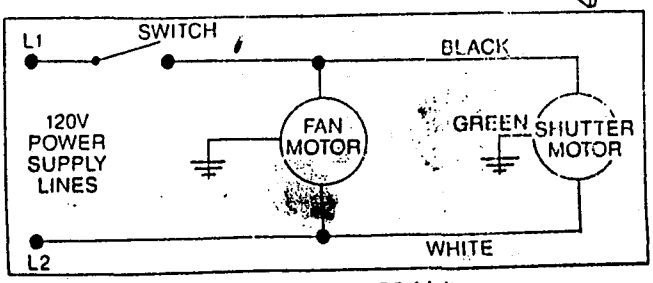


Figure 2 — Wiring Diagram – 120 Volt

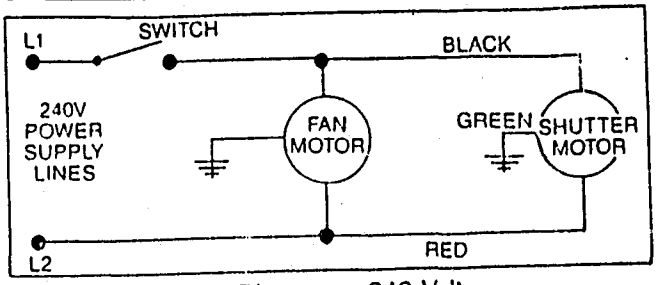


Figure 3 — Wiring Diagram – 240 Volt

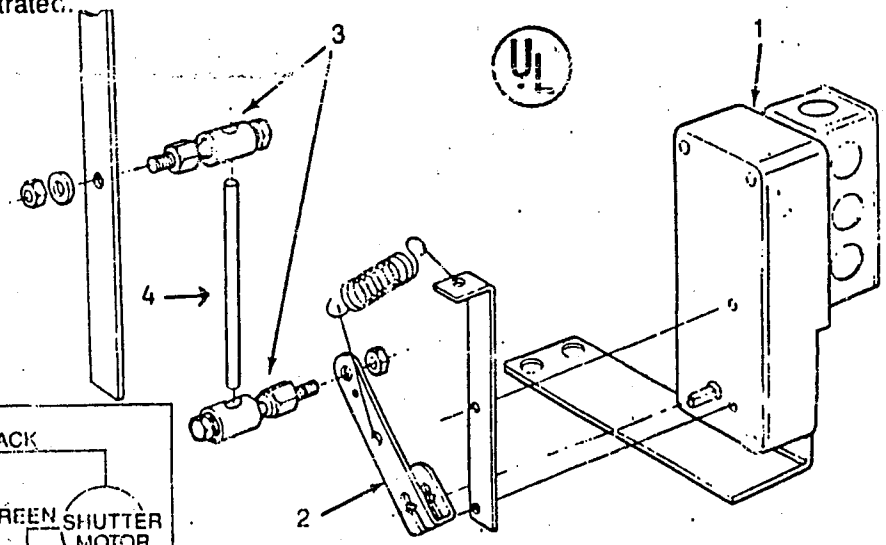


Figure 4 — Replacement Parts Illustration

Replacement Parts List

REF. NO.	DESCRIPTION	PART NO.	QTY.
1	60 Hz Motor, 120/240	UL193050	1
2	Motor crankarm	72SK006D	1
3	Swivel ball joints	DC120TFN	2
4	Connecting rods, 5/16 x 18"	5161	1

DAYTON ELECTRIC MFG. CO.

SWIVEL BRACKET

INSTALLATION INSTRUCTIONS

SWIVEL BRACKET KITS

MODELS 2E641, 2E642 AND 2E643 FOR HORIZONTAL AIR DELIVERY HEATERS

FORM 5S2259
05835
0392/078/3M

READ CAREFULLY BEFORE ATTEMPTING TO ASSEMBLE, INSTALL, OPERATE OR MAINTAIN THE PRODUCT DESCRIBED. PROTECT YOURSELF AND OTHERS BY OBSERVING ALL SAFETY INFORMATION. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE! RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

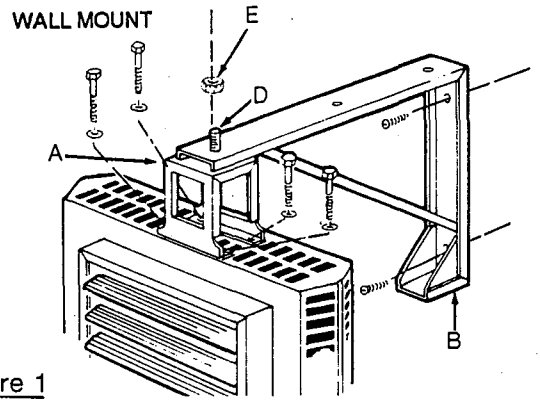


Figure 1

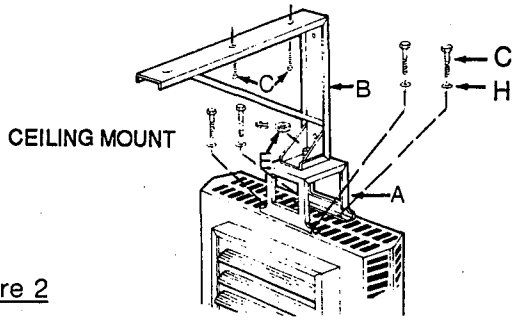


Figure 2

Description

These bracket kits are mounting accessories for Dayton electric unit heaters. All models will suspend a unit heater from either the wall or the ceiling, as shown in Figures 1 and 2. These bracket kits are to be used with heaters mounted for horizontal air discharge only.

Unpacking

Prior to beginning assembly, check for any missing, loose or damaged parts. This kit consists of:

Hanger base "A"	1	Locknut "E"	4
Hanger bracket "B"	1	Lockwashers "H"	4
Hex bolts "C"	1		
Captive bolt "D" (permanently attached to hanger base "A")			1

Specifications

Model 2E641 ..... Use with 3.3 & 5 KW Units (2E635-640, 2E669-670, 2E805 & 2E806)

Model 2E642 ..... Use with 7.5-20 KW Units (3E341-351)

Model 2E643 ..... Use with 30 & 50 KW Units (3E352-357)

General Safety Instructions

The mounting structure and anchoring provisions must be of sufficient strength to support the combined weight of the heater and mounting bracket.

The heater must be mounted with the bottom of the heater a minimum of 7 ft. from the finished floor (OSHA requirement). Maintain minimum clearances from walls and ceiling as shown in Table 1. Do not obstruct air flow to or from the heater. Install accessories (following their instructions) prior to mounting the heater.

⚠ WARNING ⚠

THESE BRACKET KITS ARE FOR USE ONLY WITH THE HEATER MODELS SPECIFIED. ANY OTHER USE VOIDS THE WARRANTY AND MAY CREATE UNSAFE CONDITIONS.

Installation

HEATER SURFACE NEAREST TO		
FLOOR	CEILING	WALLS
7 ft	12″	12″

Table 1 — Minimum Heater Mounting Distances

1. Swivel hanger brackets may be used to suspend unit heaters from either the wall (Fig. 1) or the ceiling (Fig. 2).
2. Attach hanger base "A" to top of heater with the four 5/16-18 hex bolts "C" and lockwashers "H".
3. Attach main hanger bracket "B" to wall or ceiling in desired location using suitable fasteners. Observe minimum mounting distances in Table 1.
4. Mount heater by inserting captive bolt "D" through hole in main hanger bracket. Attach locknut "E," tightening until nearly snug.
5. Position heater for desired air discharge direction, tighten locknut.

NOTE: For ceiling mounting, it is necessary to put a 5/16″ thickness of washers under castle nut on captive bolt.

Tools required: 1/2″ box-end wrench
1-1/16″ box-end wrench

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. Swivel bracket kits, Models 2E641, 2E642 & 2E643, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined by Dayton to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specific legal rights which vary from state to state.

LIMITATION OF LIABILITY. To the extent allowable under applicable law, Dayton's liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to, and shall not exceed, the purchase price paid.

WARRANTY DISCLAIMER. Dayton has made a diligent effort to illustrate and describe the products in this literature accurately; however, such illustrations and descriptions are for the sole purpose of identification, and do not express or imply a warranty that the products are merchantable, or fit for a particular purpose, or that the products will necessarily conform to the illustrations or descriptions.

Except as provided below, no warranty or affirmation of fact, expressed or implied, other than as stated in "LIMITED WARRANTY" above is made or authorized by Dayton.

PRODUCT SUITABILITY. Many states and localities have codes and regulations governing sales, construction, installation, and/or use of products for certain purposes, which may vary from those in neighboring areas. While Dayton attempts to assure that its products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a product, please review the product application, and national and local codes and regulations, and be sure that the product, installation, and use will comply with them.

Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some states do not allow limitations on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Manufactured for Dayton Electric Mfg. Co., 5959 W. Howard St., Chicago, IL 60648

DAYTON ELECTRIC MFG. CO.

TORQUE ARRESTOR

TEEL WATER SYSTEMS

INSTALLATION INSTRUCTIONS

TORQUE ARRESTOR

MODEL 2P029A

FORM
5S2300
02434

DAYTON ELECTRIC MANUFACTURING CO. CHICAGO 60648

0586/231/VP

READ INSTRUCTIONS CAREFULLY BEFORE ATTEMPTING TO INSTALL THE TEEL TORQUE ARRESTOR!
RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

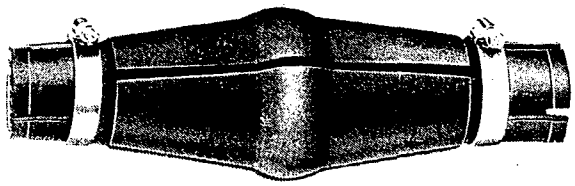


Figure 1

Description

The Teel torque arrestor snubs starting torque of pump and prevents whipping of drop pipe and damage to power cable. Torque arrestor also holds pump centered. Arrestor insures a snug fit in all well casings from 4"-8" I.D. Two stainless steel clamps included.

Specifications

Basic construction material	Pure, non-toxic rubber
Clamps	Stainless steel
Weight	4 lbs.

Installation

1. After splicing pump cable and attaching drop pipe, attach torque arrestor above pump, as close to pump as possible.
2. Torque arrestor must now be adjusted to casing size. Proceed as follows:
   a. Tighten bottom clamp securely.
   b. Push down on top of torque arrestor, leaving approximately 1/4" clearance on either side of inner diameter of well casing. Not enough clearance could cause torque arrestor to snag inside of the well casing.
   c. When torque arrestor is properly adjusted, tighten top clamp securely.
3. Run pump wire over bottom clamp inside of torque arrestor and out over top clamp.

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. Teel torque arrestor, Model 2P029A, is warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined by Dayton to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specific legal rights which vary from state to state.

LIMITATION OF LIABILITY. To the extent allowable under applicable law, Dayton's liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to, and shall not exceed, the purchase price paid.

WARRANTY DISCLAIMER. Dayton has made a diligent effort to illustrate and describe the product in this literature accurately; however, such illustrations and descriptions are for the sole purpose of identification, and do not express or imply a warranty that the product is merchantable, or fits a particular purpose, or that the product will necessarily conform to the illustrations or descriptions.

Except as provided below, no warranty or affirmation of fact, expressed or implied, other than as stated in "LIMITED WARRANTY" above is made or authorized by Dayton.

PRODUCT SUITABILITY. Many states and localities have codes and regulations governing sales, construction, installation, and/or use of products for certain purposes, which may vary from those in neighboring areas. While Dayton attempts to assure that its products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a product, please review the product application, and national and local codes and regulations, and be sure that the product, installation, and use will comply with them.

Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some states do not allow limitations on how long an implied warranty lasts, consequently the above limitation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.

Dayton Electric Mfg. Co., 5959 W. Howard St., Chicago, IL 60648

DUPONT

EXTERIOR COATING ON CARBON VESSELS AND EQUALIZATION TANK

DU PONT MAINTENANCE FINISHES
High Performance Coatings

DU PONT 25P

high solids epoxy mastic

Type:
Epoxy/Amine Modified Polyamide

Description:
Du Pont 25P is a two package (1:1 mix), high solids, high build, VOC Conforming (2.2 lbs./gal), multi-use epoxy mastic coating. It provides outstanding application properties — no induction time, long pot life, can be applied in hot or cold weather, faster dry times, excellent film build on *both* flat surfaces and edges, goes over hand-cleaned rusty surfaces, can be applied over damp surfaces, most other coatings, and can be top-coated with a wide range of coatings. Its performance and durability are excellent under most conditions and environments.

Suggested Uses:
25P is a multi-use product suitable for application in a variety of situations.

- As a single coat in non-corrosive interior environments (5-8 mils DFT).
- As a single coat in corrosive interior environments (10-12 mils DFT).
- As a primer in 2 or 3 coat systems (3-8 mils DFT).
- As an intermediate or mid-coat in a 3 coat system (4-6 mils DFT).
- Provides excellent durability and adhesion over steel, galvanized steel, masonry — concrete, and wood.

Recommended For Immersion Service:
25P is recommended for immersion service in near neutral, fresh, or salt water exposures. It is not recommended for use with potable water. It may be used for fire water towers, ballast tanks, clarifiers, waste water treatment plants, offshore structures, pier pilings and supports, and other areas where a high level of water resistance is required.

Compatibility With Other Coatings:

- 25P is highly compatible with most generic types of coatings.
- It can be applied over most coatings in sound condition; if in doubt, apply a test patch before painting.

Color Change/Chalking
Du Pont 25P is primarily designed for corrosion protection. If gloss, color retention, and color stability are important, Du Pont 25P should be topcoated with Corlar® 26P, Imron® 326 or 333, or Du Pont 50P.

Resistance:

Acids:	Very good	Solvents:	Excellent
Alkalis:	Excellent	Abrasion:	Excellent
Humidity:	Excellent	Weather:	Very good (Will chalk on exterior exposure)
Salts:	Excellent		
Ammonia:	Excellent		

Maximum Service Temperature:
200°F (93°C) in continuous service
300°F (148°C) in intermittent heat

Volume Solids (Mixed):
70% Avg.

Weight Solids (Mixed):
82% Avg.

Weight Per Gallon (Mixed):
11.8 Lb. Avg. 5.4 Kg. Avg.

Suggested Film Build (DFT):
— Single Coat — 5-8 mils in non-corrosive environment
10-12 mils in corrosive environment and immersion service
— Primer — 3-8 mils
— Mid Coat — 4-6 mils

Coverage Per Gallon:
1122 Ft² @ 1 mil DFT
224 Ft² @ 5 mils DFT
112 Ft² @ 10 mils DFT

Gloss:
Satin Finish

Colors:
Standard — White, Cirrus Gray, Shale Gray, Clay Tan, Red Oxide, Aluminum
Custom Color — See Color Spectrum Color Wheel

All technical advice, recommendations and services are rendered by the Seller gratis. They are based on technical data which the Seller believes to be reliable, and are intended for use by persons having skill and know-how at their own discretion and risk. Seller assumes no responsibility for results obtained or damages incurred from their use by Buyer in whole or in part. Such recommendations, technical advice or services are not to be taken as a license to operate under or intended to suggest infringement of any existing patent.

DUPONT

DU PONT 25P

high solids epoxy mastic

Flash Point (Tag Closed Cup):
25P Bases > 100°F
VF-525 < 73°F

Surface Preparation:
For atmospheric service an SSPC-SP-6 (Commercial) is preferred for optimal performance. If not possible or practical, then hand tool clean to an SSPC-SP-2 or power tool clean to an SSPC-SP-3. For immersion service a SSPC-SP-5 is required.

Activator:
Add 1 part VF-525 Activator to 1 part 25P Base. Mix until thoroughly blended. You may begin painting immediately — there is no induction time.

Pot Life:
8 hours at 70°F-90°F when reduced 15% by volume with Y-32035 or RTOO1P thinner.

Shelf Life:
12 Months Minimum

Reduction:
2-5% of Y-32035 is required under normal conditions. For maximum pot life, reduce 15% by volume with Y-32035 or RTOO1P. Use T-8054 thinner in hot or windy conditions for spray application. Reduce 10-15% with RTOO1P thinner when applying by roller or brush in hot or windy conditions.
If more than 25% reduction is required, consult your local Du Pont representative.

Application Thinners:
Normal Conditions — Y-32035
Hot or Windy Conditions — T-8054 (spray)
Hot or Windy Conditions — RTOO1P (roll or brush).

Clean Up Thinners:
T-8054 or MEK

Packaging:
1 & 5 Gallon Containers

Shipping Weight (lbs.):

	BASE	ACTIVATOR
1 Gallon Container	14	11
5 Gallon Container	68	55

Application Conditions:
Do not apply if material, substrate, or ambient temperature is below 35°F (2°C) or above 100°F (43°C).

Dry Times (Hours):
@ 5 mils DFT 50% R.H.

	50°F (10°C)	70°F (21°C)	90°F (32°C)
To Touch	3-4	2-3	1-2
To Handle	8	4	2
To Recoat	5	3	2
Full Cure	14 Days	7 Days	4 Days

Application Equipment:
Apply by brush, roll, or spray.
ROLL: ¼"-½" lambs wool or synthetic roll cover such as One Coater. Keep roll wet. Roll in one direction, rewet, then cross roll.

Air Spray:

	Binks	DeVilbiss	Graco
Spray Gun:	#18 or #62	JGA502 or MBC510	800 or 900
Fluid Nozzle:	66 or 67	E or D	04 or 086
Air Cap:	66 or 67PB	704, 765 or 78	02, 03 or 952

Airless Spray:
Pump: Capability to produce 3000 psi (e.g. Graco Bulldog, EH333 or GM5000)
High Pressure Filter: 60 mesh
Fluid Hose: ⅜" x 150' max.
Note: If more than 100', use 45:1 King and to ½" x 100' plus ⅜" x 50'
Airless Gun: Graco 207945, 208663, 220-954 or 220-730
Tips: .015"-.027"
Minimum pressure to avoid fingering: 2000 psi

Additional Comments:
1. VOC = 2.2 lbs./gal. (avg.)
2. Custom Color Bases are short filled to allow for colorant addition.
   1LB25P — Light Base (124 oz./gal.)
   2MB25P — Medium Base (120 oz./gal.)
   3DB25P — Deep Base (116 oz./gal.)
   4NB25P — Neutral Base (112 oz./gal.)
3. Consult the Material Safety Data Sheet prior to use.

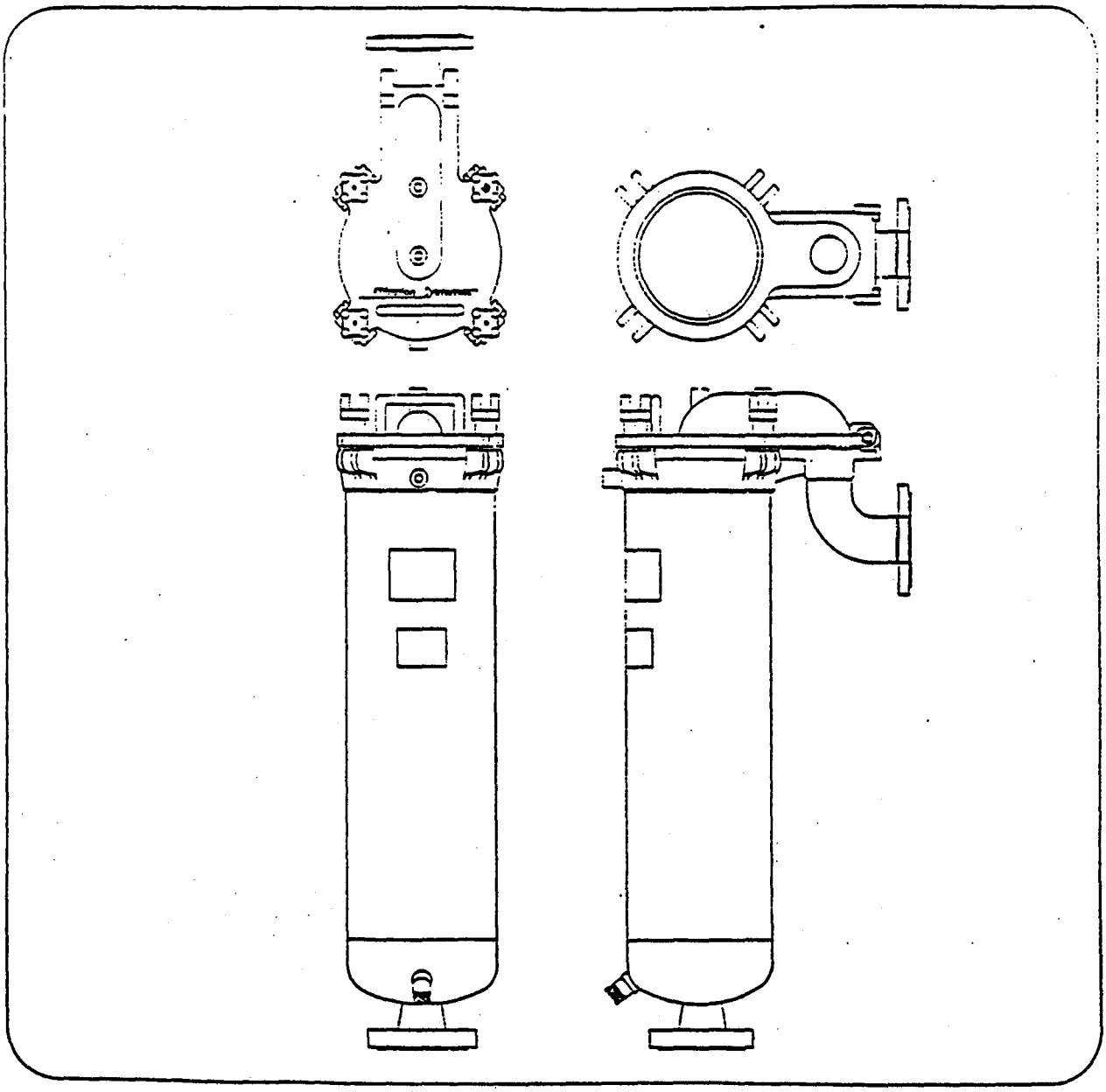
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H-30408 Printed in U.S.A. 10/91

FILTRATION SYSTEMS

FILTER BAG HOUSINGS AND FILTER BAGS

Installation, Operating and Safety Manual for Liquid Filter Housings and Filter Bags



Filtration Systems™

Division of Mechanical Mfg. Corporation
10304 NW 50th Street • Sunrise, FL 33351 USA
Tel: 305-572-2700 • Fax: 305-572-3401

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Division of Mechanical Mfg. Corporation

Introduction and Background

Filtration Systems is glad that you have selected our products for your liquid filtration requirements. Our products have the most advanced design features to achieve excellent results for straining, filtering and liquid clarification applications. By familiarizing yourself with this booklet, most of your questions about this equipment will be answered.

Our design integrates an over-the-top inlet and hinged closure which provides a 360 degree positive seal to eliminate bypass of unfiltered liquid around the filter bag. More importantly, since the filter bag is situated at the top of the overflow rim in the vessel, no contamination reaches the downstream side, even during filter bag changes. Contamination collected in the filter bag is then easier to dispose of without cleaning the vessel.

NOTE: *A filter bag that has been used with a hazardous liquid may contain residual amounts of this material and should be handled with the same safeguards that would be used in handling any hazardous and/or toxic materials i.e., gloves, respirators, protective eyewear, etc. Filter bags used for such applications should be disposed of in accordance with federal, state or local laws and requirements.*

FEATURES

Over-The-Top Inlet
360 degree Hinged Closure with Lid Handle
"O" Rings in Lid
Investment Casting for Consistent Quality
Lid Stop
Taps for Gauges (Upstream & Downstream)
Vent Valve Tap
Tap for Drain
Glass Bead Blasting for Uniform Finish
T-316 S/S Baskets with Longitudinal Taper

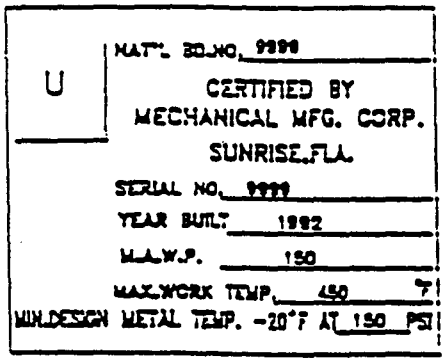
OUR VESSELS ACCOMMODATE STANDARD SIZE FILTER BAGS AS WELL AS HIGH EFFICIENCY FILTER BAGS AND CARTRIDGES MANUFACTURED BY EITHER 3M COMPANY OR PALL CORPORATION AND OTHERS.

Product Identification

All products are stamped with a unique serial number and can be identified by our factory. Below are samples of the possible nameplates that are permanently affixed to the filter housings.

NOTE: *The removal of the nameplate voids the product of any warranty and eliminates future identification of the product.*

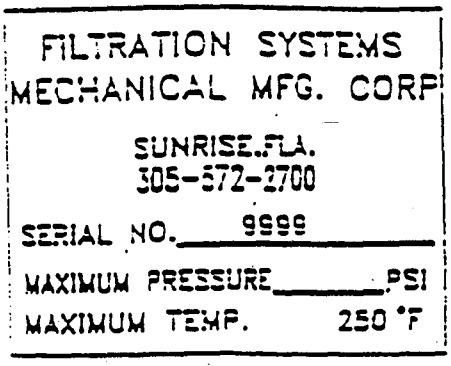
ASME CODE NAMEPLATE



Identifies both the National Board Number and the Serial Number of the vessel. It also designates the working pressures and temperatures of the vessel within safe limits. A "U" stamp indicates that the vessel has been designed and manufactured in accordance within the guidelines of ASME Code Section 8, Division 1.

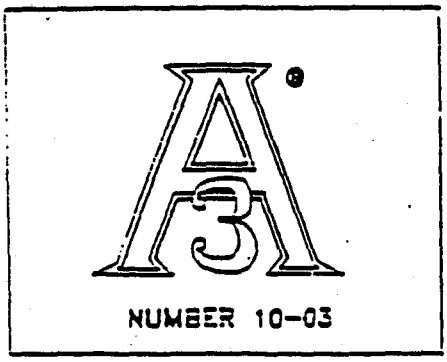
NOTE: *Any repair or modification of housings with an ASME code plate will void the housing of its ASME code status and may cause an unsafe condition in the usage of this vessel.*

NON-CODE NAMEPLATE



Identifies the serial number of the vessel as well as the working pressures and temperatures of the vessel within safe limits.

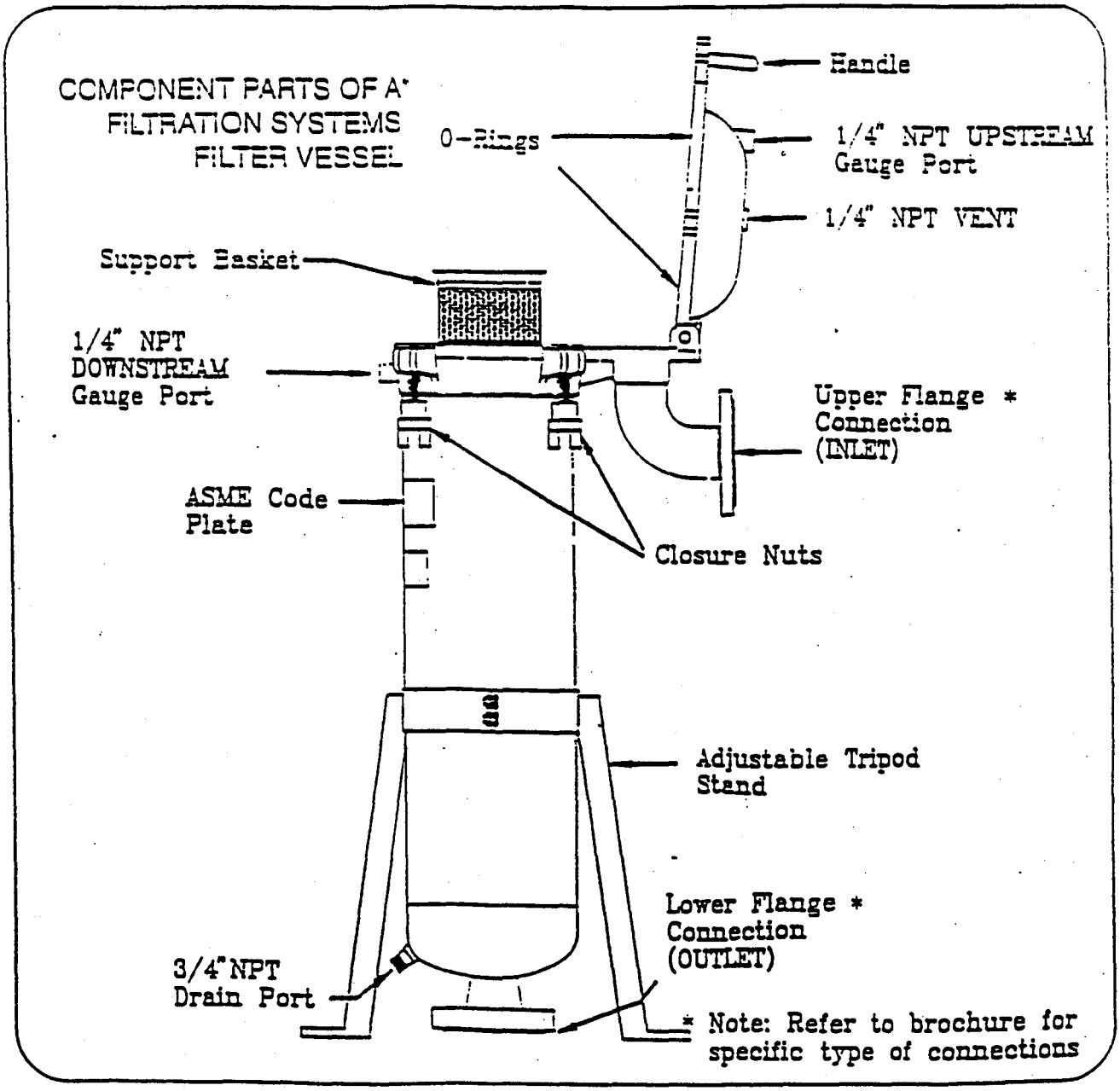
3-A SANITARY SYMBOL PLATE



Identifies the vessel as having been designed and built in accordance with 3-A Sanitary Standards, establishing design and fabrication criteria for cleanability of product contact surfaces for dairy quality products.

If it is <u>not</u> an Over-The-Top Inlet,

It is <u>not</u> Filtration...



Filtration Systems ™

Division of Mechanical Mfg. Corporation

Operating Instructions

1) Anchor the adjustable tripod stand to the floor or a base. Be certain to save additional literature that has been included with the unit for safekeeping and future reference.

2) The direction of liquid flow is from the top (inlet) through the bottom (outlet). NOTE: When making piping connections be certain not to bend the filter vessel in any way, or leaks will occur out the back of the filter vessel "O" Ring.

3) A shut off valve should be installed before and after the filter vessel to allow the filter bags, cartridges or filter baskets to be changed.

NOTE: *Valved, modular filter systems allow for individual housings to be isolated so that there is no disruption of continuous service. Filter bags may be replaced one at a time, while the other housing(s) are filtering.*

4) Flow rates for filter bags vary by manufacturer. Determining the number of vessels for use depends upon how many filter bags will be used simultaneously. Flow rates for our filter housings may be found in the individual brochures.

NOTE: *Flow rate information is based on the filter housing without the filter bag.*

5) Connections: A pressure gauge should be installed in the 1/4" NPT gauge port on the cover. The second pressure gauge should be installed in either the downstream pipeline or in the 1/4" downstream NPT gauge port on the filter vessel body. The difference between the two gauges indicates the "pressure differential" across the filter bag, signaling "blinding" and the need for filter bag replacement.

A vent valve should be installed in the 1/4" NPT vent port on the cover. As liquid enters the vessel, air is allowed to escape through the vent valve to avoid an air pocket.

GENERAL RULES

Initial operating pressure with a clean filter bag installed in the vessel will remain constant until the filter is approximately 80% "blinded".

When the pressure differential increases by approximately 15-25psi, the filter bag should be changed. This figure can vary with the manufacturer of the filter bag. Actual pressure differential, pressure drops, and the frequency of filter bag changes can only be determined by experience in each individual application.

Operating Instructions

FILTER BAG INSERTION

Insert the filter bag into the support basket installed in the housing and form the bag to the contours of the support basket, making sure to fully extend it to the bottom. Care should be taken to make sure the filter bag collar will firmly seat when the machined face of the cover makes contact with the filter bag.

It is the action of the machined face of the cover that compresses and seals the filter bag into the housing, providing a quality seal and preventing bypass around the filter bag.

LID CLOSING PROCEDURE

Close the cover of the housing, being careful not to drop it.

Bring all the hold-down bolts into position and hand tighten the rear bolts on the cover. Hand tighten the front bolts on the cover.

Final torque should be done by repeating these steps until the cover is tightly and evenly closed. This procedure should be followed to insure complete sealing. We recommend approximately 30-50 ft. lbs. of torque on the hold-down bolts.

STARTING TO FILTER

We recommend opening the upstream valve (shut-off valve) before the downstream valve (shut-off valve) to prevent any back flow from occurring.

Vent any air from the housing by using the vent valve installed in the cover and then slowly increase the pressure in the system.

FILTER BAG REMOVAL

A) Shut off the pressure to the system

B) Open the drain

Slowly open the 3/4" drain located in the bottom head of the filter vessel and capture the liquid in an appropriate container (i.e., suitable for the filtered material that you are evacuating). Safeguards should be taken in wearing the same type of protective clothing suitable for the material that is being handled.

C) Open the vent valve

NOTE: *If a filter bag is not changed on a timely basis it will not drain; if this happens: remove the filter bag and pour its contents into the new filter bag, installed in the vessel, and filter it!*

Troubleshooting

Housing Leaks.... A new filter housing will not leak. All Filtration Systems' vessels are hydrostatically pretested at our factory to eliminate any problems in the field. If a housing does leak:

1) Check "O" Rings for dirt, cuts or swelling; if so, replace the "O" Rings.
2) Check the procedure for closing the lid and apply the recommended torque pressure and reseal the filter housing.
3) Check that both shut-off valves on either side of the system are open for filtering (Upstream and Downstream).
4) Check all threaded connections and redo these threaded connections with a "leak lock" product.
5) Check to see if the filter bag is dirty and "blinded".
6) Check to see if the casting body is bent: apply a straight edge over the entire machined face of the vessel body to see if during piping it was bent out of line.

Poor Filtration Results....

1) Check the position of the filter bag in the support basket to make sure it is seated flat and flush at the top of the vessel to attain a good seal.
2) Check if the filter bag has been ripped or torn to cause bypass.
3) If there is abnormally short filter bag life you may need to increase the filter housing to a larger system. Our equipment is designed for expansion if required: also valved multi-housing systems are available to obtain longer life from a filter bag and eliminate downtime.

IF YOU HAVE ANY QUESTIONS OR NEED ASSISTANCE PLEASE DO NOT HESITATE TO CALL US (305) 572-2700

Notes on Safety

Our filter vessels are designed to be used safely to filter liquids under pressure in accordance with temperature and pressure restrictions as stamped on the name plate affixed to the product.

NOTE: <u>Improper use of a filter vessel may result in injury or property damage. Any misuse or modification of these products will void both the manufacturer's warranty as well as the ASME certification, if it is an ASME Code vessel.</u>

Filtration Systems' vessels are not designed for lethal service. "Lethal Service" refers to vessels containing lethal substances, poisonous gases or liquids of such a nature that a very small amount of the gas or vapor of the liquid (mixed or unmixed) is dangerous to life when inhaled. In addition, substances of this nature which are stored under pressure or may generate a pressure, if stored in a closed vessel are also considered lethal.

The following steps must be taken before using this equipment...

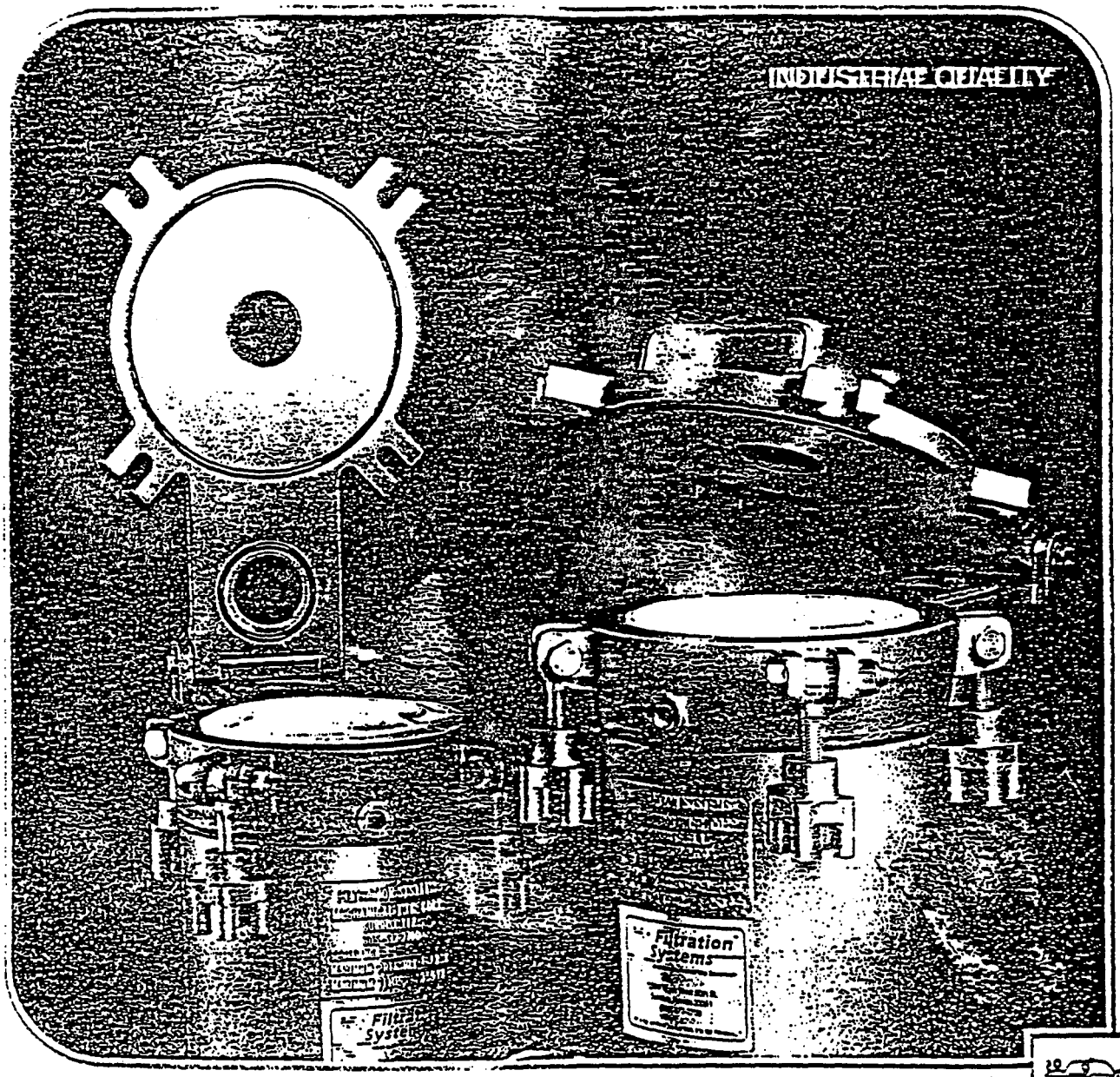
Notes on Safety

1) Follow the instructions in the installation and operations manual.
2) Before pressurizing a filter vessel, always make sure the connections and lid hardware are securely fastened. Be certain that the pressure rating of the filter vessel is greater than the possible limit you may have when the filter vessel is "blinded" with a dirty filter bag. (If the operating pressure can exceed the pressure restriction stamped on the affixed plate, a pressure relieving device must be installed.)
3) Wear protective garments, splash protection, eye protection and respirators, if necessary. Hot liquids that splash or spray can cause burns. Wear protective clothing and eyewear to prevent contact with a hot liquid or surface and when changing a filter bag. (If the liquid to be filtered emits fumes or gases, we further recommend a fume hood over the filter vessel.)
4) "O" rings (gaskets) are subject to wear and should be checked each time the filter bag is changed for dirt, cuts, abrasion or swelling. Replacement of the gaskets should be done prior to pressurization of the filter system. (Be certain that the fluid to be filtered is chemically and thermally compatible with the filter vessel, "O" ring material, and the filter bag material. Fluid compatibility includes all materials in contact with the liquid under elevated temperature and pressure.)
5) Always relieve the pressure to the filter system before loosening lid hardware, opening up a lid or removing a filter bag or cartridge.
6) Dispose of filter bags properly. A filter bag that has been used with a hazardous liquid may contain residual amounts of this material and should be handled with the same safeguards that would be used in handling any hazardous and/or toxic material; i.e., gloves, respirators, protective eyewear, protective clothing, etc... Filter bags used for such applications should be disposed of in accordance with federal, state or local laws and requirements.

1) Siga las instrucciones de instalacion y las del manual de operacion.
2) Antes de presurizar el filtro, asegurese siempre que las conecciones, tubera y tapas, esten bien selladas y apretadas. Asegurese que la capacidad de presion del filtro sea mayor que la del limite maximo posible cuando el filtro este "obstruido" debido al sucio acumulado en la bolsa o cartucho usada para filtrar. (Si la presion de operacion excede la presion de restricion estampada en la placa, debe ser instalada una valvula de seguridad).
3) Use equipo protectivo, proteccion anti-salpicdue, anteojos de seguridad y equipo respiratorio si fuese necesario. Los liquidos calientes que salpican o se esparcen, pueden causar quemaduras. Use ropa protectiva y proteccion para los ojos, previniendo asi contacto con el liquido o la superficie caliente, cuando vaya a cambiar la bolsa para filtrar. (Si el liquido que ha de ser filtrado emite humos o gases, peligrosos o toxicos, nosotros recomendamos usar ademas una cubierta protectiva sobre el filtro.)
4) Los empaques ("O" rings) estan sujetos a deterioro y siempre deben ser revisados completamente, cada vez que se cambie la bolsa o cartucho, en busca de mugre, grietas, cortadas, abrasion o engrancecimiento. El reemplazo de los empaques, debe ser hecho antes de presurizar el sistema de filtro. (Esté completamente seguro que el liquido que va a ser filtrado, es quimica y termalmente compatible con el tipo de filtro usado, los empaques y el material de las bolsas o cartuchos usados.) La compatibilidad de los liquidos con el equipo, se refiere a todos los materiales y componentes que esten en contacto con el liquido incluso cuando sean sometidos a alta temperature y presion.
5) Siempre descomprima el sistema de filtro antes de levantar una tapa, aflojar cualquier componente, o remover una bolsa o cartucho.
6) Deshagase de las bolsas y cartuchos usados en forma apropiada. Una bolsa o cartucho que ha sido usado con materiales peligrosos o toxicos, pueden contener residuous de este material, y por lo tanto deben ser tratados con el mismo cuidado con que serian tratados aquellos materiales peligrosos y toxicos, por ejemplo usando guantes, proteccion para los ojos, ropa protectiva, etcetera. Las bolsas de filtrado usadas en tal aplicacion, deben ser deshechas de acuerdo con las leyes federales, estatales o locales, y de acuerdo con todos los requisitos.

PRODUCT WARRANTY: IN THE EVENT ANY VESSEL IS FOUND TO BE DEFECTIVE IN MATERIAL OR WORKMANSHIP, FOR A PERIOD OF ONE YEAR FROM THE DATE OF PURCHASE, FILTRATION SYSTEMS' ONLY LIABILITY WILL BE TO REPAIR OR REPLACE THE PRODUCT.
THE MANUFACTURER RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE. THERE ARE NO EXPRESSED OR IMPLIED WARRANTIES, WITH RESPECT TO PRODUCT MERCHANTABILITY AND/OR FITNESS FOR A SPECIFIC PURPOSE. FILTRATION SYSTEMS WILL NOT BE LIABLE FOR ANY INCIDENTAL DAMAGES FROM THE USE OR MISUSE OF OUR PRODUCTS UNDER ANY CIRCUMSTANCES.

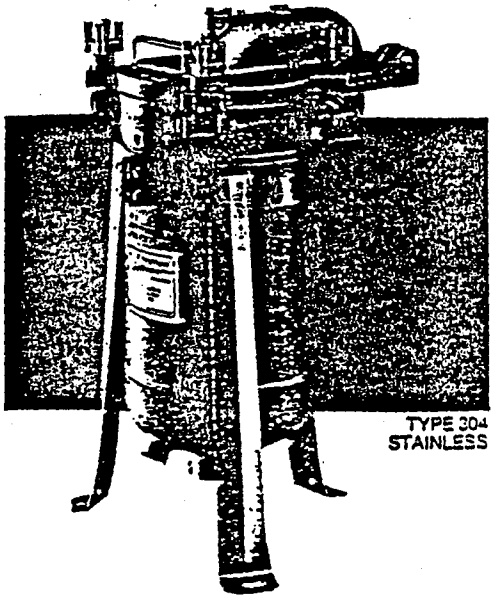
Metal Bag Housings



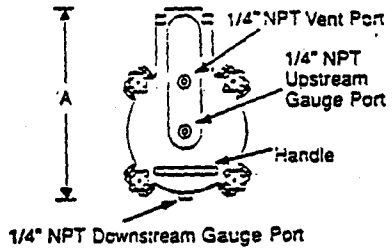
Filtration Systems™

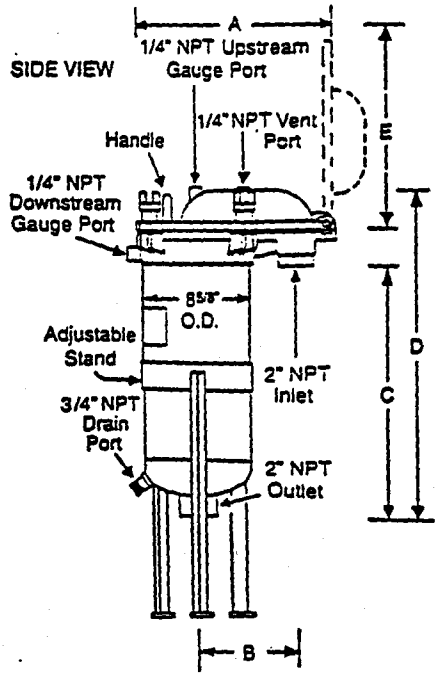
Division of Mechanical Mfg. Corporation

MODEL NS-112



TOP VIEW





MODEL NS-112	A	B	C	D	E	WT. LBS.
2" NPT CONNECTION	15 1/4"	7 1/4"	14"	20"	14 3/4"	85

Description

Model NS-112 Bag Filter Housing in T-304 Stainless Steel at 150psi(250°F). Vessel uses a #1 size filter bag (7"dia.x 16" long). Liquid flow is from the inside of the filter bag to the outside. The support basket and filter bag are securely locked into a recess at the top of the overflow rim, providing a 360 degree positive compression seal. Since the filter bag is locked in at the top of the vessel, all of the dirt is trapped inside the bag. The filter vessel never requires cleaning after use.

Specifications

Maximum Working Pressure 150psi
Maximum Working Temperature 250°F
Maximum Water Flow 110gpm (does not include a filter bag)
Maximum Support Basket Differential Operating Pressure 75psi
Hydrostatically Tested to 250psi
Inlet & Outlet: 2" NPT
Shipping Weight: 85 lbs.

Standard Features

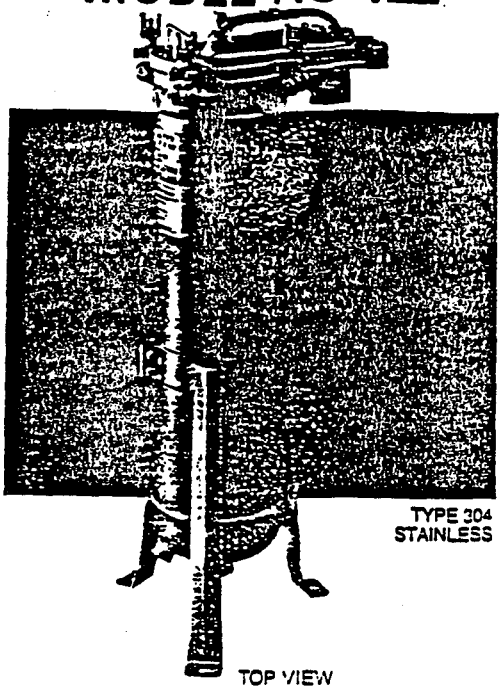
Model NS-112, type 304 stainless steel, glass bead finish:
exterior, interior and basket
Model NC-112, carbon steel, one coat shop primer, exterior

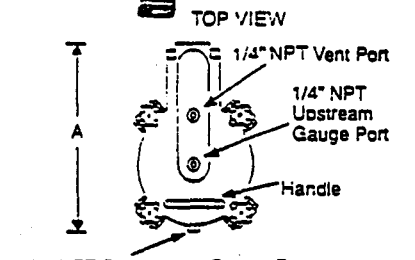
Over-The-Top Inlet
360° Hinged Closure with Lid Handle
Lid Safety Detents and Lid Stop
Investment Casting (Lid & Body)
Perforated T-316 S/S Support Basket with Longitudinal Taper
Gauge Ports (Upstream & Downstream) 1/4" NPT
Vent Port 1/4" NPT
Drain Port 3/4" NPT
Buna-N O-Rings
Plated Carbon Steel Hardware - Bar Knobs
Adjustable Stainless Tripod Stand (NS-112)
Adjustable Carbon Steel Tripod Stand (NC-112)

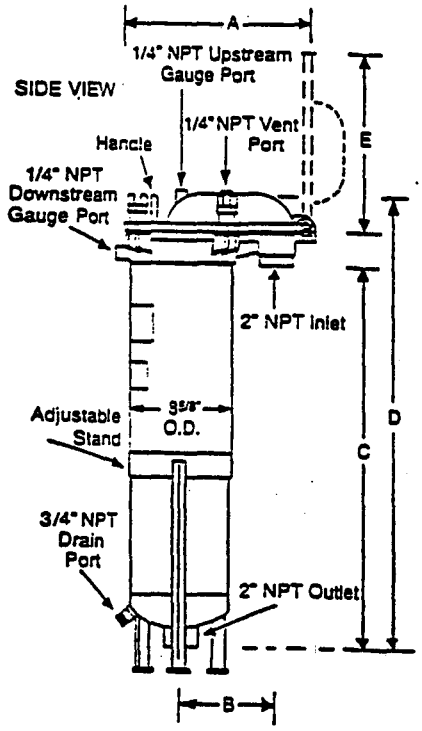
Options

Modified Connections - Flanged, Threaded or Sanitary
Interior Grade Finishes (Including 3A Sanitary)
Electropolish Finishes - Exterior, Interior or Both
Micron-Rated Strainer Baskets
Mesh & Micron Lined Baskets
Assorted O-Ring Materials
Steam & Hot Oil Jackets
Low-Profile Horizontal Outlets
Cartridge Contaminant Chambers (holds four 10" cartridges)
Drain Valves & Vent Valves
Pressure Gauges
Available in Carbon Steel (Model NC-112) at 150psi (250°F)

MODEL NS-122







MODEL NS-122	A	B	C	D	E	WT. LBS.
2" NPT CONNECTION	15 1/4"	7 1/2"	28"	34"	14 3/4"	100

Description

Model NS-122 Bag Filter Housing in T-304 Stainless Steel at 150psi(250°F). Vessel uses a #2 size filter bag (7"dia.x 32" long). Liquid flow is from the inside of the filter bag to the outside. The support basket and filter bag are securely locked into a recess at the top of the overflow rim, providing a 360 degree positive compression seal. Since the filter bag is locked in at the top of the vessel, all of the dirt is trapped inside the bag. The filter vessel never requires cleaning after use.

Specifications

Maximum Working Pressure 150psi
Maximum Working Temperature 250°F
Maximum Water Flow 220gpm (does not include a filter bag)
Maximum Support Basket Differential Operating Pressure 75psi
Hydrostatically Tested to 250psi
Inlet & Outlet: 2" NPT
Shipping Weight: 100 lbs.

Standard Features

Model NS-122, type 304 stainless steel, glass bead finish:
exterior, interior and basket
Model NC-122, carbon steel, one coat shop primer, exterior

Over-The-Top Inlet
360° Hinged Closure with Lid Handle
Lid Safety Detents and Lid Stop
Investment Casting (Lid & Body)
Perforated T-316 S/S Support Basket with Longitudinal Taper
Gauge Ports (Upstream & Downstream) 1/4" NPT
Vent Port 1/4" NPT
Drain Port 3/4" NPT
Buna-N O-Rings
Plated Carbon Steel Hardware - Bar Knobs
Adjustable Stainless Tripod Stand (NS-122)
Adjustable Carbon Steel Tripod Stand (NC-122)

Options

Modified Connections - Flanged, Threaded or Sanitary
Interior Grade Finishes (Including 3A Sanitary)
Electropolish Finishes - Exterior, Interior or Both
Micron-Rated Strainer Baskets
Mesh & Micron Lined Baskets
Assorted O-Ring Materials
Steam & Hot Oil Jackets
Low-Profile Horizontal Outlets
Cartridge Contaminant Chambers (holds four 20" cartridges)
Drain Valves & Vent Valves
Pressure Gauges
Available in Carbon Steel (Model NC-122) at 150psi (250°F)

LOW-PROFILE, HORIZONTAL OUTLET— AVAILABLE ON ALL MODELS

One piece, self-cleaning horizontal outlets are optional on all single filter housings as well as on duplex and multi-housing systems. Available in stainless and carbon steel, this option can be used on equipment with flanged, threaded or sanitary connections.

This outlet lowers filter bag removal clearance height by an additional 4" on all systems. When a filter bag is loaded, it can be removed without the use of a platform. Size #2 filter bags are 32" long and when removed from a filter housing must clear the top of the vessel, known as the **Overflow Rim.** *Filtration Systems has the lowest filter bag removal height in the industry. Note: Lower working height means easier filter bag changes.*

Low-Profile Configuration Options on Individual Filter Housings

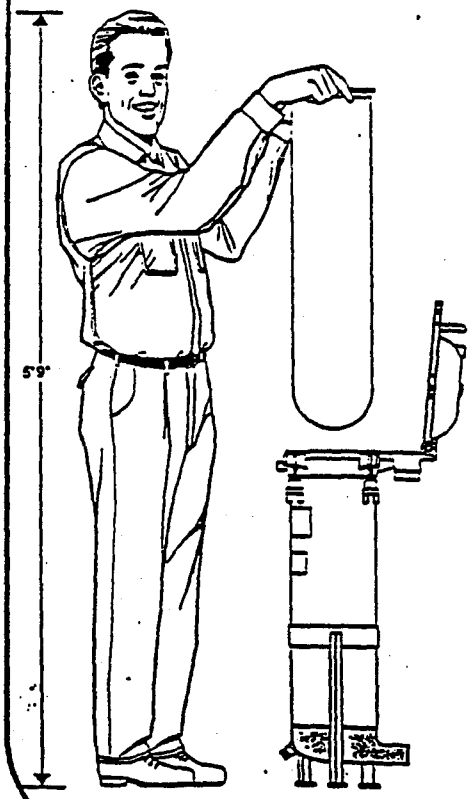
Inlet Over Outlet: (C-Configuration)
The outlet of the filter vessel, relative to the inlet is on the same plane, or in the shape of the letter "C" in a profile view. In this type of arrangement, the filter can be used in a loop on piping arrangements.

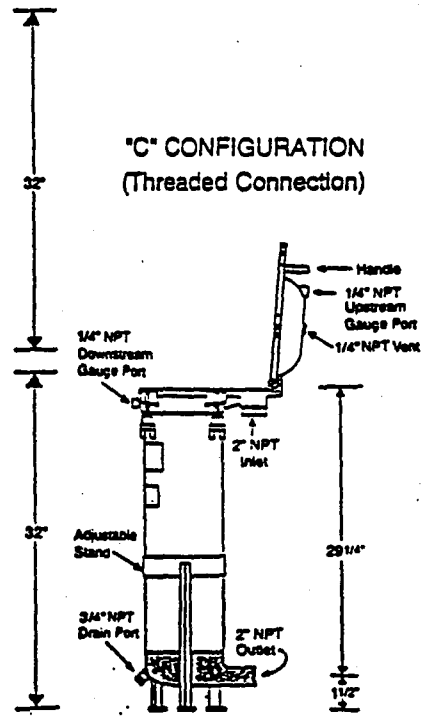
Inlet Opposite Outlet: (S-Configuration)
The outlet of the filter, relative to the inlet is 180 degrees opposite to each other, or in the shape of the letter "S" in a profile view. In this type of arrangement, the filter becomes in-line with existing piping.

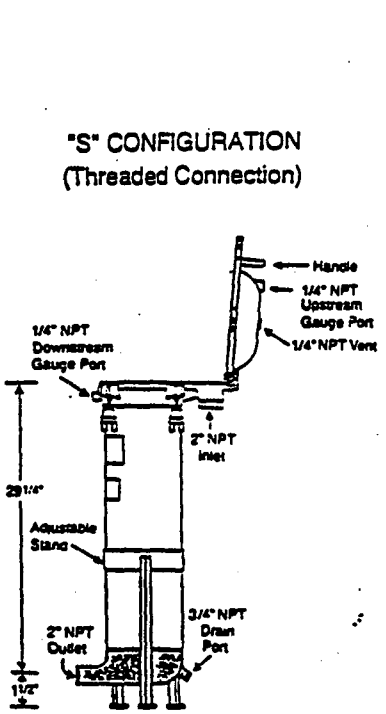
Custom Low-Profile Arrangements:
The outlet of the filter vessel, relative to the inlet can be configured in any type of 360 degree pattern, so that all types of piping arrangements can be accommodated.

Note: In all "LP" (low-profile, horizontal outlet) configurations, the standard drain placement is generally opposite the outlet of the vessel. The location of the drain can be modified upon request.

To Order: *All models can have the "LP" option by placing the characters "LP" as a suffix to the required equipment.*







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Product Warranty: In the event any vessel is found to be defective in material or workmanship for a period of one year from date of purchase, Filtration Systems only liability will be to repair or replace the product.

The manufacturer reserves the right to change specifications without notice. There are no express or implied warranties, with respect to product merchantability and/or fitness for specific purpose. Filtration Systems will not be liable for any incidental damages from the use or misuse of our products under any circumstances.

Manufactured by:
Filtration Systems™
Division of Mechanical Mfg. Corporation
10304 NW 50th Street • Sunrise, FL 33351 USA
Tel: 305-572-2700 • Fax 305-572-3401

FS/B-92

BROCHURE

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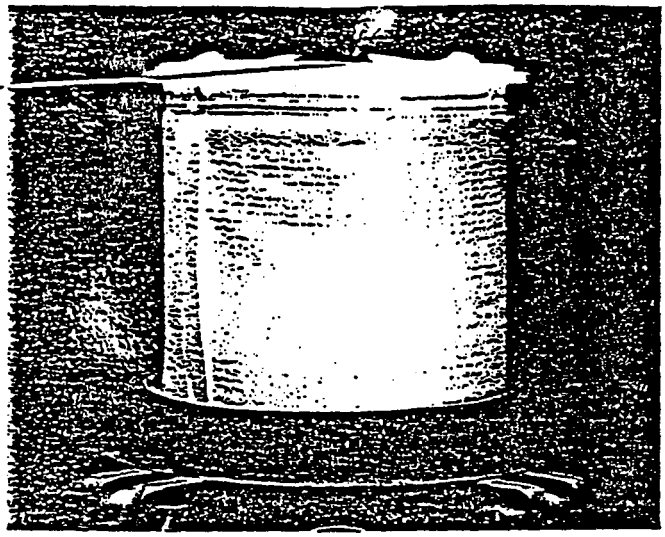
Accufit Welded Liquid Filter Bag



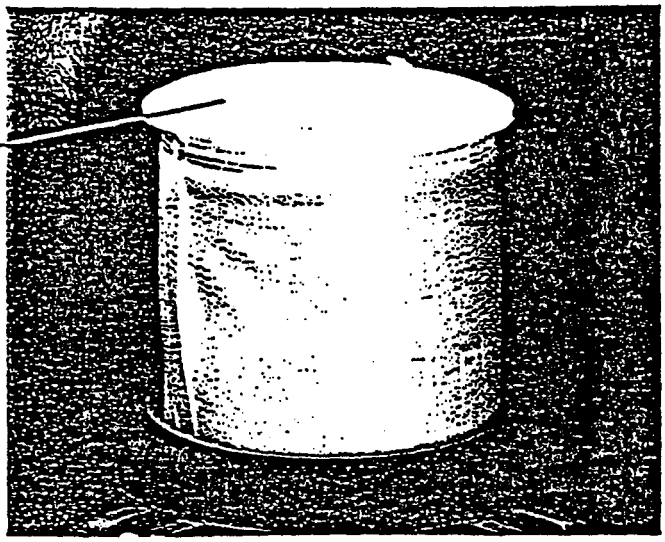
Filtration Systems™

Division of Memtec America Corporation

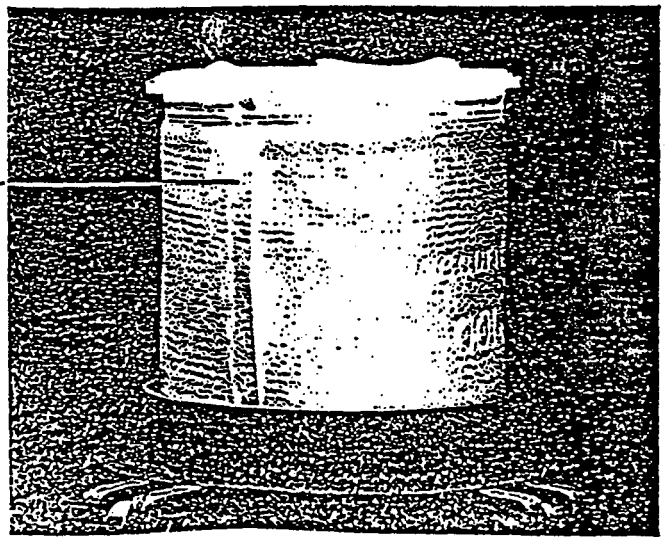
There are 3 distinct design advantages to this patented liquid filter bag



1. A flanged bag collar that provides an integral sealing gasket when used in a ***Filtration System's*** filter vessel. No bypass of particulate will occur around the sealed bag collar when the filter bag is under elevated pressure.



2. A dual handle lift-out, located above the liquid level, eliminates contact with dirt and unfiltered materials and allows quick filter bag removal for replacement.



3. Completely welded construction prevents solids, larger than the micron rating of the media, from bypassing the filter bag. Conventional filter bags are sewn, allowing particles to bypass through the needle holes of seams.

Materials of Construction

100% Polypropylene
Maximum Recommended Temperature 180°F

FEATURES	BENEFITS
HIGH EFFICIENCY	Consistent, verifiable results
NO SEWN SEAMS	No bypass of unfiltered fluid
FLANGED BAG COLLAR WITH INTEGRAL GASKET	No bypass around filter bag seal
DUAL HANDLES	Quick and easy filter bag removal eliminates contact with dirt or unfiltered material
SURFACE TREATED EXTERIOR	Minimizes fiber migration downstream
100% POLYPROPYLENE	Broad range of chemical compatibility
FULLY COMBUSTIBLE	Total incineration at low temperatures reduces disposal costs
HIGH STRENGTH	Minimizes bag breakage reducing product failures
LOW PRESSURE DROP	Low resistance to flow means greater yield per filter bag
BAG IDENTIFICATION	Micron rating and filter bag size permanently embossed eliminates incorrect replacement
ECONOMICAL	Low cost, high performance liquid filtration

Chemical Compatibility

The following list is a guide to chemical compatibility of polypropylene with several commonly used fluids grouped by chemical categories:

■ Compatible in most situations
▬ Limited compatibility, testing is suggested
◪ Generally not compatible, testing is suggested
Fluid compatibility with polypropylene filters (at room temperature)

Acids		**Chlorinated Solvents**	
Acetic Acid	■	Carbon Tetrachloride	□
Carbonic Acid	■	Chloroform	□
Citric Acid	■	Trichloroethylene	□
Formic Acid	■		
Hydrochloric Acid	◪	**Esters**	
Hydrofluoric Acid	◪	Amyl Acetate	■
Nitric Acid	◪	Butyl Acetate	■
Phosphoric Acid	◪	Ethyl Acetate	◪
Sulfuric Acid	■	Methyl Acetate	■
Alcohols		**Ketones**	
Butanol	■	Acetone	▬
Ethanol	◪	Methylethyl Ketone	▬
Ethylene Glycol	■		
Glycerine	■	**Oils**	
Isopropanol	◪	Cottonseed Oil	□
Methanol	◪	Mineral Oil	■
Alkalies			
Ammonium Hydroxide	■	**Other Fluids**	
Potassium Hydroxide	■	Formaldehyde	■
Sodium Hydroxide	■	Gasoline	□
Aromatics		Hexane	□
Benzene	▬	JP-4	■
Toluene	▬	Kerosene	■
Xylene	▬	Mineral Spirits	■
Ethers		Phenol	■
Dioxane	■	Pyridine	□
Ether	□	Turpentine	□
Tetrahydrofuran	□	Varnish	□

ACCUFIT WELDED™ FILTER BAG SIZES

Product Dimensions	Max. Recommended Flow Rate(gpm)Water
Size #1:(P1) 7" Dia. x 16" long	50gpm/filter bag
Size #2:(P2) 7" Dia. x 32" long	75gpm/filter bag
Size #4:(P4) 4" Dia. x 14" long	25gpm/filter bag
Size #5:(P5) 4" Dia. x 24" long	50gpm/filter bag

MICRON RATING AVAILABILITY										
1	3	5	10	15	25	50	75	100	150	200

IMPORTANT NOTE ON CHEMICAL & THERMAL COMPATIBILITY AND ACCUFIT WELDED™ LIQUID FILTER BAGS

The compatibility data presented in this brochure is for general guidance only. In most cases, the use of a specific filtering material, such as polypropylene, can be safely recommended without special testing. Issues of possible filter bag incompatibility, such as swelling, leaching of the filter bag material into a fluid solution or disintegration, can only be determined by the user under actual on-site operating conditions.

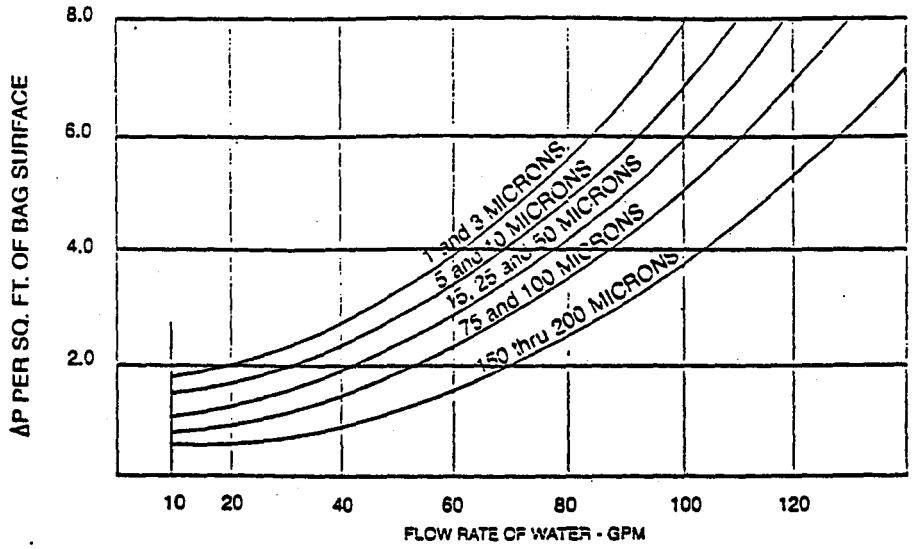
Factors such as degree of concentration of a substance in a fluid, temperature and duration of filter bag exposure are also factors to be considered. Chemical and thermal compatibility is further defined to include all materials exposed to fluids such as the filter bag, O-rings and filter vessel, under elevated pressure and/or temperature. If chemical and thermal compatibility is in doubt, please check with the manufacturer.

Applications for Accufit Welded™ Liquid Filter Bags

Low cost, high performance liquid filtration can be achieved with Accufit Welded™ Liquid Filter Bags, where fine filtration is required. Our filter bags are compatible for many applications such as...

Acids and Bases	Confectionery Products	Liquid Detergents	Plating Solutions
Adhesives	Dye Stuffs	Magnetic Media Coatings	Polymers
Aerosols	Electric Utilities	Oil Well Applications	Process Water
Amines	Electroplating	Paints & Varnishes	Printing Inks
Bulk Chemicals	Fats and Oils	Paper Coatings	Reagent Chemicals
Beverages	Fabric Coatings	Pharmaceuticals	Semiconductors
Coil Coatings	Hydraulic Fluids	Petrochemicals	Sugars
Cleaning Fluids	Industrial Coatings	Photographic Products	Vegetable Oils
Cosmetics	Lacquers	Pigments	Water
Cutting Fluids	Liquor	Plastisols	Etc.

Accufit Welded™ Liquid Filter Bag-Determining Pressure Drop



STEP 1. THE MICRON RATING AND FLOW
The graph shows the pressure drops imposed by one square foot of (clean) bag material based on various micron rates and flow rates of water. Using your rating and flow, find the pressure drop.

STEP 2. CORRECT FOR BAG SIZE
Divide the pressure drop found in step 1 by the square feet of surface in the bag size you want.

STEP 3. CORRECT FOR VISCOSITY
If the viscosity of your liquid is heavier than 1 cps(water), multiply your result from step 2 by the proper correction factor from chart at right. This should give the correct pressure drop for your application.

STEP 4. TOTAL PRESSURE DROP
Add the pressure drop from the bag to the pressure drop of the filter vessel to determine the total.

VISCOSITY (CPS)	CORRECTION FACTOR
50	4.5
100	8.5
200	16.6
400	27.7
800	50.0
1,000	56.2
1,500	77.2
2,000	113.6
4,000	161.0
6,000	250.0
8,000	325.0
10,000	430.0

Note: While the information herein is believed to be reliable, we do not guarantee its accuracy. Purchasers are urged to make their own tests.

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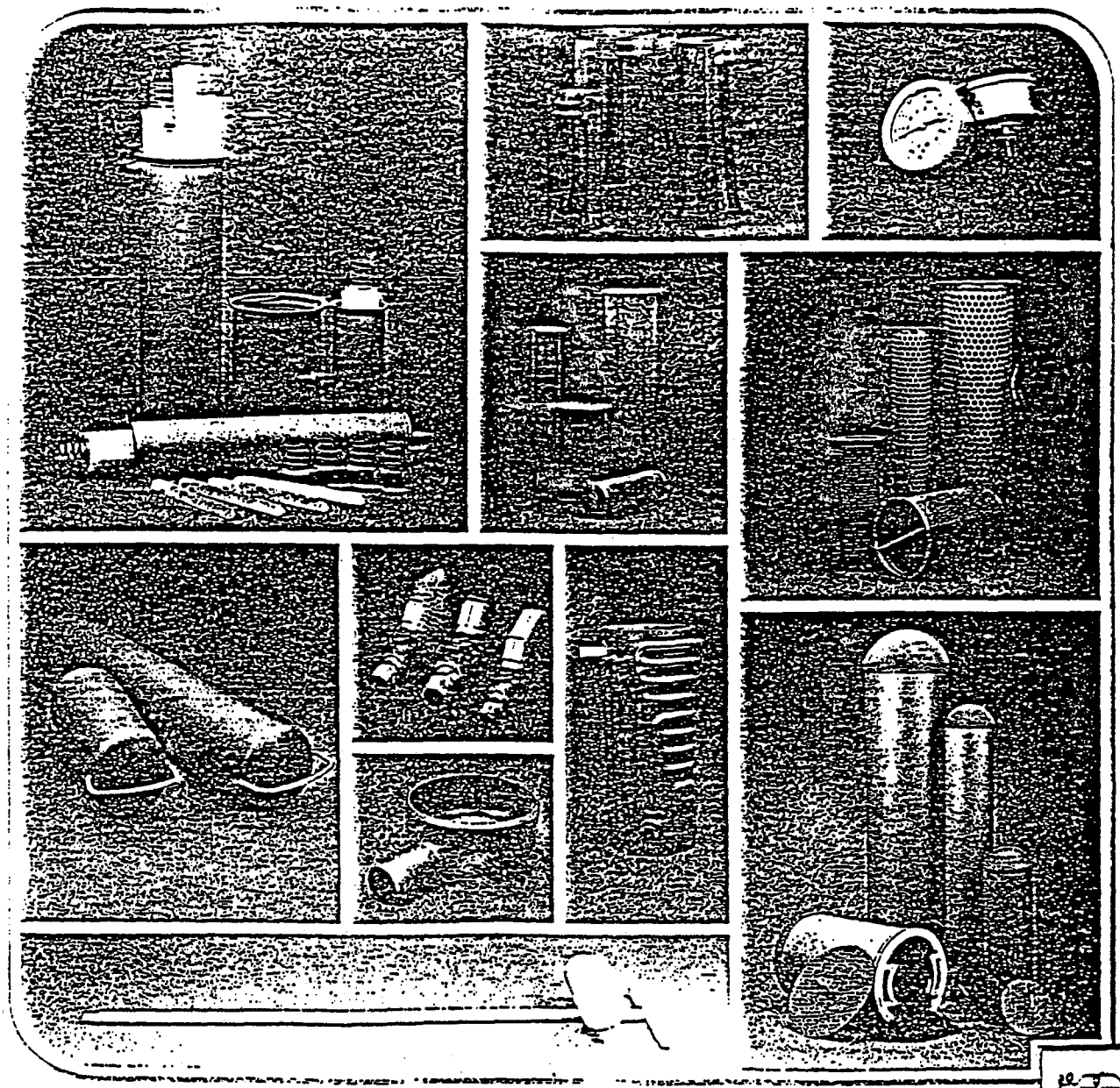
Manufactured by: **Filtration Systems™**

LIMITATION OF LIABILITY: Filtration Systems shall not be held responsible or liable for any loss or damage resulting from, direct or indirect, incidental, special or consequential, arising from the sale, use or misuse associated with product merchantability and fitness for a specific purpose. WARRANTY: In the event Filtration System's product is found to be defective in workmanship, Filtration Systems only obligation and a customer's remedy, shall be to replace the product or refund the purchase price.

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Filtration Accessories

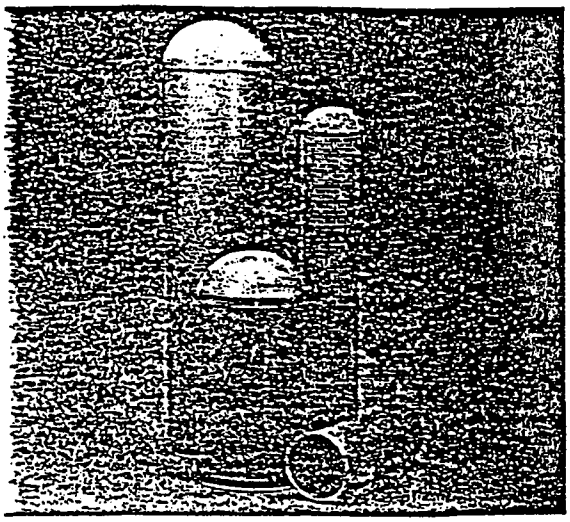
1-10 Micron
MIZSIT



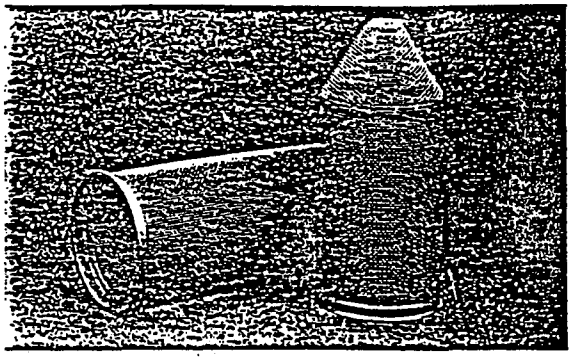
Filtration Systems

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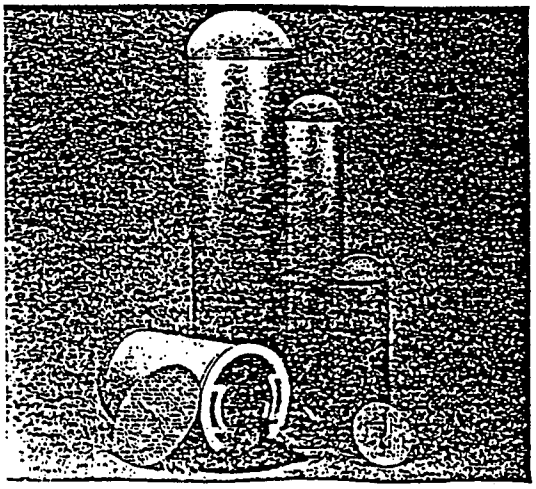
Perforated Support Basket: Type 316 stainless steel perforated (3/64" hole size) accommodates filter bag sizes #1, #2, #4 and #5. Support baskets have a longitudinal seam to assist in releasing a pinched filter bag.

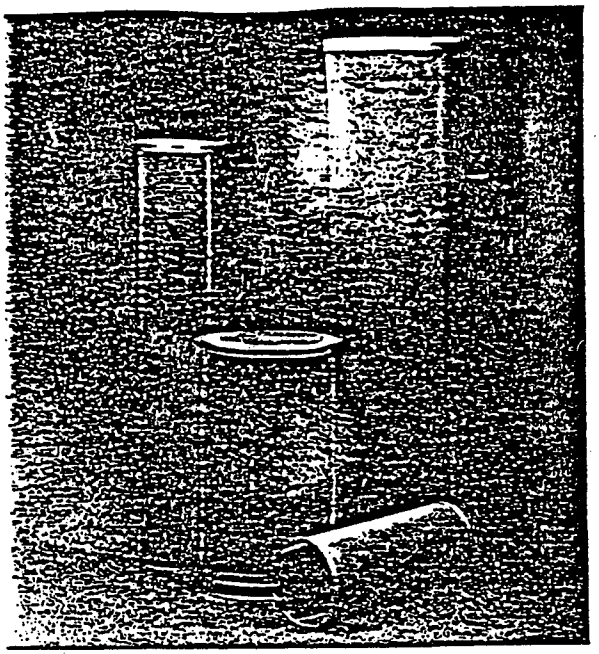


Mesh Support Basket: Type 316 stainless steel (8x8 mesh) accommodates filter bag sizes #1,#2,#4 and #5.

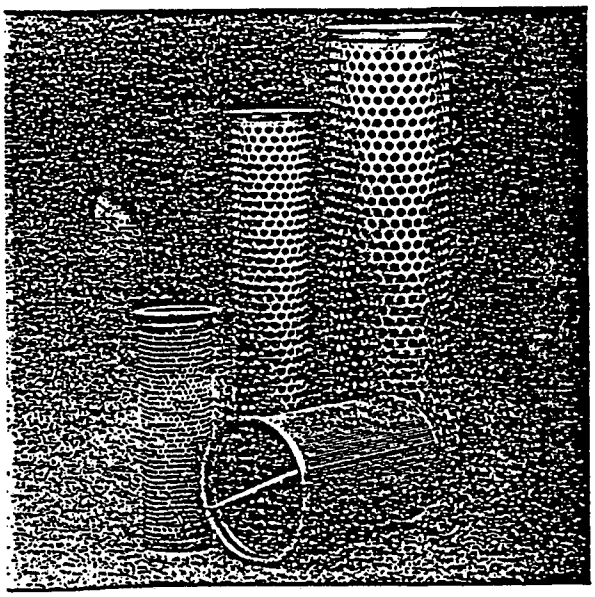


Canister Basket: This basket has a solid wall and a perforated bottom outlet and fits into ***Filtration Systems*** housings. It is used with a filter bag and is designed to hold granular chemicals, such as activated carbon. The introduction of chemicals during the filtration cycle can alter the composition of liquids passing through the charged canister by the addition or the removal of materials from those liquids. This T-316 stainless steel fixture includes a liquid diffuser.



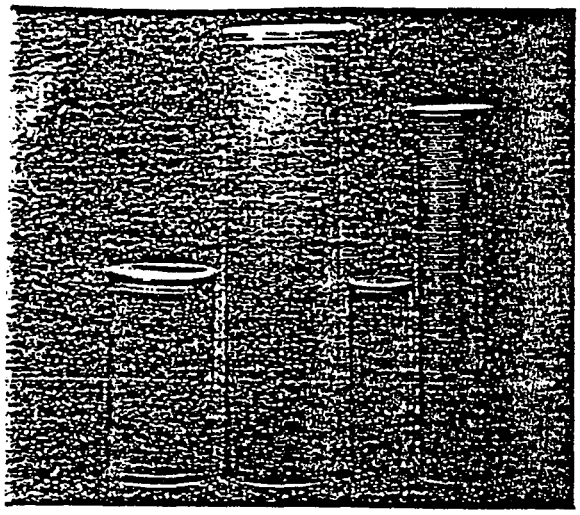


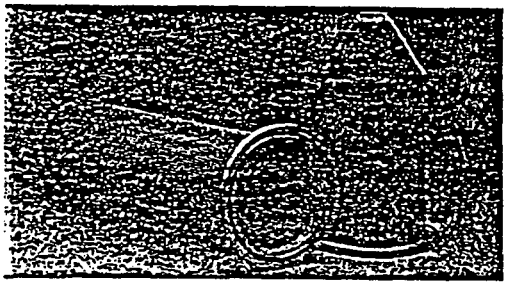
Filter Cloth Basket: These reusable micron-rated baskets provide fine filtration without the use of a disposable media. Filter cloth is made of T-316 stainless steel cotton weave and is fairly durable. As this is a self-supporting membrane (not reinforced with a backing), care should be taken to prevent this product from tearing. It is available in 90, 180 and 250 micron ratings for size #1,#2, #4 and #5 filter housings.



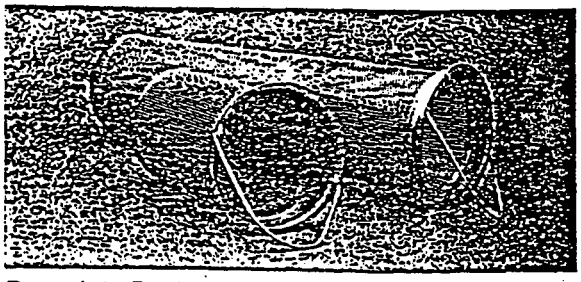
Perforated Strainer Baskets: Heavy-duty perforated strainer baskets can convert size #1,#2,#4 and #5 filter vessels into strainers. Perforated strainer baskets are fabricated from T-304 stainless steel and are available in 1/2", 3/8", 1/4", 3/16", 9/64", 3/32" and 1/16" hole diameters. All strainers contain a lift-out handle. Unlike most conventional strainers, our filter housings maintain high flow rate capacities, allow continuous service with valved systems and provide much greater cubic area for heavy dirt loading. Finer straining applications can utilize the full array of Mesh and Micron Lined Baskets.

Mesh and Micron Lined Basket Strainers: Constructed entirely of T-316 stainless steel, these heavy-duty baskets provide straining and liquid clarification for a wide variety of mesh and micron requirements. These basket strainers are precision and tie bed fixtures that allow the basket and the membrane to take the rigors of the application. The construction allows the membrane (mesh or micron) to have extended bag service life. The basket fixture takes the bearing of the membrane does the filtering. All forms of welding are performed on the solid parent metal so that no bypass will occur around the membrane. *Mesh: 20,30, 40,50, 60, 70, 80, 100, 150, 200*
Micron: 5, 10, 15, 25, 40, 90, 160, 250

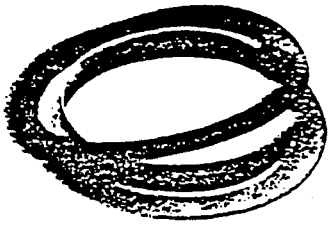




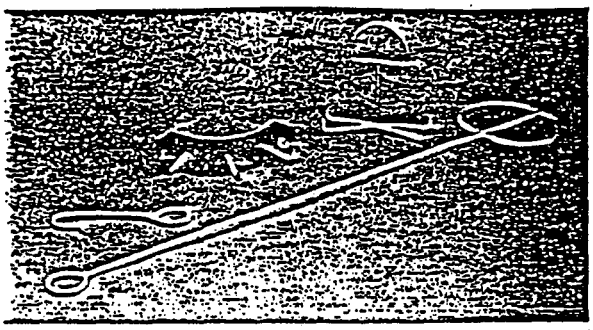
American Felt & Filter/GAF Support and Specialty Baskets: Perforated and Mesh Support Baskets for AM and RB series #1 and #2 filter vessels. Specialty baskets such as strainers, filter cloth baskets, micron-lined baskets and canister baskets can be fabricated for these filter vessels. All baskets are constructed of T-316 stainless steel.



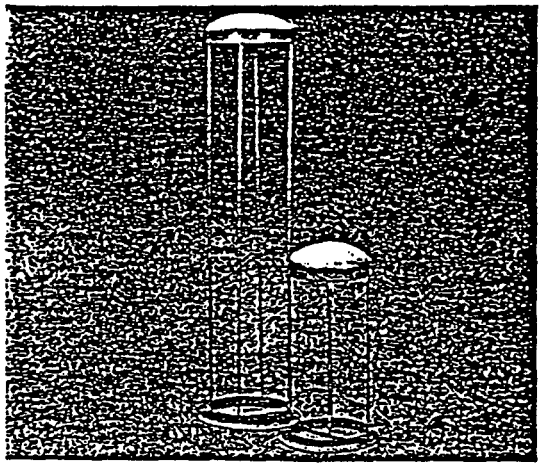
Rosedale Baskets: T-316 stainless steel perforated support basket replacements for Rosedale Brand Filter Vessels (Model S, Style B, 715 & 730). Other variations of strainers, mesh & micron lined baskets can be fabricated for these referenced filter vessels.



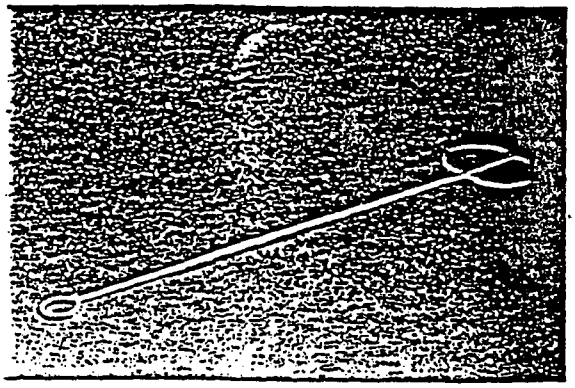
Calibrated Bag Seal Ring: This Bag Seal Ring is installed on top of a filter bag prior to closing the lid of the vessel. This unique device ensures a 360 degree positive seal and media compression, eliminating the potential for bypass. These bag seal rings are T-316 stainless steel and can be custom-fit for specific filter bag designs.



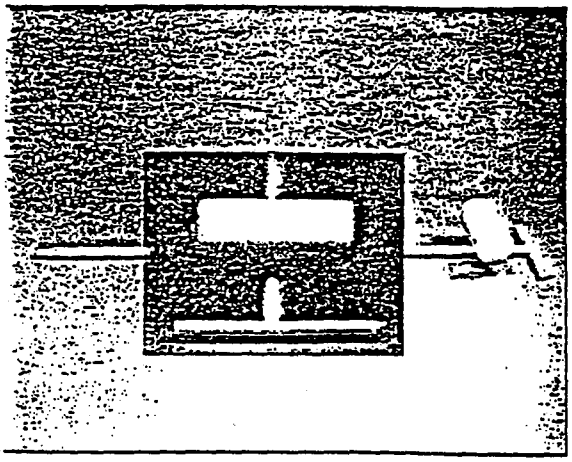
Filter Bag Accessory Kit: Stainless steel bracket and tool set designed to be mounted onto the filter vessel. Individual tools allow for the following operations: 1) reaming the bag into the support basket 2) opening and closing the filter vessel 3) allowing a used filter bag to drain into a waste disposal bucket while a replacement is installed. Once the new filter bag is installed into the vessel, the remaining contents from the used filter bag can be poured into the new filter bag for continued filtration, minimizing product waste.



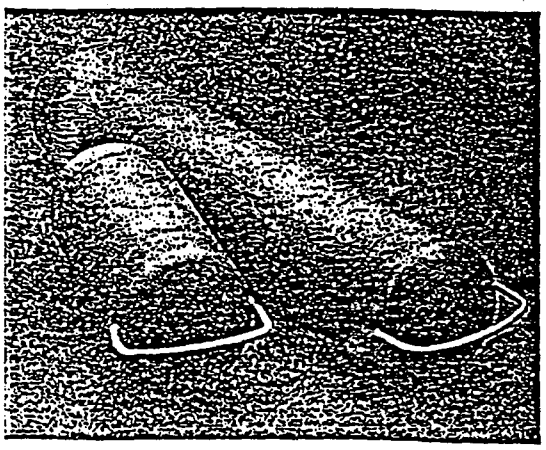
Filter Bag Insert: This fixture eliminates filter bag breakage. When an insert is placed into a filter bag, the bag is kept extended, preventing the bag from floating when heavy viscous liquids are used. The Filter Bag Insert further reduces pulsation and vibration of the bag, thus preventing erosion. It also can protect the filter bag against direct force caused by initial air pockets or quick opening of valves. This product is fabricated of T-316 stainless steel.



Bag Plunger: An effective tool for insuring that the complete area of the filter bag is used. Allows full extension of the filter bag into the basket, assuring that the filter bags are fully accessed, minimizing filter bag ruptures. Designed for #1, #2, #4 and #5 size filter housings. Fabricated from T-316 stainless steel.

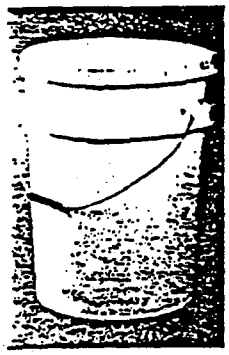


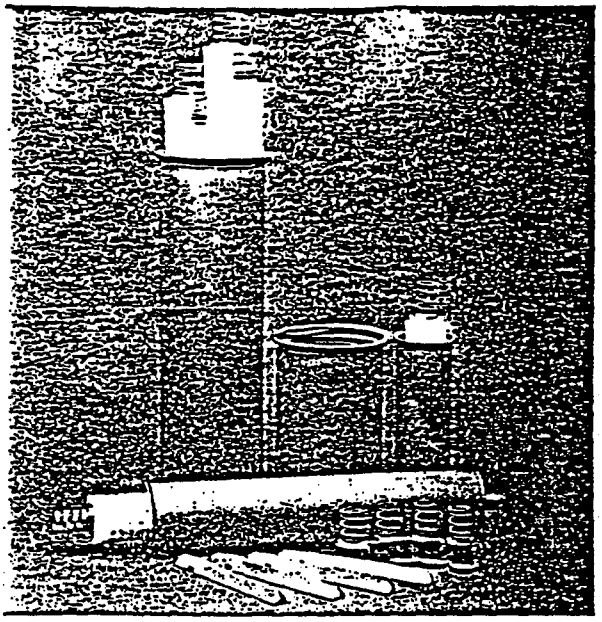
Scavenger Attachment: This accessory is used in conjunction with the Portable Liquid Pump and Filter System. When attached to the suction hose, the built-in float enables the user to remove and filter surface contaminant from liquids over a large area.



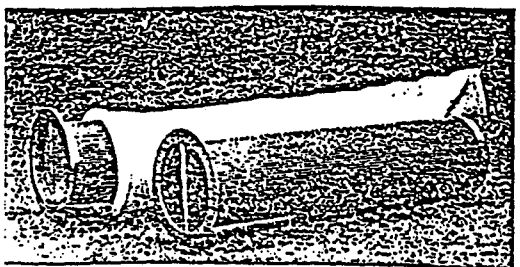
Displacement Float: This accessory, after removal from the bag, reduces liquid volume remaining in the filter bag, minimizing product loss and facilitating changing the filter bag. Displacement floats are available for size #1 and #2 housings in stainless and carbon steel and are equipped with a lift-out handle.

Filter Bag Disposal Bucket: This 14 gallon bucket comes as standard equipment with the Portable Liquid Pump and Filter System. The bucket has a positive O-ring seal to prevent accidental spilling. It can hold five used filter bags and is D.O.T. approved. Small waste producers can use this and directly ship DRUMS to hazardous waste sites.





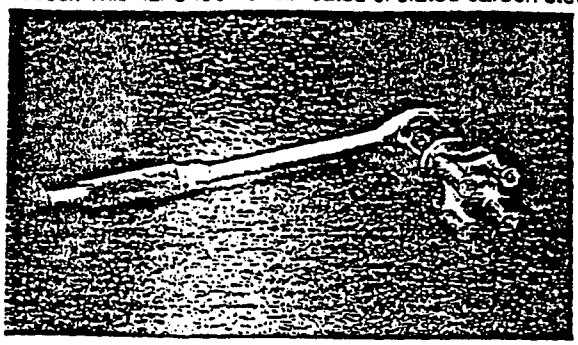
Cartridge Contaminant Chamber: This removable chamber converts any of our bag filter housings into cartridge filters. Insertion of the chamber into the vessel allows for alternate filter media without modification of piping. When the cartridges are spent, the chamber is pulled from the vessel as one unit, minimizing exposure to unfiltered material and eliminating the possibility of a hazardous spill. When the chamber is removed from the filter vessel, the contaminant is trapped within it; therefore, the filter vessel does not have to be cleaned or flushed after each use. Spare chambers preloaded with cartridges can be kept ready for the next change out. The Cartridge Contaminant Chamber and its hardware is fabricated from T-316 stainless steel and is available for #1, #2, #4 and #5 size vessels.



Prefilter/Backwash Insert: This flanged-top insert fits into the filter bag for those users performing backwash operations. The Backwash Insert prevents the filter bag from contracting when the flow is reversed. It is

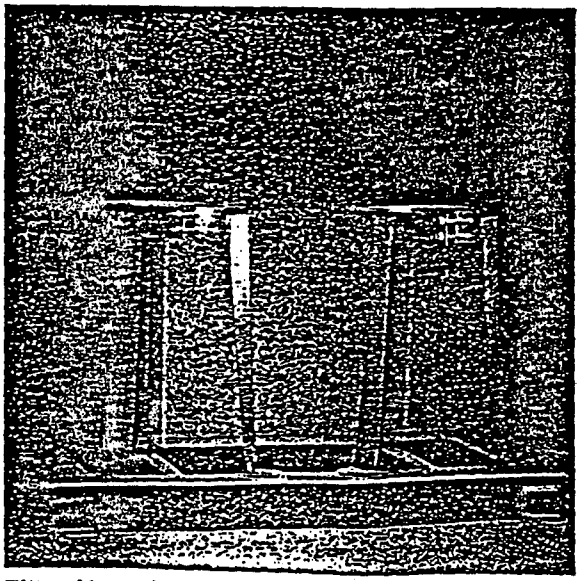
constructed of perforated T-316 stainless steel. This fixture can also be used as a Prefilter (with a filter bag) to capture larger particles first, providing dual-stage filtration. When lined with micron-rated filter cloth in 90, 160 or 250 micron ratings, the filter cloth is backed up by perforated T-316 stainless steel.

Bar Knob Wrench: This tool allows the operator to easily torque closure nuts tightly to properly seal the filter vessel. This hand tool is fabricated of plated carbon steel.

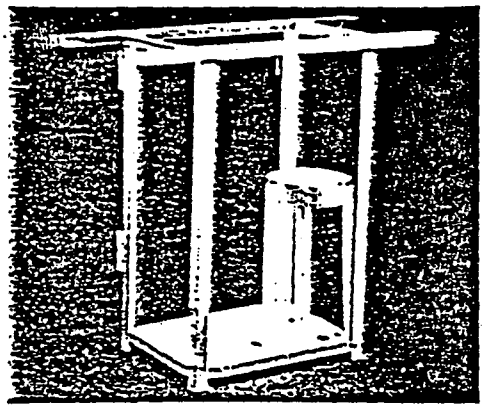




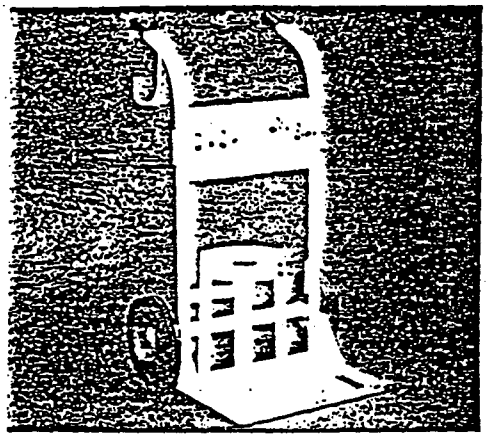
Joint Seal: Stainless steel leak preventative is an effective threaded joint compound sealer for all threaded connections. Available in 4oz. bottles.



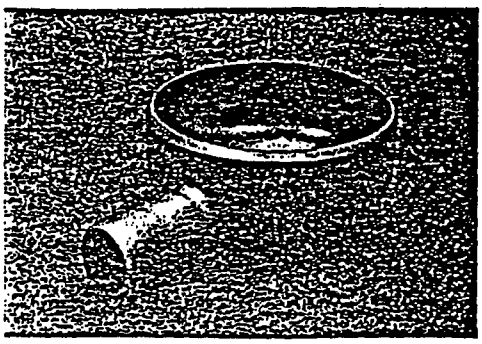
Filter Vessel Stand: Available for 2-8 modules (single filter vessels) for series filtration using individual housings. Ideal for staging filtration by descending particle levels. Available in both stainless and carbon steel.



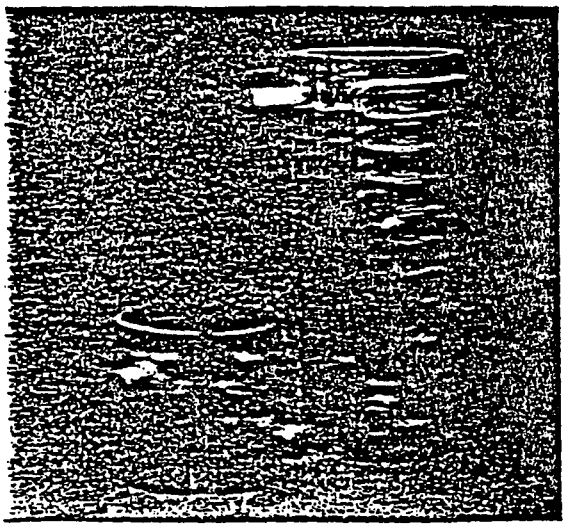
Liquid Pump and Filter Stand: Provides a protective stationary frame for the air-operated packaged system as an alternate to a hand-truck system. This stand is available in carbon steel (shop primer, exterior).



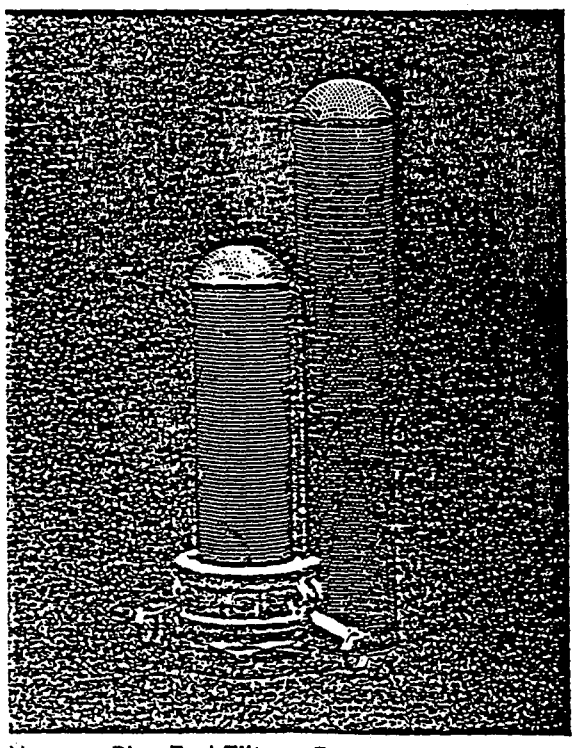
Portable Cart: The famous Portable Liquid Pump and Filter System hand-truck that can hold a filter vessel. Manufactured in carbon steel (shop primer, exterior).



Low-Profile, Horizontal Outlet: This one-piece, self-cleaning horizontal outlet is optional for all #1 and #2 size filter vessels. It reduces filter bag removal clearance height by 4" on single vessels and 3" on multi-housing systems. (Lower working height means easier filter bag changes). This option is available in stainless and carbon steel and can be used on vessels with flanged, threaded or sanitary connections. The Low-Profile, Horizontal Outlet on the filter vessel, relative to the inlet, can be configured in any type of 360 degree pattern so that all types of piping arrangements can be accommodated (See Technical Illustration F).

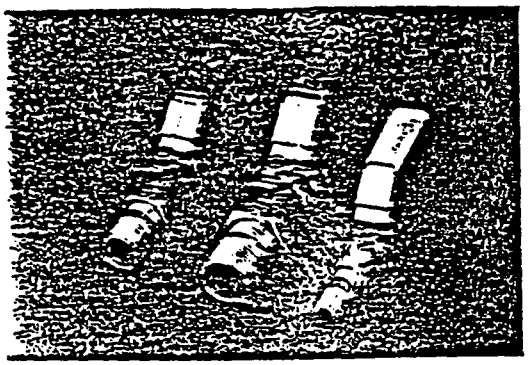


Heating Jackets: This accessory is used for maintaining desired temperatures during filtration and can be used with steam, hot oil or water. This product has ¾" NPT connections and is ASME "U" stamp. It is made of carbon steel and is rated for 150psi at 366 degrees F. These factory installed heating jackets are available for size #1 and #2 housings. Stainless steel jackets are available by special order.

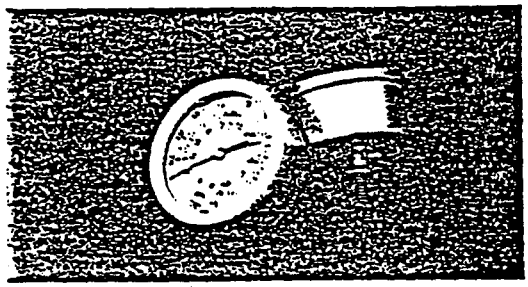


Hose or Pipe End Filter: For use with a #4 or #5 size filter bag or strainer basket. This "open system" can be adapted to any size hose or pipe up to 4" diameter. It is available in stainless steel or aluminum and is supplied with a stainless steel perforated support basket.

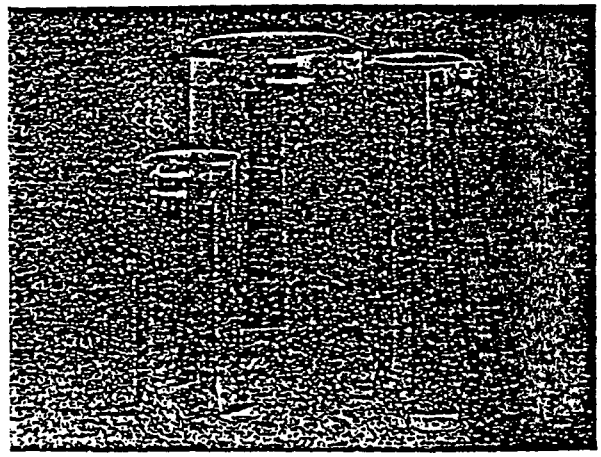
Valves: All *Filtration Systems* housings have a vent combination as well as a drain. The #1 & #2 size vessels have a 3/4" NPT drain port and the #4 & #5 size vessels have a 1 1/2" NPT drain port. Ball valves are available in stainless steel or brass and are both supplied with stainless steel threaded nipples.



Gauges: All *Filtration Systems* housings have (2) two ½" NPT gauge ports to read the upstream and downstream pressure. The differential allows users to determine whether a particular filter bag is clean or "blinded". Gauges are 1 ½" NPT back mounted, 2½" dial, glycerin filled, 0-100psi range. These gauges have a stainless steel case and are available with either brass or stainless internals.



Adjustable Tripod Stand: Available in stainless and carbon steel for size #1,#2,#4 and #5 filter vessels. These stands allow the versatility of raising and lowering the filter vessel as required.



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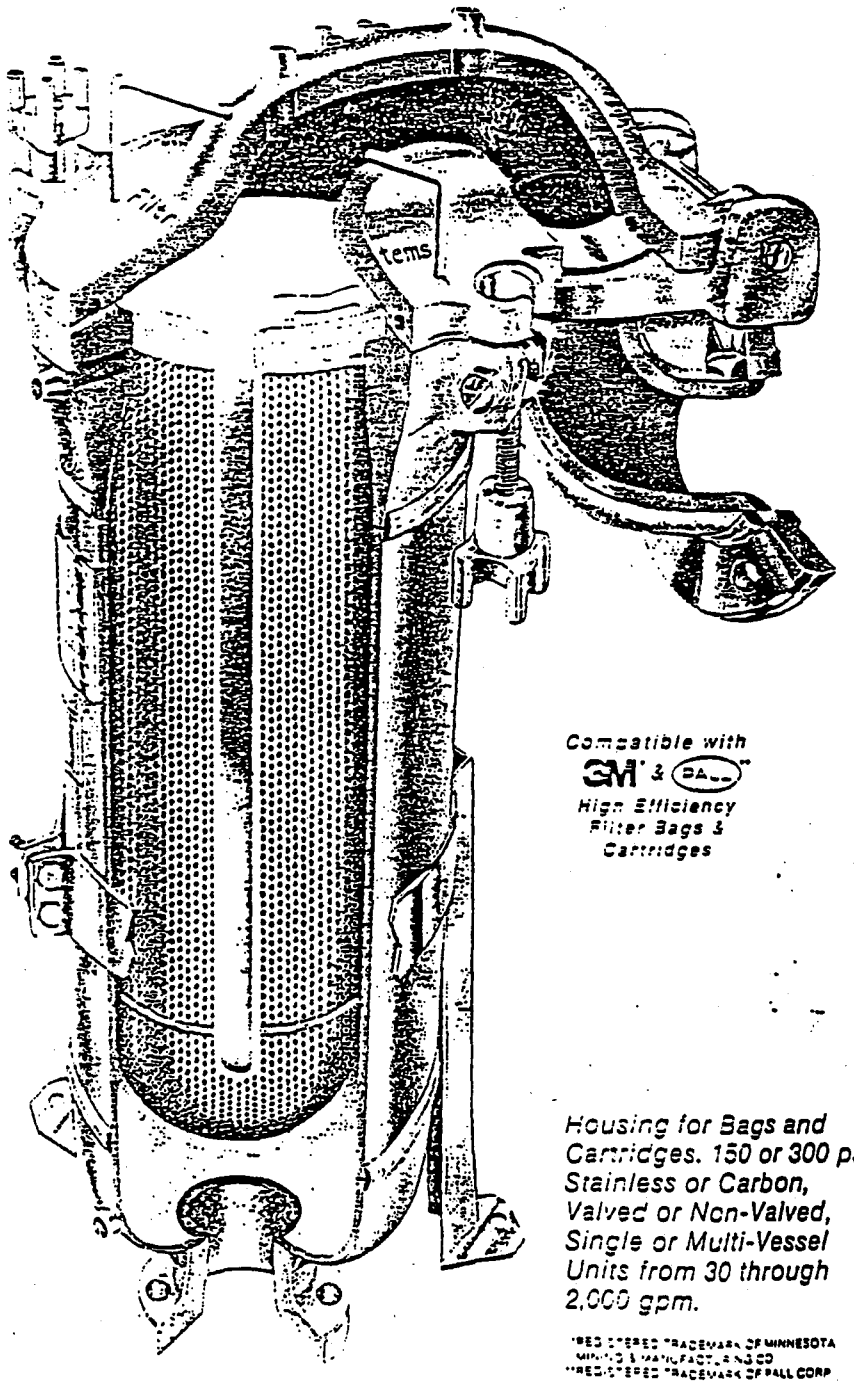
Manufactured by: **Filtration Systems**

LIMITATION OF LIABILITY: Filtration Systems shall not be held responsible or liable for any loss or damage resulting from direct or indirect, incidental, special or consequential arising from the sale, use or misuse associated with product merchantability and fitness for a specific purpose. WARRANTY: In the event Filtration Systems product is found to be defective in workmanship, Filtration Systems sole obligation and a customer's remedy shall be limited to the repair or replacement of the product only.

Division of Mechanical Mfg. Corporation
10304 N.W. 50th Street • Sunrise Florida 33351 USA
Tel: 305-572-2700 • Fax: 305-572-3401

All bag filter housings are not the same!

If it is not an Over-The-Top Inlet...
It is not filtration.



Compatible with 3M® & BALL™ *High Efficiency Filter Bags & Cartridges*

FACT: A side-entry vessel has the filter bag and restrainer basket sitting on a ledge, which does not prevent contaminant bypass around the outside of the filter bags...

FACT: A side-entry vessel has the filter bag mounted below the inlet. The filter bag, when blinded, must be pulled through the encrusted, contaminated areas which will cause particulate to fall downstream...

FACT: A side-entry vessel, with a blinded filter bag, traps liquid above the bag. When the bag is removed for changeout, the unfiltered liquid falls downstream...

FACT: The *Filtration Systems* vessel, with its over-the-top inlet, locks the basket and filter bag securely into a machined counterbore. The bag sits flush with the overflow rim; therefore, contaminant can never fall downstream.

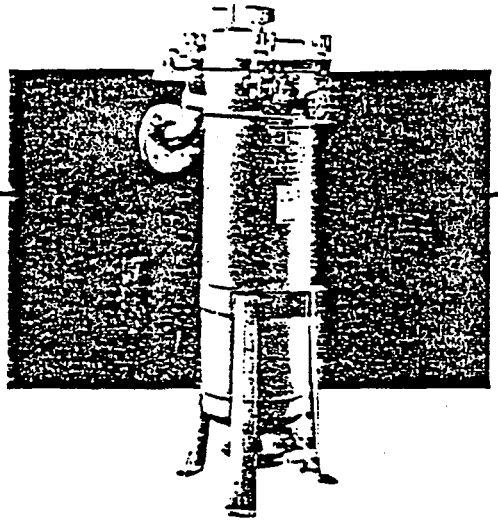
Housing for Bags and Cartridges. 150 or 300 psi, Stainless or Carbon, Valved or Non-Valved, Single or Multi-Vessel Units from 30 through 2,000 gpm.

- ☐ Volume Filtration
- ☐ Bags or Cartridges
- ☐ Micron-Rated
- ☐ Code Applications
- ☐ Industrial Applications
- ☐ Basket Strainers
- ☐ Liquid Bag Filters
- ☐ Quick Delivery
- ☐ All Products Stocked

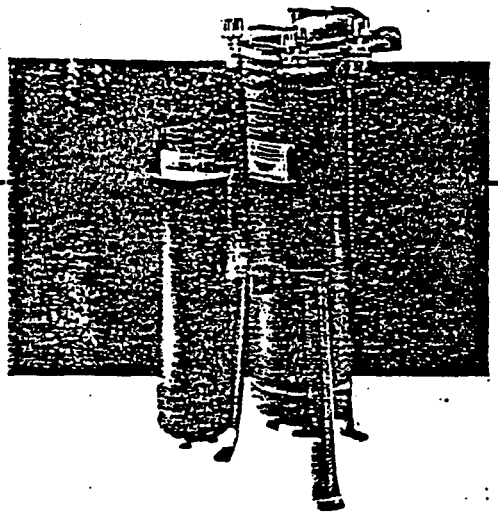
*REGISTERED TRADEMARK OF MINNESOTA MINING & MANUFACTURING CO
**REGISTERED TRADEMARK OF PALL CORP

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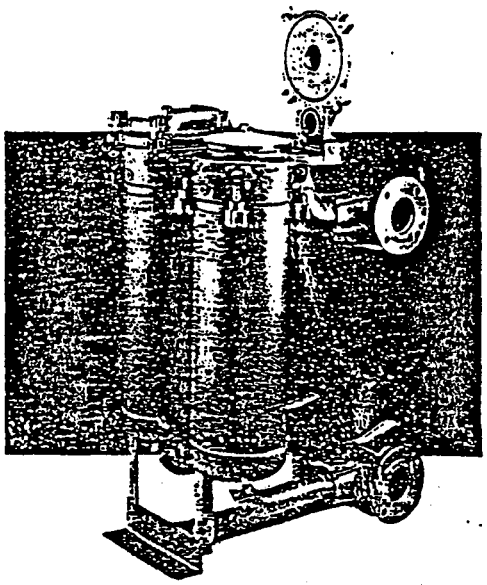
... products feature many new upgrades.
... or fax us for more detailed information.



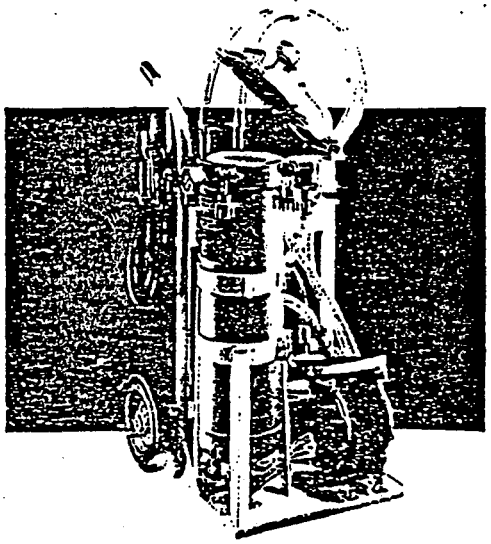
Model S-122 Bag Filter Housing in T-316 Stainless Steel at 150 or 300 psi (450°F). Vessel uses a #2 size filter bag (7" dia. x 32" long). Liquid flow is from the inside of the filter bag to the outside. The support basket and filter bag are securely locked into a recess at the top of the overflow rim, providing a 360 degree positive compression seal. Since the filter bag is locked in at the top of the vessel, all of the dirt is trapped inside the bag. The filter vessel never requires cleaning after use. ASME U Stamp meets OSHA requirements.



Model NS-120 Cartridge Filter Housings filter from the top (inlet) to the bottom (Outlet) using a Cartridge Contaminant Chamber — a removable, positive sealing fixture that holds four standard cartridge filters in a "Cluster of Four" arrangement. Designed to minimize exposure to contaminants by allowing the removal of the spent filter and chamber as a single unit. It is not necessary to clean or flush the filter vessel after use.



Model S-223-V, duplex system is equipped with individually valved housings. As both housings operate simultaneously, the onstream capacity of the system is doubled; this allows for more consistent filtration and also extends the life of the filter bags. Filter media can be changed without disruption of service.



Model PNS-122, Portable Liquid Pump and Filter System is designed to pump, transfer and filter liquids from tanks, drums or reservoirs. Ideal for cleanup of accidental spills.

- Air Operated, Non-Electric
- Pumps solids up to 1/8 inch
- Filters .5 to 600 microns
- 35 gallons per minute

Filtration Systems™

Division of Mechanical Mfg. Corporation
10304 NW 50th Street • Sunrise, FL 33351 USA
Tel: 305-572-2700 • Fax: 305-572-3401

GB 1092

GEMS

LEVEL SWITCHES

GEMS

INSTALLATION INSTRUCTIONS FOR ULS-11 ULTRASONIC LIQUID LEVEL SWITCHES

Instruction Bulletin
No. 160820

Description

General Description

The **ULS-11 Series Liquid Level Detection System** is an ideal, low cost, ultrasonic liquid level detection system for many applications. It operates in a broad spectrum of viscous to light liquids.

Principle of Operation

The **ULS-11 Series** operates using ultrasonic sound wave propagation. Ultrasonic sound waves are greatly attenuated when transmitted through air. Conversely, when liquid is present, transmission of the sound waves is greatly enhanced. The electronic control unit generates electrical signals that are converted to bursts of ultrasonic energy at the sensor. The ultrasonic bursts are transmitted across the liquid sensing gap. Upon receipt of a valid signal, the solid-state electronics generate a ***data enable*** condition, indicating liquid is present. This signal energizes a relay to provide a contact closure.

Model Description

GEMS Model No.	Mounting Type	Input Power	Output	Function
ULS-11	Integral	9 - 42 VDC	1 Amp N.O. or N.C.	Level

Notes:

1. Standard sensor for contact type point level: 316 stainless steel.
3. 3/4" NPT is standard, different NPT and flanges are optional.
4. Standard length of sensor is 2.5". Extension up to 99" is available.

Installation

General

The unit is easy to install. The sensor, with its integral electronics control unit, can be mounted in any position or orientation desired.

Make sure that all wiring, conduit and electrical fittings conform to local Electrical Codes for the location selected.

Visual Inspection

Unpack the control unit and sensor assemblies. Visually inspect them for any damage. Advise Factory immediately if either assembly is damaged.

Preliminary Operational Check

Before installing the unit, a simple operational check-out should be performed:

1. Fill a container with liquid.

   WARNING: In a hazardous environment, never open housing cover or connect power leads without first disconnecting electrical power at the source.

2. See wiring diagram for making the proper wiring connections. (9 to 42 VDC)

3. Apply power from the source.

4. Place the sensor in the liquid. Relay should energize.

5. Remove sensor from the liquid. Relay will deenergize. System is functioning properly

6. Disconnect power to the control unit.

7. Proceed to final installation.

If the system does not function, notify the Factory immediately.

Final Installation

Invasive Contact Type

Follow the instructions below:

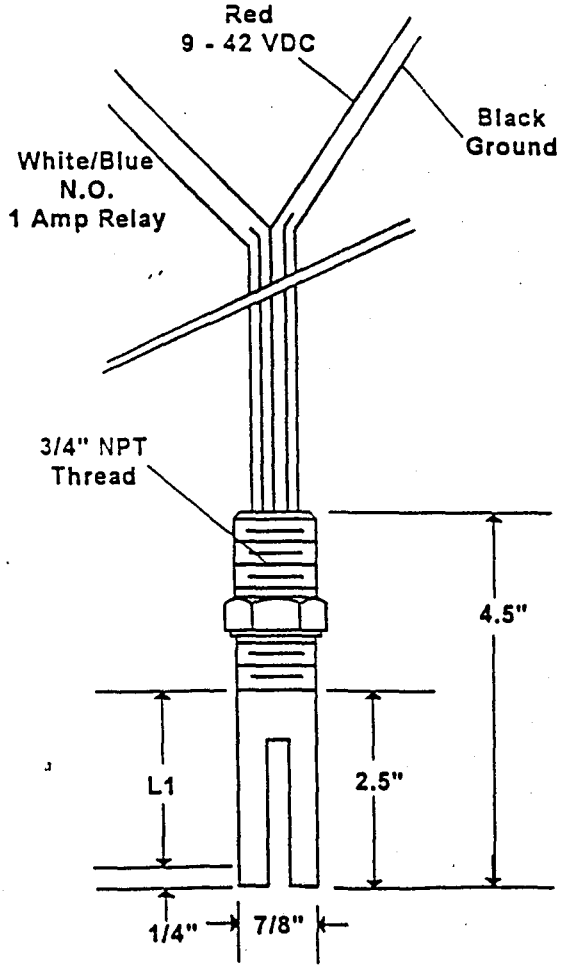
1. Drill a suitable hole in the vessel or pipe wall and tap for 3/4" NPT. In thin walled vessel or material not suitable for threading, weld or braze a bushing to accept the sensor.

2. Screw the sensor in the threaded section and make sure that there is a good seal. Use a pipe compound or sealing tape to avoid excessive tightening. Do not overtighten.

3. Run the power and control wiring cables to the electronics control unit.

Observe all applicable electrical codes and proper wiring procedures.

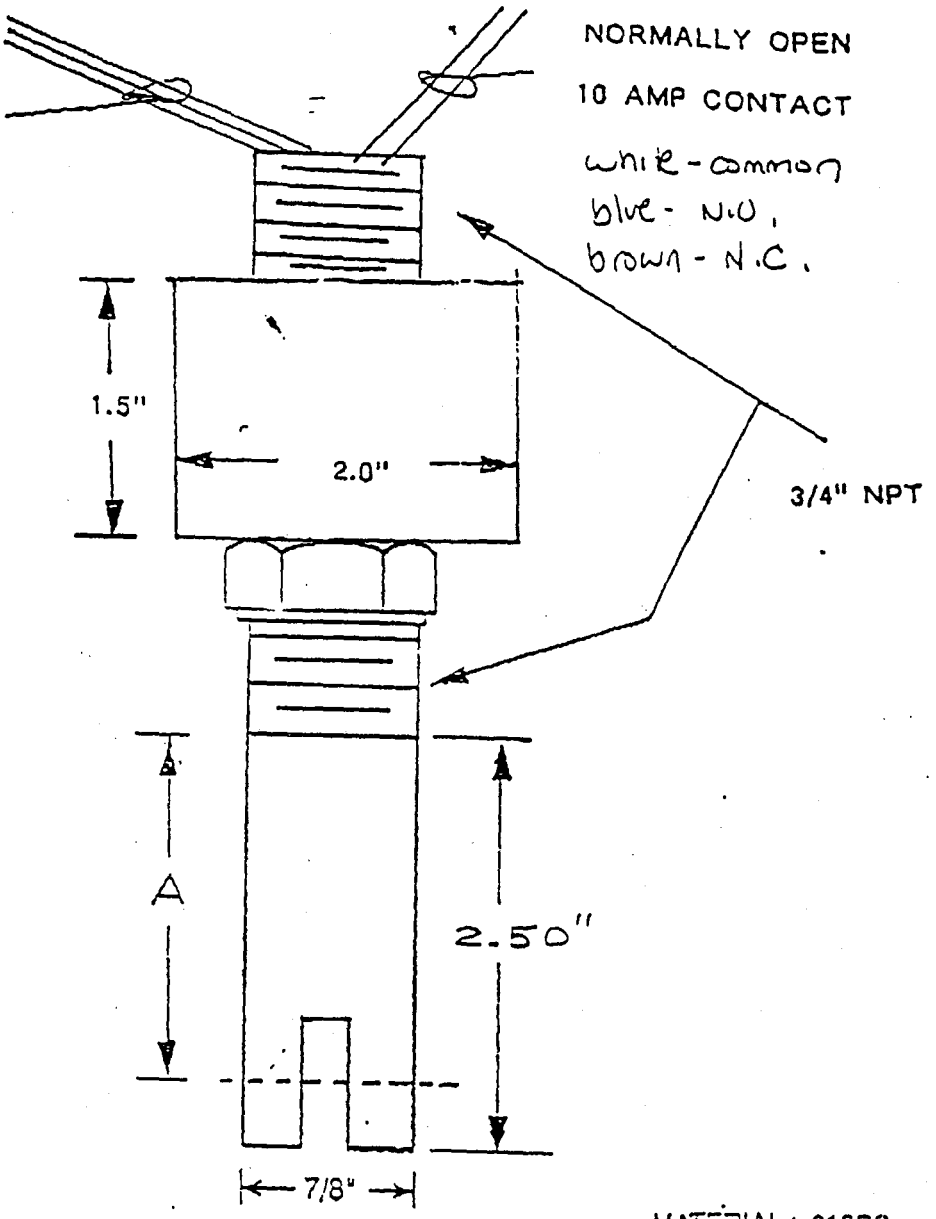
Wiring Diagram Model ULS-11



Wiring Color Code

1. Power
   Red (+)
   Black (-)

2. Relay
   COM = White
   N.O. = Blue
   N.C. = Brown



A (std.) = 2 1/4"

MATERIAL: 316SS

CALL FACTORY FOR SPECIAL SIZE, MATERIAL, EXTENSION LENGTH

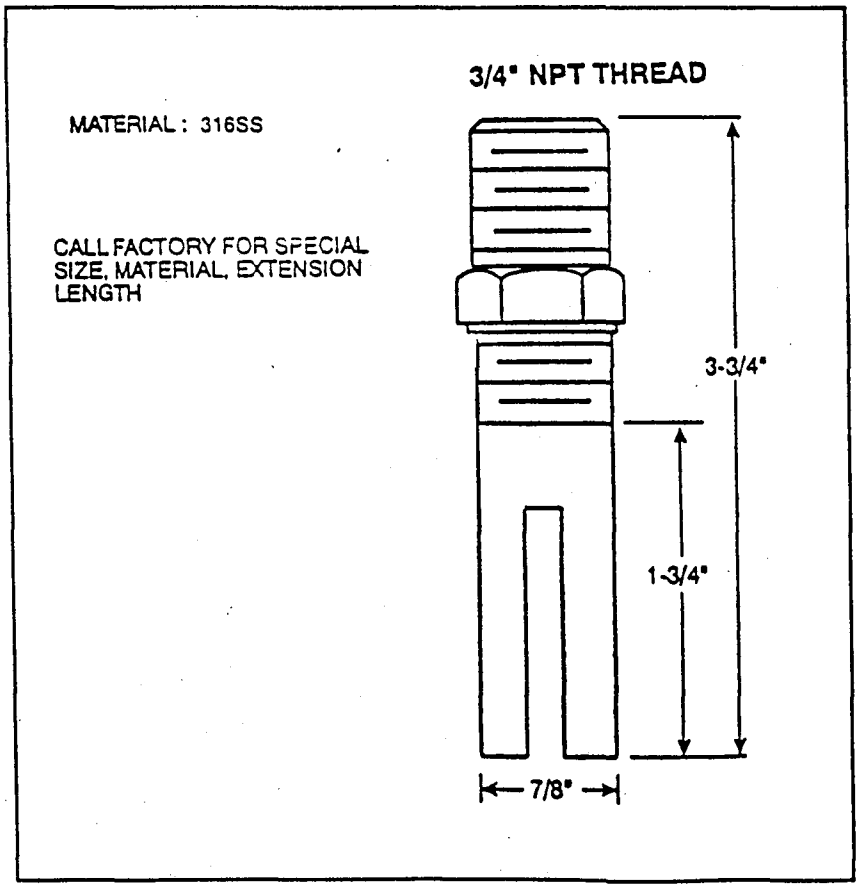
Imo Industries Inc.
Gems Sensors Division
Plainville, CT 06062-1198

TITLE

SYSTEM WIRING DIAGRAM ULTRASONIC LEVEL SENSOR

Specifications and Dimensions

Repeatability:	2 mm or better
Delay (On):	0.5 seconds
Input Power:	9 VDC to 42 VDC (optional A.C.power available)
Leakage Current:	Less than 50 μ A
Output:	One Amp, Relay output (dry contact, N.O. or N.C.)
Protection:	Transient, Reverse Polarity
Sensor:	316 SS standard. Consult Factory for other materials
Temperature:	-20°F to +160°F
Pressure:	Up to 1000 psig
Mounting:	3/4" NPT STD. (For special mounting, consult Factory.)
Cable Length:	10 Feet (For longer lengths, consult Factory.)



Maintenance

Electronics are constructed with solid-state components and epoxy-potted. Periodically, check and clean the sensor when used with liquids which cause a coating build-up on the sensor. No other maintenance is required.

Cleaning

If the pipe or vessel to which the unit is mounted is to be steam-cleaned or cleaned with abrasive detergents, remove the entire unit before cleaning by:

(1) Disconnecting the power at source;

(2) Opening the housing cover;

(3) Removing power and control wiring cables;

(4) Unthreading the sensor.

To reinstall, follow installation procedures.

System Malfunction

Should the system malfunction, notify the Factory immediately.

Warranty

All components of GEMS systems are warranted to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. This warranty applies to general purchaser and to components installed, serviced and operated according to GEMS' instruction manual.

GEMS will repair or replace, at its option, FOB at its plant or any other location designated, any part which proves to be defective in manufacture or workmanship.

All claims must be made within the Warranty period. No claims outside of the Warranty period will be honored.

Warranties are not applied to any components which have been damaged by improper installation, use exposure to unusual atmospheric conditions or components which have been misused, abused, damaged by neglect or accident. This warranty shall not apply to any components which have been altered or repaired without the prior written consent of GEMS.

GEMS assumes no responsibility or liability for any labor or material or back charges, without written authorization. Any products returned must be with prior written authorization.

THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTIES OF MERCHANTABILITY AND/OR FOR FITNESS FOR PARTICULAR PURPOSE AND GEMS ASSUMES NO OTHER LIABILITIES EXPRESS OR IMPLIED. GEMS SHALL NOT BE LIABLE FOR NORMAL WEAR AND TEAR, NOR FOR DIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES. IN NO EVENT SHALL GEMS LIABILITY EXCEED THE PRICE OF ITS PRODUCT AT THE TIME OF PURCHASE.

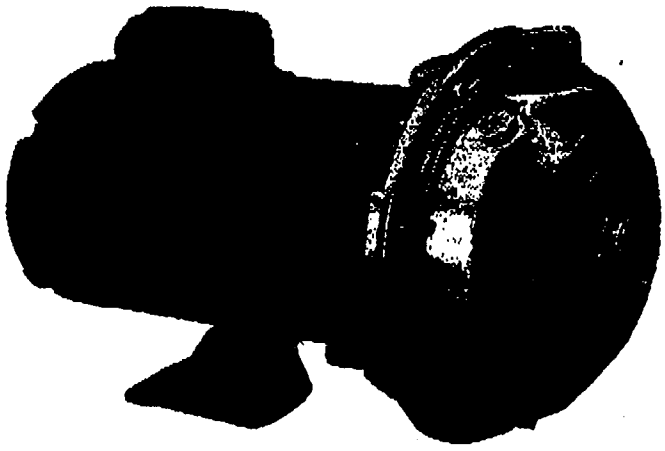
GOULD

TRANSFER PUMP

GOULDS PUMPS, INC.
WATER TECHNOLOGIES GROUP
SENECA FALLS, NEW YORK 13148

Installation, Operation and Maintenance Instructions

Series NPO



SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

This is a **SAFETY ALERT SYMBOL.** When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

⚠ DANGER Warns of hazards that **WILL** cause serious personal injury, death or major property damage.

⚠WARNING Warns of hazards that CAN cause serious personal injury, death or major property damage.

⚠ CAUTION Warns of hazards that CAN cause personal injury or property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

⚠WARNING



Hazardous fluids can cause fire, burns or death.

UNIT NOT DESIGNED FOR USE WITH HAZARDOUS LIQUIDS OR FLAMMABLE GASES.

NOTICE: INSPECT UNIT FOR DAMAGE AND REPORT ALL DAMAGE TO THE CARRIER OR DEALER IMMEDIATELY.

Owner's Information

Model Number: _____

Serial Number: _____

Dealer: _____

Date of Purchase: _____ Installation: _____

Table of Contents

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DESCRIPTION AND SPECIFICATIONS

The Series NPO embraces a line of 1" NPT discharge, general liquid transfer and booster pump application end suction centrifugal pumps. The liquid end construction is of AISI 304 stainless steel, stamped and welded. Trimable, semi-open impellers are of AISI 316 stainless steel.

Engineering Data

Max Liquid Temperature:
212° F (100° C) Standard seal
250° F (120° C) Optional high temp seal

Max Pressure: 125 psi (862 kPa)

Starts per Hour: 20 – Evenly distributed

Optional Pump Styles

Optional single and three phase, ODP, TEFC and three phase explosion proof motors are available. Optional mechanical seals include: Carbon/Ceramic/BUNA, Carbon/Ceramic/EPR, Carbon/Tungsten/Viton, Carbon/Ni-Resist/EPR, Silicon Carbide/BUNA, Siliconized Carbon/Viton and Siliconized Carbon/BUNA. Consult with your G&L distributor for price and availability.

Piping – General

- Piping should be no smaller than 1" (25.4 mm) discharge and 1¼" (31.8 mm) suction and kept as short as possible, avoiding unnecessary fittings to minimize friction losses.
- All piping MUST be independently supported and MUST NOT place any piping loads on the pump.

NOTICE: DO NOT FORCE PIPING INTO PLACE AT PUMP SUCTION AND DISCHARGE CONNECTIONS.

- All pipe joints MUST be airtight.

PIPING – SUCTION

- Short and direct suction piping is recommended. For suction lifts over 10' (3 m) and liquid temperatures over 120° F (49° C), consult pump performance curve for net positive suction head required ($NPSH_R$).
- If a pipe size larger than pump suction is required, an eccentric pipe reducer, with the straight side up, MUST be installed at the pump suction.
- If pump is installed below the liquid source, install a full flow isolation valve in the suction for pump inspection and maintenance.

NOTICE: DO NOT USE THE ISOLATION VALVE TO THROTTLE PUMP. THIS MAY CAUSE LOSS OF PRIME, EXCESSIVE TEMPERATURES AND DAMAGE TO PUMP, VOIDING WARRANTY.

- If the pump is installed above the liquid source, the following MUST be provided:
  - To avoid air pockets, no part of the piping should be above the pump suction connection.
  - Slope piping upward from liquid source.
  - Use a foot valve or check valve ONLY if necessary for priming or to hold prime during intermittent duty.
  - The suction strainer or suction bell MUST be at least 3 times the suction pipe diameter area.
  - Insure that the size and minimum submergence over suction inlet is sufficient to prevent air from entering through a suction vortex. See Figures 1 through 4.

PIPING – DISCHARGE

- Install a check valve suitable to handle the flow, liquids and to prevent backflow. After the check valve, install an appropriately sized gate valve to be used to regulate the pump capacity, pump inspection and for maintenance.
- When required, the pipe increaser should be installed between the check valve and the pump discharge.

Wiring and Grounding



- Install, ground and wire according to local and National Electrical Code requirements.
- Install an all leg disconnect switch near the pump.
- Disconnect and lockout electrical power before installing or servicing pump.
- Electrical supply MUST match pump's nameplate specifications. Incorrect voltage can cause fire, damage to the motor and voids warranty.
- Motors equipped with automatic thermal protection open the motor's electrical circuit when a thermal overload exists. This can cause the pump to start unexpectedly and without warning.
- Use only stranded copper wire to motor and ground. The ground wire MUST be at a least as large as the wire to the motor. Wires should be color coded for ease of maintenance.

⚠WARNING Hazardous voltage

FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO ELECTRICAL POWER CAN CAUSE SHOCK, BURNS OR DEATH.

NOTICE: UNIT ROTATION IS CLOCKWISE, WHEN VIEWED FROM THE MOTOR END. INCORRECT ROTATION MAY CAUSE DAMAGE TO THE PUMP AND VOIDS THE WARRANTY.

Operations

NOTICE: PUMP MUST BE FULLY PRIMED BEFORE OPERATION.

⚠WARNING



OPERATION AT OR NEAR ZERO FLOW CAN CAUSE EXTREME HEAT, PERSONAL INJURY OR PROPERTY DAMAGE.

- After stabilizing the system at normal operating conditions, check the piping. If necessary adjust the pipe supports.

Maintenance

- Motors have permanently lubricated bearings. No lubrication is possible or necessary. Follow the motor manufacturer's recommendations for maintenance.

Disassembly

⚠WARNING Hazardous voltage

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SHOCK, BURNS OR DEATH.

⚠WARNING



CASING MAY CONTAIN HAZARDOUS FLUIDS THAT CAN CAUSE PERSONAL INJURY OR PROPERTY DAMAGE.

- Containing pumpage as required, remove pump casing vent and drain plugs (408). Remove and discard the respective plug O-rings. Drain and flush system, as required.
- Remove the four motor bolts from the motor base or foundation.
- Remove the eight casing cap screws (370), then using the slots provided about the casing (100), pry the back pull-out assembly from the casing.
- Remove and discard the casing O-ring (513) and the internal casing O-ring (349).

NOTICE: IMPELLER COMPRESSES THE MECHANICAL SEAL SPRING – BE PREPARED FOR THE IMPELLER TO SPRING FROM SHAFT WHEN IMPELLER IS REMOVED.

- Remove the end cap from the motor, exposing a slot in the end of the motor shaft. While holding the shaft from rotation with a screwdriver, remove the impeller locknut (304) by turning it **COUNTERCLOCKWISE.**
- While continuing to hold the motor shaft from rotation, remove the impeller by turning it **COUNTERCLOCKWISE.** Inspect for wear or damage and replace as necessary.
- Using two pry bars, 180° apart, **CAREFULLY** separate the s housing (184) from the motor adapter (108). The mechanical seal (383) rotary assembly will slide from the motor shaft wit the seal housing.
- **CAREFULLY** push out the mechanical seal stationary seat fi the seal housing. Inspect and wipe clean the stationary seat bo Replace as necessary. **DISCARD** the mechanical seal assemb
- If necessary, remove the four motor hex bolts (371) and **CAREFULLY** slide the motor adapter from the shaft.
- Replace the motor assembly and deflector (123), as required.
- Disassembly is complete.

Assembly

- If removed, replace the motor shaft deflector. Install the motor adapter, with the drain opening **DOWN**, using the four hex bo Torque bolts to 14 lbs ft (19 N m).
- Using a quality grade of O-ring lubrication, lubricate the outer elastomer of the mechanical seal stationary seat. Fully and squarely install the stationary seat into the seal housing. With a clean, lint free cloth, **CAREFULLY** wipe the seat face clean o a lubrication or debris. **DO NOT** damage the seat face.
- Slide the seal housing assembly onto the motor shaft, seating i fully and squarely against the motor adapter.
- Using a quality grade of O-ring lubricant, lubricate the inner elastomer of the mechanical seal rotary assembly. Fully and squarely install the rotary assembly against the stationary seat.
- While holding the motor shaft from rotation with a screwdrive install the impeller by turning it **CLOCKWISE**, insuring that impeller seats securely against the motor shaft. Install the impe locknut, turning it **CLOCKWISE**, torquing to 10 lbs ft (13.6 N m). Replace the motor end bell cap.
- Using a quality grade of O-ring lubricant, lubricate and install new inner casing and casing O-ring.
- Slide the back pullout assembly into the pump casing and secu using the eight casing cap screws. Torque the cap screws to 70 in (13.6 N m), using a cross pattern sequence to assure the casi is pulled down evenly.
- With new O-rings installed, install the casing vent and drain plugs, tightening securely.
- Assembly is complete.

Trouble Shooting

⚠WARNING Hazardous voltage

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SHOCK, BURNS OR DEATH.

SYMPTOM

MOTOR NOT RUNNING
See Probable Causes 1 through 5

LITTLE OR NO LIQUID DELIVERED
See Probable Causes 6 through 13

EXCESSIVE POWER CONSUMPTION
See Probable Causes 3, 13, 14, 15 and 18

EXCESSIVE NOISE AND VIBRATION
See Probable Causes 3, 6, 7, 8, 10, 12, 14, 16 and 17

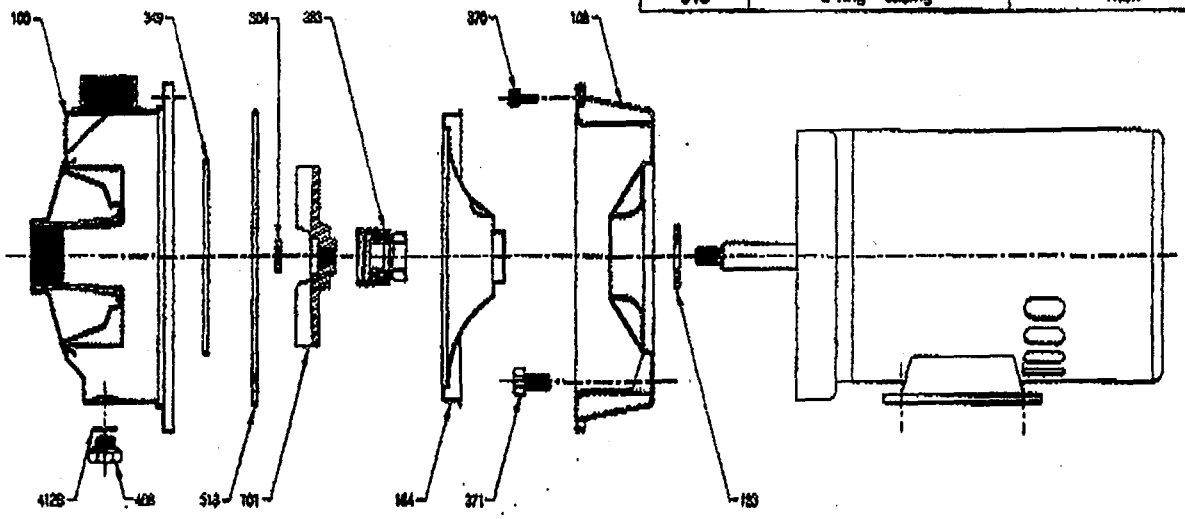
Trouble Shooting (continued)

PROBABLE CAUSES

1. Motor thermal protector tripped
2. Open circuit breaker or blown fuse
3. Impeller binding
4. Motor improperly wired
5. Defective motor
6. Pump is not primed, air or gases in pumpage
7. Discharge, suction plugged or valve closed
8. Incorrect rotation (three phase only)
9. Low voltage or phase loss
10. Impeller worn or plugged
11. System head too high
12. $NPSH_A$ too low – Excessive suction lift or losses
13. Incorrect impeller diameter
14. Discharge head too low – excessive flow rate
15. Fluid viscosity, specific gravity too high
16. Worn bearing
17. Pump, motor or piping loose

Pump Parts Series NPO

Item No.	Part Name	Material	Qty.
100	Casing	AISI 304 SS	1
101	Impeller – 4.31" diameter	AISI 316 SS	1
	Impeller – 4.00" diameter		
	Impeller – 3.75" diameter		
	Impeller – 3.50" diameter		
	Impeller – 3.25" diameter		
	Impeller – 3.00" diameter		
108	Motor adapter	AISI 304 SS	1
123	Deflector	BUNA-N	1
184	Seal housing	AISI 304 SS	1
304	Impeller lock nut	AISI 304 SS	1
349	O-ring – internal casing	Viton	1
370	Cap screw – casing	AISI 430 SS	8
371	Hex bolts – motor	Steel/Plated	4
383	Mechanical seal – Standard	Carbon/Ceramic/Viton	1
	Mechanical seal – Optional	Carbon/Ceramic/BUNA	
	Mechanical seal – Optional	Carbon/Ceramic/EPR	
	Mechanical seal – Optional	Carbon/Tungsten/Viton	
	Mechanical seal – Optional	Carbon/Ni-Resist/EPR	
	Mechanical seal – Optional	Silicon Carbide/BUNA	
	Mechanical seal – Optional	Siliconized Carbon/Viton	
	Mechanical seal – Optional	Siliconized Carbon/BUNA	
408	Plug – vent and drain	AISI 304 SS	2
412B	O-ring – plug	Viton	2
513	O-ring – casing	Viton	1



LIMITED WARRANTY

This warranty applies to all pumps and related accessories manufactured and/or supplied by Goulds Pumps, Inc., Water Technologies Group – America.

Any 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 dealer, or authorized service center, from whom the equipment was originally purchased and furnish complete details regarding the claim. The dealer, or authorized service center, 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.

GRUNDFOS

RW-1 AND RW-2
GROUND WATER RECOVERY PUMP

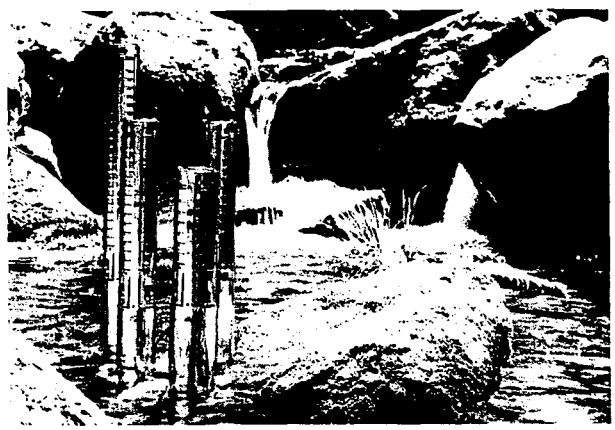
Installation and Operating Instructions

GRUNDFOS

Redi-Flo4

Your Grundfos Redi-Flo4 Environmental Pump is of the utmost quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.



SECTION 1.

Shipment Inspection

Examine the components carefully to make sure no damage has occurred to the pump-end, motor, cable or control box during shipment.

This Grundfos Redi-Flo4 Environmental Pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage. During unpacking and prior to installation, **make sure that the pump is not contaminated, dropped or mishandled.**

The motor is equipped with an electrical cable. **Under no circumstance should the cable be used to support the weight of the pump.**

You will find a loose data plate wired to the pump. It should be securely mounted at the well or attached to the control box.

SECTION 2.

Pre-Installation Checklist

Before beginning installation, the following checks should be made. They are all critical for the proper installation of this submersible pump.

☑ A. CONDITION OF THE WELL

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. Dispose of discharged materials in accordance with the specific job site requirements. The stainless steel construction of the Redi-Flo4 Environmental Pump makes it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy groundwater.

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

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor.

☑ B. CONDITION OF THE WATER

Redi-Flo4 pumps are designed for pumping cold groundwater that is free of air or gases. Decreased pump performance and life expectancy can occur if the groundwater is not cold or contains air or gases.

☑ C. INSTALLATION DEPTH

Pumping sand or well sediment can occur when the pump motor is installed lower than the top of the well screen or within five feet of the well bottom. This can reduce the performance and life expectancy of the pump and should be avoided.

If the pump is to be installed in a lake, containment pond, tank or larger diameter well, the water velocity passing over the motor must be sufficient to ensure proper motor cooling. The minimum recommended water flow rates which ensure proper cooling are listed in Table A.

☑ D. ELECTRICAL SUPPLY

The motor voltage, phase and frequency indicated on the motor nameplate should be checked against the actual electrical supply.

SECTION 3.

Wire Cable Type

Type of wire used between the pump and control box should be approved for submersible pump applications. The conductor insulation should have a continuous Teflon® jacket with no splices and must be suitable for use with submersible pumps.

SECTION 4.

Installation

The riser pipe or hose should be properly sized and selected based on estimated flow rates and friction-loss factors.

A back-up wrench should be used when attaching a riser pipe or metallic nipple to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. **The body of the pump, cable guard or motor should not be gripped under any circumstance.**

If steel riser pipe is used:

An approved pipe thread compound should be used on all joints. Make sure the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

When tightened, the first section of the riser pipe 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.

The drop cable should be secured to the riser pipe at frequent intervals using an approved clip or tape to prevent sagging, looping and possible cable damage.

If plastic or flexible riser pipe is used:

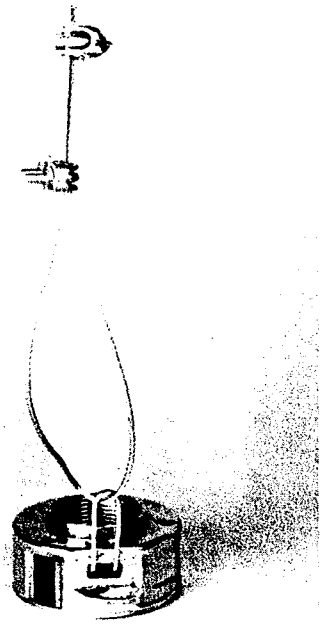
Use the correct compound recommended by the pipe manufacturer or specific job specifications. Besides making sure that joints are securely fastened, the use of a torque arrester is recommended when using these types of pipe.

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

The drop cable should be secured to the riser pipe at frequent intervals using an approved clip or tape to prevent sagging, looping and possible cable damage.

IMPORTANT- Plastic and flexible pipe tend to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave enough slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. If the depth setting is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

When these types of pipe are used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge piece of Redi-Flo4 submersibles is designed to accommodate this cable. (Figure 4)



Protect the well from contamination:

While installing the pump, proper care should be used not to introduce foreign objects or contaminants into the well. The well should be finished off above grade to protect against surface water from entering the well, causing contamination.

NOTE: Teflon® is a registered trademark of DuPont.

SECTION 5.

Electrical

WARNING: To reduce the risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor, at least the size of the circuit supplying the pump, to the grounding screw provided within the wiring compartment.

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.

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor. Motor electrical data can be found in Table C.
If voltage variations are larger than ± 10%, do not operate the pump.
Direct on-line starting is used due to the extremely fast run-up time of the motor (0.1 second maximum), and the low moment of inertia of the pump and motor. Direct on-line starting current (locked rotor amp) is between 4 and 6.5 times the full-load current.

Engine-Driven Generators

If the Redi-Flo4 pump is going to be operated using an engine driven generator, we suggest the manufacturer of the generator be contacted to ensure the proper generator is selected and used. See Table B for generator sizing guide.

Control Box, Single-Phase Motors

Single-phase motors must be connected as indicated in the motor control box. A typical single-phase wiring diagram using a Grundfos control box is shown. (Figure 5-A)

High Voltage Surge Arresters

A high voltage surge arrester should be used to protect the motor against lightning and switching surges. The correct voltage-rated surge arrester should be installed on the supply(line) side of the control box.(Figure 5-B) **The arrester must be grounded in accordance with the National Electric Code, local codes and regulations.**

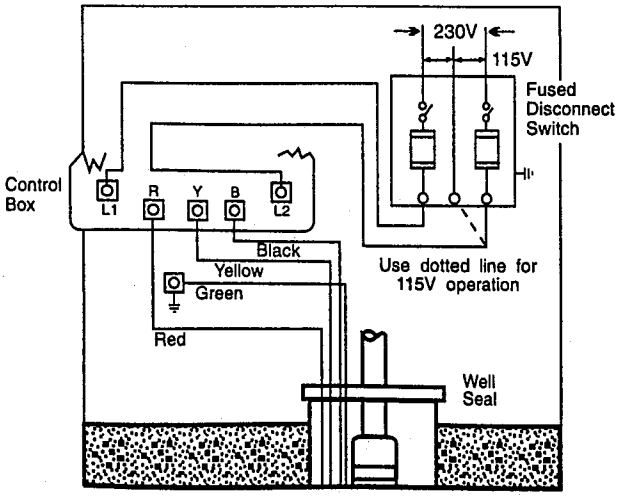
Control Box and Surge Arrester Grounding

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

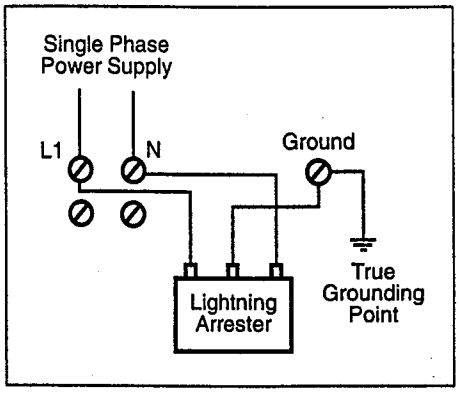
Wiring Checks

Before making the final wiring connections of the drop cable to the control box terminal, it is a good practice to check the insulation resistance to ensure that the cable is good. Measurements for a new installation must be at least 1,000,000 ohm. Do not start the pump if the measurement is less than this. If it is higher, finish wiring and verify that all electrical connections are made in accordance with the wiring diagram. Check to ensure the control box and high voltage surge arrester have been grounded.



Single Phase Wiring Diagram for Grundfos Control Boxes

(Figure 5-A)



Single Phase Hookup

(Figure 5-B)

SECTION 6.

Start-Up

...er the pump has been set into the well and the wiring connections have been made, the following procedures should be performed.

A. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.

B. If required, make provisions to capture discharged fluids for disposal.

C. Adjust the gate valve one-third open.

D. Start the pump and let it operate until the water runs clear of sand and silt.

E. As the water clears, slowly open the gate valve in small increments until the desired flow rate of clear water is reached. The pump should not be operated beyond its maximum flow rating and should not be stopped until the groundwater runs clear.

F. If the groundwater is clean and clear when the pump is first started, the valve should still be opened until the desired flow rate is reached.

G. Disconnect the temporary piping arrangements and complete the final piping connections.

H. Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed. This can result in motor damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

I. Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

Operation

A. The pump and system should be periodically checked for water quantity, pressure, drawdown, periods of cycling, and operation of controls. **Under no circumstances should the pump be operated for any prolonged periods of time with the discharge valve closed.** This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

B. If the pump fails to operate, or there is a loss of performance, refer to Troubleshooting, Section 7.

SECTION 7.

Troubleshooting

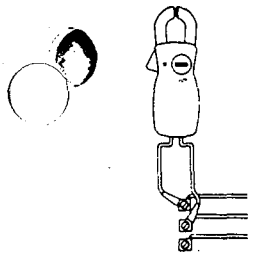
The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following charts cover most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

Usually only two instruments are needed – a combination voltmeter/ammeter, and an ohmmeter. These are relatively inexpensive and can be obtained from most water systems suppliers.

WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. It is recommended that rubber gloves and boots be worn and that care is taken to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well. WARNING: Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in serious electrical shock.

Preliminary Tests

SUPPLY VOLTAGE



How to Measure

By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box. On single-phase units, measure between line and neutral.

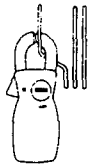
What it Means

When the motor is under load, the voltage should be within ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and 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

By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box. See the Electrical Data, Table C, for motor amp draw information.

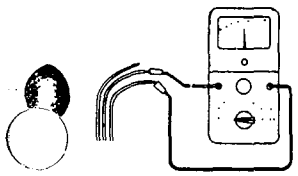
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA), check for the following:

1. Loose terminals in control box or possible cable defect. Check winding and insulation resistances.
2. Too high or low supply voltage.
3. Motor windings are shorted.
4. Pump is damaged causing a motor overload.

WINDING RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and and Rx10 for values over 10 ohms.

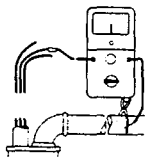
Zero-adjust the meter and measure the resistance between leads. Record the values.

Motor resistance values can be found in the Electrical Data, Table C. Cable resistance values are in Table D.

What it Means

If all the ohm values are normal, and the cable colors correct, the windings are not damaged. If any one ohm value is less than normal, the motor may be shorted. If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open. If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values in Electrical Data, Table C.

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohm or mega ohmmeter, set the scale selector to Rx100K and zero-adjust the meter.

Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

What it Means

For ohm values, refer to table below. Motors of all Hp, voltage, phase and cycle duties have the same value of insulation resistance.

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
		Motor not yet installed:
2,000,000 (or more)	2.0	New Motor
1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
		Motor in well (Ohm readings are for drop cable plus motor):
500,000 - 1,000,000	0.5 - 1.0	A motor in reasonably good condition.
20,000 - 50,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

Troubleshooting Chart

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
A. Pump Does Not Run	**1.** No power at pump panel.	Check for voltage at panel.	If no voltage at panel, check feeder panel for tripped circuits.
	2. Fuses are blown or circuit breakers are tripped.	Remove fuses and check for continuity with ohmmeter.	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation and motor must be checked.
	3. Defective controls.	Check all safety and pressure switches for operation. Inspect contact in control devices.	Replace worn or defective parts.
	4. Motor and/or cable are defective.	Turn off power. Disconnect motor leads from control box. Measure the lead to lead resistances with the ohmmeter (Rx1). Measure lead to ground values with ohmmeter (Rx100K). Record measured values.	If open motor winding or ground is found, remove pump and recheck values at the surface. Repair or replace motor or cable.
	5. Defective capacitor.	Turn off the power, then discharge capacitor. Disconnect leads and check with an ohm-meter (Rx100K). When meter is connected, the needle should jump forward and slowly drift back.	If there is no needle movement, replace the capacitor.
B. Pump Runs But Does Not Deliver Water	**1.** Groundwater level in well is too low or well is collapsed.	Check well drawdown.	Lower pump if possible. If not, throttle discharge valve and install water level control.
	2. Integral pump check valve is blocked.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off. After taking reading, open valve to its previous position. Convert PSI to feet (For water: PSI x 2.31 ft/PSI = _____ ft.), and add to this the total vertical distance from the pressure gauge to the water level in the well while the pump is running. Refer to the specific pump curve for the shut-off head for that pump model. If the measured head is close to the curve, pump is probably OK.	If not close to the pump curve, remove pump and inspect discharge section. Remove blockage, repair valve and valve seat if necessary. Check for other damage. Rinse out pump and reinstall.
	3. Inlet strainer is clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and reinstall.
	4. Pump is damaged.	Same as B.2 above.	If damaged, repair as necessary. Rinse out pump and reinstall.
C. Pump Runs But at Reduced Capacity	**1.** Drawdown is larger than anticipated.	Check drawdown during pump operation.	Lower pump if possible. If not, throttle discharge valve and install water level control.
	2. Discharge piping or valve leaking.	Examine system for leaks.	Repair leaks.
	3. Pump strainer or check valve are clogged.	Remove pump and inspect.	Clean, repair, rinse out pump and reinstall.
	4. Pump worn.	Same as B.2 above.	If not close to pump curve, remove pump and inspect.

Troubleshooting (continued)

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
D. Pump Cycles Too Much	**1.** Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts.	Re-adjust switch or replace if defective.
	2. Level control is not properly set or is defective.	Check setting and operation.	Re-adjust setting (refer to manufacturer data). Replace if defective.
	3. Plugged snifter valve or bleed orifice.	Examine valve and orifice for dirt or corrosion.	Clean and/or replace if defective.
E. Fuses Blow or Circuit Breakers Trip	**1.** High or low voltage.	Check voltage at pump panel. If not within ± 10%, check wire size and length of run to pump panel.	If wire size is correct, contact power company. If not, correct and/or replace as necessary.
	2. Control box wiring and components.	Check that control box parts match the parts list. Check to see that wiring matches wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
	3. Defective capacitor.	Turn off power and discharge capacitor. Check using an ohmmeter (Rx100K). When the meter is connected, the needle should jump forward and slowly drift back.	If no meter movement, replace the capacitor.
	4. Starting relay (Franklin single phase motors only).	Check resistance of relay coil with an ohmmeter (Rx1000). Check contacts for wear.	Replace defective relay.

Table A

Minimum Water Flow Requirements for Submersible Pump Motors

MOTOR DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. FLOW PAST THE MOTOR (GPM)
4"	4	1.2
	5	7
	6	13
	7	21
	8	30

NOTES: 1. 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.

2. The minimum recommended water velocity over 4" motors is 0.25 feet per second.

Table B

Guide for Engine-Driven Generators in Submersible Pump Applications

	MINIMUM KILOWATT RATING OF GENERATOR FOR THREE-WIRE SUBMERSIBLE PUMP MOTORS	
MOTOR HP	EXTERNALLY REGULATED GENERATOR	INTERNALLY REGULATED GENERATOR
0.33 HP	1.5 KW	1.2 KW
0.50	2.0	1.5
0.75	3.0	2.0
1.0	4.0	2.5
1.5	5.0	3.0

NOTES:

1. Table is based on typical 80°C rise continuous duty generators with 35% maximum voltage dip during start-up of single phase motors.
2. Contact the manufacturer of the generator to assure the unit has adequate capacity to run the submersible motor.
3. If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

Table C
Electrical Data - 60 Hz Submersible Pump Motors

GRUNDFOS MOTORS

4 Inch (Two Wire) Motors - Control Box Not Required — 60 Hz

HP	Ph	VOLT	Ser. Fact.	Circ. Brk. or Stnd. Fuse	Dual Element Fuse	AMPERAGE Full Load	AMPERAGE Lock Rotor	AMPERAGE S.F. Amps	FULL LOAD Eff.	FULL LOAD Power Factor	Line-to-Line Resistance(Ohms) Blk-Yel / Red-Yel Delta	KVA Code **	Maximum Thrust (lbs)	GRUNDFOS PART NO.
SINGLE PHASE														
1/3	1	230	1.75	15	5	3.0	25.5	4.4	47.3	63.0	6.8-8.2	S	750	79.952301
1/2	1	230	1.60	15	7	4.3	34.5	5.9	50.6	64.7	5.2-6.3	R	750	79.952302
3/4	1	230	1.50	20	9	6.6	40.5	8.0	57.0	70.0	3.2-3.8	N	750	79.952303
1	1	230	1.40	25	12	8.0	47.4	9.6	59.8	74.3	2.5-3.1	M	750	79.952304
1 1/2	1	230	1.30	35	15	10.6	60.8	13.1	64.3	77.2	1.9-2.3	L	750	79.952305

4 Inch (Three Wire) Motors

SINGLE PHASE

1/3	1	230	1.75	15	5	3.0	14.0	4.4	47.0	63.0	6.8-8.3 17.3-21.1	L	750	79.453301
1/2	1	230	1.60	15	7	4.3	20.0	5.9	50.7	64.6	4.7-5.7 15.8-19.6	L	750	79.453302
3/4	1	230	1.50	20	9	6.6	30.8	8.0	57.3	70.0	3.2-3.9 14-17.2	L	750	79.453303
1	1	230	1.40	25	12	8.0	36.3	9.6	59.8	74.5	2.6-3.1 10.3-12.5	K	750	79.453304
1 1/2	1	230	1.30	30	15	9.7	44.0	11.5	67.5	84.1	1.9-2.3 7.8-9.6	H	750	79.453305

Franklin Motors

(refer to the Franklin Submersible Motors Application Maintenance Manual)

Table D
Total Resistance of Drop Cable (OHMS)

The values shown in this table are for copper conductors. Values are for the total resistance of drop cable from the **Control box to the motor and back.**

To determine the resistance:

1. Disconnect the drop cable leads from the control box.
2. Record the size and length of drop cable.
3. Determine the cable resistance from the table.
4. Add drop cable resistance to motor resistance. Motor resistances can be found in the Electrical Data Chart, Table C.
5. Measure the resistance between each drop cable lead using an ohmmeter. Meter should be set on Rx1 and zero-balanced for this measurement.
6. The measured values should be approximately equal to the calculated values.

Wire Resistances

Distance From Control Box to Pump Motor (FT.)	12 AWG Wire Resistance (OHMS)	14 AWG Wire Resistance (OHMS)
10	0.03	0.05
20	0.06	0.10
30	0.10	0.15
40	0.13	0.21
50	0.16	0.26
60	0.19	0.31
70	0.23	0.36
80	0.26	0.41
90	0.29	0.46
100	0.32	0.51
110	0.36	0.57
120	0.39	0.62
130	0.42	0.67
140	0.45	0.72
150	0.49	0.77
160	0.52	0.82
170	0.55	0.87
180	0.58	0.93
190	0.62	0.98
200	0.65	1.03

Redi-Flo4

LIMITED WARRANTY

Redi-Flo4 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 which vary from jurisdiction to jurisdiction.

GRUNDFOS®

GRUNDFOS PUMPS CORP. • 2555 Clovis Ave. • Clovis, CA 93612
Sales Support Centers: Allentown, PA • Atlanta, GA • Chicago, IL
Canada: Mississauga, ONT

L-RF-IO-001 | Rev. 10/93
PRINTED IN USA

ATTENTION!
IMPORTANT INFORMATION FOR INSTALLERS OF THIS EQUIPMENT!

THIS EQUIPMENT IS INTENDED FOR INSTALLATION BY TECHNICALLY QUALIFIED PERSONNEL. FAILURE TO INSTALL IT IN COMPLIANCE WITH NATIONAL AND LOCAL ELECTRICAL CODES, AND WITH FRANKLIN ELECTRIC RECOMMENDATIONS, MAY RESULT IN ELECTRICAL SHOCK OR FIRE HAZARD, UNSATISFACTORY PERFORMANCE, AND EQUIPMENT FAILURE. FRANKLIN INSTALLATION INFORMATION IS AVAILABLE FROM PUMP MANUFACTURERS AND DISTRIBUTORS, AND DIRECTLY FROM FRANKLIN ELECTRIC. CALL FRANKLIN TOLL FREE 800-348-2420 FOR INFORMATION. RETAIN THIS INFORMATION SHEET WITH THE EQUIPMENT FOR FUTURE REFERENCE.

WARNING

SERIOUS OR FATAL ELECTRICAL SHOCK MAY RESULT FROM FAILURE TO CONNECT THE MOTOR, CONTROL ENCLOSURES, METAL PLUMBING, AND ALL OTHER METAL NEAR THE MOTOR OR CABLE, TO THE POWER SUPPLY GROUND TERMINAL USING WIRE NO SMALLER THAN MOTOR CABLE WIRES. TO REDUCE RISK OF ELECTRICAL SHOCK, DISCONNECT POWER BEFORE WORKING ON OR AROUND THE WATER SYSTEM. DO NOT USE MOTOR IN SWIMMING AREAS.

ATTENTION!
INFORMATIONS IMPORTANTES POUR L'INSTALLATEUR DE CET EQUIPEMENT.

CET EQUIPEMENT DOIT ETRE INSTALLE PAR UN TECHNICIEN QUALIFIE. SI L'INSTALLATION N'EST PAS CONFORME AUX LOIS NATIONALES OU LOCALES AINSI QU'AUX RECOMMANDATIONS DE FRANKLIN ELECTRIC, UN CHOC ELECTRIQUE, LE FEU, UNE PERFORMANCE NON ACCEPTABLE, VOIRE MEME LE NON-FONCTIONNEMENT PEUVENT SURVENIR. UN GUIDE D'INSTALLATION DE FRANKLIN ELECTRIC EST DISPONIBLE CHEZ LES MANUFACTURIERS DE POMPES, LES DISTRIBUTEURS, OU DIRECTEMENT CHEZ FRANKLIN. POUR DE PLUS AMPLES RENSEIGNEMENTS, APPELEZ SANS FRAIS LE 1-800-348-2420. CONSERVEZ CETTE FEUILLE D'INFORMATION AVEC L'EQUIPEMENT POUR CONSULTATION FUTURE.

AVERTISSEMENT

UN CHOC ELECTRIQUE SERIEUX OU MEME MORTEL EST POSSIBLE, SI L'ON NEGLIGE DE CONNECTER LE MOTEUR, LA PLOMBERIE METALLIQUE, BOITES DE CONTROLE ET TOUT METAL PROCHE DU MOTEUR A UN CABLE ALLANT VERS UNE ALIMENTATION D'ENERGIE AVEC BORNE DE MISE A LA TERRE UTILISANT AU MOINS LE MEME CALIBRE QUE LES FILS DU MOTEUR. POUR REDUIRE LE RISQUE DE CHOC ELECTRIQUE. COUPER LE COURANT AVANT DE TRAVAILLER PRES OU SUR LE SYSTEM D,EAU. NE PAS UTILISER CE MOTEUR DANS UNE ZONE DE BAIGNADE.

ATENCION!
INFORMACION PARA EL INSTALADOR DE ESTE EQUIPO.

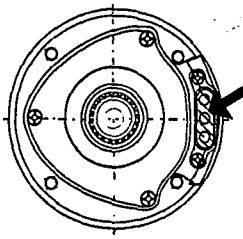
PARA LA INSTALACION DE ESTE EQUIPO, SE REQUIERE DE PERSONAL TECNICO CALIFICADO. EL NO CUMPLIR CON LAS NORMAS ELECTRICAS NACIONALES Y LOCALES, ASI COMO CON LAS RECOMENDACIONES DE FRANKLIN ELECTRIC DURANTE SU INSTALACION, PUEDE OCASIONAR: UN CHOQUE ELECTRICO, PELIGRO DE UN INCENDIO, OPERACION DEFECTUOSA E INCLUSO LA DESCOMPOSTURA DEL EQUIPO. LOS MANUALES DE INSTALACION Y PUESTA EN MARCHA DE LOS EQUIPOS, ESTAN DISPONIBLES CON LOS DISTRIBUIDORES, FABRICANTES DE BOMBAS O DIRECTAMENTE CON FRANKLIN ELECTRIC. PUEDE LLAMAR GRATUITAMENTE PARA MAYOR INFORMACION AL TELEFONO 800-348-2420. GUARDAR ESTA INFORMACION JUNTO AL EQUIPO PARA FUTURAS CONSULTAS.

ADVERTENCIA

PUEDE OCURRIR UN CHOQUE ELECTRICO, SERIO O FATAL DEBIDO A UNA ERRONEA CONECCION DEL: MOTOR, DE LOS TABLEROS ELECTRICOS, DE LA TUBERIA, DE CUALQUIER OTRA PARTE METALICA QUE ESTA CERCA DEL MOTOR O POR NO UTILIZAR UN CABLE PARA TIERRA DE CALIBRE IGUAL O MAYOR AL DE LA ALIMENTACION. PARA REDUCIR EL RIESGO DE CHOQUE ELECTRICO. DESCONECTAR LA ALIMENTACION ELECTRICA ANTES DE INICIAR A TRABAJAR EN EL SISTEMA HIDRAULICO. NO UTILIZAR ESTE MOTOR EN ALBERCAS O AREAS EN DONDE SE PRACTIQUE NATACION.

Franklin Electric
Bluffton, Indiana 46714

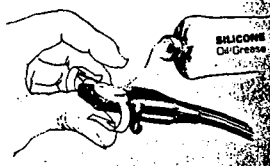
MS402 Motors



Remove Cover or Old Lead

1

2





3

Lead plug must be flush with top of motor. Tighten lead screws to 18 inch lbs.

GRUNDFOS

GRUNDFOS PUMPS CORPORATION

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

HEVI-DUTY ELECTRIC

BOOST TRANSFORMER

PART NUMBER 985554

SELECTION AND CONNECTION INSTRUCTIONS

A UNIT OF GENERAL SIGNAL GS

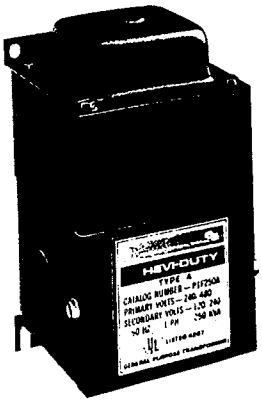
HEVI-DUTY

HEVI-DUTY ELECTRIC, P.O. BOX 268, GOLDSBORO, NORTH CAROLINA 27533-0268

Buck-Boost Transformers

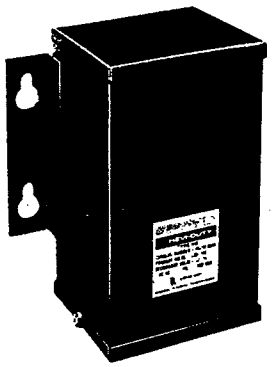
SELECTION AND CONNECTION INSTRUCTIONS

Design Style A, Wall Mounting, suitable for indoor or outdoor use, .050 through .250 KVA.



the HIGH / LOW Voltage

Problem Solvers



Design Style B, Hardshell, encapsulated, .500 through 5 KVA, for indoor or outdoor use.

Hevi-Duty Buck-Boost Transformers are insulating transformers with low voltage secondary windings. By field connecting the primary and secondary windings in accordance with recommended instructions, the transformer is "field converted" to an autotransformer which will buck or boost the supply voltage a small amount, usually no more than ±20%. Autotransformers are inherently much more economical to purchase and operate compared to isolation transformers of equivalent rating. This is why buck-boost transformers are the most practical and economical solution for changing line voltages small amounts. Most common applications are boosting 208V. to 230V., 230V. to 277V. and vice-versa. When a buck-boost transformer is wired as an autotransformer, only a fraction of the load KVA is actually transformed. In an autotransformer circuit, the majority of the load KVA passes directly from the supply to the load. This is why a buck-boost transformer can supply a load which has much larger KVA rating than the nameplate indicates.

Buck-Boost Transformers

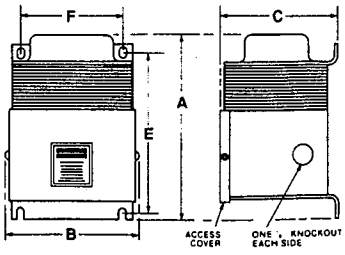
DIMENSIONS

KVA/ Voltage	CATALOG NUMBERS 120 x 240 12/24	120 x 240 16/32	240 x 480 24/48	Dimensions A	B	C	Mounting Dimensions E	F	Temp Rise	Insul. Class	Approx. Weight (Lbs.)	Design Style
.050	P19FB50	P20FB50	P22FB50	5½	3⅜	2¾	4¾	2½	80°C	185°C	3	A
.100	P19FB100	P20FB100	P22FB100	6⅛	3⅜	2¾	5⅜	2½	80°C	185°C	3⅞	A
.150	P19F150A	P20F150A	P22F150A	6⅝	3⅜	2¾	5⅞	2½	115°C	185°C	5	A
.250	P19F250A	P20F250A	P22F250A	7	4⅛	3½	5 13/16	3¼	115°C	185°C	7	A
.500	HS19F500A	HS20F500A	HS22F500A	9⅞	8⅝	5⅜	4	7¼	115°C	185°C	22	B
.750	HS19F750A	HS20F750A	HS22F750A	9⅞	8⅝	5⅜	4	7¼	115°C	185°C	27	B
1.0	HS19F1A	HS20F1A	HS22F1A	9⅞	8⅝	5⅜	4	7¼	115°C	185°C	28	B
1.5	HS19F1.5A	HS20F1.5A	HS22F1.5A	10½	9⅞	6½	4	8½	115°C	185°C	40	B
2.0	HS19F2A	HS20F2A	HS22F2A	10½	9⅞	6½	4	8½	115°C	185°C	46	B
3.0	HS19F3A	HS20F3A	HS22F3A	12¼	10¾	7	6	9⅛	115°C	185°C	62	B
5.0	HS19F5A	HS20F5A	HS22F5A	17	13¾	8⅝	8	12	115°C	185°C	100	B

Dimensions are approximate and subject to change without notice.
Request certified drawings for construction purposes.
Complete connection instructions are enclosed with each transformer.

Design Style A

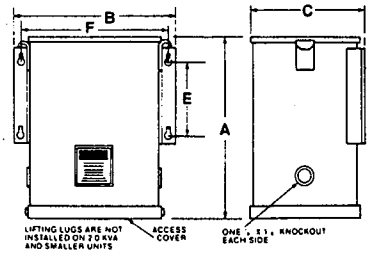
Wall Mounting .050 Through .250 KVA Suitable for Indoor or Outdoor Use.



Design Style B

hardshell

Wall Mounting Encapsulated .500 KVA Through 5 KVA Suitable for Indoor or Outdoor Use.



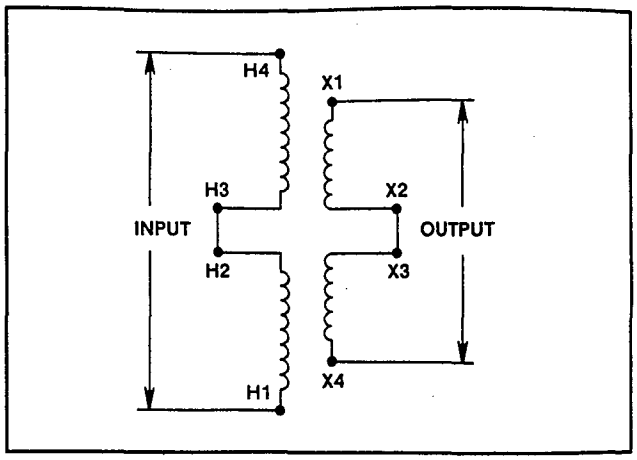
UL LISTED POWER TRANSFORMER 338H

All transformers shown in this catalog are UL Listed and OSHA acceptable. UL file number E25872.

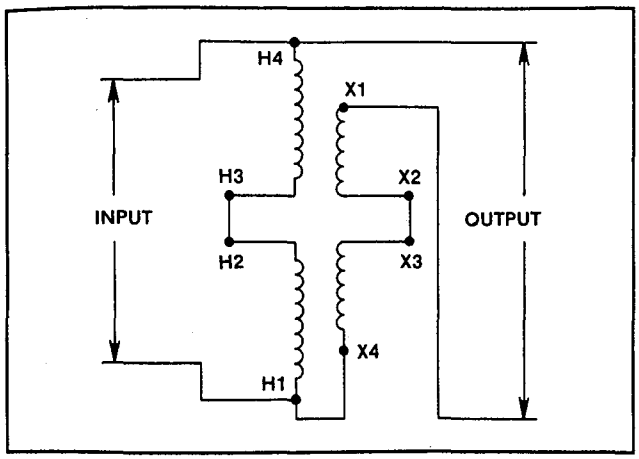
A UNIT OF GENERAL SIGNAL GS

HEVI-DUTY

Three Phase Applications



Buck-Boost transformer connected as a low voltage insulating transformer (high voltage and low voltage windings illustrated series connected) with no interconnection of high voltage and secondary windings. This is how they are shipped from the factory. A typical 120 x 240V - 12 x 24V model is shown.



Identical Buck-Boost transformer connected as a boosting autotransformer. The interconnection of H1 and X4 is made in the field by the installer, converting it to an autotransformer.

How to Use Selection Charts — 4 Easy Steps

1. From the top row of the appropriate single or three-phase chart, locate the high and low voltage which is closest to the required voltage.
2. Move down that column to the ampere/current or KVA rating closest to, but greater than, the rating required by the load. In boosting applications, the HV circuit amps in the charts will correspond to load amps. For bucking applications, LV circuit amps will correspond to load amps.
3. Obtain the transformer catalog number from the far left column.
4. The identification code of the wiring/connection diagram to be used is found at the bottom of the voltage, KVA and ampere column. Using the catalog number, the dimensions can be found on page 2. Mounting dimensions are also provided in these tables. Three-phase applications will require either 2 or 3 transformers as noted at the bottom of the three-phase selection charts.

EXAMPLE:

Number of Phases — Single
Frequency — 60 Hertz
Supply or Input Line Voltage — 208V
Voltage Required by Load — 230V
Load KVA Rating — 6 KVA

From Table 1 with a 208 volt supply or input line voltage, a boost to 229 volts can be obtained. Move down the column until the KVA listed is larger than 6.0 KVA. Move to the left and the correct catalog number is HS19F750A using wiring diagram D.

The tables can be used to determine the maximum KVA or ampere/current rating for Buck-Boost transformers using catalog numbers.

EXAMPLE:

Find the maximum load KVA and amps a HS20F500A can handle when used to buck 136 volts to 120 volts, single-phase.

From Table 2, locate catalog number HS20F500A in left column. From the top line locate the voltage required (120-136). From the point of intersection read the maximum load amps and KVA. The correct answers are 35.4 amps and 4.25 KVA.

WIRING DIAGRAMS

The diagrams are used for either Boosting or Bucking applications. For Boosting, connect the supply voltage to terminal shown as "L.V." (Low Voltage). The load terminals are to be connected to the terminals shown as "H.V." (High Voltage). For Bucking, connect the supply voltage to the terminals shown as "H.V." (High Voltage). The load terminals are to be connected to the terminals shown as "L.V." (Low Voltage).

The connection of H1 to X4 allows the unit to be used as an autotransformer. This permits the use of a transformer which is economical in cost yet small in size for its load handling capability. When wired as an autotransformer, only a fraction of the KVA is transformed. The portion of the KVA which is transformed is related directly to the percentage buck or boost desired. For example, if a Buck-Boost transformer is wired for a 10% voltage boost, only 10% of the KVA is passed directly from the source to the load. The balance of the power passes directly from the source to the load and is not "transformed." Therefore, the KVA size of the Buck-Boost transformer required is only one-tenth the KVA capacity of the insulating transformer one normally would expect to use for the required load.

Buck-Boost transformers should be installed as close to the load as possible. This will avoid normal voltage drop due to long line circuits. Use a wire size of sufficient capacity to carry the current of the load. In selecting your transformer, be sure that the KVA size selected is correct for the voltage change and current requirements.

Since the Buck-Boost transformer is a dual primary and dual secondary insulating transformer, it can also be used for applications where transformation to either 12V, 16V, 24V, 32V or 48 volts is required. ***Do not use Buck-Boost formulas when using a Buck-Boost transformer for transformation to 12V, 16V, 24V, 32V or 48 volts.*** When used as an insulating transformer, KVA capacity is limited to nameplate rating when applied as an insulating transformer.

How to Select the Proper Transformer

To select the proper transformer for Buck-Boost applications, determine:

1. **Input Line Voltage** — By using a voltmeter, measure the supply voltage.
2. **Voltage Required for the Load** — Check the load equipment nameplate to determine the voltage requirement.
3. **KVA or Ampere Rating of the Load** — Knowing either the load KVA or the load ampere requirement is sufficient. This information will also be listed on the nameplate of the load equipment.
5. **Number of Phases** — Single- or three-phase line and load should match because a transformer is not capable of converting single-phase to three-phase. It's a common application to make a single-phase transformer connection from a three-phase supply by use of one leg of the three-phase supply circuit. Care must always be taken not to overload the leg of the three-phase supply. This is particularly true in a Buck-Boost application because the supply must provide for the load KVA, not just the nameplate rating of the Buck-Boost transformer.

Three Phase Wiring Connection Diagrams

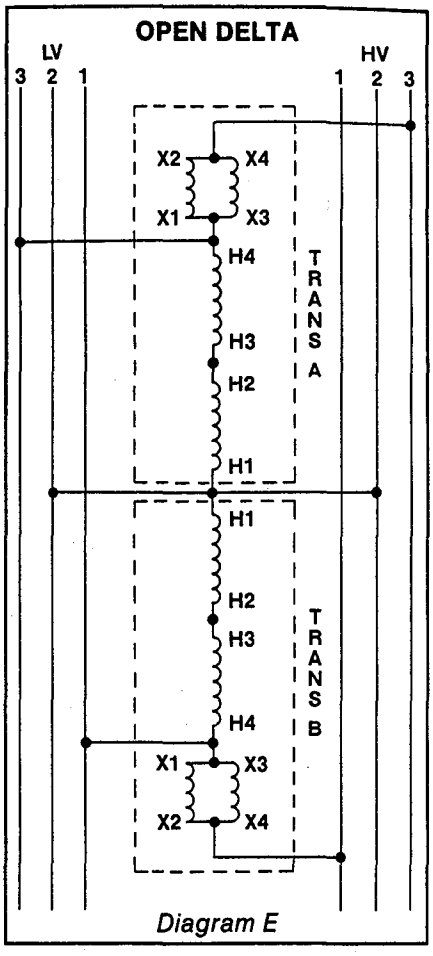


Diagram E

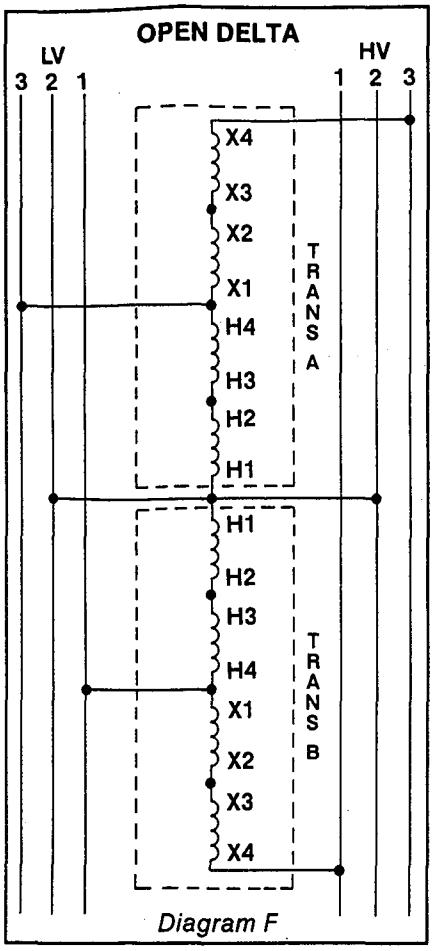


Diagram F

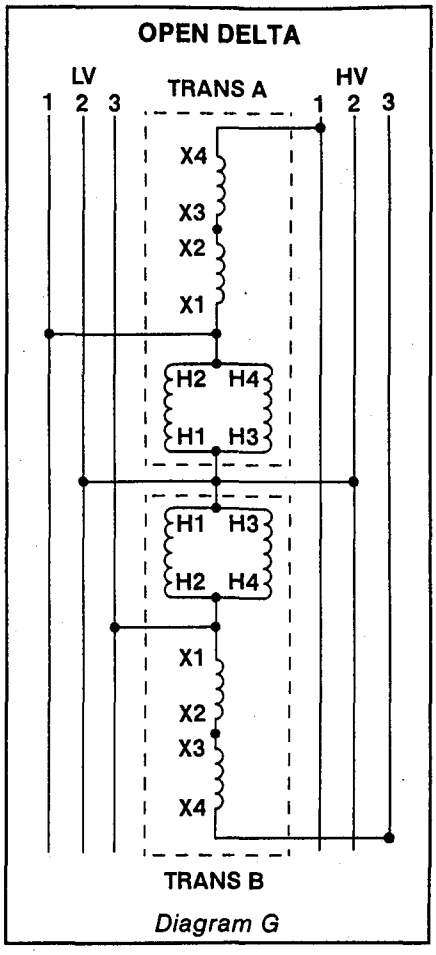


Diagram G

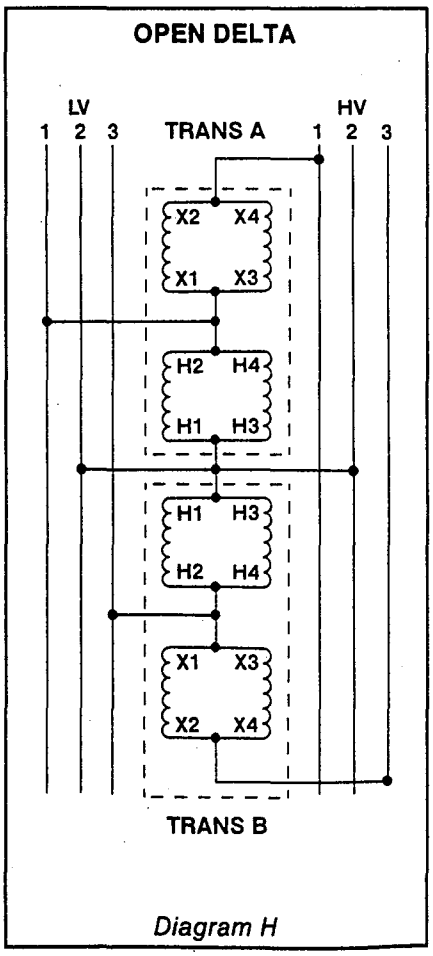


Diagram H

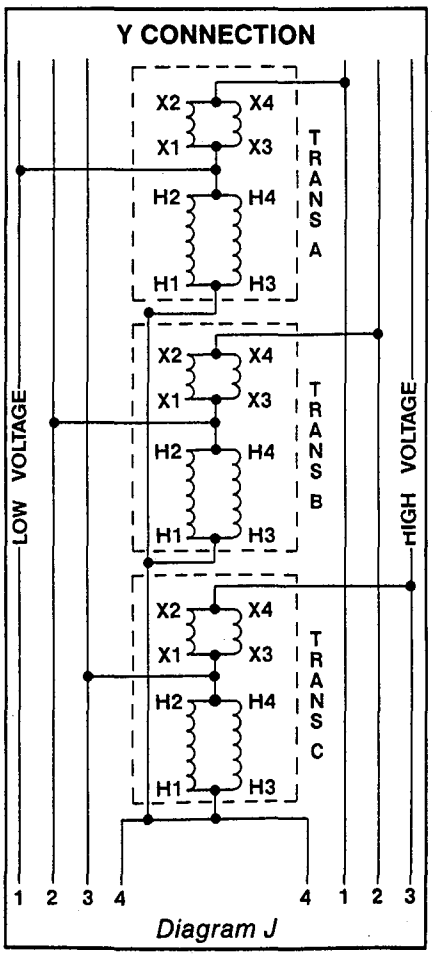


Diagram J

Single Phase Wiring Connection Diagrams

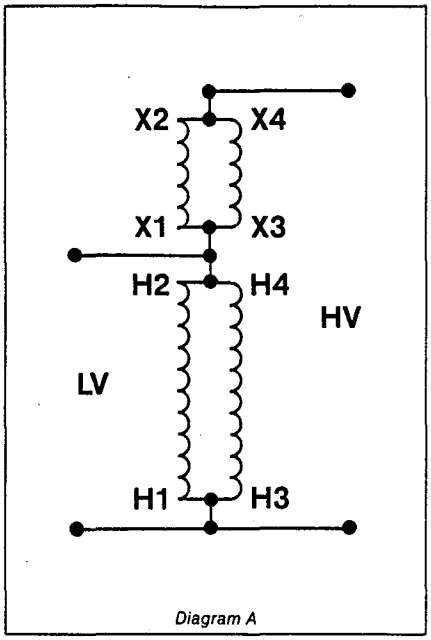


Diagram A

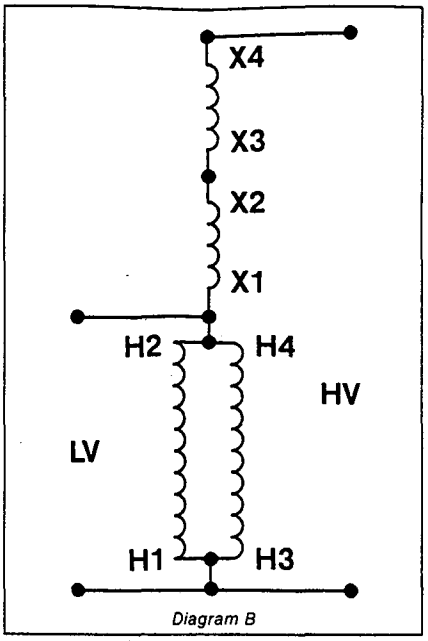


Diagram B

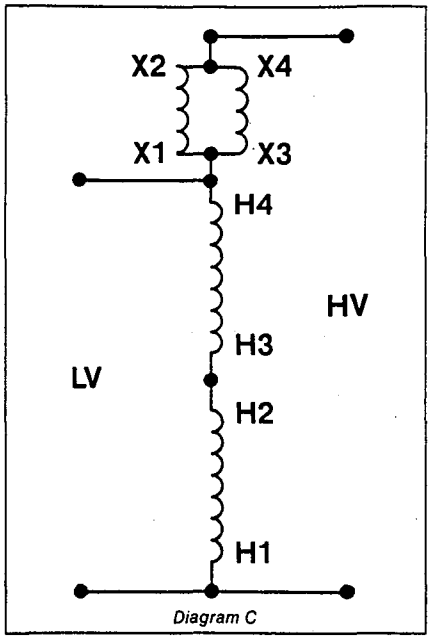


Diagram C

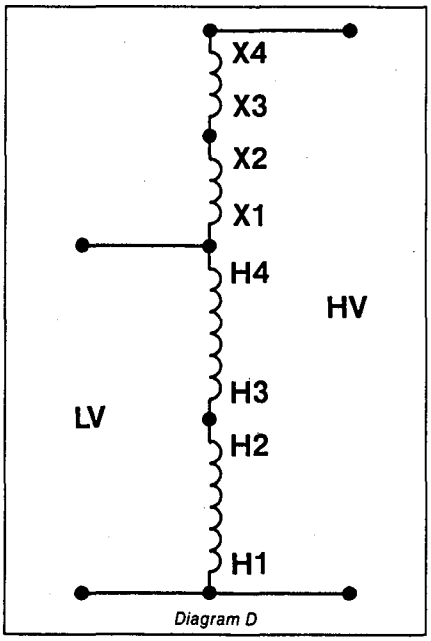
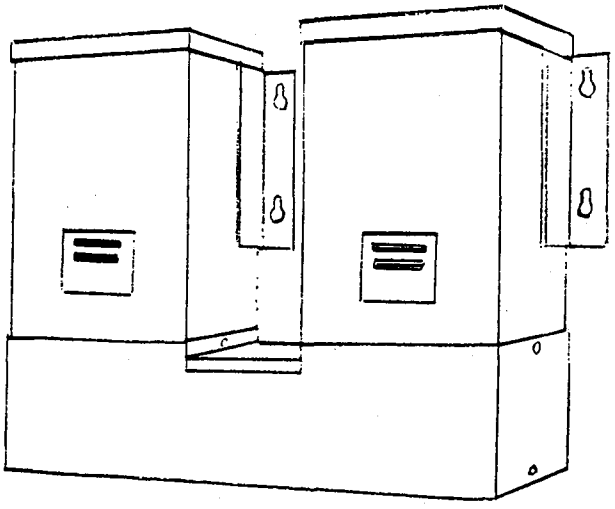


Diagram D

Three Phase Applications



Now available to ease wiring — U.L. rated (Rainproof type-3R) field installed junction boxes for ganging two and three hardshell style units. Consult factory for details.

A UNIT OF GENERAL SIGNAL GS

HEVI-DUTY

SINGLE-PHASE
120 × 240 VOLTS PRIMARY — 12/24 VOLTS SECONDARY

TABLE 1

Catalog Number	Low Voltage	96	100	100	105	110	110	115*	115*	120*	120*	200	208	220	220*	240*	240*
	High Voltage	115	110	120	115	121	132	126	138	132	144	220	229	231	242	252	264
P19FB50	HV Amps	2.08	4.16	2.08	4.16	4.16	2.08	4.16	2.08	4.16	2.08	2.08	2.08	4.16	2.08	4.16	2.08
	KVA	.239	.458	.250	.479	.504	.275	.525	.287	.550	.300	.458	.477	.962	.504	1.04	.550
	LV Amps	2.49	4.58	2.50	4.56	4.58	2.50	4.56	2.50	4.58	2.50	2.29	2.29	4.37	2.29	4.34	2.29
P19FB100	HV Amps	4.16	8.33	4.16	8.33	8.33	4.16	8.33	4.16	8.33	4.16	4.16	4.16	8.33	4.16	8.33	4.16
	KVA	.479	.916	.500	.958	1.00	.550	1.05	.575	1.10	.600	.916	.954	1.92	1.00	2.10	1.10
	LV Amps	4.99	9.16	5.00	9.12	9.16	5.00	9.13	5.00	9.16	5.00	4.58	4.58	8.75	4.58	8.75	4.58
P19F250A	HV Amps	10.4	20.8	10.4	20.8	20.8	10.4	20.8	10.4	20.8	10.4	10.4	10.4	20.8	10.4	20.8	10.4
	KVA	1.19	2.29	1.25	2.39	2.52	1.37	2.62	1.43	2.75	1.50	2.29	2.38	4.81	2.52	5.25	2.75
	LV Amps	12.4	22.9	12.5	22.8	22.9	12.5	22.8	12.5	22.9	12.5	11.4	11.4	21.8	11.4	21.8	11.4
HS19F500A	HV Amps	20.8	41.6	20.8	41.6	41.6	20.8	41.6	20.8	41.6	20.8	20.8	20.8	41.6	20.8	41.6	20.8
	KVA	2.39	4.58	2.50	4.79	5.04	2.75	5.25	2.87	5.50	3.00	4.58	4.77	9.62	5.04	10.5	5.50
	LV Amps	24.9	45.8	25.0	45.6	45.8	25.0	45.6	25.0	45.8	25.0	22.9	22.9	43.7	22.9	43.7	22.9
HS19F750A	HV Amps	31.2	62.5	31.2	62.5	62.5	31.2	62.5	31.2	62.5	31.2	31.2	31.2	62.5	31.2	62.5	31.2
	KVA	3.59	6.87	3.75	7.18	7.56	4.12	7.87	4.31	8.25	4.50	6.87	7.15	14.4	7.56	15.7	8.25
	LV Amps	37.43	68.7	37.5	68.4	68.7	37.5	68.4	37.5	68.7	37.5	34.3	34.4	65.6	34.3	65.6	34.3
HS19F1A	HV Amps	41.6	83.3	41.6	83.3	83.3	41.6	83.3	41.6	83.3	41.6	41.6	41.6	83.3	41.6	83.3	41.6
	KVA	4.79	9.16	5.00	9.58	10.0	5.50	10.5	5.75	11.0	6.00	9.16	9.54	19.2	10.0	21.0	11.0
	LV Amps	49.9	91.6	50.0	91.2	91.6	50.0	91.3	50.0	91.6	50.0	45.8	45.8	87.5	45.8	87.5	45.8
HS19F1.5A	HV Amps	62.5	125	62.5	125	125	62.5	125	62.5	125	62.5	62.5	62.5	125	62.5	125	62.5
	KVA	7.18	13.7	7.50	14.3	15.1	8.25	15.7	8.62	16.5	9.00	13.7	14.3	28.8	15.1	31.5	16.5
	LV Amps	74.8	137	75.0	136	137	75.0	136	75.0	137	75.0	68.7	68.8	131	68.7	131	68.7
HS19F2A	HV Amps	83.3	166	83.3	166	166	83.3	166	83.3	166	83.3	83.3	83.3	166	83.3	166	83.3
	KVA	9.58	18.3	10.0	19.1	20.1	11.0	21.0	11.5	22.0	12.0	18.3	19.0	38.5	20.1	42.0	22.0
	LV Amps	99.8	183	100	182	183	100	182	100	183	100	91.6	91.7	175	91.6	175	91.6
HS19F3A	HV Amps	125	250	125	250	250	125	250	125	250	125	125	125	250	125	250	125
	KVA	14.3	27.5	15.0	28.7	30.2	16.5	31.5	17.2	33.0	18.0	27.5	28.6	57.7	30.2	63.0	33.0
	LV Amps	149	275	150	273	275	150	273	150	275	150	137	137	262	137	262	137
HS19F5A	HV Amps	208	416	208	416	416	208	416	208	416	208	208	208	416	208	416	208
	KVA	23.9	45.8	25.0	47.9	50.4	27.5	52.5	28.7	55.0	30.0	45.8	47.7	96.2	50.4	105	55.0
	LV Amps	249	458	250	456	458	250	456	250	458	250	229	229	437	229	437	229
Applicable Connection Diagram		B	A	B	A	A	B	A	B	A	B	D	D	C	D	C	D

*60 HZ ONLY (ALL OTHER RATINGS 50/60 HZ)

SINGLE PHASE
120 × 240 VOLTS PRIMARY — 16/32 VOLTS SECONDARY

TABLE 2

Catalog Number	Low Voltage	95	101	106	110	110	115*	115*	120*	120*	203	208	220	220	230*	240*	240*
	High Voltage	120	115	120	125	139	130	146	136	152	230	236	235	249	261	256	272
P20FB50	HV Amps	1.56	3.12	3.12	3.12	1.56	3.12	1.56	3.12	1.56	1.56	1.56	3.12	1.56	1.56	3.12	1.56
	KVA	.187	.359	.375	.390	.217	.406	.228	.425	.237	.359	.368	.734	.389	.407	.800	.425
	LV Amps	1.97	3.55	3.53	3.55	1.97	3.53	1.98	3.54	1.97	1.77	1.77	3.33	1.76	1.77	3.33	1.77
P20FB100	HV Amps	3.12	6.25	6.25	6.25	3.12	6.25	3.12	6.25	3.12	3.12	3.12	6.25	3.12	3.12	6.25	3.12
	KVA	.375	.718	.750	.781	.434	.812	.456	.850	.475	.718	.737	1.46	.778	.815	1.60	.850
	LV Amps	3.94	7.11	7.07	7.10	3.94	7.06	3.96	7.08	3.95	3.54	3.54	6.67	3.53	3.54	6.66	3.54
P20FB250A	HV Amps	7.81	15.6	15.6	15.6	7.81	15.6	7.81	15.6	7.81	7.81	7.81	15.6	7.81	7.81	15.6	7.81
	KVA	.937	1.79	1.87	1.95	1.08	2.03	1.14	2.12	1.18	1.79	1.84	3.67	1.94	2.03	4.00	2.12
	LV Amps	9.81	17.7	17.6	17.7	9.87	17.6	9.91	17.7	9.89	8.85	8.86	16.6	8.84	8.86	16.6	8.85
HS20F500A	HV Amps	15.6	31.2	31.2	31.2	15.6	31.2	15.6	31.2	15.6	15.6	15.6	31.2	15.6	15.6	31.2	15.6
	KVA	1.87	3.59	3.75	3.90	2.17	4.06	2.28	4.25	2.37	3.59	3.68	7.34	3.89	4.07	8.00	4.25
	LV Amps	19.7	35.5	35.3	35.5	19.7	35.3	19.8	35.4	19.7	17.7	17.7	33.3	17.6	17.7	33.3	17.7
HS20F750A	HV Amps	23.4	46.8	46.8	46.8	23.4	46.8	23.4	46.8	23.4	23.4	23.4	46.8	23.4	23.4	46.8	23.4
	KVA	2.81	5.39	5.62	5.85	3.25	6.09	3.42	6.37	3.56	5.39	5.53	11.1	5.83	6.11	12.0	6.37
	LV Amps	29.6	53.3	53.0	53.2	29.6	53.0	29.7	53.1	29.6	26.5	26.5	50.0	26.5	26.5	50.0	26.5
HS20F1A	HV Amps	31.2	62.5	62.5	62.5	31.2	62.5	31.2	62.5	31.2	31.2	31.2	62.5	31.2	31.2	62.5	31.2
	KVA	3.75	7.18	7.50	7.81	4.34	8.12	4.56	8.50	4.75	7.18	7.37	14.6	7.78	8.15	16.0	8.50
	LV Amps	39.4	71.1	70.7	71.0	39.4	70.6	39.6	70.8	39.5	35.4	35.4	66.7	35.3	35.4	66.6	35.4
HS20F1.5A	HV Amps	46.8	93.7	93.7	93.7	46.8	93.7	46.8	93.7	46.8	46.8	46.8	93.7	46.8	46.8	93.7	46.8
	KVA	5.62	10.7	11.2	11.7	6.51	12.1	6.84	12.7	7.12	10.7	11.0	22.0	11.6	12.2	24.0	12.7
	LV Amps	59.2	106	106	106	59.2	106	59.5	106	59.3	53.1	53.1	100	53.0	53.1	100	53.1
HS20F2A	HV Amps	62.5	125	125	125	62.5	125	62.5	125	62.5	62.5	62.5	125	62.5	62.5	125	62.5
	KVA	7.50	14.3	15.0	15.6	8.68	16.2	9.12	17.0	9.50	14.3	14.7	29.3	15.5	16.3	32.0	17.0
	LV Amps	78.9	142	141	142	79	141	79.3	141	79.1	70.8	70.9	133	70.7	70.9	133	70.8
HS20F3A	HV Amps	93.7	187	187	187	93.7	187	93.7	187	93.7	93.7	93.7	187	93.7	93.7	187	93.7
	KVA	11.2	21.5	22.5	23.4	13.0	24.3	13.6	25.5	14.2	21.5	22.1	44.0	23.3	24.4	48.0	25.5
	LV Amps	118	213	212	213	118	212	119	212	118	106	106	200	106	106	200	106
HS20F5A	HV Amps	156	312	312	312	156	312	156	312	156	156	156	312	156	156	312	156
	KVA	18.7	35.9	37.5	39.0	21.7	40.6	22.8	42.5	23.7	35.9	36.8	73.4	38.9	40.7	80.0	42.5
	LV Amps	197	355	353	355	197	353	198	354	197	177	177	333	176	177	333	177
Applicable Connection Diagram		B	A	A	A	B	A	B	A	B	D	D	C	D	D	C	D

*60 HZ ONLY (ALL OTHER RATINGS 50/60 HZ)

SINGLE-PHASE
240 × 480 VOLTS PRIMARY — 24/48 VOLTS SECONDARY

TABLE 3

Catalog Number	Low Voltage	200	230*	230*	345	380	380	400	415	415	436	440	440	460*	460*	480*	480*
	High Voltage	240	253	276	380	400	418	440	436	456	480	462	484	483	506	504	528
P22FB50	HV Amps	1.04	2.08	1.04	1.04	2.08	1.04	1.04	2.08	1.04	1.04	2.08	1.04	2.08	1.04	2.08	1.04
	KVA	250	.527	.287	.395	.833	.435	.458	.908	.475	.500	.962	.504	1.00	.527	1.05	.550
	LV Amps	1.25	2.29	1.24	1.14	2.19	1.14	1.14	2.19	1.14	1.14	2.18	1.14	2.17	1.14	2.18	1.14
P22FB100	HV Amps	2.08	4.16	2.08	2.08	4.16	2.08	2.08	4.16	2.08	2.08	4.16	2.08	4.16	2.08	4.16	2.08
	KVA	.500	1.05	.575	.791	1.66	.870	.916	1.81	.950	1.00	1.92	1.00	2.01	1.05	2.10	1.10
	LV Amps	2.50	4.56	2.50	2.29	4.36	2.29	2.29	4.36	2.29	2.29	4.36	2.27	4.36	2.28	4.37	2.28
P22FB250A	HV Amps	5.20	10.4	5.20	5.20	10.4	5.20	5.20	10.4	5.20	5.20	10.4	5.20	10.4	5.20	10.4	5.20
	KVA	1.25	2.63	1.43	1.98	4.16	2.17	2.29	4.54	2.37	2.50	4.81	2.52	5.03	2.63	5.25	2.75
	LV Amps	6.25	11.4	6.21	5.73	10.9	5.71	5.72	10.9	5.71	5.73	10.9	5.72	10.9	5.71	10.9	5.73
HS22F500A	HV Amps	10.4	20.8	10.4	10.4	20.8	10.4	10.4	20.8	10.4	10.4	20.8	10.4	20.8	10.4	20.8	10.4
	KVA	2.5	5.27	2.87	3.95	8.33	4.35	4.58	9.08	4.75	5.00	9.62	5.04	10.0	5.27	10.5	5.50
	LV Amps	12.5	22.7	12.4	11.4	21.9	11.4	11.4	21.8	11.4	11.4	21.8	11.4	21.7	11.4	21.8	11.4
HS22F750A	HV Amps	15.6	31.2	15.6	15.6	31.2	15.6	15.6	31.2	15.6	15.6	31.2	15.6	31.2	15.6	31.2	15.6
	KVA	3.75	7.90	4.31	5.93	12.5	6.53	6.87	13.6	7.12	7.50	14.4	7.56	15.0	7.90	15.7	8.25
	LV Amps	18.7	34.3	18.7	17.1	32.8	17.1	17.1	32.8	17.1	17.1	32.7	17.1	32.7	17.1	32.7	17.1
HS22F1A	HV Amps	20.8	41.6	20.8	20.8	41.6	20.8	20.8	41.6	20.8	20.8	41.6	20.8	41.6	20.8	41.6	20.8
	KVA	5.00	10.5	5.75	7.91	16.6	8.70	9.16	18.1	9.50	10.0	19.2	10.0	20.1	10.5	21.0	11.0
	LV Amps	25.0	45.6	25.0	22.9	43.6	22.9	22.9	43.6	22.8	22.9	43.6	22.7	43.6	22.9	43.6	22.9
HS22F1.5A	HV Amps	31.2	62.5	31.2	31.2	62.5	31.2	31.2	62.5	31.2	31.2	62.5	31.2	62.5	31.2	62.5	31.2
	KVA	7.50	15.8	8.62	11.8	25.0	13.0	13.7	27.2	14.2	15.0	28.8	15.1	30.1	15.8	31.5	16.5
	LV Amps	37.5	68.7	37.5	34.2	65.7	34.2	34.2	65.5	34.2	34.2	65.4	34.3	75.2	34.3	65.6	34.3
HS22F2A	HV Amps	41.6	83.3	41.6	41.6	83.3	41.6	41.6	83.3	41.6	41.6	83.3	41.6	83.3	41.6	83.3	41.6
	KVA	10.0	21.0	11.5	15.8	33.3	17.4	18.3	36.3	19.0	20.0	38.5	20.1	40.2	21.0	42.0	22.0
	LV Amps	50.0	91.3	50.0	45.7	87.6	45.7	45.7	86.4	45.7	45.8	87.5	45.6	87.3	45.6	87.5	45.8
HS22F3A	HV Amps	62.5	125	62.5	62.5	125	62.5	62.5	125	62.5	62.5	125	62.5	125	62.5	125	62.5
	KVA	15.0	31.6	17.2	23.7	50.0	26.1	27.5	54.5	28.5	30.0	57.7	30.2	60.3	31.6	63.0	33.0
	LV Amps	75.0	137	74.7	68.6	131	68.6	68.7	131	68.6	68.8	131	68.6	131	68.6	131	68.7
HS22F5A	HV Amps	104	208	104	104	208	104	104	208	104	104	208	104	208	104	208	104
	KVA	25.0	52.7	28.7	39.5	83.3	43.5	45.8	90.8	47.5	50.0	96.2	50.4	100	52.7	105	55.0
	LV Amps	125	229	124	114	219	114	114	218	114	114	218	114	217	114	218	114
Applicable Connection Diagram		B	A	B	D	C	D	D	C	D	D	C	D	C	D	C	D

*60 HZ ONLY (ALL OTHER RATINGS 50/60 HZ)

THREE-PHASE
120 x 240 VOLTS PRIMARY — 12/24 VOLTS SECONDARY

TABLE 4

Catalog Number	Low Voltage	92	96	100	110	115*	120*	120*	200	208	208	218	220	230*	230*	240*	240*
	High Voltage	110	115	120	121	126	132	144	220	229	229	240	231	241	253	252	264
P19FB50	HV Amps	2.08	2.08	2.08	4.16	4.16	4.16	2.08	2.08	2.08	4.16	2.08	4.16	4.16	2.08	4.16	2.08
	KVA	.397	.415	.433	.873	.909	.952	.519	.793	.826	1.65	.866	1.66	1.73	.912	1.81	.952
	LV Amps	2.49	2.49	2.50	4.58	4.56	4.58	2.50	2.29	2.29	4.58	2.29	4.37	4.36	2.29	4.37	2.29
P19FB100	HV Amps	4.16	4.16	4.16	8.33	8.33	8.33	4.16	4.16	4.16	8.33	4.16	8.33	8.33	4.16	8.33	4.16
	KVA	.793	.830	.866	1.74	1.81	1.90	1.04	1.58	1.65	3.30	1.73	3.33	3.47	1.82	3.63	1.90
	LV Amps	4.98	4.99	5.00	9.16	9.13	9.16	5.00	4.58	4.58	9.17	4.58	8.75	8.73	4.58	8.75	4.58
P19FB250A	HV Amps	10.4	10.4	10.4	20.8	20.8	20.8	10.4	10.4	10.4	20.8	10.4	20.8	20.8	10.4	20.8	10.4
	KVA	1.98	2.07	2.16	4.36	4.54	4.76	2.60	3.97	4.13	8.26	4.33	8.33	8.69	4.56	9.09	4.76
	LV Amps	12.4	12.4	12.5	22.9	22.8	22.9	12.5	11.4	11.4	22.9	11.4	21.8	21.8	11.4	21.8	11.4
HS19F500A	HV Amps	20.8	20.8	20.8	41.6	41.6	41.6	20.8	20.8	20.8	41.6	20.8	41.6	41.6	20.8	41.6	20.8
	KVA	3.97	4.14	4.33	8.73	9.09	9.52	5.19	7.93	8.26	16.5	8.66	16.6	17.3	9.12	18.1	9.52
	LV Amps	24.9	24.9	25.0	45.8	45.6	45.8	25.0	22.9	22.9	45.8	22.9	43.7	43.6	22.9	43.7	22.9
HS19F750A	HV Amps	31.2	31.2	31.2	62.5	62.5	62.5	31.2	31.2	31.2	62.5	31.2	62.5	62.5	31.2	62.5	31.2
	KVA	5.95	6.22	6.49	13.0	13.6	14.2	7.79	11.9	12.3	24.7	13.0	25.0	26.0	13.6	27.2	14.2
	LV Amps	37.3	37.4	37.5	68.7	68.4	68.7	37.5	34.3	34.4	68.8	34.4	65.6	65.4	34.3	65.6	34.3
HS19F1A	HV Amps	41.6	41.6	41.6	83.3	83.3	83.3	41.6	41.6	41.6	83.3	41.6	83.3	83.3	41.6	83.3	41.6
	KVA	7.93	8.3	8.66	17.4	18.1	19.0	10.3	15.8	16.5	33.0	17.3	33.3	34.7	18.2	36.3	19.0
	LV Amps	49.8	49.9	50.0	91.6	91.3	91.6	50.0	45.8	45.8	91.7	45.8	87.5	87.3	45.8	87.5	45.8
HS19F1.5A	HV Amps	62.5	62.5	62.5	125	125	125	62.5	62.5	62.5	125	62.5	125	125	62.5	125	62.5
	KVA	11.9	12.4	13.0	26.1	27.2	28.5	15.5	23.8	24.7	49.5	25.9	50.0	52.1	27.3	54.5	25.8
	LV Amps	74.7	74.8	75.0	137	136	137	75.0	68.7	68.8	137	68.8	131	131	68.7	131	68.7
HS19F2A	HV Amps	83.3	83.3	83.3	166	166	166	83.3	83.3	83.3	166	83.3	166	166	83.3	166	83.3
	KVA	15.8	16.5	17.3	34.9	36.3	38.1	20.7	31.7	33.0	66.1	34.6	66.6	69.5	36.5	72.7	38.1
	LV Amps	99.6	83.3	100	183	182	183	100	91.6	91.7	183	91.7	175	174	91.6	175	91.6
HS19F3A	HV Amps	125	125	125	250	250	250	125	125	125	250	125	250	250	125	250	125
	KVA	23.8	24.9	26.0	52.3	54.5	57.1	31.1	47.6	49.5	99.1	52.0	100	104	54.7	109	57.1
	LV Amps	149	149	150	275	274	275	150	137	137	275	137	262	262	137	262	137
HS19F5A	HV Amps	208	208	208	416	416	416	208	208	208	416	208	416	416	208	416	208
	KVA	39.7	41.4	43.3	87.3	90.9	95.2	51.9	79.3	82.6	165	86.6	166	174	91.3	182	95.2
	LV Amps	249	249	250	458	456	458	250	229	229	458	229	437	436	229	437	229
Applicable Connection Diagram		G	G	G	H	H	H	G	F	F	J	F	E	E	F	E	F
Number of Units Required		2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2

*60 HZ ONLY (ALL OTHER RATINGS 50/60 HZ)

THREE-PHASE
120 x 240 VOLTS PRIMARY — 16/32 VOLTS SECONDARY

TABLE 5

Catalog Number	Low Voltage	97	101	106	110	115*	120*	184	194	203	208	208*	212	220	230*	240*	240*
	High Voltage	110	115	120	139	146	152	208	220	230	236	236	240	249	261	256	272
P20FB50	HV Amps	3.12	3.12	3.12	1.56	1.56	1.56	1.56	1.56	1.56	1.56	3.12	1.56	1.56	1.56	3.12	1.56
	KVA	595	622	649	376	395	411	562	595	622	638	1.27	649	673	706	1.38	.736
	LV Amps	3.54	3.55	3.53	1.97	1.98	1.97	1.76	1.77	1.77	1.77	3.35	1.76	1.76	1.77	3.33	1.77
P20FB100	HV Amps	6.25	6.25	6.25	3.12	3.12	3.12	3.12	3.12	3.12	3.12	6.25	3.12	3.12	3.12	6.25	3.12
	KVA	1.19	1.24	1.30	752	790	822	1.12	1.19	1.24	1.27	2.55	1.30	1.34	1.41	2.77	1.47
	LV Amps	7.08	7.11	7.07	3.94	3.96	3.95	3.53	3.54	3.54	3.54	7.09	3.53	3.53	3.54	6.66	3.54
P20FB250A	HV Amps	15.6	15.6	15.6	7.81	7.81	7.81	7.81	7.81	7.81	7.81	15.6	7.81	7.81	7.81	15.6	7.81
	KVA	2.97	3.11	3.24	1.88	1.97	2.05	2.81	2.97	3.11	3.19	6.38	3.24	3.36	3.53	6.92	3.68
	LV Amps	17.7	17.7	17.6	9.87	9.91	9.89	9.83	8.85	8.85	8.86	17.7	8.84	8.84	8.86	13.6	8.85
HS20F500A	HV Amps	31.2	31.2	31.2	15.6	15.6	15.6	15.6	15.6	15.6	15.6	31.2	15.6	15.6	15.6	31.2	15.6
	KVA	5.95	6.22	6.49	3.76	3.95	4.11	5.62	5.95	6.22	6.38	12.7	6.49	6.73	7.06	13.8	7.36
	LV Amps	35.4	35.5	35.3	19.7	19.8	19.7	17.6	17.7	17.7	17.7	35.4	17.6	17.6	17.7	33.3	17.7
HS20F750A	HV Amps	46.8	46.8	46.8	23.4	23.4	23.4	23.4	23.4	23.4	23.4	46.8	23.4	23.4	23.4	46.8	23.4
	KVA	8.93	9.33	9.74	5.64	5.92	6.17	8.44	8.93	9.33	9.58	19.1	9.74	10.1	10.5	20.7	11.0
	LV Amps	53.1	53.3	53.0	29.6	29.7	29.6	26.5	26.5	26.5	26.5	53.1	26.5	26.5	26.5	50.0	26.5
HS20F1A	HV Amps	62.5	62.5	62.5	31.2	31.2	31.2	31.2	31.2	31.2	31.2	62.5	31.2	31.2	31.2	62.5	31.2
	KVA	11.9	12.4	13.0	7.52	7.90	8.22	11.2	11.9	12.4	12.7	25.5	13.0	13.4	14.1	27.7	14.7
	LV Amps	70.8	71.1	70.7	39.4	39.6	39.5	35.3	35.4	35.4	35.4	70.9	35.3	35.3	35.4	66.6	35.4
HS20F1.5A	HV Amps	93.7	93.7	93.7	46.8	46.8	46.8	46.8	46.8	46.8	46.8	93.7	46.8	46.8	46.8	93.7	46.8
	KVA	17.8	18.6	18.4	11.2	11.8	12.3	16.8	17.8	18.6	19.1	38.3	19.4	20.2	21.1	41.5	22.0
	LV Amps	106	106	106	59.2	59.5	59.3	53.0	53.1	53.1	53.1	106	53.0	53.0	53.1	100	53.1
HS20F2A	HV Amps	125	125	125	62.5	62.5	62.5	62.5	62.5	62.5	62.5	125	62.5	62.5	62.5	125	62.5
	KVA	23.8	24.8	25.9	15.0	15.8	16.4	22.5	23.8	24.8	25.5	51.0	25.9	26.9	28.2	55.4	29.4
	LV Amps	141	142	141	79.0	79.3	79.1	70.6	70.8	70.8	70.9	141	70.7	70.7	70.9	133	70.8
HS20F3A	HV Amps	187	187	187	93.7	93.7	93.7	93.7	93.7	93.7	93.7	187	93.7	93.7	93.7	187	93.7
	KVA	35.7	37.3	39.0	22.5	23.7	24.6	33.7	35.7	37.3	38.3	76.6	39.0	40.4	42.3	83.1	44.1
	LV Amps	212	213	212	118	119	118	106	106	106	106	212	106	106	106	200	106
HS20F5A	HV Amps	312	312	312	156	156	156	156	156	156	156	312	156	156	156	312	156
	KVA	59.5	62.2	64.9	37.6	39.5	41.1	56.2	59.5	62.2	63.8	127	64.9	67.3	70.6	138	73.6
	LV Amps	354	355	353	197	198	198	176	177	177	177	354	176	176	177	333	177
Applicable Connection Diagram		H	H	H	G	G	G	F	F	F	F	J	F	F	F	E	F
Number of Units Required		2	2	2	2	2	2	2	2	2	2	3	2	2	2	3	2

*60 HZ ONLY (ALL OTHER RATINGS 50/60 HZ)

THREE PHASE
240 x 480 VOLTS PRIMARY — 24/48 VOLTS SECONDARY

TABLE 6

Catalog Number	Low Voltage	173	200	208	208	220	230*	240*	345	380	380	400	415	415	440	480*	480*
	High Voltage	208	240	229	250	264	276	288	380	399	418	440	456	456	484	504	528
P22FB50	HV Amps	1.04	1.04	2.08	1.04	1.04	1.04	1.04	1.04	2.08	1.04	1.04	1.04	2.08	1.04	2.08	1.04
	KVA	375	433	.826	.451	.476	.498	519	685	1.44	754	793	822	1.64	.873	1.81	.952
	LV Amps	1.25	1.25	2.29	1.25	1.25	1.25	1.25	1.14	2.18	1.14	1.14	1.14	2.28	1.14	2.18	1.14
P22FB100	HV Amps	2.08	2.08	4.16	2.08	2.08	2.08	2.08	2.08	4.16	2.08	2.08	2.08	4.16	2.08	4.16	2.08
	KVA	750	866	1.65	.902	.952	.996	1.03	1.37	2.88	1.50	1.58	1.64	3.29	1.74	3.63	1.90
	LV Amps	2.50	2.50	4.58	2.50	2.50	2.50	2.50	2.29	4.37	2.29	2.29	2.29	4.57	2.29	4.37	2.29
P22F250A	HV Amps	5.20	5.20	10.4	5.20	5.20	5.20	5.20	5.20	10.4	5.20	5.20	5.20	10.4	5.20	10.4	5.20
	KVA	1.87	2.16	4.13	2.25	2.38	2.49	2.60	3.42	7.20	3.77	3.96	4.11	8.22	4.36	9.09	4.76
	LV Amps	6.25	6.25	11.4	6.26	6.25	6.25	6.25	5.73	10.9	5.72	5.72	5.72	11.4	5.72	10.9	5.73
HS22F500A	HV Amps	10.4	10.4	20.8	10.4	10.4	10.4	10.4	10.4	20.8	10.4	10.4	10.4	20.8	10.4	20.8	10.4
	KVA	3.75	4.33	8.26	4.51	4.76	4.98	5.19	6.85	14.4	7.54	7.93	8.22	16.4	8.73	18.1	9.52
	LV Amps	12.5	12.5	22.9	12.5	12.5	12.5	12.5	11.4	21.8	11.4	11.4	11.4	22.8	11.4	21.8	11.4
HS22F750A	HV Amps	15.6	15.6	31.2	15.6	15.6	15.6	15.6	15.6	31.2	15.6	15.6	15.6	31.2	15.6	31.2	15.6
	KVA	5.63	6.50	12.3	6.76	7.14	7.47	7.79	10.2	21.6	11.3	11.9	12.3	24.6	13.1	27.2	14.2
	LV Amps	18.7	18.7	34.4	18.7	18.7	18.7	18.7	17.2	32.8	17.1	17.1	17.1	34.3	17.1	32.8	17.1
HS22F1A	HV Amps	20.8	20.8	41.6	20.8	20.8	20.8	20.8	20.8	41.6	20.8	20.8	20.8	41.6	20.8	41.6	20.8
	KVA	7.50	8.66	16.5	9.02	9.52	9.96	10.3	13.7	28.8	15.0	15.8	16.4	32.9	17.4	36.3	19.0
	LV Amps	25.0	25.0	45.8	25.0	25.0	25.0	25.0	22.9	43.7	22.9	22.9	22.9	45.7	22.9	43.7	22.9
HS22F1.5A	HV Amps	31.2	31.2	62.5	31.2	31.2	31.2	31.2	31.2	62.5	31.2	31.2	31.2	62.5	31.2	62.5	31.2
	KVA	11.2	13.0	24.7	13.5	14.2	14.9	15.5	20.5	43.1	22.6	23.8	24.6	49.3	26.1	54.5	28.5
	LV Amps	37.5	37.5	68.8	37.5	37.5	37.5	37.5	34.4	65.6	34.3	34.3	34.3	68.6	34.3	65.6	34.3
HS22F2A	HV Amps	41.6	41.6	83.3	41.6	41.6	41.6	41.6	41.6	83.3	41.6	41.6	41.6	83.3	41.6	83.3	41.6
	KVA	15.0	17.3	33.0	18.0	19.0	19.9	20.7	27.4	57.5	30.1	31.7	32.9	65.8	34.9	72.7	38.1
	LV Amps	50.0	50.0	91.7	50.0	50.0	50.0	50.0	45.8	87.5	45.8	45.8	45.7	91.5	45.8	87.5	45.8
HS22F3A	HV Amps	62.5	62.5	125	62.5	62.5	62.5	62.5	62.5	125	62.5	62.5	62.5	125	62.5	125	62.5
	KVA	22.5	25.9	49.5	27.0	28.5	29.8	31.1	41.1	86.3	45.2	47.6	49.3	98.7	52.3	109	57.1
	LV Amps	75.1	75.0	137	75.1	75.0	75.0	75.0	68.8	131	68.7	68.7	68.6	137	68.7	131	68.7
HS22F5A	HV Amps	104	104	208	104	104	104	104	104	208	104	104	104	208	104	208	104
	KVA	37.5	43.3	82.6	45.1	47.6	49.8	52.0	68.5	144	75.4	79.3	82.2	164	87.3	181	95.2
	LV Amps	125	125	229	125	125	125	125	114	218	114	114	114	228	114	218	114
Applicable Connection Diagram		G	G	H	G	G	G	G	F	E	F	F	F	J	F	E	F
Number of Units Required		2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2

*60 HZ ONLY (ALL OTHER RATINGS 50/60 HZ)

HONEYWELL

CHART RECORDER

Honeywell

DR4500A Truline Circular Chart Recorder With or Without Control Product Manual

44-45-25-30D
5/95

About This Publication

How this manual is organized

This manual covers both model DR45AT and DR45AR Truline recorders. The data is tailored primarily for the standard model DR45AT, but it also applies for model DR45AR except where noted. The DR45AR functions that differ from model DR45AT are detailed in Appendix C.

The manual contains 13 sections. The first four sections deal with set-up tasks for a DR4500A recorder; sections 5, 6, 7, and 8 cover operation, setpoint programming and calibration, respectively. Section 9 covers troubleshooting/service. Section 10 is a parts list, and sections A, B, and C are appendices. Use the master table of contents to locate specific topics.

Warranty

The device described herein has been manufactured and tested for correct operation and is warranted as follows:

The DR4500A Truline Recorder carries a two year warranty. This warranty includes immediate technical assistance via a toll free telephone number and complete replacement of the controller, if necessary.

Technical Assistance

If you encounter a problem with your DR4500A recorder, review all the configuration data under the Set-up groups to verify that your selections are consistent with your application; i.e. Inputs, Outputs, Alarms, Limits, etc. If the problem persists after checking the above, you can get technical assistance by dialing

1-800-423-9883 USA
1-800-461-0013 Canada

An engineer will discuss your problem with you. Please have your complete model number, serial number, and Software version available. The model and serial numbers can be found on the chassis nameplate. The software version can be viewed under Setup Group "Status." See *subsection 9.2*.

If it is determined that a hardware problem exists, a replacement controller or part will be shipped with instructions for returning the defective unit. Do not return your controller without authorization from Honeywell's Technical Assistance Center or until the replacement has been received.

Section 1 – Overview

1.1 Introduction

Function

The DR4500A Truline Recorder is a one to four-channel microprocessor-based circular chart recorder. Its "one-pen" stylus printhead produces up to four analog traces and prints alphanumeric chart data on a blank heat-sensitive chart. All four traces share the same time line reference which the Truline prints. This eliminates the error caused by pen alignment offsets in conventional pen designs. Since the Truline prints the chart and generates the analog traces at the same time, there is no error due to variations in chart size caused by changes in temperature and humidity.

In addition to printing chart records, the Truline recorder alternately displays process variable values for all channels in the selected engineering units.

Models with up to four input channels accept inputs from any one of a variety of sensors or transmitters within the configurable range limits.

The Truline is also available with one or two independent digital controllers.

Microprocessor controlled recording and printing

Both the chart and printhead are driven by stepper motors controlled by the microprocessor with configurable chart speed through the keypad.

You can configure various "printed" chart data such as range marking in engineering units, digital values for process variables, and trace identification. This data plus printed time lines and engineering units of scale eliminate the need to maintain an inventory of a variety of preprinted charts.

The Truline recorder uses a dot fill technique from a microprocessor algorithm to produce a continuous analog trace of a process variable.

Digital controller

The DR4500A recorder controller includes an integral microprocessor-based, single loop, PID controller. A variety of output types, including a duplex variation for heat cool applications, lets you select the output that is right for your final control element.

You can configure the control action as On-Off, PID-A, PID-B, or PD with manual reset. English language prompts guide you through the entry of all the controller's configurable parameters.

Construction

The DR4500A recorder is housed in a molded case which can be panel or surface mounted. A glass or acrylic windowed door protects the internal components while allowing easy access to the chart and operator interface.

Circuitry is partitioned on printed circuit boards for ease of service.

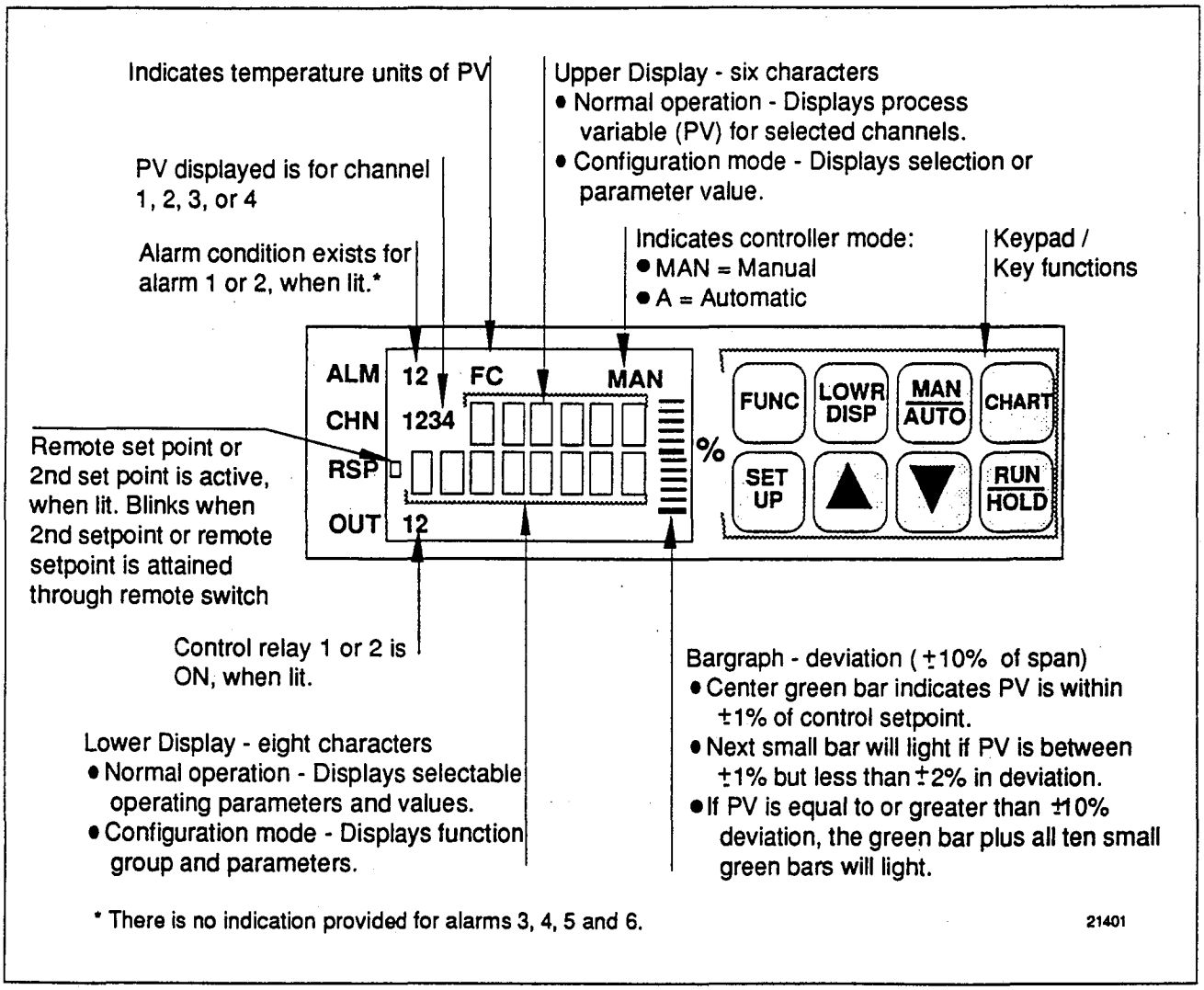
Power, input, and output wiring connect to terminations inside the case. Knockouts in the sides and bottom of the case accept conduit connections for convenient wire entry.

1.2 Operator Interface

Operator Interface

Figure 1-1 shows the operator interface and defines the displays and indicators. The function of the keys is described in Table 1-1.

Figure 1-1 Operator Interface



Continued on next page

Key functions

Table 1-1 shows each key on the operator interface and defines its function.

Table 1-1 Function of Keys

Key	Function
SET UP	• Places the controller in the Configuration Set Up group select mode. Sequentially displays Set Up groups and allows the FUNC key to display individual functions in each Set Up group.
FUNC	• Used in conjunction with the SET UP key to select the individual functions of a selected Configuration Set Up group. • Used to toggle between SP1 and SP2. • Used during field calibration procedure.

LOWR DISP	• Selects an operating parameter to be shown in the lower display:
	OUT = Output Value
	SP = Local Setpoint 1
	2SP = Local Setpoint 2
	RSP = Remote Setpoint
	2IN = Input 2
	3IN = Input 3
	4IN = Input 4
	DEV = Deviation
	EU = PV Engineering Units
	RH = % RH Value
	PIDSETX = Tuning Parameter Set X=1 or 2
	RAMP = Minutes remaining in Setpoint Ramp
	#RA = Minutes remaining in SP Prog Ramp
	#SK = Minutes remaining in SP Prog Soak
	RECYC = Number of recycles left in SP Program
	ATTENTION The lower display can be configured to scroll through the operating parameters.

MAN AUTO	• Alternately selects: AUTO Lower display automatically displays setpoint value in engineering units. MAN Lower display automatically indicates output in %.
CHART	• Used to stop printing operation and move pen to outer limit for chart change. Display will revert to date and time.
RUN HOLD	• Alternate action switch initiates or holds the Setpoint Ramp or Setpoint Program. • In configuration mode, restores the original value or selection if you do not want to enter a change you are making to a parameter.
▲	• Increases the setpoint, output, or configuration values displayed.
▼	• Decreases the setpoint, output, or configuration values displayed.

5.13 Maximizing Pen Life

Steps for maximizing pen life

Table 5-24 lists nine steps that will help to maximize the life of your chart pen.

Table 5-24 Maximizing Pen Life

Step	Action
1	Store the chart paper in a cool, clean dry place where the temperature does not exceed 40°C (104°F) and the humidity is below 65% RH.
2	Do not expose the pen tip and chart paper to abrasive chemicals or dust that cause excessive pen wear.
3	If the recorder is used in a dusty atmosphere, provide a positive 'clean air purge' to minimize dust particle accumulation on the chart paper.
4	Periodically clean the pen arm using a cotton swab dipped in alcohol. This is more important when the recorder is located in a dusty environment and no 'clean air purge' is used.
5	Never let the pen tip ride on the chart plate when the paper is not present. Use the pen lifter to raise the arm when changing the paper.
6	Keep the door closed while recording.
7	Always insert the pen arm tip into the shipping sponge when storing or shipping the recorder.
8	Be sure that the chart paper lays flat against the chart plate. Any ripple in the paper will cause light pen printing.
9	Be sure the chart hub assembly is pushed onto the motor shaft so that it is flush with the chart plate.

5.14 Routine Maintenance

Introduction

The DR4500A recorder does not require any periodic maintenance as such. But, you will have to clean the pen tip, and replace the chart and optional chart lamp as required.

WARNING **Do not lubricate the plastic gears on the chart and pen motors.**

Cleaning the pen tip

Follow the procedure in Table 5-25 to clean the pen tip.

ATTENTION Cleaning frequency varies with the recording application environment.

Table 5-25 Cleaning the Pen Tip

Step	Action
1	Open the recorder door.
2	Pull the pen lifter up in order to raise the pen from the chart.
3	Carefully clean the pen tip with a cotton swab that has been dipped in alcohol.
4	Push the pen lifter down to lower the pen.
5	Close the door and resume normal operation.

Replacing a burned-out chart lamp (optional)

Follow the procedure in Table 5-26 to replace a burned-out chart lamp.

Table 5-26 Replacing a Chart Lamp

Step	Action
1	Open the recorder door and remove power.
2	Unscrew and remove the hood from the lamp assembly.
3	Push the (bayonet-type) lamp in and turn it counterclockwise to remove it from the socket.
4	Reverse step 3 and install the replacement lamp (General Instrument type 1828 or equivalent) in the socket.
5	Replace the hood on the lamp assembly.
6	Close the door and apply the power.

Continued on next page

Installing/replacing procedure

Follow the procedure in Table 5-27 to install/replace the chart.

CAUTION Store replacement charts in a dust-resistant location. Otherwise, accumulated dust on the chart may cause excessive pen tip abrasion which can shorten expected pen life. In addition, you may want to air purge the case if the recorder is mounted in an extremely dusty environment.

Table 5-27 Installing/Replacing the Chart

Step	Action
1	Open the recorder door.
2	Press the CHART key. The pen moves to and stops at the outer limit of pen travel near the edge of the chart. Also, chart rotation stops and the date and time appear in the displays.
3	Pull the pen lifter up to raise the pen from the chart.
4	Carefully remove the used chart from the hub and retaining clips (do not remove the hub adapter).
5	Install the new chart so that its edges are under the four retaining clips and its small alignment hole is over the alignment pin on the hub (that is, press the chart down completely around the hub adapter).
6	Push the pen lifter down to lower the pen.
7	Press the CHART key. The recorder goes to the "CHART RUN." The date and time in the display is replaced by the parameter prompt/value that was last selected using the LOWR DISP key. **ATTENTION** The recorder has a non-volatile memory. You can reset the processor by cycling the power, but it will have no affect on any data stored. One portion of this stored data is how many motor steps remain in the 7200 steps contained in 360 degrees of chart rotation. The counter that holds this data is reset by going from "CHART HOLD" to "CHART RUN." If, in the "CHART" set up group, the recorder is configured for "HEADER" (YES), a new header is printed, then the pen recording of input values resumes. If "HEADER" (NO) is configured, recording resumes immediately.
8	Be sure to keep the door closed during operation to minimize dust collection on the chart.

5.16 Chart Operation

Normal operation

The recorder functions differently if "NO CONTINUE" or "YES CONTINUE" is selected in Configuration Setup Group "CHART," function prompt "CONTINUE." Refer to *subsection 3.8* for selection instructions.

NO CONTINUE Operation

- A header is printed (only if "HEADER YES" is selected in Configuration Setup Group "CHART," function prompt "HEADER." Refer to *subsection 3.8* for selection instructions.)
- Graph starts with a major time line if not a standard chart.

  If standard chart, graph starts with a solid line indicating where the chart began. An incomplete segment will be printed with *no* time or text information up to the next hour mark. At that point, a new time line will be printed, on the hour. The initial incomplete segment will be completed, including any partially printed range values, at the end of the rotation. Additionally, any time or text information being printed when the chart hits 7200 steps will continue to be completed.
- Chart motor takes 7200 steps printing graph, time lines, and PV.
- Counter decrements to 0.
- Chart stops rotation.

YES CONTINUE Operation

- A header is printed (only if "HEADER YES" is selected in Configuration Setup Group "CHART," function prompt "HEADER." Refer to *subsection 3.8* for selection instructions.)
- Graph starts with a major time line.
- Chart motor takes 7200 steps printing graph, time lines, and PV.
- Counter decrements to 0.
- Graph stops printing.
- PV prints forever (or until the next transition from "CHART RUN" to "CHART HOLD."

Continued on next page

Remote chart operation

The Remote Chart feature can be configured to activate on any one of six events. Refer to *Subsection 3.8—Table 3-5* or *Subsection 4.4—Table 4-3* under Function prompt "REMCHT" to select an event.

When the Remote Chart feature is activated, there are three chart modes as defined in Table 5-28.

Table 5-28 Remote Chart Modes

Mode	Definition
HOLD	HOLD is the mode when you are changing the paper or when the chart has completed. HOLD is indicated by the "CHT HLD" flashing in the lower display.
READY	You enter the READY mode from the Hold mode by pressing the [CHART] key *once*. When in the READY mode, the lower display will flash "REM CHT". READY is the "armed" mode where the remote events are allowed. The chart is waiting to be activated by whatever event has been configured or by pressing [CHART] again. It is not retriggerable.
RUN	RUN is the mode where the chart has received its trigger. The chart will remain in RUN until the chart is finished (for non-continue charts) or until you press the [CHART] key. When the [CHART] key is pressed during the RUN mode, the chart will enter the HOLD mode. RUN mode can be *forced* from the READY mode by pressing the [CHART] key.

All modes are saved in battery backed RAM and will be maintained over power cycles.

Continued on next page

Recovery from a power loss

The chart will operate as listed below when power is restored after a power loss.

- Recorder shuts down with the remainder of the 7200 motor steps stored.
- The processor goes through memory self-test when power is restored.
- The recorder prints a new motor time line if not a standard chart. If standard chart, text information will be lost until the next hour mark.
- The chart counter starts to decrement from the motor step value stored at power loss.
- Normal chart operation resumes.
- A new "HEADER" is *not* printed.
- If power is not interrupted again and normal operation is allowed to continue, the time and date will be printed behind the new major time line. This documents the time that power was restored.

ATTENTION Multiple major time divisions on varying time bases indicate power or operator problems.

SIGNET

FLOW METER

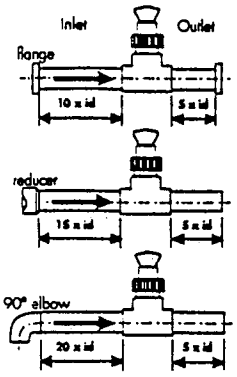
SIGNET 515/3-8510-XX Rotor-X Paddlewheel Flow Sensor

WARNING!
Never remove the flow sensor from a pressurized pipe. Always wear protective clothing during sensor installation/service.



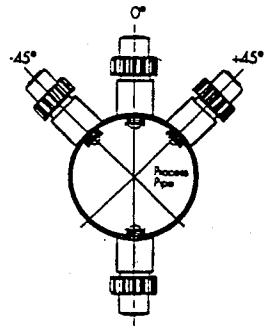
1 Location of Fitting

Recommended sensor upstream/downstream mounting requirements

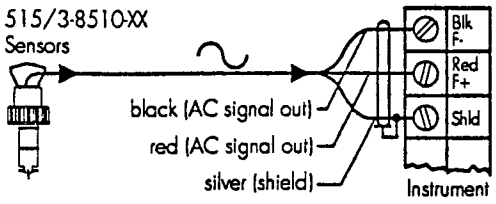


2 Sensor Mounting Position

Vertical mounting is recommended for best overall performance. Mount at a maximum of 45° when air bubbles are present. Do not mount on the bottom of the pipe when sediments are present.



3 Sensor Wiring



- Use 2-conductor shielded cable for cable extensions up to 200 ft/60 m.
- Cable shield must be maintained through cable splice.
- Refer to your instrument manual for specific wiring details.

4 SIGNET Fittings

Type	Description
Plastic tees 	• 0.5 to 4 in. versions • PVC or CPVC • Mounts via glue-on fittings
PVC glue-on saddles (O-ring not required) 	• 2 to 4 in., cut 1-7/16 in. hole in pipe • 6 to 8 in., cut 2-1/4 in. hole in pipe • Align wedge arrows with saddle arrows during assembly. • Pipes over 8 in., use iron saddle
Iron strap-on saddles 	• 2 to 4 in., cut 1-7/16 in. hole in pipe • Over 4 in., cut 2-1/4 in. hole in pipe • Special order over 12 in.
Carbon steel weld-on weldolets 	• 2 to 4 in., cut 1-7/16 in. hole in pipe • Over 4 in., cut 2-1/4 in. hole in pipe • Remove insert before welding • Installed by certified welder only • Special order over 12 in.
Carbon steel threaded tees 	• 0.5 to 2 in. versions • Mounts on threaded pipe ends



Metric plastic saddle
- For pipes DN 65 to 200 mm
- Requires a 30 mm diam. hole in the pipe
- Wedge and saddle arrows must match



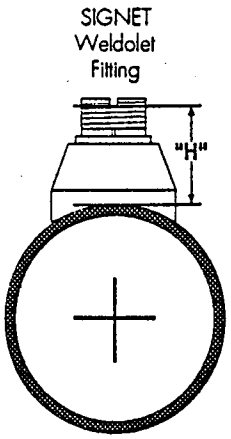
Metric wafer fitting
- For pipes DN 65 to 200 mm
- Follow the recommended installation guidelines



Metric union fitting
- For pipes from DN 15 to 50 mm
- Follow the recommended installation guidelines

5 H-Dimensions

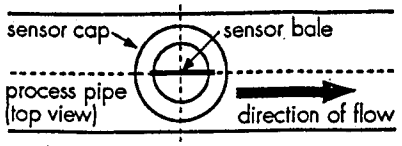
The plastic sensor insert in the Weldolet fitting MUST be removed during the welding process. When reinstalled, it is important that the insert be threaded to the proper height ("H" dimension).



Weldolet part number	"H" dimension inches	mm
CS4W020	2.38	60.45
CS4W025	2.33	59.18
CS4W030	2.32	58.92
CS4W040	2.30	58.42
CS4W050	3.09	78.48
CS4W060	2.96	75.18
CS4W080	2.73	69.34
CS4W100	5.48	139.19
CS4W120	5.25	133.35
CS4W140	5.10	129.54
CS4W160	4.85	123.19
CS4W180	4.60	116.84
CS4W200	4.38	111.25
CS4W240	4.16	105.66
CS4W360	4.10	104.14
CR4W020	2.38	60.45
CR4W025	2.33	59.18
CR4W030	2.32	58.92
CR4W040	2.30	58.42
CR4W050	3.09	78.48
CR4W060	2.96	75.18
CS4W080	2.73	69.34
CR4W100	5.48	139.19
CR4W120	5.25	133.35

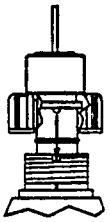
6 Standard Sensor Installation

1. Lubricate the sensor O-rings with a silicone lubricant (e.g. GE silicone compound #G632 or equivalent). Do not use any petroleum based lubricant that will attack the O-rings.



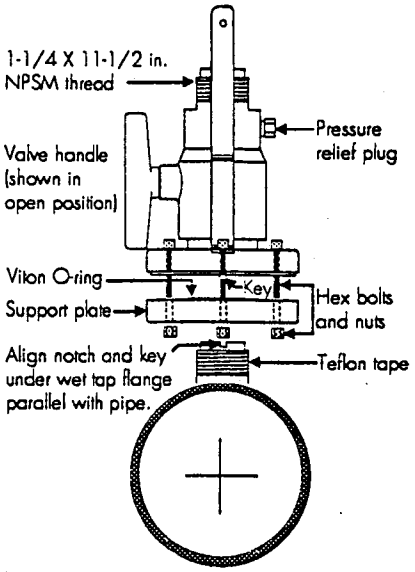
2. Using an alternating/twisting motion, lower the sensor into the fitting, making sure the installation arrows on the black cap are pointing in the direction of flow.

3. Engage one thread of the sensor cap then turn the sensor until the alignment tab is seated in the fitting notch. **Hand tighten the sensor cap. DO NOT** use any tools on the sensor cap or the cap threads and/or fitting flange threads will be damaged.



7 Wet-Tap Installation

The SIGNET 319 Wet-Tap Assembly attaches directly onto any Signet fitting to enable sensor removal without system shutdown. It consists of a flange and support plate which thread onto the pipe fitting insert, and a PVC ball valve through which an extended length 515 sensor is inserted into the pipe.



1. Remove six hex nuts and bolts from the Wet-Tap flange. Separate the support plate from the main assembly. Be sure that the Viton O-ring is properly seated in the support plate groove.

2. Wrap several turns of Teflon tape around the pipe fitting insert threads to prevent leaks.

3. Screw support plate onto pipe fitting insert. It must be threaded completely down until the notches at the top of the pipe fitting insert are exposed.

4. Mount the main Wet-Tap Assembly on the support plate. Make certain the alignment keys on the flange mate with the notches on the pipe fitting insert.

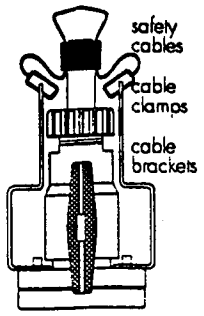
5. Replace the six hex nuts and bolts to secure the Wet-Tap Assembly in place. Adjust the support plate position as necessary to align screws.

6. Check the pressure relief plug on Wet-Tap Assembly. It must closed be finger tight to prevent leaks.

7. Close ball valve by turning the orange handle to the fully closed position (parallel with pipe).

8 Wet-Tap Sensor Installation

The 319 Wet-Tap Assembly allows installation into pressurized pipes without system shutdown. **Signet recommends reducing flow system pressure to 25 psi or less during sensor installation in a pressurized pipe.**



Non-Pressurized Installation

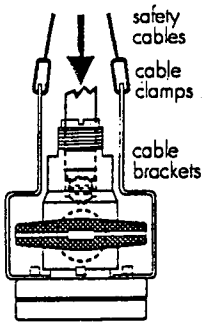
Open the orange ball valve handle to the full open position. Follow the steps 1-3 outlined in section 6. Attach the cable clamps and safety cables to the cable brackets. Verify the relief valve is closed before system operation.

Pressurized Installation

1. Lubricate the sensor O-rings with a silicone lubricant (e.g. GE silicone compound #G632 or equivalent). Do not use any petroleum based lubricant that will attack the O-rings.

2. Being careful not to bump the sensor rotor against the closed ball valve orifice, gently insert the extended 515 sensor into the 319 Assembly until the first two O-rings seat inside the bore.

3. Attach the cable clamps on each of the sensor's safety cables to the 319 Assembly cable brackets (Hand tighten only).



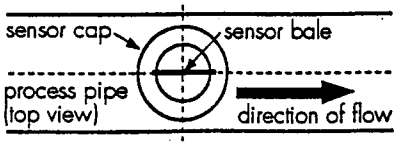
4. Pull the flow sensor upward to remove slack in the safety cables.

5. Reduce system pressure to 25 psi or less.

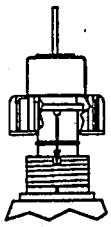
6. Wearing safety face protection, slowly open the ball valve to the full open position (perpendicular to pipe).



7. Using an alternating/twisting motion, push the extended sensor into the 319 assembly, making sure



the sensor's installation decal is pointing in the direction of flow and the alignment tab seats into the fitting notch. Align the tab under the red sensor cap in the notches on the fitting insert. Hand tighten the red sensor cap.



DO NOT use any tools on the red sensor cap or the cap threads and/or fitting flange threads will be damaged.

CAUTION: Maximum 319 Wet-Tap operating pressure: 100 psi/7 bar @ 68 °F/20 °C

Maximum 515 sensor installation/removal pressure: 25 psi/1.7 bar @ 72 °F/22 °C

9 K-Factors

The **K-Factor** is the number of pulses the sensor will generate for each engineering unit of fluid which passes. They are listed in U.S. gallons and in liters. For example, in a 1 inch PVC pipe, the paddlewheel generates 176.670 pulses per gallon of fluid passing the rotor. K-factors are listed for pipes up to 12 inch. For pipes over 12 inch, consult your Signet distributor.

PIPE SIZE	SIGNET FITTING TYPE	—K-FACTOR— U.S. GAL	LITERS
SCH 80 PVC TEES FOR SCH 80 PVC PIPE			
1/2 IN.	PV8T005	480.190	126.867
3/4 IN.	PV8T007	257.720	68.090
1 IN.	PV8T010	174.670	46.148
1 1/4 IN.	PV8T012	83.390	22.032
1 1/2 IN.	PV8T015	58.580	15.477
2 IN.	PV8T020	32.480	8.581
2 1/2 IN.	PV8T025	21.833	5.768
3 IN.	PV8T030	13.541	3.578
4 IN.	PV8T040	7.626	2.015
SCH 80 CPVC TEES FOR SCH 80 CPVC PIPE			
1/2 IN.	CPV8T005	480.190	126.867
3/4 IN.	CPV8T007	257.720	68.090
1 IN.	CPV8T010	174.670	46.148
1 1/4 IN.	CPV8T012	83.390	22.032
1 1/2 IN.	CPV8T015	58.580	15.477
SCH 80 PVC SADDLES FOR SCH 80 PVC PIPE			
2 IN.	PV8S020	32.480	8.581
2 1/2 IN.	PV8S025	21.833	5.768
3 IN.	PV8S030	13.541	3.578
4 IN.	PV8S040	7.626	2.015
6 IN.	PV8S060	4.162	1.100
8 IN.	PV8S080	2.370	0.626
SCH 80 PVC SADDLE ON SCH 40 PVC PIPE			
2 IN.	PV8S020	27.350	7.226
2 1/2 IN.	PV8S025	18.874	4.987
3 IN.	PV8S030	12.638	3.339
4 IN.	PV8S040	6.728	1.778
6 IN.	PV8S060	3.730	0.985
8 IN.	PV8S080	2.153	0.569
CARBON STEEL TEES ON SCH 40 PIPE			
1/2 IN.	CS4T005	370.202	97.808
3/4 IN.	CS4T007	212.063	56.027
1 IN.	CS4T010	141.138	37.289
1 1/4 IN.	CS4T012	60.655	16.025
1 1/2 IN.	CS4T015	45.350	11.982
2 IN.	CS4T020	26.767	7.072
STAINLESS STEEL TEES ON SCH 40 PIPE			
1/2 IN.	CR4T005	358.960	94.838
3/4 IN.	CR4T007	202.610	53.530
1 IN.	CR4T010	127.140	33.590
1 1/4 IN.	CR4T012	61.910	16.357
1 1/2 IN.	CR4T015	40.410	10.676
2 IN.	CR4T020	22.300	5.892
GALVANIZED IRON TEES ON SCH 40 PIPE			
1 IN.	IR4T010	104.537	27.619
1 1/4 IN.	IR4T012	62.979	16.639
1 1/2 IN.	IR4T015	46.688	12.335
2 IN.	IR4T020	29.459	7.783
BRONZE TEES ON SCH 40 PIPE			
1 IN.	BR4T010	104.537	27.619
1 1/4 IN.	BR4T012	62.979	16.639
1 1/2 IN.	BR4T015	46.688	12.335
2 IN.	BR4T020	29.459	7.783
COPPER TEE FITTINGS ON COPPER PIPE PIPE			
1/2 IN.SK K	CUKT005	443.206	117.095
1/2 IN. SK L		414.413	109.488
3/4 IN.SK K	CUKT007	212.156	56.052
3/4 IN. SK L		191.086	50.485
1 IN.SK K	CUKT010	127.176	33.600
1 IN. SK L		119.840	31.662
1 1/4 IN.SK K	CUKT012	88.218	23.307
1 1/4 IN. SK L		85.451	22.576
1 1/2 IN.SK K	CUKT015	56.962	15.049
1 1/2 IN. SK L		55.160	14.573
2 IN.SK K	CUKT020	29.370	7.759
2 IN. SK L		28.605	7.558

PIPE SIZE	SIGNET FITTING TYPE	—K-FACTOR— U.S. GAL	LITERS
STAINLESS STEEL WELDOLETS ON SCH 40 PIPE			
2 1/2 IN.	CR4W025	18.800	4.967
3 IN.	CR4W030	12.170	3.215
4 IN.	CR4W040	6.960	1.839
5 IN.	CR4W050	5.260	1.390
6 IN.	CR4W060	3.690	0.975
8 IN.	CR4W080	2.130	0.563
10 IN.	CR4W100	1.350	0.357
12 IN.	CR4W120	0.960	0.254
CARBON STEEL WELDOLETS ON SCH 40 PIPE			
2 1/2 IN.	CS4W025	18.800	4.967
3 IN.	CS4W030	12.170	3.215
4 IN.	CS4W040	6.960	1.839
5 IN.	CS4W050	5.260	1.390
6 IN.	CS4W060	3.690	0.975
8 IN.	CS4W080	2.130	0.563
10 IN.	CS4W100	1.350	0.357
12 IN.	CS4W120	0.960	0.254
COPPER/BRONZE BRAZOLETS ON SCH 40 PIPE			
2 1/2 IN.	BR4B025	18.800	4.967
3 IN.	BR4B030	12.170	3.215
4 IN.	BR4B040	6.960	1.839
5 IN.	BR4B050	5.260	1.390
6 IN.	BR4B060	3.690	0.975
8 IN.	BR4B080	2.130	0.563
10 IN.	BR4B100	1.350	0.357
12 IN.	BR4B120	0.960	0.254
SCH 80 IRON SADDLES ON SCH 80 PIPE			
2 IN.	IR8S020	32.360	8.550
2 1/2 IN.	IR8S025	22.220	5.871
3 IN.	IR8S030	13.420	3.546
4 IN.	IR8S040	7.660	2.024
5 IN.	IR8S050	5.860	1.548
6 IN.	IR8S060	4.090	1.081
8 IN.	IR8S080	2.330	0.616
10 IN.	IR8S100	1.530	0.404
12 IN.	IR8S120	1.060	0.280
SCH 80 IRON SADDLE ON SCH 40 PIPE			
2 IN.	IR8S020	26.820	7.086
2 1/2 IN.	IR8S025	18.800	4.967
3 IN.	IR8S030	11.990	3.168
4 IN.	IR8S040	6.850	1.810
5 IN.	IR8S050	5.330	1.408
6 IN.	IR8S060	3.760	0.993
8 IN.	IR8S080	2.130	0.563
10 IN.	IR8S100	1.350	0.357
12 IN.	IR8S120	0.960	0.254

K-Factors DIN Pipes

PIPE SIZE	SIGNET FITTING TYPE	—K-FACTOR— U.S. GAL	LITERS	CODE
POLYPROPYLENE FITTINGS (DIN/ISO AND BS AND ANSI)				
DN 15	PPMT005	481.553	127.227	198.150.522
DN 20	PPMT007	277.089	73.207	198.150.523
DN 25	PPMT010	141.181	37.300	198.150.524
DN 32	PPMT012	83.540	22.071	198.150.525
DN 40	PPMT015	51.265	13.544	198.150.526
DN 50	PPMT020	29.596	7.819	198.150.527
DN 65	PPMT025	20.658	5.458	198.150.560
DN 80	PPMT030	13.330	3.522	198.150.561
DN 100	PPMT040	8.708	2.301	198.150.562
DN 125	PPMT050	5.067	1.339	198.150.563
DN 150	PPMT060	3.689	0.975	198.150.564
DN 200	PPMT080	2.040	0.539	198.150.565

(continued)

K-Factors DIN Pipes (continued)

PIPE SIZE	SIGNET FITTING TYPE	—K-FACTOR— U.S. GAL	LITERS	CODE
PVDF FITTINGS (DIN/ISO AND BS AND ANSI)				
DN 15	SFMT005	420.868	111.104	198.150.529
DN 20	SFMT007	228.149	60.277	198.150.530
DN 25	SFMT010	136.397	36.036	198.150.531
DN 32	SFMT012	79.294	20.950	198.150.532
DN 40	SFMT015	43.490	11.490	198.150.533
DN 50	SFMT020	25.908	6.845	198.150.534
DN 65	SFMT025	18.067	4.773	198.150.571
DN 80	SFMT030	12.357	3.265	198.150.572
DN 100	SFMT040	5.797	1.532	198.150.573
DN 125	SFMT050	4.431	1.171	198.150.574
DN 150	SFMT060	3.227	0.853	198.150.575
DN 200	SFMT080	2.036	0.538	198.150.576
PVC FITTINGS (DIN/ISO) - EUROPE ONLY				
DN 15	PVMT005	486.183	128.450	198.150.480
DN 20	PVMT007	242.846	64.160	198.150.481
DN 25	PVMT010	148.637	39.270	198.150.482
DN 32	PVMT012	85.125	22.490	198.150.483
DN 40	PVMT015	51.855	13.700	198.150.484
DN 50	PVMT020	29.750	7.860	198.150.485
DN 65	PVMT025	17.487	4.620	198.150.538
DN 80	PVMT030	12.491	3.300	198.150.539
DN 100	PVMT040	8.138	2.150	198.150.540
DN 150	PVMT060	4.088	1.080	198.150.543
DN 200	PVMT080	2.044	0.540	198.150.545

Conversion Formulas

1 U.S. gallon = 0.003785 cubic meters
0.000003069 Acre feet
8.3454 pounds of water

10 Order Information

Standard 515 Rotor-X Paddlewheel Flow Sensors (All O-rings are Viton®)

Order No.	Sensor Body	Rotor Pin	Rotor	Pipe Size	Code
P515301P0	Polypro.	Titanium	PVDF (black)	0.5 to 4.0 in.	198 801 620
P515301P1	Polypro.	Titanium	PVDF (black)	5.0 to 8.0 in.	198 801 621
P515301P2	Polypro.	Titanium	PVDF (black)	10 to 36 in.	198 801 622
P515301H0	PVDF (natural)	Hastelloy C	PVDF (natural)	0.5 to 4.0 in.	198 801 623
P515301V1	PVDF (natural)	Hastelloy C	PVDF (natural)	5.0 to 8.0 in.	198 801 624
P515301V2	PVDF (natural)	Hastelloy C	PVDF (natural)	10 to 36 in.	198 801 625
P515301T0	PVDF (natural)	PVDF (natural)	PVDF (natural)	0.5 to 4.0 in.	198 801 663
P515301T1	PVDF (natural)	PVDF (natural)	PVDF (natural)	5.0 to 8.0 in.	198 801 664
P515301T2	PVDF (natural)	PVDF (natural)	PVDF (natural)	10 to 36 in.	198 801 669

319 Wet-Tap Assembly Including Extended 515 Sensor (Rotor pin material is Titanium)

Order No.	Valve	Sensor Body	Rotor	Pipe Size	Code
MK319/515P3	PVC	Polypro.	PVDF (black)	0.5 to 4.0 in.	198 840 119
MK319/515P4	PVC	Polypro.	PVDF (black)	5.0 to 8.0 in.	198 840 120
MK319/515P5	PVC	Polypro	PVDF (black)	10 to 36 in	198 840 121

319 Wet-Tap Without 515 Sensor

Order No.	Material	Description
P319-40	PVC	319 Wet-Tap

Extended 515 Sensors for 319 Wet-Tap

Order No.	Sensor Body	Rotor Pin	Rotor	Pipe Size	Code
P515301P3	Polypro.	Titanium	PVDF (black)	0.5 to 4.0 in.	198 840 310
P515301P4	Polypro.	Titanium	PVDF (black)	5.0 to 8.0 in.	198 840 311
P515301P5	Polypro	Titanium	PVDF (black)	10 to 36 in	198 840 312

515 Accessories

Order No. Rotors	Material	Code
M1538-2	PVDF (std.)	198 801 181
M1538-4	Tefzel	198 820 018
P51546	PVDF (black) with sleeve	198 820 017
P515503	PVDF (natural) + Rotor Pin	198 820 043

Order No. Rotor Pin	Material	Code
M15461	Titanium	198 801 182
M15462	Hastelloy C	198 801 183
M15463	Tantalum	198 820 014
M15464	Stainless steel	198 820 015
P51545	Ceramic	198 820 016
P515503	PVDF (natural) + Rotor	198 820 043

Order No. O-Rings	Material	Code
12200021	Viton® (std.)	198 801 186
12240021	EPR	198 820 006
12280021	Kalrez	198 820 007

Order No.	Description	Code
P31542	Sensor cap, PP	198 801 630
P31536	Plug, PP	198 840 201
P315362	Plug, PVDF (nat.) with std. cap	198 840 202

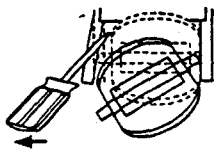
SIGNET 3-8510XX Integral Sensor Accessories

Order No.	Description	Code
3-8011	Integral sensor mounting kit with 1/2 in. NPT ports	198 864 500
3-8011-0	Integral sensor mounting kit with PG 13.5 ports	198 864 501

Order No.	Description	Pipe Size	Code
3-8510-P0	Integral sensor, Polypro.	0.5 to 4 inch	198 864 504
3-8510-P1	Integral sensor, Polypro.	5 to 8 inch	198 864 505
3-8510-V0	Integral sensor, PVDF (natural)	0.5 to 4 inch	198 864 506

11 Rotor Replacement Procedure

- To remove the rotor, insert a small screwdriver between the rotor and the ear of the sensor.
- Twist the screwdriver blade to flex the ear outward enough to remove one end of the rotor and pin. **DO NOT** flex the ear any more than necessary! If it breaks, the sensor cannot be repaired.
- Install the new rotor by inserting one ear into the hole, then flex the opposite ear back enough to slip rotor into place.



12 Specifications

General Data

Flow Rate Range:	1 to 20 ft/s, 0.3 to 6 m/s
Linearity:	±1% of maximum range
Repeatability:	±0.5% of maximum range
Pipe Size Range:	0.5 to 36 in., 15 to 900 mm
Cable Length:	25 ft/7.6 m, can splice up to 200 ft/60 m without amplification
Cable type:	2-conductor twisted pair with shield (Belden 8451)

Materials

Sensor Assembly: Various thermoplastics available. Refer to section 10 for details.

Electrical

Source Impedance: 8 kΩ

Fluid Conditions

Pressure/Temperature Ratings

Polypropylene Body:

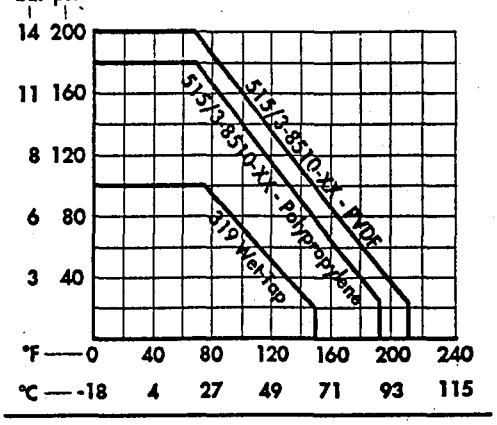
- 180 psi/12.5 bar max. @ 68 °F/20 °C
- 25 psi/1.7 bar max. @ 194 °F/90 °C

PVDF Body:

- 200 psi/14 bar max @ 68 °F/20 °C
- 25 psi/1.7 bar max @ 212 °F/100 °C

319 Wet-Tap Assembly Pressure/Temperature Ratings

- 100 psi/7 bar max. @ 77 °F/25 °C
- 20 psi/1.4 bar max @ 150 °F/66 °C



13 Warranty

This product includes a limited warranty. Consult your Signet distributor for specific warranty conditions.

SIGNET

George Fischer +GF+

Flow Sensor Test Certificate
Prüfbescheinigung Durchfluss-Sensor
Certificat de test pour capteur de débit

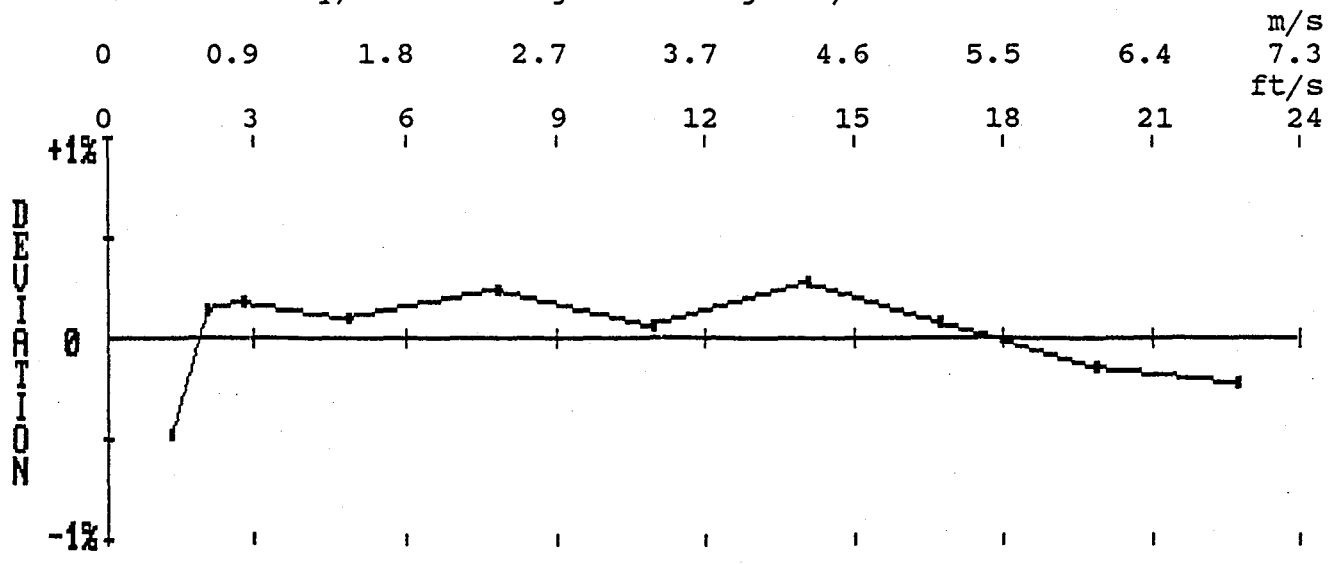
Type : Flow Transmitter
Model No.: 8510-P0
Test date: 08/15/95

Water Temperature: 22 degrees C
QA Procedure : QAP-FTCS
Traceable to NIST standards

PN: 3-8510-P0
SN: 6950815642

Flow Velocity Durchflussgeschwindigkeit Vitesse d'ecoulement (ft/s)	(m/s)	Reynolds No.	Sensor Freq. (Hz)	Sensor % deviation Sensor % Abweichung % deviation de capteur
1.42	0.43	16868.40	6.53	-0.491
2.14	0.65	25509.65	10.88	0.131
2.89	0.88	34457.18	14.69	0.176
5.00	1.52	59496.83	25.13	0.093
7.92	2.42	94355.71	39.94	0.225
11.04	3.37	131513.11	55.37	0.056
14.16	4.32	168596.57	71.22	0.279
16.87	5.14	200901.57	84.56	0.065
19.98	6.09	237890.57	99.87	-0.147
22.87	6.97	272396.38	114.29	-0.222

Flow Velocity/Durchflussgeschwindigkeit/Vitesse d'ecoulement

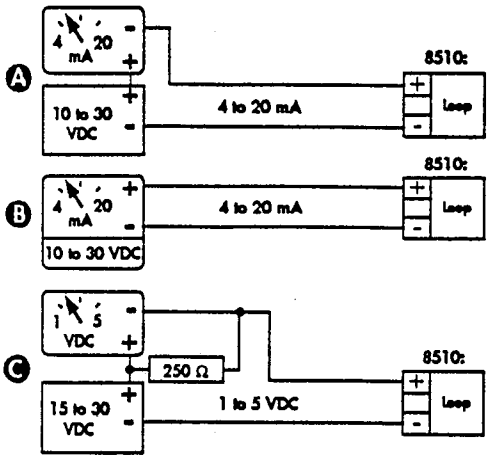


Test and calibration performed at the automated transducer test facility.
Test was performed with sensor conduit adaptor pointing downstream.

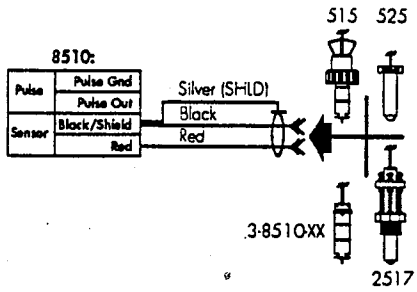
SIGNET 8510 Compak Flow Transmitter Instructions

CAUTION!
Remove power to unit before wiring input and output connections.

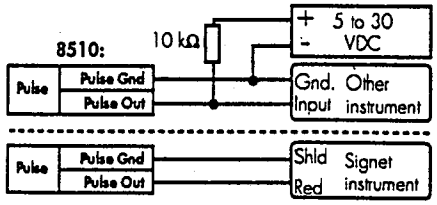
1 Loop Power Connections



2 Compatible Sensor Wiring



3 Pulse Output Wiring

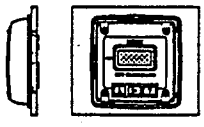


- Use 3-2507.278 input module for Signet instruments
- Signet Intelek-Pro, use 2530 input card setting

4 Installation Options

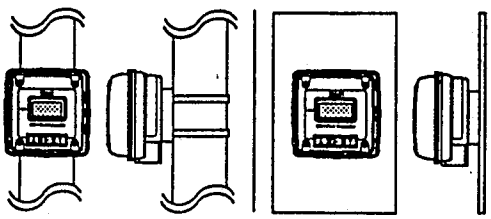
4.1 Standard Panel Mount

- Panel cutout template/instructions (included).

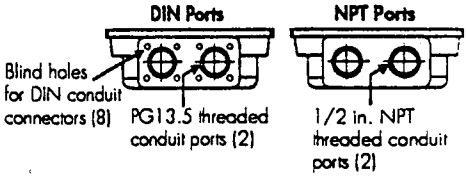


4.2 Optional 3-8010 Universal Mounting Kit

- See section 9 for ordering options.

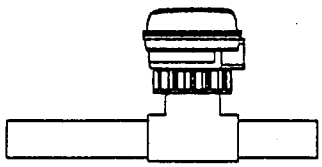


Conduit Port Options

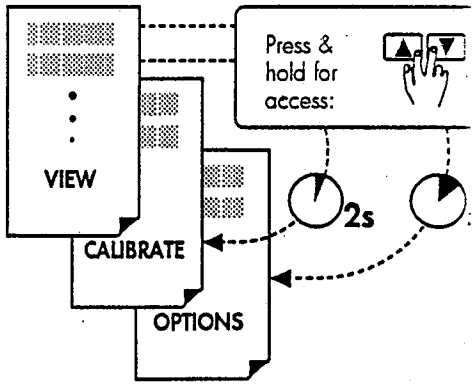


4.3 Optional 3-8011 Integral Mounting Kit

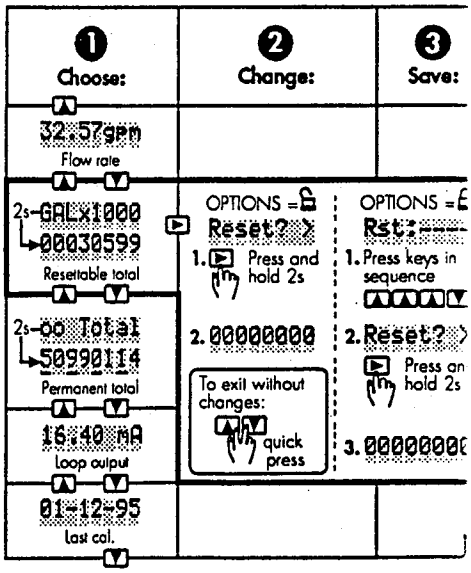
- NPT and DIN conduit port kits available, see illustration (above).
- Compatible with 3-8510-XX flow sensors (only).
- Flow sensor and fitting purchased separately, see section 9 for ordering options.



5 FUNCTIONS

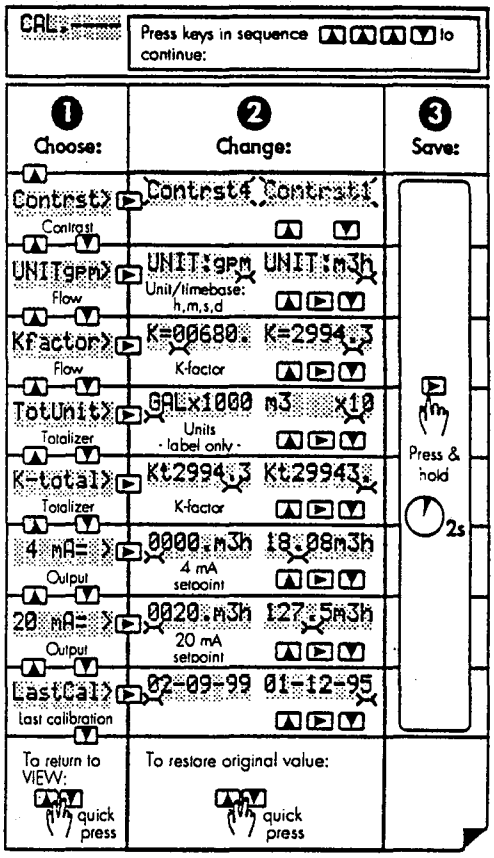


6 VIEW (example)

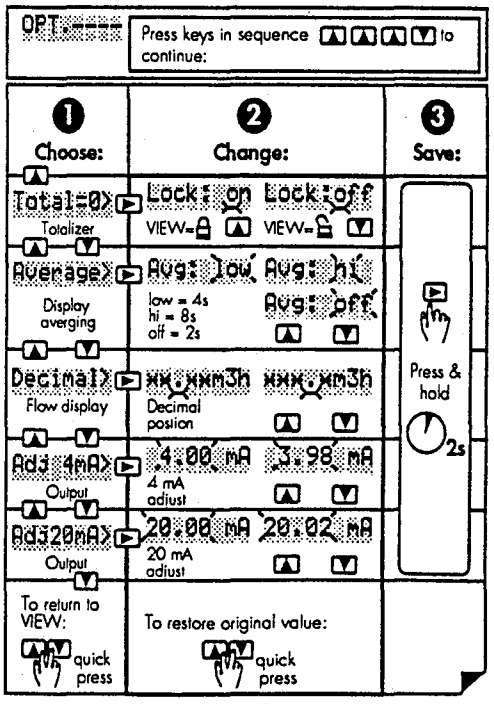


7 CALIBRATE (example)

Find K-factor for your pipe size in your sensor manual



8 OPTIONS (example)



9 Accessories

Universal mounting kit (NPT ports)	3-8010
Universal mounting kit (DIN ports)	3-8010-D
Integral sensor mounting kit (NPT ports)	3-8011
Integral sensor mounting kit (DIN ports)	3-8011-D
Integral sensor, 0.5 to 4 inch pipe - PP	3-8510-P0
Integral sensor, 5 to 8 inch pipe - PP	3-8510-P1
Integral sensor, 0.5 to 4 inch pipe - PVDF	3-8510-V0

10 Specifications

General Data

Enclosure rating:	NEMA 4X/IP65
Enclosure material:	Glass-filled polypropylene
Enclosure gasket:	Silicone rubber (captive)
Enclosure screws:	8-32, self-tapping black oxide (captive)
Display type:	8-digit alphanumeric dot matrix
Display contrast:	Variable
Display ranges:	Flow, 0.01 to 9999., Resettable/permanent totalizers, 0 to 99999999 Loop current, 3.90 to 21.00 mA
Display accuracy:	Flow, ±0.1% of reading, Totalizers, ±0.03% of reading
Loop accuracy:	±0.050 mA
Loop resolution:	5 µA

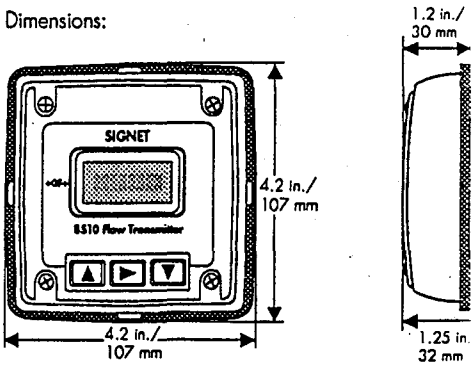
Electrical Data

Loop power:	10 to 30 VDC
Loop impedance:	1 Ω max. @ 10 VDC 100 Ω max. @ 12 VDC 1000 Ω max. @ 30 VDC
Current output:	4 to 20 mA (adjustable)
Pulse output:	Sensor frequency, optically isolated open-collector transistor, max. current sink 3.6 mA @ 30 VDC
Frequency range:	5 to 500 Hz

Ambient Conditions

Operating temperature:	-15 to 70 °C/5 to 158 °F
Storage temperature:	-15 to 80 °C/5 to 176 °F

Dimensions:



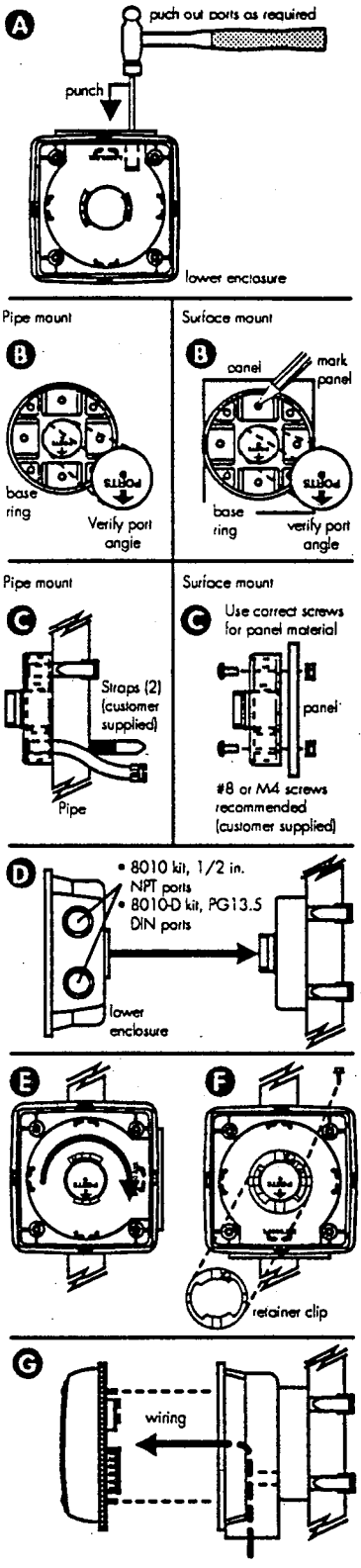
(front view) (side vie

11 Warranty

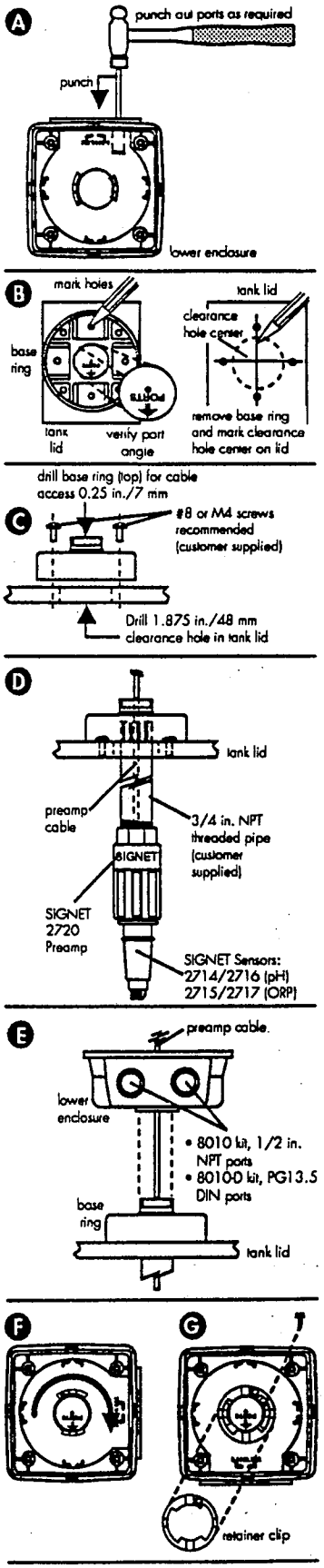
This product includes a limited warranty. Consult you Signet distributor for specific warranty conditions.

SIGNET Compak Transmitter Mounting Instructions 8010, 8010-D Kits

1 Pipe/Surface Mount Instructions

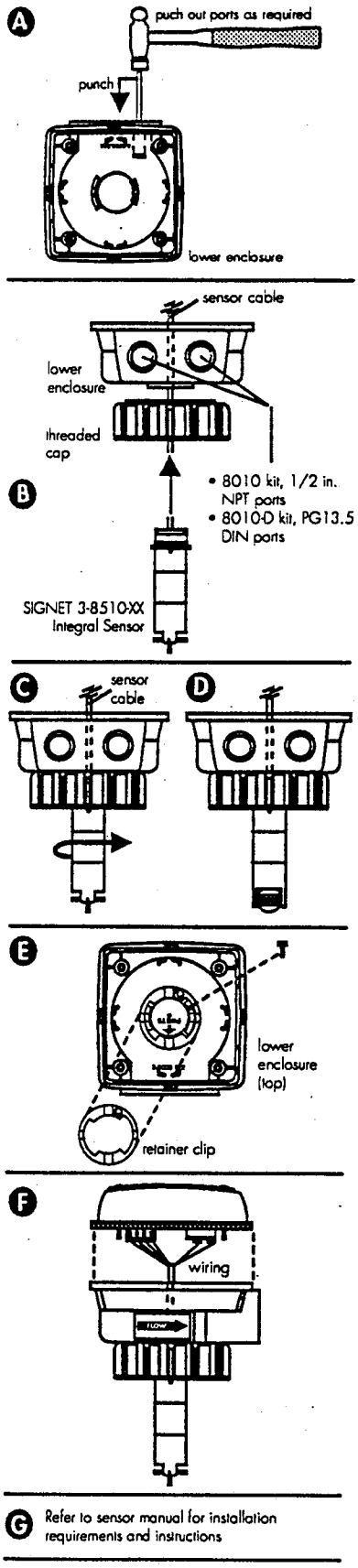


2 Tank Lid Mounting



SIGNET Compak Transmitter Mounting Instructions 8011, 8011-D Kits

1 Integral Sensor Mounting



Specifications

8010/8010-D Universal Mounting Kits

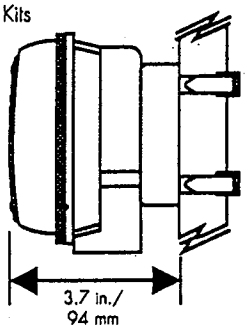
Enclosure base options:	
• 8010 kit:	1/2 in. NPT conduit ports
• 8010-D kit:	PG13.5/DIN conduit port
Materials:	Glass filled polypropylene
Base ring hole patterns:	2.60 in./66 mm bolt circ
	2.25 in./57 mm bolt circ

8011/8011-D Integral Sensor Mounting Kits

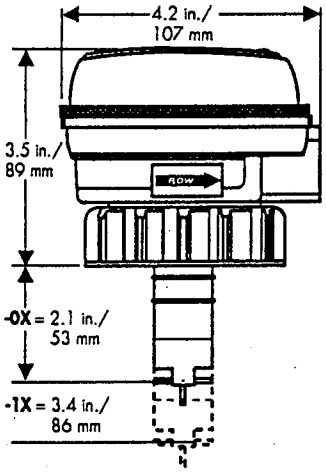
Enclosure base options:		
• 8011 kit:	1/2 in. NPT conduit ports	
• 8011-D kit:	PG13.5/DIN conduit port	
Materials:	Glass filled polypropylene	
Compatible sensors:		
• 0.5 to 4 inch	Polypropylene	3-8510-
• 5 to 8 inch	Polypropylene	3-8510-
• 0.5 to 4 inch	PVDF	3-8510-

Mounting dimensions:

8010/8010-D Kits



8011/8011-D Kits



Warranty

This product includes a limited warranty. Consult yo
Signet distributor for specific warranty conditions.

SIGNET

Signet Scientific Company, 3401 Aerojet Avenue, El Monte, CA 91731-2882/U.S.A., Phone (818) 571-2770, Fax (818) 573-2057

Representative Offices

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CH Georg Fischer Rohrleitungssysteme AG, CH-8201 Schaffhausen/Schweiz, Tel. 053/81 11 11, Telex 89 70 70 64 gf ch, Fax 053/25 91 30
SIN George Fischer Pte Ltd., 15 Kaki Bukit Road 2, KB Warehouse Complex, Singapore 1441, Tel: 65/747 0611, Fax: 65/747 0577

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3-8510.090-1/(C-1/95)

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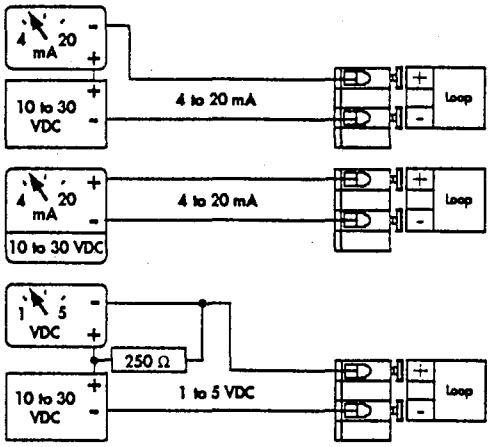
SIGNET

pH METER

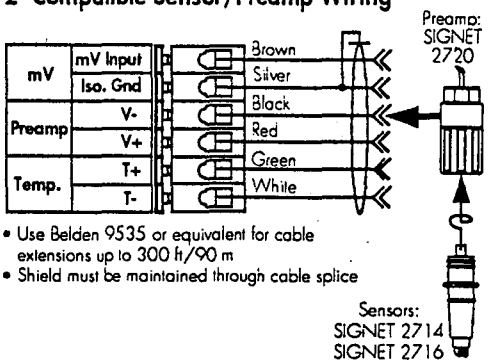
SIGNET 8710 Compak pH/ORP Transmitter - pH Instructions

CAUTION!
Remove power to unit before wiring input and output connections.

1 Loop Power Connections



2 Compatible Sensor/Preamp Wiring

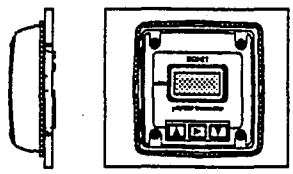


- Use Belden 9535 or equivalent for cable extensions up to 300 ft/90 m
- Shield must be maintained through cable splice

3 Installation Options

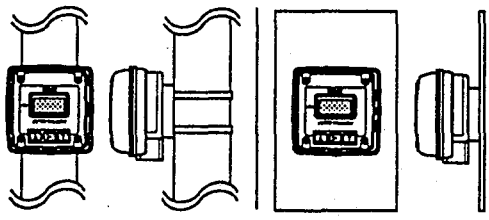
3.1 Standard Panel Mount

- Panel cutout template/instructions (included).

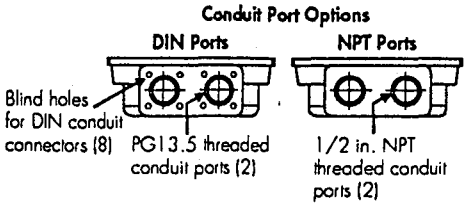


3.2 Optional 3-8010 Universal Mounting Kit

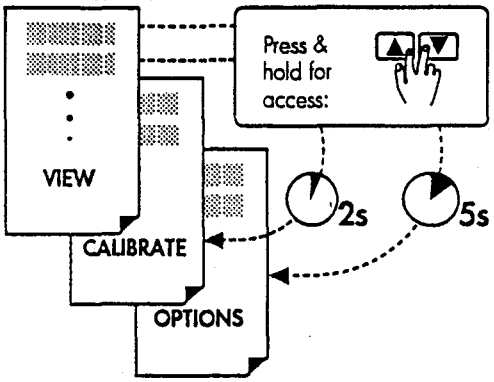
- See section 9 for ordering options.



Conduit Port Options



4 FUNCTIONS



5 VIEW

❶ To choose:	❷ To change:	❸ To save:
10.17 pH pH -183 mV Raw mV 22.4 °C Temperature 16.40 mA Output 01-12-94 Last Cal. EasyCal> Buffer cal.	Press and release to access EASY CAL	

6 EASY CAL

- Requires 2 pH buffers. Use pH 4.0, 7.0, 10.0 buffers only.

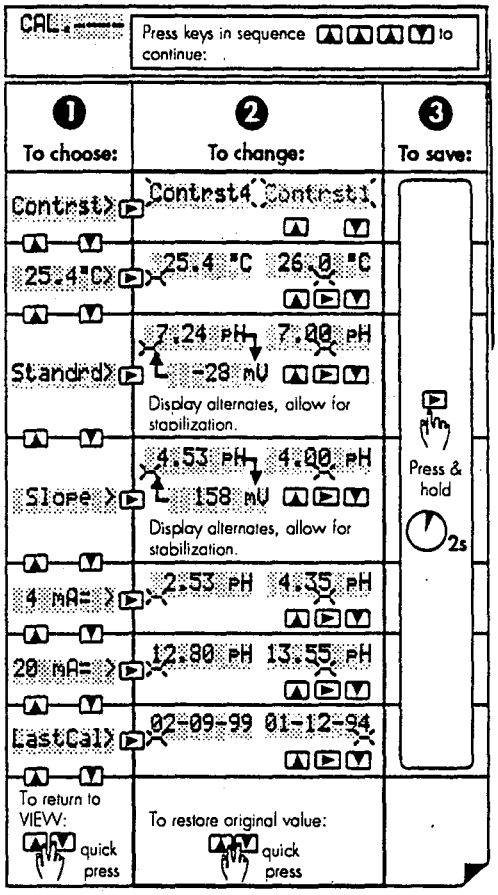
EASY---- Press keys in sequence ▲▲▲▼ to continue:

❶ To calibrate:	❷ Response:	❸ To accept:
Buffer 1 Place sensor tip in **first** pH buffer; pH 4.00, pH 7.00, or pH 10.00	10.17 pH ↔ -183 mV Display alternates every 2 seconds. Allow for stabilization.	10.13 pH Press ▶ for 1 second to accept buffer calibration 10.00 pH
Buffer 2 Place sensor tip in **second** (different) pH buffer: pH 4.00, pH 7.00, or pH 10.00	3.93 pH ↔ 179 mV Display alternates every 2 seconds. Allow for stabilization.	3.97 pH Press ▶ for 1 second to accept buffer calibration 4.00 pH Display returns to VIEW

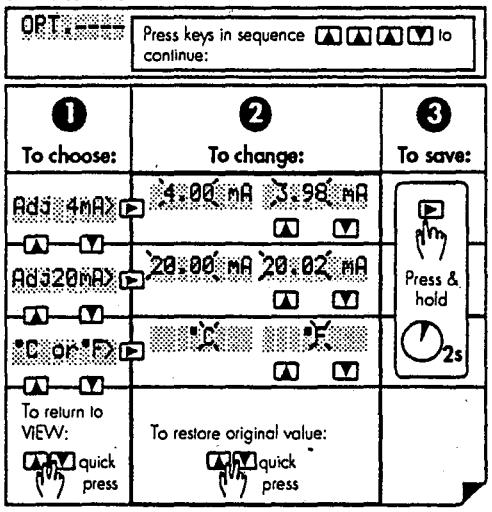
To exit EASY CAL at any time without saving and return to VIEW: ▲▼ quick press

7 CALIBRATE

- Standard and Slope requires 2 buffer values



8 OPTIONS



9 Accessories

Universal mounting kit (NPT ports)	3-8010
Universal mounting kit (DIN ports)	3-8010-D
pH buffer kit, pH 4.0, 7.0, 10.0	3-0700.390

10 Specifications

General Data

pH range:	0 to 14
Enclosure rating:	NEMA 4X/IP65
Enclosure material:	glass-filled polypropylene
Enclosure gasket:	silicone rubber (captive)
Enclosure screws:	8-32, self-tapping black oxide (captive)
Display type:	8-digit alphanumeric dot matrix
Display contrast:	variable
Display ranges:	pH, 0 to 14 raw mV, ±515 mV loop current, 3.90 to 21.00 mA temperature -10 to 120 °C
Display accuracy:	±0.03 pH
Loop accuracy:	±0.016 mA
Buffer recognition:	Automatic for pH 4.0, 7.0, and 10.0 using EASY CAL

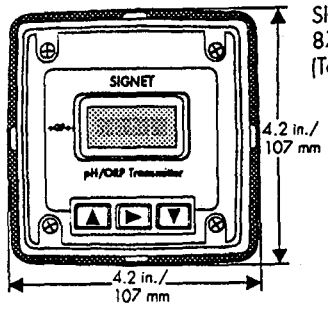
Electrical Data

Loop power:	10 to 30 VDC
Loop impedance:	50 Ω max. @ 10 VDC 100 Ω max. @ 12 VDC 1000 Ω max. @ 30 VDC
Input isolation:	500 VDC galvanic isolation
Current output:	4 to 20 mA (adjustable)
Compatible preamp:	SIGNET 2720 only, for use with SIGNET 2714/2716 pH sensors
Preamp power:	±5 to 7.5 VDC @ 50 µA max. (from 8710)
Input signal:	-999 to 1999 mV maximum from preamp
Thermistor signal:	3 KΩ Balco, 2600 to 4200 Ω from -10 to 120 °C

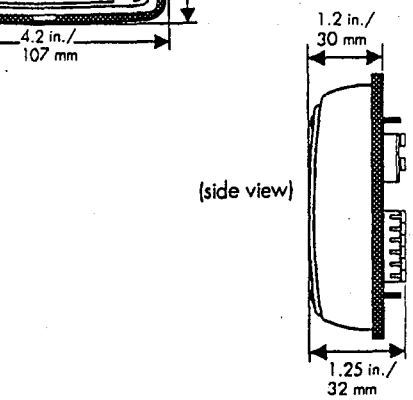
Ambient Conditions

Operating temperature:	-15 to 70 °C/5 to 158 °F
Storage temperature:	-15 to 80 °C/5 to 176 °F

Dimensions:



SIGNET 8710 (Top View)



11 Warranty

This product includes a limited warranty. Consult your Signet distributor for specific warranty conditions.

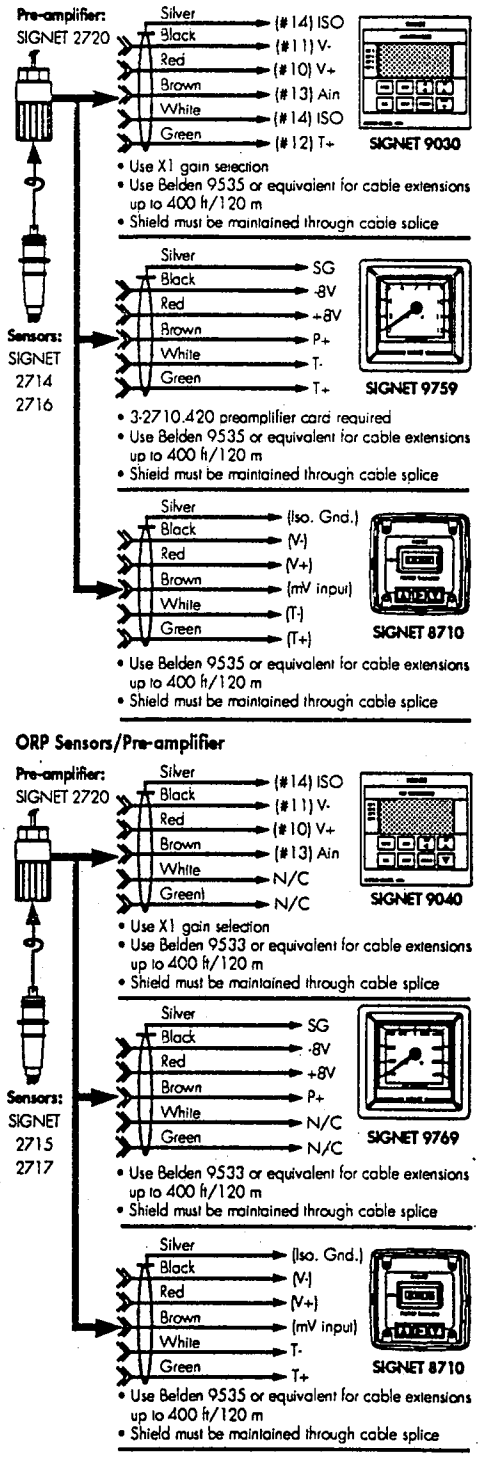
SIGNET pH/ORP Sensor/Preamp Instructions

CAUTION!
Never remove a sensor from a pressurized pipe. Always wear safety face protection during sensor installation and removal.



1 Wiring

pH Sensors/Pre-amplifier



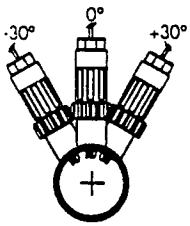
ORP Sensors/Pre-amplifier

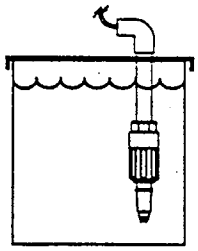
2 SIGNET Fittings

Type	Description
Plastic tees 	• 0.5 to 4 in. versions • PVC or CPVC • Mounts via glue-on fittings
PVC glue-on saddles (O-ring not required) 	• 2 to 4 in. versions • 1-7/16 in. hole required in pipe • Align wedge arrows with saddle arrows during assembly.
Iron strap-on saddles 	• 2 to 4 in. versions • 1-7/16 in. hole required in pipe
Carbon steel weld-on weldolets 	• 2 to 4 in. versions • 1-7/16 in. hole required in pipe • Remove insert before welding • Installed by certified welder only
Carbon steel threaded tees 	• 0.5 to 2 in. versions • Mounts on threaded pipe ends
Universal pipe adapter for large pipes 	• For existing pipe fittings 2 in. and up • External 1-1/4 inch NPT male threads

Consult your local Signet distributor for additional fitting information.

3 Recommended Position

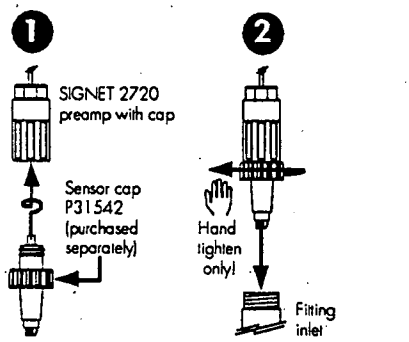




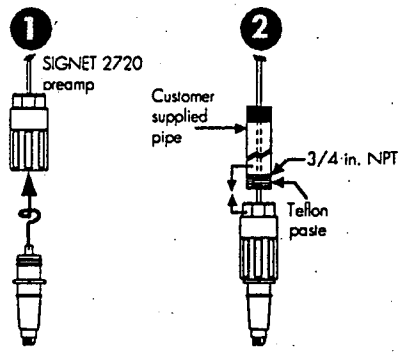
- Vertical (0°) position optimum
- 4 fps or less for max. performance and sensor life

4 Installation

In-line Applications



Submersible Applications



5 Sensor Accessories

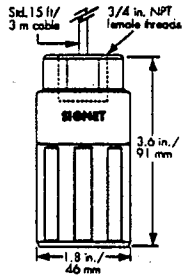
Description	Material	Part no.
Sensor cap 	Polypropylene	P31542
O-ring 	Viton® EPR Kalrez	1220-0021 1224-0021 1228-0021

6 Specifications

SIGNET 2720 pH/ORP Preamplifier

Housing material:	CPVC
Compatible sensors:	2714 Flat Surface pH Sensor 2715 Flat Surface ORP Sensor 2716 Bulb pH Sensor 2717 Bulb ORP Sensor
Input Impedance:	$>10^{11}$ Ω
Operating temp.:	0 to 80 °C
Gain:	X1 (unity)
Input power:	±4.5 to ±8 VDC, dual supply
Current consumption:	<1 mA, dual supply

Dimensions:



pH/ORP Sensors

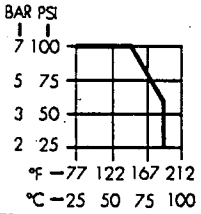
General Specifications

Wetted parts

Sensor body:	CPVC
O-rings:	Viton®
Electrode junction:	Porous UHMW polyethylene

Maximum pressure/temperature ratings:

- 100 psi/7 bar max. @ ≤65 °C/149 °F,
- 58 psi/4 bar max. @ ≤85 °C/185 °F



SIGNET 2714/2716 pH Sensors

Sensor tips:	2714 (flat glass), 2716 (bulb glass type)
Range:	0 to 14 pH
Response time:	<5 seconds for 95% of signal change @ 25 °C (in calibrated standards)
Temp. compensation:	3 KΩ Balco

Reference Electrode

Junction type:	Coaxial type (double)
Junction electrolyte:	3.5 M KCl (front), 3.5 M KCl saturated with AgCl (rear)
Reference electrolyte:	Ag/AgCl
Sodium error:	None ≤12 pH <0.2 at 13 pH
Efficiency:	≥97% @ 25 °C/77 °F
Offset voltage:	±15 mV or ±0.25 pH max

Impedance:
SIGNET 2714: 300 to 500 MΩ @ 25 °C/77 °F
SIGNET 2716: 50 to 100 MΩ @ 25 °C/77 °F

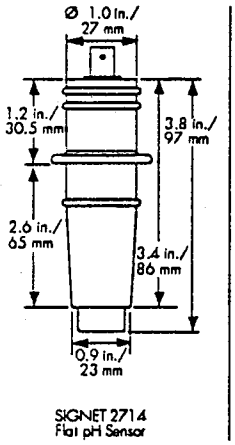
SIGNET 2715/2717 ORP Sensors

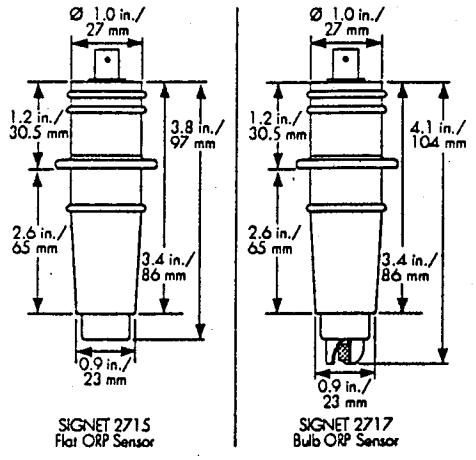
Sensor tips:	2715 (flush platinum wire/ glass sealed) 2717 (platinum band/ bulb type)
Range:	-999 to 1999 mV
Response time:	<5 seconds for 95% of signal change @ 25 °C (in calibrated standards)
Offset voltage:	±25 mV maximum

Reference Electrode

Junction type:	Ag/AgCl double junction
Junction material:	Porous Polyethylene
Junction electrolyte:	3.5 M KCl Gel (front), 3.5 M KCl saturated with AgCl (rear)

Dimensions:





7 Maintenance

- Keep sensor tip wet during storage
- Store sensor in a cool dry location

Readings drift or shown poor response when the glass membrane or reference junction is coated or clogged. Sometimes the sensor can be restored with proper cleaning techniques. Clean as follows:

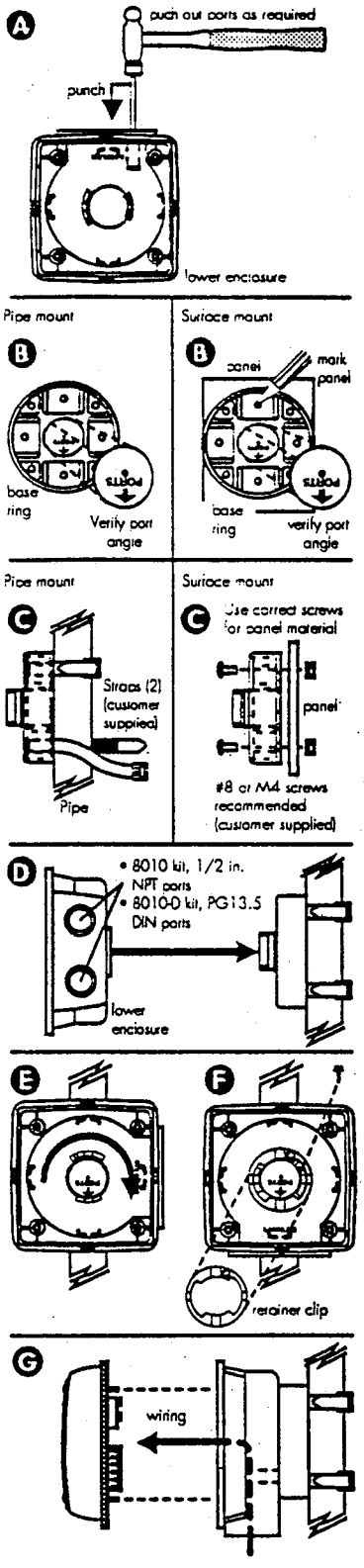
- Lightly soiled: rinse sensor tip in methyl alcohol then rinse in clean tap water.
- Heavily soiled: soak sensor tip in 0.1 Molar HCl for 5 minutes then rinse in clean tap water.

8 Warranty

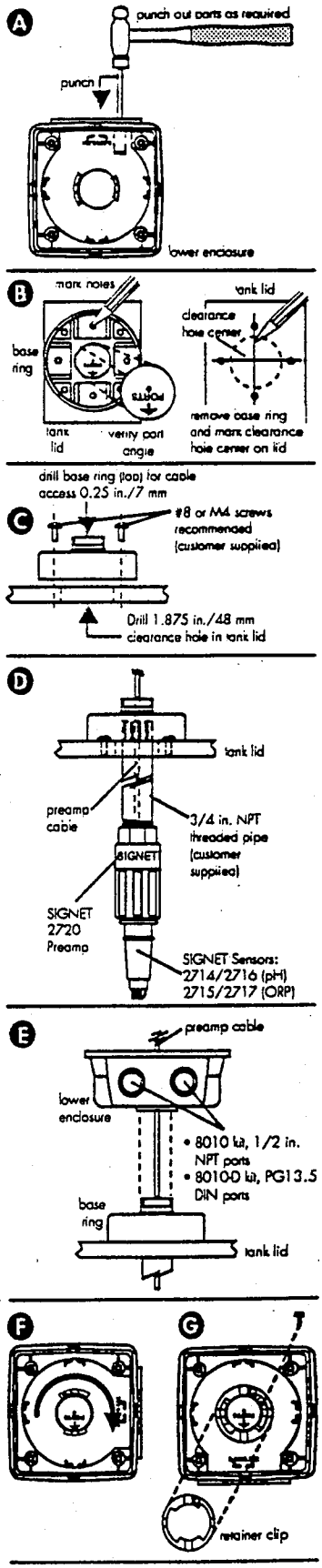
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SIGNET Compak Transmitter Mounting Instructions 8010, 8010-D Kits

1 Pipe/Surface Mount Instructions

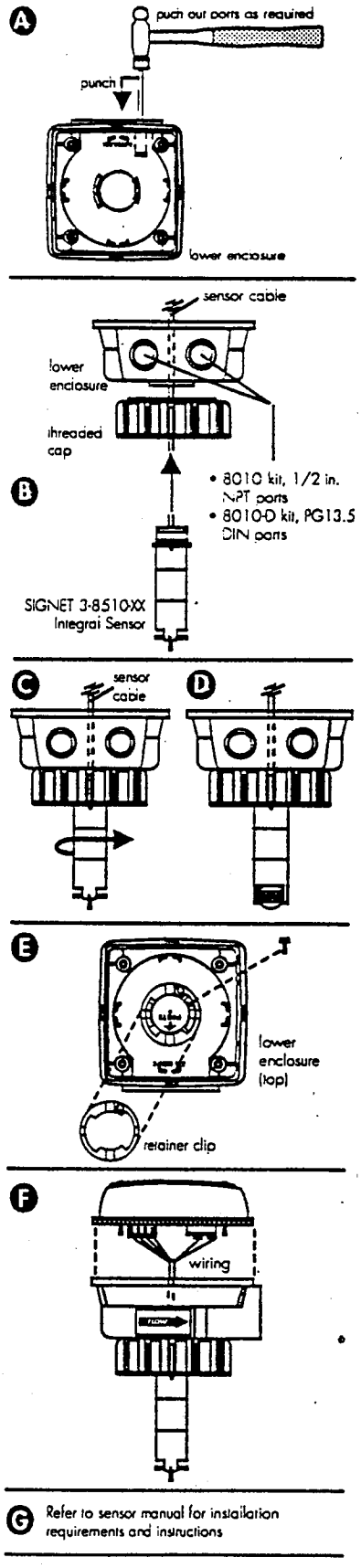


2 Tank Lid Mounting



SIGNET Compak Transmitter Mounting Instructions 8011, 8011-D Kits

1 Integral Sensor Mounting



Specifications

8010/8010-D Universal Mounting Kits

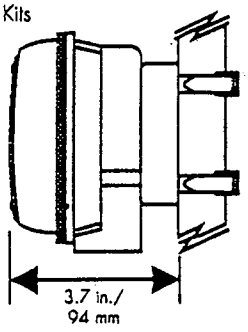
Enclosure base options:	
• 8010 kit:	1/2 in. NPT conduit ports
• 8010-D kit:	PG13.5/DIN conduit por
Materials:	Glass filled polypropylene
Base ring hole patterns:	2.60 in./66 mm bolt circ
	2.25 in./57 mm bolt circ

8011/8011-D Integral Sensor Mounting Kits

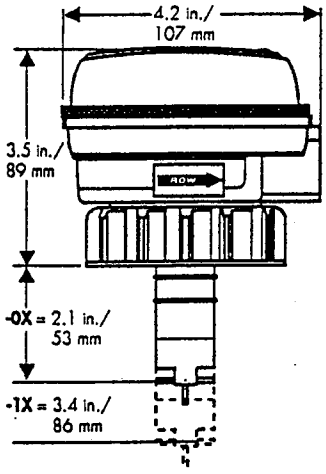
Enclosure base options:		
• 8011 kit:	1/2 in. NPT conduit ports	
• 8011-D kit:	PG13.5/DIN conduit por	
Materials:	Glass filled polypropylene	
Compatible sensors:		
• 0.5 to 4 inch	Polypropylene	3-851C-
• 5 to 8 inch	Polypropylene	3-851C-
• 0.5 to 4 inch	PVDF	3-851C-

Mounting dimensions:

8010/8010-D Kits



8011/8011-D Kits



Warranty

This product includes a limited warranty. Consult yo
Signet distributor for specific warranty conditions.

SIGNET
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CH Georg Fischer Rohrleitungssysteme AG, CH-8201 Schaffhausen/Schweiz, Tel. 053/81 11 11, Telex 89 70 70 64 gf ch, Fax 053/25 91 30
SIN George Fischer Pte Ltd., 15 Kaki Bukit Road 2, KB Warehouse Complex, Singapore 1441, Tel: 65/747 0611, Fax: 65/747 0577

GEORGE FISCHER +GF+ Piping Systems
3-8510.090-1/(C-1/95)
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WISCONSIN PROTECTIVE COATINGS CORP.

INTERIOR COATING ON CARBON VESSELS

PLASITE ®

TECHNICAL BULLETIN

9060
FEBRUARY 1994
(Replaces January 1984)

PLASITE 9060 HI-RESISTANT PROTECTIVE COATING

TYPE: A high solids modified epoxy cured with an amine adduct curing agent. Designed specifically as a high chemical-resistant, non-toxic odorless coating.
INTENDED USE: Primarily as a tank lining and equipment coating material for the food & beverage industries. This material, when properly applied and force cured, will not impart taste or odor.

FOR INDUSTRIAL USE ONLY!

GOVERNMENT AGENCY ACCEPTANCE: Meets the requirements of the U. S. Food and Drug Administration 21 CFR 175.300. (NOTE: Special colors may not meet FDA requirements; consult PLASITE Technical Service Department).

PLASITE 9060 White, Lt. Gray and Lt. Blue have been accepted by the U. S. Department of Agriculture for use in direct food contact areas.

CHEMICAL RESISTANCE: Excellent resistance to various fermentation processes, beer and high alcohol content wine storage. Refer to CHEMICAL RESISTANCE on Page 2.
TEMPERATURE RESISTANCE: Dry film basis is 400°F for short periods; 250°F continuous. Immersion temperatures depend on particular reagent.
SURFACE PREPARATION: Steel surfaces may be prepared by blasting as required by ZONE OF USAGE. Refer to PRIMER section on Page 2.
APPLICATION: PLASITE 9060 is formulated for standard heavy duty spray equipment.
COLORS: White; Lt. Gray; Lt. Blue.
FILM THICKNESS PER COAT: A 6 to 7 mil film is easily produced in one multi-pass spray coat.
COVERAGE: 1315 mil ft²/gallon ± 4% theoretical. For estimating purposes — 81 ft²/gallon will produce a 13 mil film (20% loss included). Two to three coats will produce a 12 to 15 mil film for immersion service.
DRYING TIME: Surface will normally be tack-free in 10-12 hours at 70°F.
CURING TIME: 7 days at 70°F to 90°F. Refer to Page 2 for force curing information. Force curing is required to prevent possible taste and odor pickup by sensitive food products.
RECOAT TIME: Must be topcoated within two weeks for metal temperature exposure to 130°F. For temperature exposure of 131 to 150°F must be topcoated in a maximum of 24 hours.

PHYSICAL SPECIFICATIONS

PIGMENTS: Titanium dioxide, inert fillers and tinting colors.
SOLIDS: 90 ± 4% by weight; 82 ± 4% by volume.
POT LIFE: Approximately 1 hour at 70°F.
SHELF LIFE: 12 months minimum at 70°F.
SHIPPING WT.: Approximately 13 lbs./gallon.
CURING AGENT RATIO: 1 part of curing agent to 4 parts of coating material. Coating is supplied in short filled containers with proper amount of curing agent supplied in separate containers.

*__ABRASIVE RESISTANCE:__ 70 milligrams average loss per 1000 cycles, Taber CS-17 Wheel, 1000 gram weight.
*__SURFACE HARDNESS:__ Konig Pendulum Hardness of 152 seconds (Glass Standard = 250 seconds); ASTM Method D4366-84.
THERMAL SHOCK: Unaffected 5 cycles, minus 70° to plus 200°F.
FLEXIBILITY: 1/2" bend Zuhr Conical Mandrel 6 mil film.
GLOSS: 72 at 60°.
*__NOTE:__ Above tests were conducted on film cured at 150°F.

VOLATILE ORGANIC COMPOUNDS CONTENT

Color	COATING AS SUPPLIED (ASTM METHOD D2369) Lbs./Gal.	Grams/Liter	THINNED 10% BY VOLUME WITH PLASITE 71 THINNER *Lbs./Gal.	*Grams/Liter
Lt. Gray	1.02 ±4%	123 ±4%	1.54 ±4%	185 ±4%

NOTE: VOC content varies between colors. Contact PLASITE Technical Service Department for VOC of specific colors.
*Determined theoretically by using ASTM Method test results.

ZONE OF USAGE

A ZONE: Includes immersion service for process, transportation and storage vessels, as well as exteriors of high temperature equipment, sumps, sewers, exhaust ducts, concrete bases and floors, or other surfaces subject to combinations of high temperature and heavy spills of corrosive chemicals. SSPC-SP5 blast and a film thickness of 12 to 15 mils required.
B ZONE: Interior process areas where structural steel, floors, equipment, ducts and other surfaces are subject to attack by strong fumes, occasional spills and splashes at intermediate temperatures. SSPC-SP5 or SSPC-SP10 blast and a film thickness of 12 to 15 mils required. With surface preparation as indicated, the finish coating is considered self-priming although, if desired, a heavy duty primer may be incorporated as part of the system.
C ZONE: Interior and exterior area surfaces subject to fumes of fairly high concentration at ambient temperatures. Heavy or medium duty primer over SSPC-SP6 or SSPC-SP7 blast and a total film thickness, primer and topcoat, of 7 to 10 mils required.
D ZONE: Process plant exteriors subject to chemical atmosphere and weathering. Medium duty primer over SSPC-SP7 or SSPC-SP3 surface preparation and a total film thickness, primer and topcoat, of 6 to 8 mils required.

WISCONSIN PROTECTIVE COATINGS CORP.
614 Elizabeth Street
P.O. Box 8147
Green Bay, WI 54308-8147
414-437-6561

Represented by:

CHEMICAL RESISTANCE

The following list of laboratory tests is an indication of the range of chemical resistance. These tests consist of mild steel test panels coated to a film thickness of 12 to 15 mils. The panels are one-half immersed in the solution for the noted time with no effect on the coating.

Beer	100°F	1 year	Methyl ethyl keytone	100°F	1 year
Corn oil	150°F	1 year	Oil Prudhoe Bay sour crude	210°F	1 year
Corn syrup, hi fructose	150°F	1 year	Sodium hydroxide 10%, in water	100°F	1 year
Ethyl alcohol 20%, in water	150°F	6 months	Toluol	100°F	1 year
Ethyl alcohol 20%, in water, 3.2 pH with citric acid	150°F	6 months	Vodka, 190 proof	100°F	1 year
Gasoline, premium no-lead	100°F	1 year	Wine, 14% by vol. alcohol	100°F	1 year
			Wine, Fortified, 20% by vol. alcohol	100°F	1 year

Although the chemical tests indicated may show that PLASITE 9060 is unaffected by immersion as listed, it is not meant to imply an express guarantee in actual service. The service is dependent upon proper application and actual operating conditions and it is generally recommended that users confirm adaptability of the product for a specific use by their own tests.

PLASITE 9060 is classified as a relatively thin film coating and should not be used for total and continuous immersion in certain chemicals, such as those acids referred to under CHEMICAL RESISTANCE, which have extremely high corrosion rates to mild steel and other substrates. Use in such chemical exposure should be confined to fumes and spills.

THINNERS

PLASITE 71 THINNER is recommended. The amounts required will vary depending upon air and surface temperatures and application equipment. Normal application temperatures and conditions will require addition of approximately 5 to 10% by volume with approximately 5% additional thinner added for each 5° of increased temperature.

It is recommended that the actual amount of thinner included on each order amount to approximately 20% of the coating order.

PRIMER

Primers of the inhibitive type must be used when steel surfaces are not blasted to white metal and when finish coatings are below 8 mils in thickness. The following primer IS NOT recommended for A Zone Service or service requiring FDA compliance:
PLASITE 7102 HEAVY DUTY PRIMER described in Bulletin 7102 is an Epoxy Metal primer with superior bond and water resistance as well as chemical resistance for Zones B, C and D.

CURING

1. Normally polymerization and curing will take place in 5 to 7 days at 70°F. This coating should not be applied when air temperature or temperature of surface to be coated is below 50°F. Within 24 hours after coating is applied a minimum substrate temperature of 70°F is required for proper polymerization.
2. Force curing at elevated temperature is desirable for certain exposures. Where coating is to be subject to immersion in high temperature solutions, wine and beer, and other severe exposures, it is recommended that the curing temperature be at 170°F to 200°F. In order to insure the complete removal of solvents and odor, force curing is generally recommended when coating is to be used in potable water and food material service.
3. Listed below are a few curing schedules that may be used for time and work planning. Prior to raising the metal to the force curing temperature, it is necessary that an air dry time of 2 to 5 hours at temperatures from 70°F to 100°F be allowed. After the air dry period has elapsed, the temperature should be raised approximately 30°F each 30 minutes until the desired force curing temperatures are reached.

METAL TEMPERATURE °F	CURING TIME	METAL TEMPERATURE °F	CURING TIME
150	12 Hours	200	6 Hours
175	10 Hours	225	4 Hours

4. Final cure may be checked by exposing coated surface to MIBK for ten minutes. If no dissolving and only minor softening of film occurs, the curing can be considered complete. The film should reharden after exposure if cured.

SURFACE PREPARATION

STEEL

A and B Zones (As described under ZONE OF USAGE.) High Temperature & Immersion Service

1. All sharp edges shall be ground to produce a radius and all imperfections, such as, skip welds, delaminations, scabs, slivers and slag shall be corrected prior to abrasive blasting. Skip welds shall be welded solid.
2. Degrease surface prior to sandblasting. Organic solvents, alkaline solutions, steam, hot water with detergents or other systems that will completely remove dirt, oil, grease, etc. may be used. Prebaking of old tanks is recommended. Additional decontamination may also be necessary.
3. The surface shall be blasted to an SSPC-SP5 or NACE No. 1 white metal surface using a Venturi blast nozzle supplied with 80 to 100 psi. An anchor pattern or "tooth" in the metal shall correspond to approximately 20 to 25% of the total film thickness of the coating.
4. Contaminated grit shall not be used for the finish work.
5. The blasting media used shall be a natural abrasive, or steel grit, or slag grit (similar or equal to BLACK BEAUTY®). These abrasives shall be sharp with a hard-cutting surface, properly graded, dry, and of best quality. The media shall be of proper size to obtain the specified anchor pattern and shall be free of objectionable contaminants.
6. The anchor pattern shall be sharp and no evidence of a polished surface is allowed.
7. Remove all traces of grit and dust with a vacuum cleaner or by brushing. Care must be taken to avoid contaminating the surface with fingerprints or from detrimental material on the workers' clothes.
8. The surface temperature shall be maintained at a minimum of 5° above the dew point to prevent oxidation of the surface. The coating shall be applied within the same day that the surface has been prepared.

B, C and D Zones (As described under ZONE OF USAGE.) Service in Corrosive Atmosphere

1. Degreased as described in Item 2 under A & B Zones.
2. Remove all loose mill scale, rust scale, and old paint scale by one of the following methods:
   a. Near white metal blast cleaning — (B Zone) SSPC-SP10 or NACE No. 2.
   b. Commercial blast cleaning — (C Zone) SSPC-SP6 or NACE No. 3.
   c. Brush-off blast cleaning — (C & D Zones) SSPC-SP7 or NACE No. 4.
   d. Power tool cleaning — (D Zone) SSPC-SP3.

When utilized, inhibitive primer should be applied as soon as possible after surface preparation.

D Zone applications surface preparation as in above Paragraph 2(d) must result in a relatively rough surface. If the steel is new and this type of surface preparation does not leave a reasonably rough surface on the steel, then the heavy film system is not recommended.

NOTE: The above specification numbers are from Steel Structure Painting Council Surface Preparation Specifications, 4516 Henry Street, Suite 301, Pittsburgh, PA 15213-3728 and National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 77218.

CONCRETE

A ZONE: All concrete surfaces require whip blasting for immersion service. Fully cured concrete must be blasted to provide a hard, firm, clean and neutral surface for coating. All concrete surfaces must be filled and sealed with PLASITE 9028M1 or PLASITE 9028M2, applied in accordance with PLASITE Bulletin 9028. All surface imperfections, "bug holes," etc. must be completely repaired before application of PLASITE 9060. PLASITE 9028M1 and 9028M2 are not recommended for food service. When coating system requires FDA compliance, refer to PLASITE Bulletin 9029 Concrete Filler-Sealer.

B ZONE: Severity of expected service will dictate minimum concrete surface preparation. Severe service (strong fumes, spillage, etc.) will probably require A Zone surface preparation and PLASITE 9028M1 or PLASITE 9028M2 filling and sealing before application of PLASITE 9060.

ALUMINUM

Surface shall be clean and grease free with a blast produced anchor pattern or "tooth" as described earlier under "STEEL." In addition, the blasted surface shall be given a chemical treatment such as:

ALODINE® 1200S available from
Parker & Amchem
32100 Stephenson Highway
Madison Heights, MI 48071
(800) 521-1355

IRIDITE® 14-2 produced by
Allied-Kelite Division of
Witco Corporation
2701 Lake Street
Melrose Park, IL 60160
(800) 323-9784

OAKITE® CRYSCOAT 747LTS
Plus
OAKITE® CRYSCOAT ULTRASEAL
Produced by Oakite Products
50 Valley Road
Berkeley Heights, NJ 07922
(908) 464-6900
Canada: (416) 791-1628

For immersion, blasting with sharp grit followed by the chemical surface treatment is required.

NOTE: On metallic surfaces prepared only by chemical etching, the total coating film thickness applied should be restricted to only half the film normally applied to blasted surfaces. This reduced film thickness should be considered during selection of the coating for the service and the type of surface preparation performed.

WOOD, TRANSITE AND SIMILAR SURFACES

Normally these materials need no surface treatment provided they are dry and free of grease, oil and dirt. It is generally recommended that the first coat be diluted one part of recommended PLASITE Thinner to one part of material and brush applied.

EQUIPMENT

SPRAY APPLICATION

1. All spray equipment should be thoroughly cleaned and the hose, in particular, should be free of old paint film and other contaminants.
2. Use standard production-type spray guns:

GUN	FLUID	AIR
DeVilbiss JGA-503	E	794
Binks #18	66-SS	63-PB
Graco P800	04	02

3. When airless spray equipment is used, the recommended liquid pressure is 1500 to 1800 psi with tip size from .017" to .025". Thinning requirements are more than for conventional spray.

BRUSH APPLICATIONS

Use a high quality brush.

READ THIS NOTICE!
SAFETY AND MISCELLANEOUS EQUIPMENT

1. For tank lining work, it is recommended that the operator provide himself with rubber soled shoes and observe good personal hygiene. Certain personnel may be sensitive to various types of resins which may cause dermatitis.
2. THE SOLVENT IN THIS COATING IS FLAMMABLE AND CARE AS DEMANDED BY GOOD PRACTICE, OSHA, STATE AND LOCAL SAFETY CODES, ETC. MUST BE FOLLOWED CLOSELY. Keep away from heat, sparks and open flame, and use necessary safety equipment, such as, air mask, explosion-proof electrical equipment, non-sparking tools and ladders, etc. Avoid contact with skin and breathing of vapor or spray mist. When working in tanks, rooms and other enclosed spaces, adequate ventilation must be provided. Refer to PLASITE Bulletin PA-3. Keep out of reach of children.
3. CAUTION - Read and follow all caution statements on this product technical bulletin, material safety data sheet and container label for this product.

MIXING

The catalyst and coating are supplied in separate containers at a 4:1 ratio. For splitting purposes, use 1 part curing agent to 4 parts coating by volume. Thoroughly mix coating, then add curing agent slowly and mix completely with coating. PLASITE 71 Thinner may be added before curing agent to extend pot life.

APPLICATION PROCEDURE

SPRAY GUN

1. Air supply shall be uncontaminated. Adjust air pressure to approximately 50 lbs. at the gun and provide 5 to 10 lbs. of pot pressure. Adjust spray gun first by opening liquid valve and then adjusting air valve to give an 8" to 12" wide spray pattern with best possible atomization.
2. Apply a "mist" bonding pass.
3. Allow to dry approximately one minute but not long enough to allow film to completely dry.
4. Apply crisscross multi-passes, moving gun at fairly rapid rate, maintaining a wet appearing film. Fast multi-passes may be applied until you have a film thickness of approximately 6 to 7 mils (approximately 7 to 9 wet mils).
5. Overcoat Time: This will vary both with temperature and ventilation and will require from 10 to 12 hours at 70°F for enclosed spaces. Less time is required for exteriors. Remove all overspray by dry brushing or scraping if required.
6. By repeating Step 4 a homogeneous film of 12 to 15 mils is obtained.
7. Equipment must be thoroughly cleaned immediately after use with PLASITE thinner to prevent the setting of the coating.

NOTE: All welds, pits and rough metal areas should be coated by brush prior to spray application.

BRUSH APPLICATION

(Recommended for small areas and repairs only)

1. Apply a very light crisscross brush coat.
2. Allow to dry for approximately 5 minutes.
3. Apply a heavy coat using crisscross brush pattern. "Flow" the coating on rather than try to "brush out".
4. Allow to dry tack-free.
5. Repeat Steps 3 and 4 until sufficient film thickness is obtained. Normally a film thickness of 2½ to 3 mils can be obtained per coat by this method.

This bulletin provides standard information on the coating and application procedure. Since varying conditions may not be covered, consult with your local sales representative or PLASITE Technical Service Department for further information.

INSPECTION

Degree of surface preparation shall conform to appropriate specification as outlined in SURFACE PREPARATION section. Film thickness of each coat and total dry film thickness of coating system shall be determined with a nondestructive magnetic gauge properly calibrated.
Refer to PLASITE Bulletin PA-3 for inspection requirements.

METRIC COMPARISONS

1 mil = .001" = 25.4 microns

1 U.S. gallon = 3.785 liters

1 sq. ft. x 0.0929 = sq. meters

$$°C = \frac{5(°F - 32)}{9}$$

We guarantee our product to be free of defects in material and workmanship and to be in accordance with our company quality control standards. All data, statements and recommendations made herein are based upon information we believe to be reliable but are made without any representation or guarantee or warranty of accuracy and are made with reservation of all patent rights. Our products are sold on the condition that the user himself will evaluate them, as well as our recommendations, to determine their suitability for his own purpose before adoption. Also, statements regarding the use of our products or processes are not to be construed as recommendations for their use in violation of any patent rights or in violation of any applicable laws or regulations. Liability under any condition shall be limited to replacement of material only. No liability is assumed or implied, for injury to personnel, labor costs, product loss or any other expenses incidental to the structure or operation of the plant and equipment where this coating is applied.

EXHIBIT B

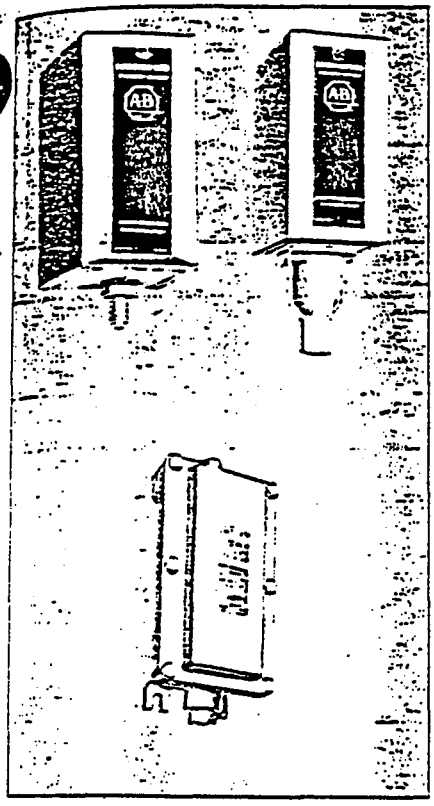
MANUFACTURERS' SHOP DRAWINGS

MANUFACTURERS' SHOP DRAWINGS INDEX

Manufacturer	Product
Allen-Bradley Co.	Pressure switch
Aurora	Sump ground water recovery pump
B/W Controls	RW-1 & RW-2 well level transducers
Calgon	Carbon
GEMS	Float switch
Gould	Transfer pump
Grundfos	RW-1 & RW-2 ground water recovery pumps
Honeywell	Chart recorder
Neptune	Flow meter
OBG Manufacturing	Control schematic
OBG Manufacturing	Equalization tank
OBG Manufacturing	GAC tanks
OBG Manufacturing	Water treatment system schematic
US Gauge	Pressure gauge

ALLEN-BRADLEY CO.

PRESSURE SWITCH



DESCRIPTION — Bulletin 836 Pressure Controls are accurate, rugged, compact units of attractive appearance adaptable to a wide variety of pressure applications. The control features a snap action precision switch equipped with silver contacts. Contact force is maintained at a high value up to the instant of snap over avoiding dead center conditions. Normal industrial vibration has little effect upon the positive opening and closing of the contacts. Straight in-line and relatively friction-free construction provides accurate and consistent operation regardless of the angle at which the control is mounted.

The long life copper alloy bellows are designed for use with air, water, oil, non-corrosive liquids, vapors or gases in a series of pressure ranges from 30" vacuum (Hg) to 900 psi. Type 316 stainless steel bellows are available for use with many of the more corrosive liquids or gases at pressures to 375 psi.

OPERATION — Bulletin 836 pressure controls operate on the principal of responding to changes in pneumatic (air or gas) or hydraulic (water or oil) pressure applied to a bellows. This force is opposed by a main spring. Varying the force on the main spring (by turning the range adjusting screw) allows setting the contacts to trip at the upper pressure setting. Turning the differential adjusting screw (when provided) varies the force on a secondary spring and allows setting the lower pressure setting, where the contacts reset to their static state. Many ranges and differentials are achieved by using bellows of different sizes to meet most application requirements.

SELECTION — When selecting a pressure control there are several factors to be considered for proper application. These include:

- operating pressure
- medium applied to the bellows or piston
- differential
- line pressure
- surge pressure
- enclosure types
- contact configuration

The simplified illustration (Figure 1) on Page 642 used in conjunction with the table for Bulletin 836 on Page 642 and Bulletin 836T on Page 652 provide a comprehensive explanation for ease of selection.

Mechanical life and repeat accuracy of bellows type controls is graphically illustrated in the typical curve (Figure 2) on Page 643. For general applications, controls selected where the contacts operate between 30% and 80% of the operating range and where the maximum line and surge pressures do not exceed the specified values will provide excellent life and repeat accuracy. For more specific applications it is important to note that the controls are designed to operate below or above these values. However, there may be a small trade-off between the factors of life and repeat accuracy as illustrated in Figure 2 Page 643.

CONTACT BLOCKS — Contact blocks are single pole, double throw and can be wired to open or close on increasing or decreasing pressures.

NON-INDUCTIVE RATINGS —
5 Amperes, 240 Volts
3 Amperes, 600 Volts

CONTROL CIRCUIT RATINGS —
AC — 125 VA, 24 to 600 Volts
DC — 57.5 VA, 115 to 230 Volts

CONTACT BLOCK MODIFICATIONS
See Page 645.

TEMPERATURE RANGE
Operating: +32[1] to +150°F
(0°C[1] to +66°C)
Storage: −22° to +200°F
(−30° to +93°C)

[1] Temperature at +32° F (0°C) or below limited only to the possibility of moisture frosting of the mechanism and contacts which could impede operation. Also, moisture or liquid solidifying in the system may also hamper operation.

REPEAT ACCURACY[2] — The design and construction of the Bulletin 836 Style A and C devices provide a typical repeat accuracy of ±0.5%[3] or better.

[2] Evaluation made from test data and calculated using formula per NEMA ICS 2-225 Standards.
[3] Based on % of maximum range.

SPECIAL CONTROLS — A large number of unlisted catalog modifications and complete devices are available for specific and OEM applications.

Special controls and modification service is available to meet many applications unique to the OEM market.

Consult your nearest Allen-Bradley Sales Office for assistance with special modified controls or accessories. See Page 818.

FACTORY SET PRESSURE CONTROLS — In quantities of less than 10 identical controls and settings on the same order item, add setting charge per control.

- When a specific differential is unimportant, or not required, and the approximate minimum differential present in the selected control, without adjusting, satisfies the application, specify the factory settings as follows:
  Ref: Set to open (or close) at ___[4] increasing (or decreasing). Minimum differential.
- When a specific differential is required specify factory settings as follows:
  Ref: Set to open at ___[4]. Close at ___[4].

Quality analog "Test"[5] gauges[6] are used when applying requested factory settings to these rugged Industrial Grade pressure controls. The actual requested setting is applied to the control reading the set point directly from the gauge being used. However, traceable gauge tolerance variance between source and user, and possible severe shock during shipping and installation, may contribute to the factory settings deviating slightly from the specified values. Slight recalibration can easily be accomplished upon final installation to meet specific requirements for the more demanding applications. Once installed the controls will perform with a repeat accuracy as established in the paragraph entitled REPEAT ACCURACY on this page.

Special service is available to factory set controls on Digital Laboratory Instruments, up to 600 psi, when required for the more critical applications. An additional charge may be added for this service contingent upon setting tolerance and quantity. Consult your nearest Allen-Bradley Sales Office. See Page 818.

[4] Specify psi (pounds per square inch) or, in Hg Vac. (inches of mercury vacuum) and ± tolerance specification, if known.
[5] Per ANSI B40.1 Grade 2A (0.5% accuracy full scale), Grade 3A (0.25% accuracy full scale), etc.
[6] Gauges are calibrated and the accuracy is traceable to the National Bureau of Standards.

Type	Adjustable Operating Range psi [1] [7]	Adjustable Differential psi — Approximate Mid-Range Values — Adjustment Span [2] [4]	Maximum psi — Line Pressure [5]	Maximum psi — Occasional Surge Pressure [6]	NEMA Type 1 General Purpose Enclosure — Catalog Number
STYLE A CONTROLS WITH INTERNAL BELLOWS ● ADJUSTABLE WITHIN RANGE ● ADJUSTABLE DIFFERENTIAL ¼" COPPER TUBING CONNECTION — FOR 45° FLARE 7/16"-20 THREAD					
Copper Alloy Bellows [8]	30" Vac to 75	2 to 20	160	160	836-A1A
	6 to 140	3 to 35	280	340	A2A
	12 to 250	6 to 65	500	600	A3A
	16 to 375	8 to 95	750	850	A4A
STYLE C CONTROLS WITH EXTERNAL BELLOWS ● ADJUSTABLE WITHIN RANGE ● ADJUSTABLE DIFFERENTIAL ¼" FEMALE PIPE CONNECTION					
Copper Alloy Bellows [8]	12" Vac to 8	0.2 to 2.5	25	30	836-C1A
	30" Vac to 10	0.4 to 6	65	75	C2A
	0.8 to 30	0.4 to 6	80	80	C3A
	30" Vac to 45	1 to 12	175	190	C4A
	2 to 60	1 to 12	190	210	C5A
	30" Vac to 100	2 to 25	300	375	C6A
	4 to 150	2 to 25	300	375	C7A
	6 to 250	3 to 45	500	650	C8A
	35 to 375	6 to 80	900	1200	C9A
	50 to 600	12 to 115	1300	1600	C10A
	80 to 650	16 to 125	1300	1600	C11A
	200 to 900	20 to 125	1300	1600	C12A
Type 316 Stainless Steel Bellows [9]	30" Vac to 10	0.4 to 6	65	65	836-C60A
	0.8 to 30	0.4 to 6	65	65	C61A
	30" Vac to 100	2 to 25	270	270	C62A
	4 to 150	2 to 25	270	270	C63A
	6 to 250	3 to 45	450	450	C64A
	35 to 375	6 to 80	650	650	C65A

[1] The total span within which the contacts can be adjusted to TRIP [2] and RESET [3] when adjusted to minimum differential or [4] when adjusted to maximum differential.
[2] TRIP — the higher pressure (temperature) setting the contacts change state.
[3] [4] RESET — the lower pressure (temperature) setting the contacts return to their normal state.
Note: Differential is the difference between TRIP [2] and RESET [3] (minimum adjusted setting) to [4] (maximum adjusted setting).
[5] The maximum sustained pressure that can be applied to the bellows without permanent damage. The control should not be cycled at this pressure. Note: Does not apply to piston type controls.
[6] Transient(s) [Pulse(s)] that can occur in a system prior to reaching a steady-state condition. Expressed in milliseconds, complex electronic instrumentation is required to measure the varying amplitude, frequency, and duration of this wave form. Frequent occurrence of extreme surge pressures could reduce bellows life. Surge pressure within published value generated during start-up or shut-down of a machine or system, not exceeding 8 times per day, are negligible.
[7] Vac. — inches of mercury vacuum (negative pressure). psi — pounds per square inch gauge (positive pressure).
[8] Copper alloy bellows may be used on water or air, and other liquids or gasses not corrosive to this alloy.
[9] Type 316 stainless steel bellows are available for the more corrosive liquids or gases.

Conversion Factors (Rounded)
psi x 703.1 = mm/H_2O
psi x 27.68 = in. H_2O
psi x 51.71 = mm/Hg
psi x 2.036 = in. Hg
psi x .0703 = kg/cm²
psi x .0689 = bar
psi x 68.95 = mbar
psi x 6895 = Pa
psi x 6.895 = kPa

Note: psi — pounds per square inch (Gauge)
H_2O at 39.2° F.
Hg at 32° F.

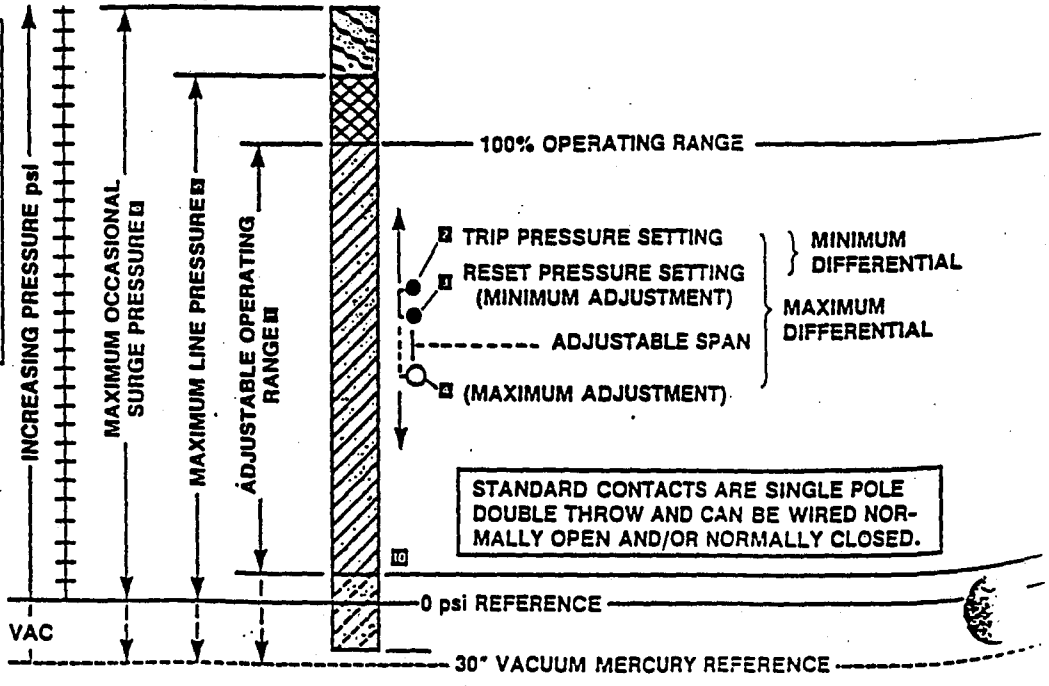


Figure 1

[10] Applications where settings approach 0 psi, select a control that has an adjustable range that goes into vacuum.

NEMA Type 4 & 13 Watertight, Oiltight & Dust-tight Industrial Use Enclosure	NEMA Type 4X Watertight Corrosion-Resistant Enclosure ROSITE Glass Polyester	NEMA Type 7 & 9 Enclosure Class I, Groups C & D Class II, Groups E, F & G Hazardous Locations	Open Type Without Enclosure
Catalog Number	Catalog Number	Catalog Number	Catalog Number
STYLE A CONTROLS WITH INTERNAL BELLOWS ● ADJUSTABLE WITHIN RANGE ● ADJUSTABLE DIFFERENTIAL 1/4" COPPER TUBING CONNECTION — FOR 45° FLARE 7/16"-20 THREAD			
836-A1J A2J A3J A4J	—	836-A1E A2E A3E A4E	836-A1 A2 A3 A4
STYLE C CONTROLS WITH EXTERNAL BELLOWS ● ADJUSTABLE WITHIN RANGE ● ADJUSTABLE DIFFERENTIAL 1/4" FEMALE PIPE CONNECTION			
— 836-C2J C3J C4J C5J C6J C7J C8J C9J C10J C11J C12J	— 836-C2S C3S C4S C5S C6S C7S C8S C9S C10S C11S C12S	— 836-C2E C3E C4E C5E C6E C7E C8E C9E C10E C11E C12E	836-C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C12
836-C60J C61J C62J C63J C64J C65J	836-C60S C61S C62S C63S C64S C65S	836-C60E C61E C62E C63E C64E C65E	836-C60 C61 C62 C63 C64 C65

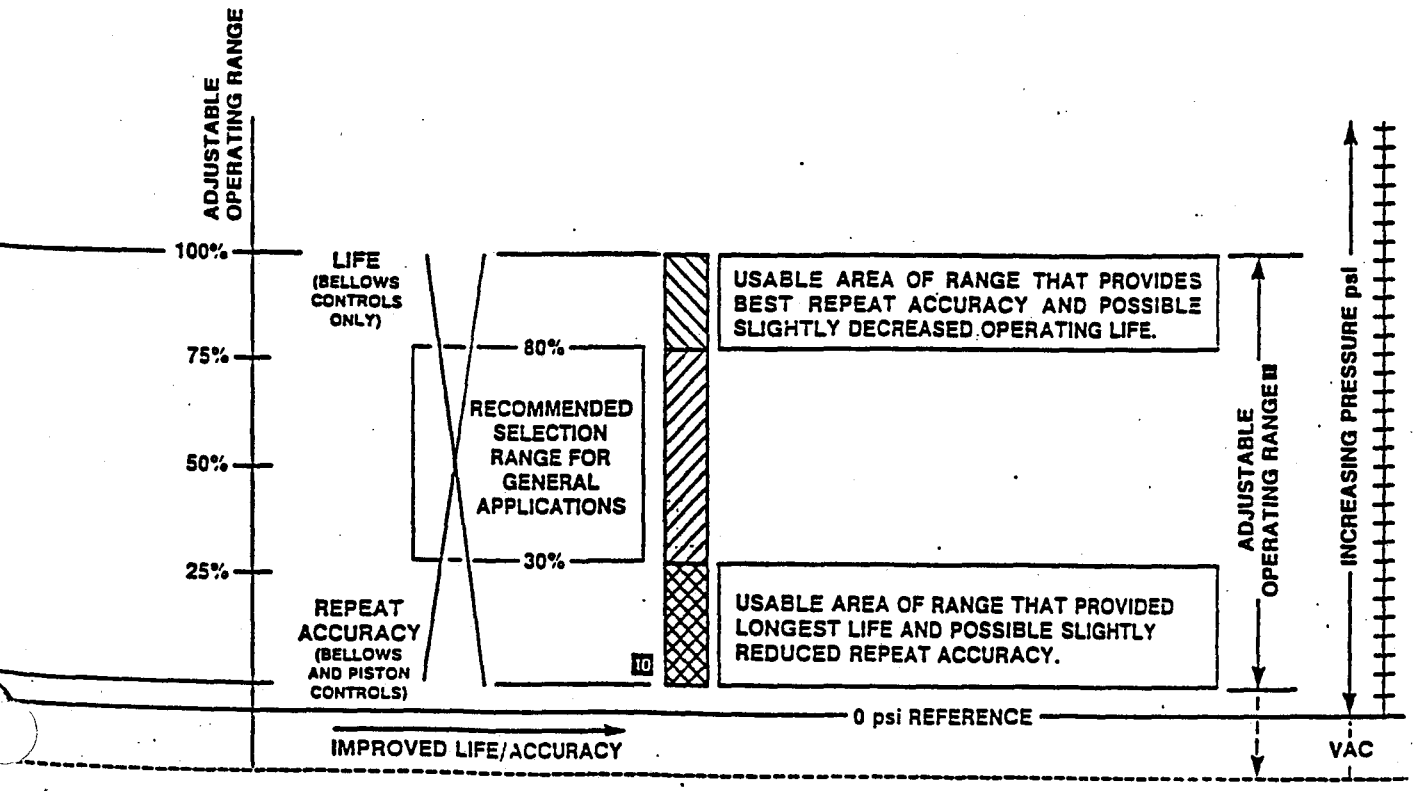


Figure 2

10 Applications where settings approach 0 psi, select a control that has an adjustable range that goes into vacuum.

MODIFICATIONS

TAMPER RESISTANT ADJUSTMENT — Range and differential adjustment screws are designed so that after a setting has been applied to the control, the screwdriver slotted heads can be broken off with a pliers. For "break-off" adjustments, Bulletin 836 Style A and C, or Bulletin 837 temperature controls, add the suffix **"X4"** to the desired catalog number in the table on Page 642 or 658 and add $36 per control to the price.
Example: Catalog Number **836-A1AX4** **$156**

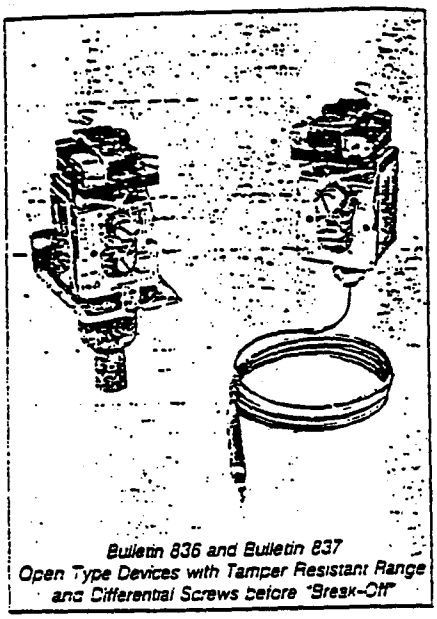
The "break-off" adjustment will not be broken off unless a factory setting is given and the order specifies "Break-off Adjustment Screw/s".

See paragraph entitled FACTORY SET PRESSURE CONTROLS on Page 641, or FACTORY SET TEMPERATURE CONTROLS on Page 657 for setting information.

TWO STYLE A CONTROLS IN ONE ENCLOSURE — Controls which function independently may be mounted side by side in a single NEMA Type 1 enclosure. This design is ideal for installations where ordinarily two controls would be mounted. Each dual unit can be a combination of the pressure controls listed or combined with bulb and capillary type temperature controls. Add prices of the individual units in a NEMA Type 1 enclosure.

REFRIGERATION TYPE CONTROLS — Available for heavy duty refrigeration service or other applications. Low pressure controls have ranges from 20" Hg. Vac. to 120 psi. High pressure cut-out controls have ranges from 100 to 500 psi. These are available with or without maximum limited range stops to meet high pressure safety adjustment requirements. Both low and high pressure controls are supplied either with a built-in pulsation snubber or a capillary up to 72" long terminating with a choice of fittings.

A complete line of refrigeration controls are available. Consult your nearest Allen-Bradley Sales Office. See Page 818.



Bulletin 836 and Bulletin 837 Open Type Devices with Tamper Resistant Range and Differential Screws before "Break-Off"

ACCESSORIES

ANGLE MOUNTING BRACKETS — For mounting one or two Open Type Bulletin 836 Style A Pressure Controls or Bulletin 837 Bulb and Capillary Temperature Controls on an enclosure mounting plate.

Single Bracket
Catalog Number **836-N11** .....
Dual Mounting Bracket
Catalog Number **836-N12** .....

CONTACT BLOCK REPLACEMENT KIT — Kit consists of a Contact Block and instructions. Catalog Number **836-N2** .....

PIPE ADAPTER — For Style A Only.
¼" Male Pipe Adapter Catalog Number **836-N1** .....

EXTERNAL PULSATION SNUBBER — Controls, unless modified, are supplied with a pulsation snubber to dampen the effects of transient pulsating peaks common to fluid systems.

External pulsation snubbers are available to provide additional dampening when extreme pulsations or surges are present. See footnote [6] on Page 642.

(For Style A)
Catalog Number **836-N6** .....
(For Style C)
Catalog Number **836-N7** .....

HARDWARE KITS FOR MOUNTING OPEN TYPE CONTROLS IN SPECIAL ENCLOSURES BY THE USER — For Bulletin 836 Style A and C Pressure Controls and Bulletin 837 Bulb and Capillary Temperature Controls. Allows ease of connecting pressure line or running capillary external to the enclosure. For use with NEMA Type 1, 4 and 13 enclosures with wall thickness up to ¼".

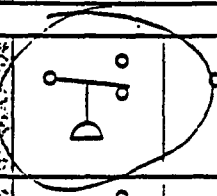
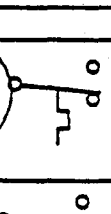
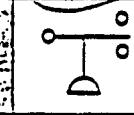
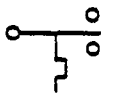
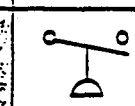
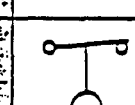
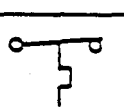
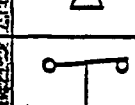
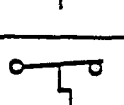
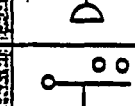
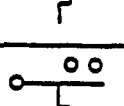
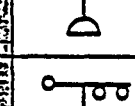
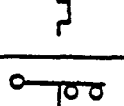
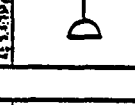
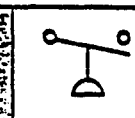
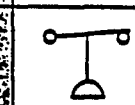
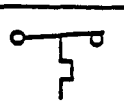
Description For use with Open Type Controls	Material	Catalog Number
Bulletin 836 Style A or Bulletin 837 Bulb and Capillary Type Temperature Controls without Armor.	Plated Steel	836-N5
Bulletin 836 Style C	Brass	836-N8
	Stainless Steel	836-N10
Bulletin 837 Bulb and Capillary Type with Armored Capillary	Brass	837-N17



Single Bracket Catalog Number 836-N11

Contact Block Catalog Number 836-N2

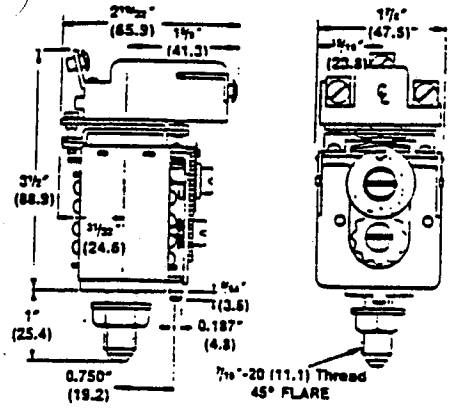
MODIFICATIONS

Catalog Number Suffix	Symbol: Pressure Controls	Symbol: Temperature Controls	Description	Rating	NEMA Type 1	NEMA Type 4 & 13, and 7 & 9	Open Type Without Enclosure
CONTACT BLOCKS [1]							
AUTOMATIC OPERATION							
Supplied as standard with all devices listed in the table on Pages 642 and 656			Single pole double throw — automatically opens or closes on rise or fall.	Non-inductive 5A, 240V 3A, 600V Control Circuit Rating AC-125VA, 24 to 600V DC-57.5VA, 115 to 230V	—	—	—
X171 [2] [3]			Single pole double throw — slow acting contact with no snap action. Contacts close on rise and close on fall with an open circuit between contact closures.	Control Circuit Rating AC-125VA, 24 to 250V			
X221 [2] [3]			Single pole single throw, normally open — closes on rise.	1 H.P., 230V AC .5 H.P., 115V AC Control Circuit Rating AC-125VA, 24-110V AC-345VA, 110-600V DC-57.5VA, 110-250V			
X231 [2] [3]			Single pole single throw, normally closed — opens on rise.				
X321 [2] [3]			Single pole single throw, normally open — closes on rise.	1 H.P., 115V AC 1.5 H.P., 230V AC Control Circuit Rating AC-600VA, 110-600V DC-57.5VA, 110-250V			
X331 [2] [3]			Single pole single throw, normally closed — opens on rise.				
X021 [3]			Two circuit, single pole single throw, normally open — a common terminal is connected to 2 separate contacts which close on rise.	Non-inductive 5A, 240V 3A, 600V Control Circuit Rating AC-125VA, 24 to 600V DC-57.5VA, 115 to 230V			
X031 [3]			Two circuit, single pole single throw, normally closed — a common terminal is connected to 2 separate contacts which open on rise.				
EXTERNAL MANUAL RESET [4]							
X140 [3]			Single pole single throw, normally open — contacts open at a predetermined setting on fall and remain open until system is restored to normal run conditions at which time contacts can be manually reset.	Non-inductive 5A, 240V 3A, 600V Control Circuit Rating AC-125VA, 24 to 600V DC-57.5VA, 115 to 230V			
X150 [3]			Single pole single throw, normally closed — contacts open on rise and remain open until system is restored to normal run conditions at which time contacts can be manually reset.				
X15A [5]			Single pole double throw, one contact normally closed — contact opens on rise and remains open until system is restored to normal run condition at which time contact can be manually reset. A second contact closes when the first contact opens.				

[1] To order a control with a contact block modification add the desired suffix number to the appropriate catalog number listed in the table for pressure controls on Page 642 or temperature controls on Page 658.
[2] Minimum specified differential value approximately doubles.
[3] Contact blocks not available for field conversion or replacement.
[4] Manual reset devices cannot be supplied with an adjustable differential. Differential is approximately the minimum differential of the corresponding adjustable differential control.
[5] Available only for replacement of complete open type control in an existing NEMA Type 1 or 4 & 13 enclosure. User replacement in a NEMA Type 7 & 9 enclosure is not recommended.

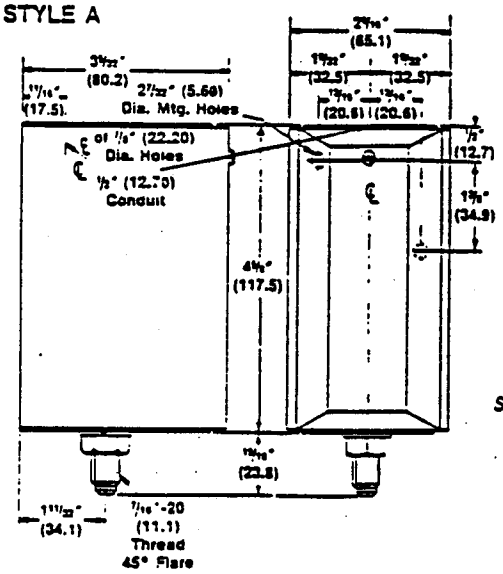
APPROXIMATE DIMENSIONS AND SHIPPING WEIGHTS

Dimensions in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.

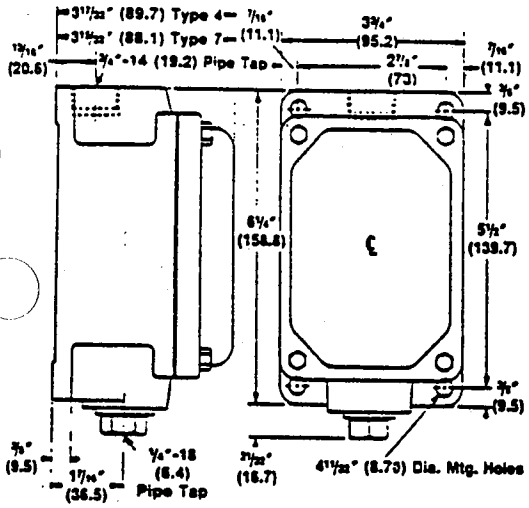


OPEN Type
Approximate
Shipping Wt. 1 lb. (.45 kg)

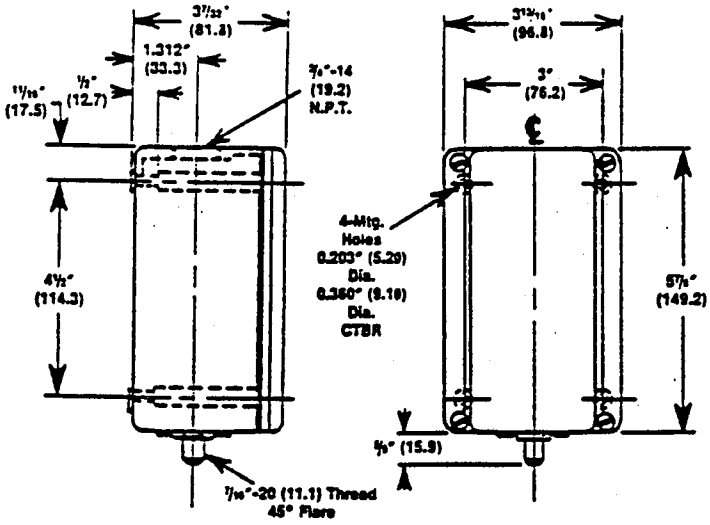
STYLE A



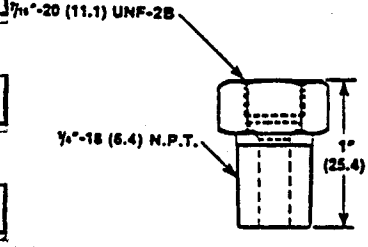
NEMA Type 1
Approximate
Shipping Wt. 2 lbs. (.91 kg)



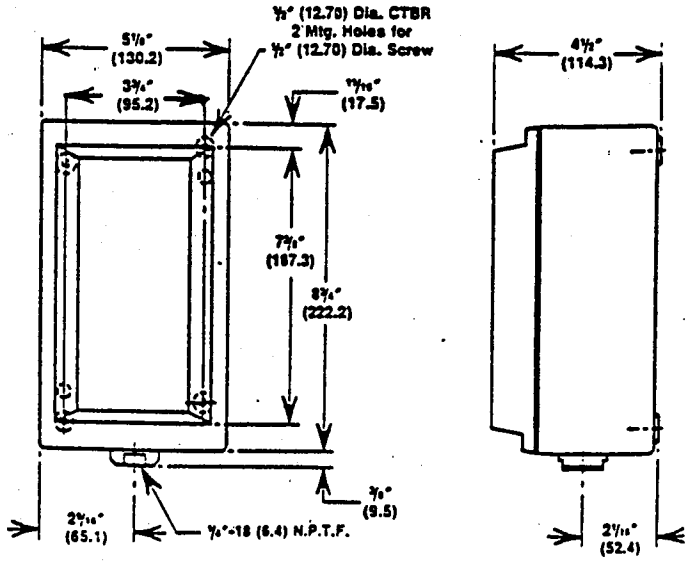
NEMA Type 4, 7 & 9
Approximate
Shipping Wt. 9 lbs. (4.1 kg)



NEMA Type 4 & 13
Approximate
Shipping Wt. 3 lbs. (1.4 kg)



Catalog Number 836-N1
Approximate
Shipping Wt. 1/4 lb. (.1 kg)



Style C — NEMA Type 4X
Approximate
Shipping Wt. 6 lbs. (2.7 kg)

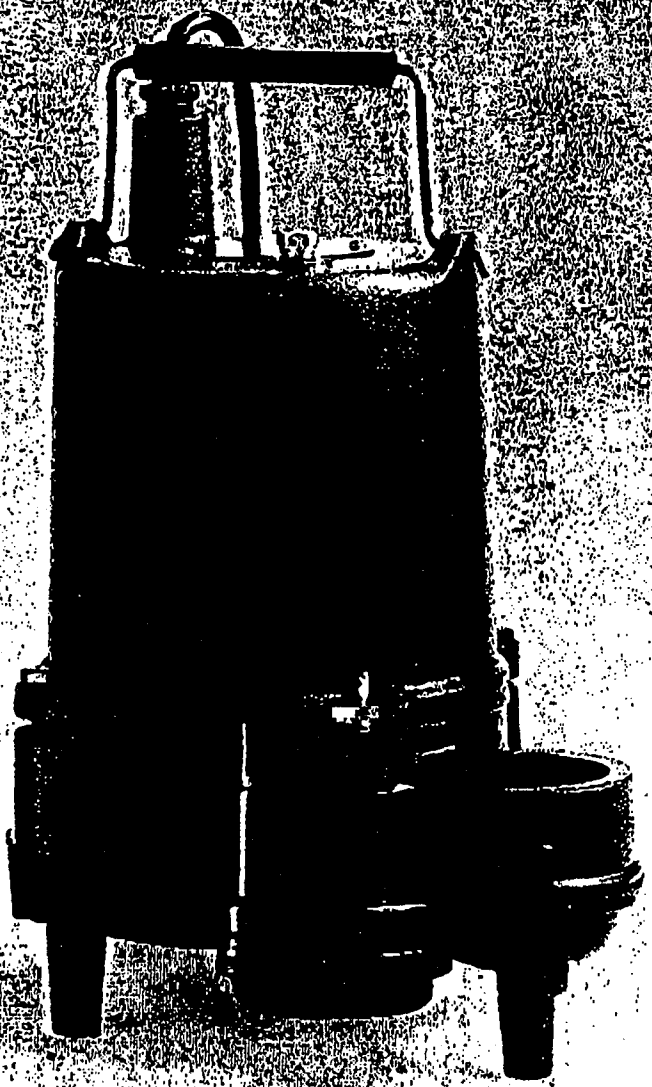
AURORA

SUMP GROUND WATER RECOVERY PUMP

HYDROMATIC SP40

Submersible Sewage Ejector Pump

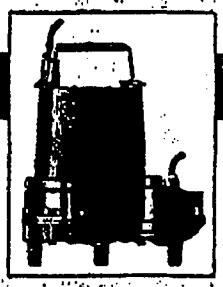
- Residential Sewage
- High-Capacity Sump
- Septic Tank Effluent



©1990 AURORA PUMP, NORTH AURORA, ILLINOIS

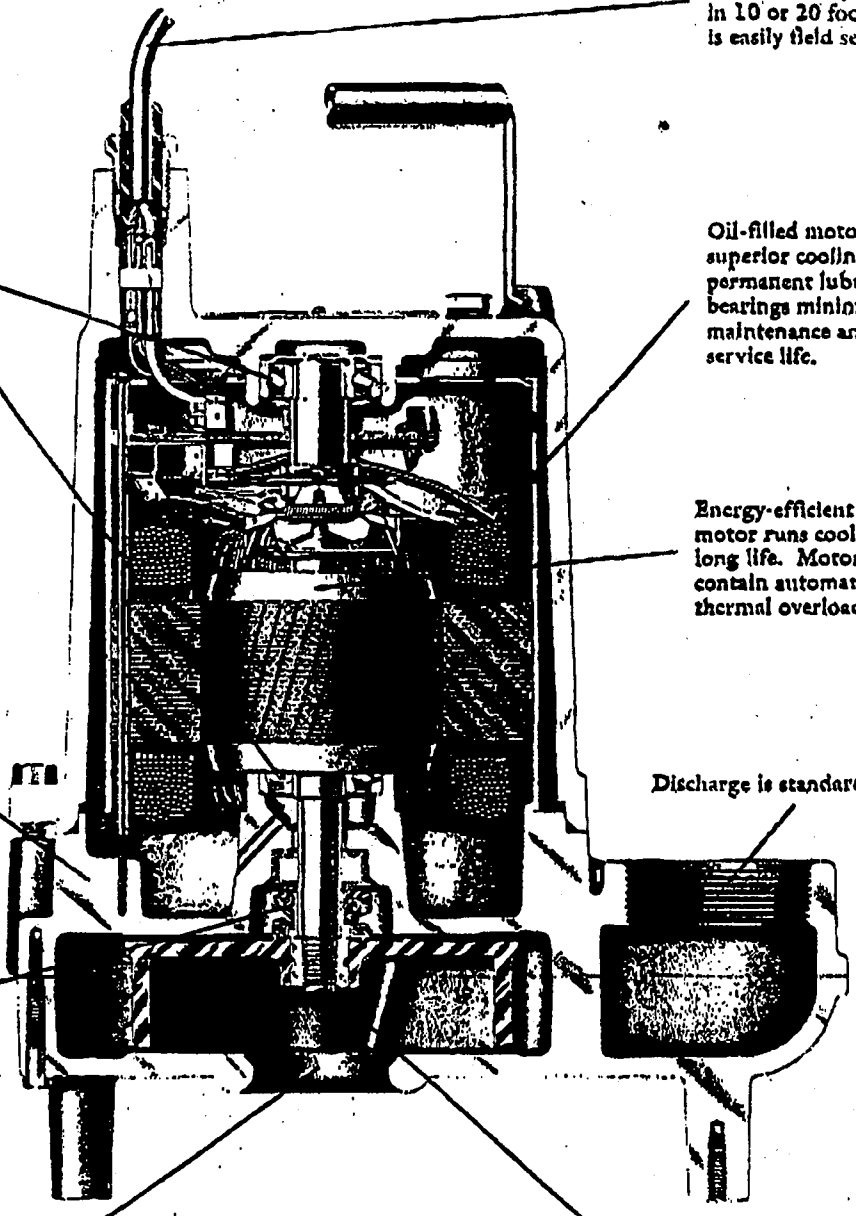
AURORA PUMP
A UNIT OF GENERAL SIGNAL

FEATURES/BENEFITS



The SP40 is a completely submersible ejector pump for use in handling wastewater and sewage in residential and commercial building applications; and is available in automatic or manual configurations.

Automatic models feature the exclusive Hydromatic diaphragm pressure switch with piggyback plug-in arrangement. Proven reliability for automatic operation in installations where a float might hang up. The switch is easily serviced and may be disconnected for manual pump operation.



Water-resistant power cord with molded plug is available in 10 or 20 foot lengths, and is easily field serviceable.

Upper radial- and lower thrust-bearings are heavy-duty, single-row ball bearings that are permanently lubricated for service-free life.

Oil-filled motor provides superior cooling and permanent lubrication of bearings minimizing maintenance and extending service life.

Energy-efficient 4/10 HP motor runs cool and quiet for long life. Motor windings contain automatic-reset, thermal overload protection.

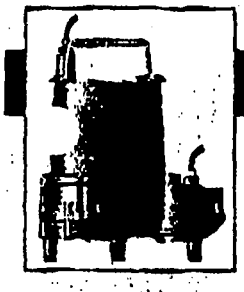
Heavy-duty, cast iron construction provides long life and assists in heat dissipation for cooler motor operation.

Discharge is standard 2 inch NPT.

Precision, mechanical shaft seal is extensively-lapped, carbon- and ceramic-faced for a long leakproof life.

Bottom inlet has no screen to become clogged, providing optimum pump performance and minimal maintenance.

The high-capacity, non-clog, thermoplastic impeller, which is threaded to a stainless steel shaft, efficiently handles up to 1-1/4 inch spherical solids. Pump-out vanes on back on impeller prevent stringy materials from binding impeller or shaft.



SP40 SUBMERSIBLE SEWAGE EJECTOR PUMP

The Hydromatic SP40 submersible pump is specifically designed to meet the demands of handling wastewater and sewage in residence and commercial building applications. The 2 inch NPT discharge pump is available with a powerful 4/10 horsepower motor, in both automatic and manual configurations; and can handle capacities up to 120 gallons per minute and heads to 28 feet.

The SP40 features a heavy-duty cast iron construction that provides durability in rugged applications, as well as assisting in dissipating heat from the motor, for cooler operation. The pump's , non-clog, non-corrosive, thermoplastic impeller, which is threaded to a stainless steel shaft provides long life even in demanding applications; and is capable of handling up to 1-3/4 inch spherical solids and lint. The SP40 also features a precision, carbon- and ceramic-faced mechanical shaft seal that is extensively lapped, providing for a long, leakproof life.

The SP40's oil-filled motor provides superior cooling characteristics, allowing the motor to run cool and quiet for years. This oil-filled design also provides permanent lubrication of the shaft bearings, minimizing maintenance and extending the service life of the pump.

In addition, to protect against overheating, the motor windings contain an automatic reset thermal overload.

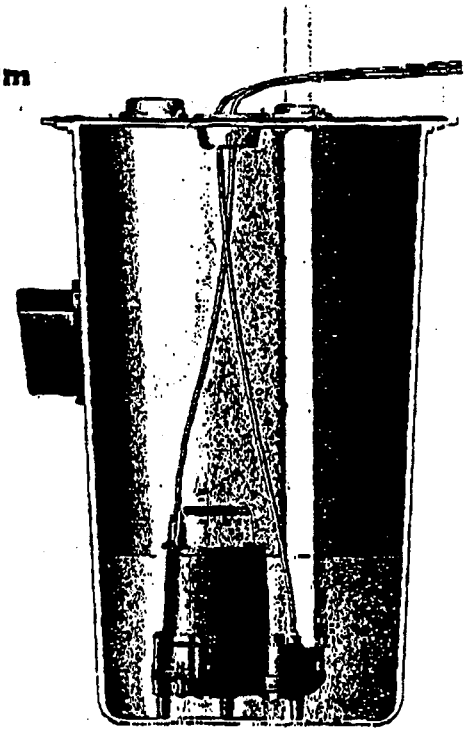
Automatic models feature the exclusive Hydromatic diaphragm pressure switch, which provides proven reliability in installations where a float might hang up. It also incorporates a unique piggyback plug arrangement, which allows for simple conversion to manual operation by simply removing the switch plug and inserting the motor plug directly into the electrical outlet. This feature provides an easy way of periodically cycling the pump to ensure it is operating properly.

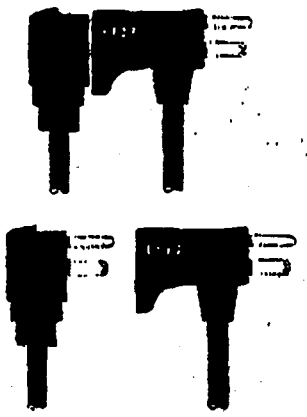
SP40 TYPICAL INSTALLATION

Piggyback Diaphragm Pressure Switch

The exclusive Hydromatic piggyback pressure switch is mounted to the SP40A with a stainless steel mounting strap, for automatic pump operation. The pressure switch is sealed in a tough, non-corrosive engineered thermoplastic housing for a long service life.

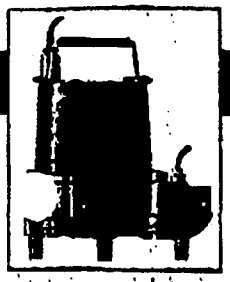
The diaphragm pressure switch with piggyback plug-in arrangement is perfect for installations in smaller diameter sump basins where a float switch might hang-up.





Piggyback Switch Plug

The Hydromatic wide-angle float switch features a unique piggyback plug arrangement. The pump power cord plugs into the back of the switch plug to provide automatic operation. To operate the pump manually, simply plug the pump power cord directly into the electrical outlet, bypassing the switch plug. The piggyback plug provides ease of service and allows the pump to be cycled manually on a periodic basis to ensure proper operation.



ENGINEERING DETAILS - SP40

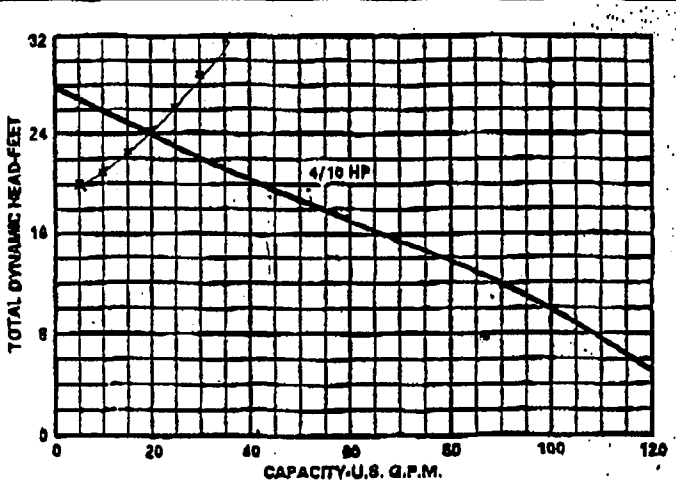
Pump Characteristics

Pump/Motor Unit	Submersible	
Manual Models	SP40M1	SP40M2
Automatic Models	SP40A1	SP40A2
Horsepower	4/10	
Full Load Amps	9.4	4.7
Motor Type	Split-Phase	
R.P.M.	175	
Phase Ø	1	
Voltage	115	230
Hertz	60	
Operation	Intermittent	
Temperature	140°F Ambient	
NEMA Design	A	
Insulation	Class A	
Discharge Size	2" NPT	
Solids Handling	1-1/4"	
Net Weight	60 lbs.	
Power Cord	18/3, SJTW, 115V = 10' std. (20' opt.) 230V = 20' std.	

Materials of Construction

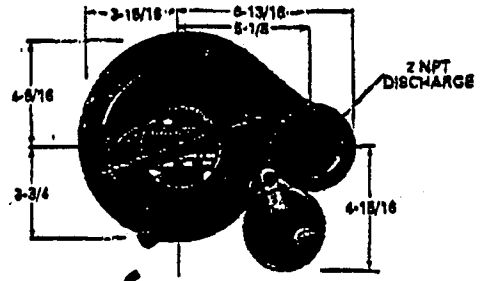
Handle	Steel
Lubricating Oil	Dielectric Oil
Motor Housing	Cast Iron
Pump Casing	Cast Iron
Shaft	Stainless Steel
Mechanical Shaft Seal	Seal Faces: Carbon/Ceramic Seal Body: Brass Spring: Stainless Steel Bellows: Buna-N
Impeller	Thermoplastic
Upper Bearing	Single Row Ball Bearing
Lower Bearing	Single Row Ball Bearing
Fasteners	Stainless Steel

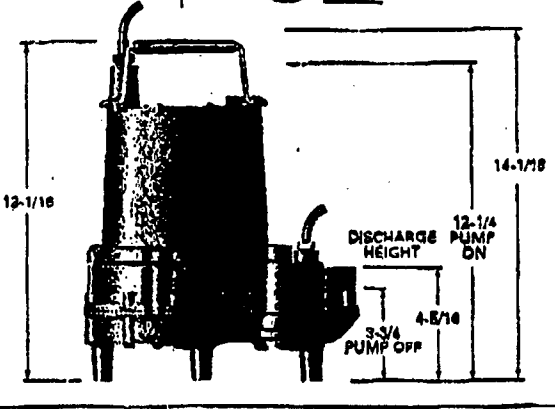
Performance Data



Total Head (feet)		4	8	12	16	20	24	28
GPM	4/10 HP	120	108	90	68	42	20	0

Dimensional Data





1. All dimensions in inches
2. Component dimensions may vary ± 1/8 inch
3. Not for construction purpose unless certified
4. Dimensions and weights are approximate
5. We reserve the right to make revisions to our products and their specifications without notice

AURORA/HYDROMATIC Pumps, Inc.
1840 Baney Road, Ashland, Ohio 44805
(419) 289-3042

B/W CONTROLS

RW-1 AND RW-2
WELL LEVEL TRANSDUCERS

PRINCIPLE OF OPERATION

A B|W floatless liquid level control system consists of a relay of the proper type, a holder designed to support one or more electrodes or probes in the liquid container, and the corrosion resistant electrodes themselves. Inasmuch as all B|W induction relays are quite similar — differing only in contact arrangement, the following description of how a 1500-C Relay functions on a pump down control application will serve to explain the design, construction, and operating principles for the entire line.

As shown in diagrams below, the laminated core of the relay is H shaped. The primary coil is assembled to the upper bar of the core, and the secondary coil for the electrode is placed on the lower bar. An armature located below the legs of the H core is connected to an insulated arm carrying the movable contacts. When the armature is raised, these contacts close or open the motor and electrode circuits, depending upon whether the contacts are normally open or closed. (Contacts shown normally open in this example.)

When a source of alternating current is connected to the primary coil at terminals 3 and 4, the primary coil sets up a magnetic flux which — following the lines of least resistance — circulates through the shortest path. As shown in Figure 1, this is through the lower bar of the laminated core on which the secondary coil is mounted. This magnetic flux induces a voltage in the secondary or electrode circuit coil. No current can flow in this coil, however, until the circuit is completed between the electrodes. **Thus, the electrode circuit voltage being generated within the relay has no connection with the power line.**

The B|W 1500 induction relay utilizes the liquid as an electrical conductor to complete the secondary circuit between the upper and lower electrodes. Thus, when the liquid contacts the upper electrode, the resulting flow of current in this circuit sets up a bucking action in the lower bar of the core. This action tends to divert lines of magnetic force to the core legs and sets up an attraction that pulls the armature into contact with the legs, as shown in Figure 2. This armature movement closes the electrode and load contacts.

The lower contacts on 1500-C Relays (terminals 9 and 10) connect the secondary circuit to ground when liquid contacts the upper electrode and act as a holding circuit to maintain the relay in its closed position until the liquid falls below the lower electrode. This holding circuit provides control of the relay over any desired range in the liquid level, depending on the distance between the upper and lower electrodes.

The flow of current through the low energy secondary circuit is very small and varies with the voltage of the secondary coil. The secondary coil is selected to operate over the resistance of the liquid being controlled. Accordingly, since there is a wide range of secondary coils from which to choose, it is important that complete information regarding the nature of the liquid be furnished when ordering B|W induction relays.

1500-C RELAY USED FOR PUMP DOWN CONTROL

THIS CONCEPT

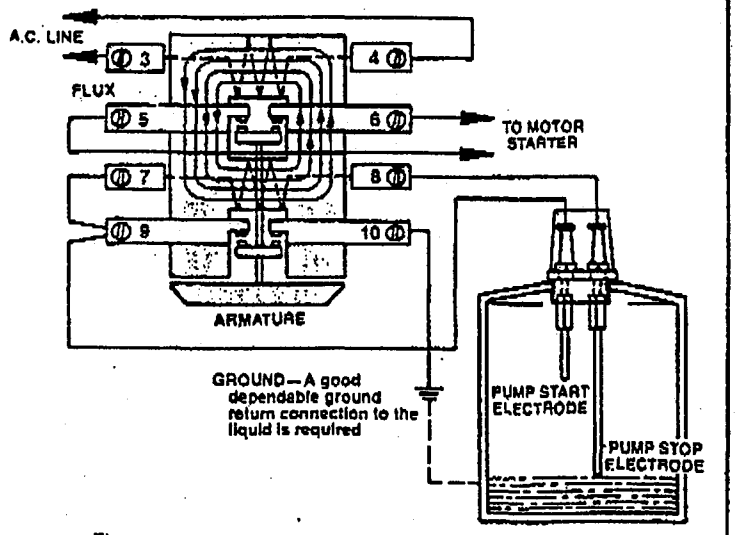


Figure 1—Secondary coil circuit open; armature down.

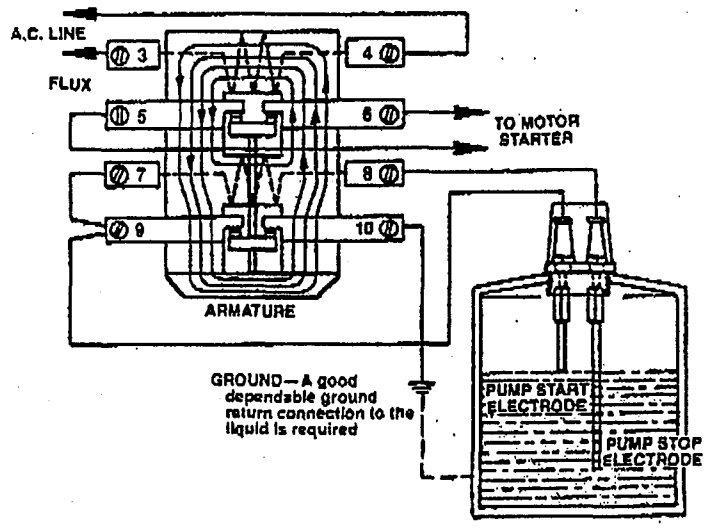


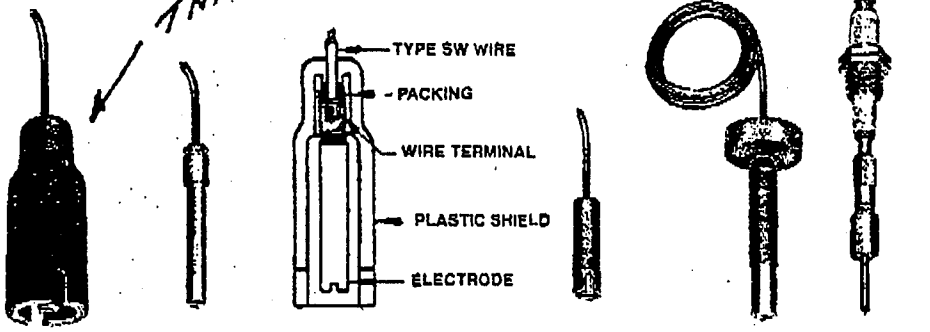
Figure 2—Secondary coil circuit closed; armature up.

ELECTRODE HOLDERS AND ELECTRODES

B|W Controls

WIRE SUSPENSION ELECTRODES

THIS ELECTRODE



E-1P WITH SHIELD | E-1P LESS SHIELD | E-1P CUT-AWAY | E-1S WITH SHIELD | 13-064700 | PLUG WITH CONNECTOR

Wire suspension electrodes are designed for use in applications requiring long lengths, or where limited head room prevents installation of solid rod electrodes. They can be used with all holders except Type CE-2 & 3. Electrode Types E-1P and E-1S are for use in water and non-corrosive liquids. Type 13-064700 is designed for corrosive liquids and is available with a variety of rod materials.

E-1P-Shielded: This electrode is approximately 4" long and assembled in a molded plastic insulating shield 1 7/16" in diameter. Designed for general purpose use, it is ideal for elevated tanks, sewage pumping stations, and deep well installations.

Type E-1P — Less Shield: This electrode is intended for applications where space prevents the use of other electrodes and where vertical spacing between electrodes is 4" or more.

Type E-1S-Shielded: A 2" long electrode assembled in a molded plastic shield 9/16" in diameter. Ideal for use in submersible pump installations and other applications where little clearance is provided for installation.

Type 13-064700: This electrode is intended for corrosive liquids. It is 3" long made from a ½" diameter rod and available in any of the materials listed below. The type SW wire is attached at the factory and the connection is completely sealed with PVC and bonded to the insulation of the SW wire.

WIRE CONNECTOR: This adapter is necessary to attach the Type SW suspension wire to the ¼-20 female electrode holder connections. One is required for each wire suspension electrode used with electrode plugs, and Type E and Type AE-2 holders. See pages 6 & 7.

CATALOG NUMBER
6013 — C — BR



Material		LIST PRICE
Brass Old No. 12-038400	BR	$3.80
303 SS Old No. 12-043800	SS	$6.80

Type SW Suspension Wire: Designed to provide maximum strength and insulation. Type SW wire should always be used with BIW wire suspension electrodes to assure that a watertight seal is accomplished by the packing in the electrode. The wire is single conductor 18 gauge, 41 strand copper with 4/64" vinyl insulation.

CATALOG NUMBER
6013 — SW — 10



		LIST PRICE
Specify Length In Feet Old No. 01-130500		$0.60 per ft.

6013 — W1

CATALOG SECTION	ELECTRODE TYPE	ELECTRODE MATERIAL	OLD PART NO.	LIST PRICE
W1	E-1P With Shield	Brass	13-020600	$11.80
W2	E-1P With Shield	303 Stainless	13-020700	17.20
W3	E-1P Less Shield	Brass	13-052700	4.80
W4	E-1P Less Shield	303 Stainless	13-052600	9.80
W5	E-1S With Shield	Brass	13-022000	10.00
W6	E-1S With Shield	303 Stainless	13-024300	13.00

These electrodes are field assembled and the required amount of Type SW wire must be ordered as a separate item. See above.

NOTE — When wire suspension electrodes are to be used with electrode plugs, or Type E or Type AE-2 electrode holders, wire connectors must also be ordered for each electrode. See above.

6013 — W7 ——— 10

CATALOG SECTION	ELECTRODE TYPE	ELECTRODE MATERIAL	OLD PART NO.	LIST PRICE
W7	13-064700 With SW Wire	316 Stainless	13-064702	$46.00
W8	13-064700 With SW Wire	Monel	13-064703	50.00
W9	13-064700 With SW Wire	Nickel	13-064704	50.00
W10	13-064700 With SW Wire	Carpenter 20	13-064705	49.00
W11	13-064700 With SW Wire	Hastelloy B	13-064707	62.00
W12	13-064700 With SW Wire	Hastelloy C	13-064706	58.00
W13	13-064700 With SW Wire	Titanium	13-064709	58.00

		LIST PRICE
	Type SW Wire Length In Feet	ADD $.60 per ft.

These electrodes come complete with the Type SW wire permanently attached to the electrode. Lengths must be specified when ordering.

CALGON

CARBON

CALGON CARBON CORPORATION
P.O. BOX 717 • PITTSBURGH, PA 15230-0717

CALGON DRY SCREENED REACTIVATED CARBON - TYPE C

SPECIFICATIONS

TEST	SPECIFICATION
IODINE NUMBER - MIN.	800
ASH, WT. % - MAX.	9
A.D., G/CC - MAX.	0.60
MESH SIZE NOMENCLATURE	8 X 30
PARTICLE SIZE	
THRU U.S. #30 MESH, % MAX.	5

#27-257
7/90

GEMS

FLOAT SWITCH

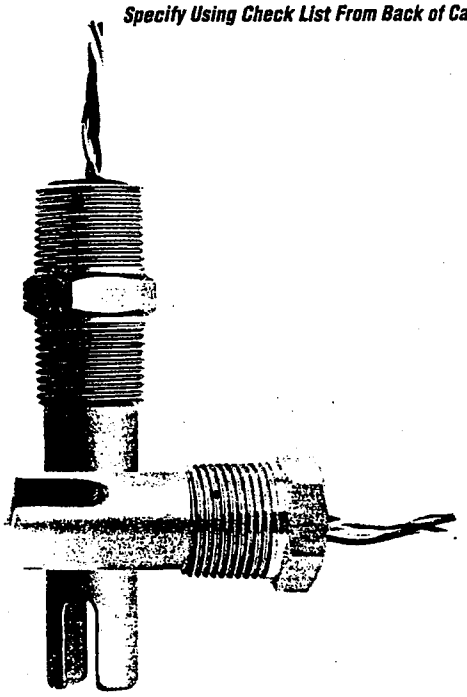
ULS-11 Series – Single Point

Self-Contained Relay Saves Space

- 1 Amp Relay Output
- 9 to 36 VDC Input
- Temperatures to 160°F (71.1°C)
- Lengths to 99 inches (251.5 cm)

By integrating a 1 amp relay into the stem, we've made the ULS-11 our most compact ultrasonic unit. Yet, as unobtrusive as it is, the ULS-11 still delivers ultra-reliable solid-state performance in lengths up to 99 inches. Tip gap probe configuration places sensing point at 1/4 inch from probe tip for closer tank bottom sensing. Electronics are completely epoxy sealed for years of maintenance free service.

FAX IT!
Specify Using Check List From Back of Catalog

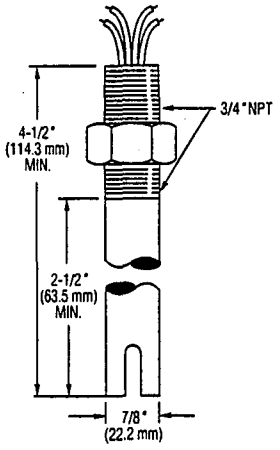
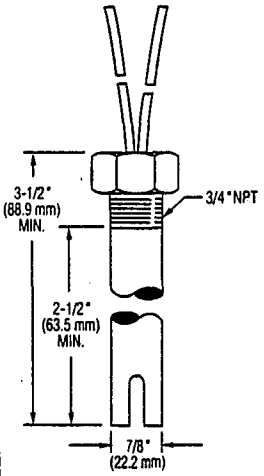


Specifications

Input Power*	9 VDC to 36 VDC
Leakage Current	<50 μA
Gain	300:1
Output	1 Amp, SPST Relay Output (Specify Dry Contact, N.O. or N.C.)
Repeatability	2mm typical
Delay (On)	0.5 Seconds
Operating Temperature	-20°F to +160°F (-28.9°C to +71.1°C)
Pressure, PSIG, Max.	1000
Protection	Transient Reverse Polarity
Lead length	12" PVC**

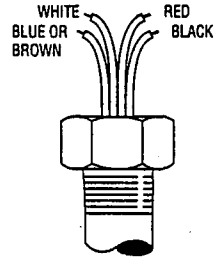
* Contact GEMS for optional AC input versions.
** Consult factory for longer lead lengths.

1. Mounting Types

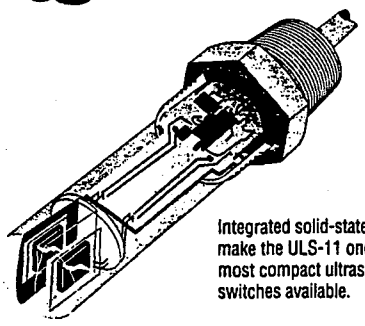
Type 1 3/4"NPT	Type 3 3/4"NPT
	
Mounting and Sensor Materials	316 Stainless Steel*

Other materials available. See Page E-3.

Wiring Diagram

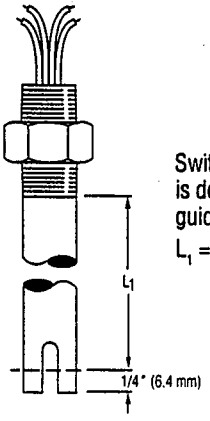


Color Code
Power: Red (+)
Black (-)
Relay: Common - White
N.O. - Blue
N.C. - Brown



Integrated solid-state electronics make the ULS-11 one of the most compact ultrasonic level switches available.

2. Actuation Level Dimensions



Switch actuation level (L_1) is determined following the guidelines below.
L_1 = 2-1/4" (57.2 mm) Minimum
99" (251.5 cm) Maximum

GOULD

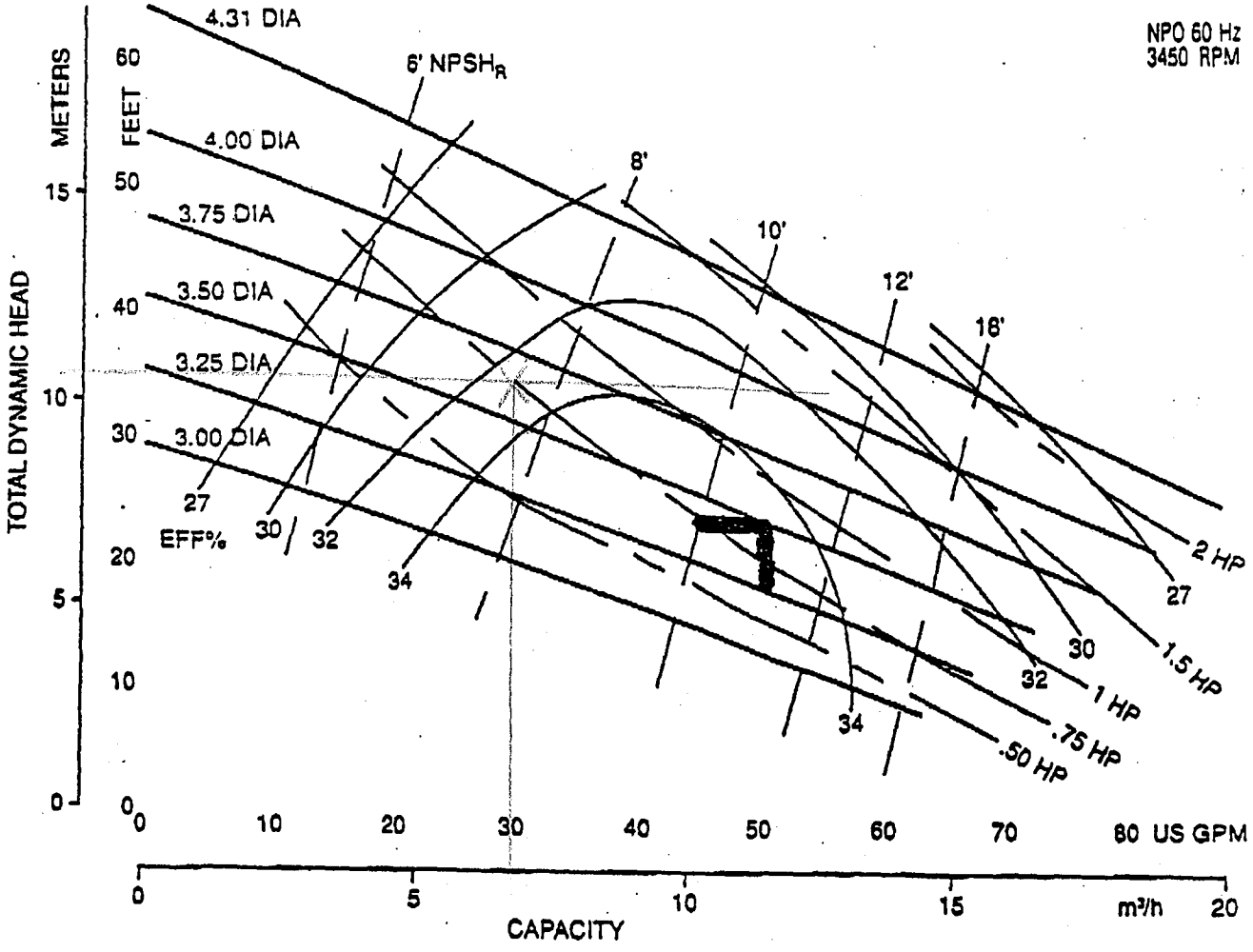
TRANSFER PUMP

Performance Curves

TRANSFER PUMP

These curves show the performance of the NPO at the six standard impeller trims when operating at 3500 RPM.

IMPORTANT NOTE: The NPO performance is dependent on impeller clearance. The curves show the worst case performance with NPO motors. Individual pumps may produce up to five feet additional pressure. Use of other motors may result in lower performance. The motor loading will remain as listed independent of what motor manufacturer is used.



General Pump Description

Capacities to:	75 GPM (283 L/MIN)
Heads to:	60 feet (17 M)
Working pressure to:	125 PSIG (9 BAR)
Maximum temperature to:	212° F (100° C) with standard seal or 250° F (121° C) with optional high temperature seal.
Motors:	NEMA standard 56J frame, 3500 RPM, ½ through 2 HP. Open drip proof, totally enclosed fan cooled or explosion proof enclosures. Stainless steel shaft with ball bearing. Single phase 115/230 V and three phase 208-230/460 V.

Product Features

The NPO pump from G&L has been designed with exclusive technical benefits to serve the needs of manufacturers in a wide variety of washer applications.

- AISI 304 and 316 stainless steel liquic end components resist detergent corrosion and eliminates rust in wash water.
- Open impeller design passes up to ⅜" solids including food particles, lint, metal filings, and other wash residue.
- NPT threaded connections and casing rotation to eight positions permit easy fit to a variety of piping.
- Close-coupled design saves space and simplifies maintenance and installation.
- NEMA standard open drip proof, totally enclosed fan cooled or explosion proof motors with rugged ball bearing design.
- Standard John Crane type 21 mechanical seals with carbon versus ceramic faces and viton elastomers. Optional high temperature and chemical duty seals available.
- The NPO can be installed in either a horizontal or vertical position. An optional seal chamber vent is available.

Applications

- Dishwashers
- Bottle and glass washers
- Commercial laundry systems
- Parts washers
- Machine tool coolant
- Liquid transfer

NPO Numbering System

The various versions of the NPO are identified by a product code number on the pump label. This number is also the catalog number for the pump. The meaning of each digit in the product code number is shown below.

Example Product Code

1 SN 1 C 1 A 3 F

Seal Vent/Flush Option

Mechanical Seal and O-Ring
3 = standard seal

Seal Code	Rotary	Stationary	Elastomers	Metal Parts	Part No.	Casing O-ring
3	Carbon	Ceramic	Viton	18-8 SS	10K24	Viton
2		Ni-Resist	EPR		10K18	BUNA
1		Ceramic	BUNA		10K40	BUNA
4		Tungsten	Viton		10K55	Viton
6	Siliconized Carbon		Viton		10K02	Viton
7	Siliconized Carbon		BUNA		10K29	BUNA
8	Carbon	Ceramic	EPR		10K55	EPR

Impeller Option Code
A = 4 9/16"
B = 4"
C = 3 3/4"
D = 3 1/2"
E = 3"

Driver

1 = 1 PH, ODP	6 = 575 V, TEFC
2 = 3 PH, ODP	7 = 3 PH, XP
3 = 575 V, ODP	8 = 575 V, XP
4 = 1 PH, TEFC	0 = 3 PH, XP
5 = 3 PH, TEFC	

HP Rating

C = ½ HP	F = 1½ HP
D = ¾ HP	G = 2 HP
E = 1 HP	H = 3 HP

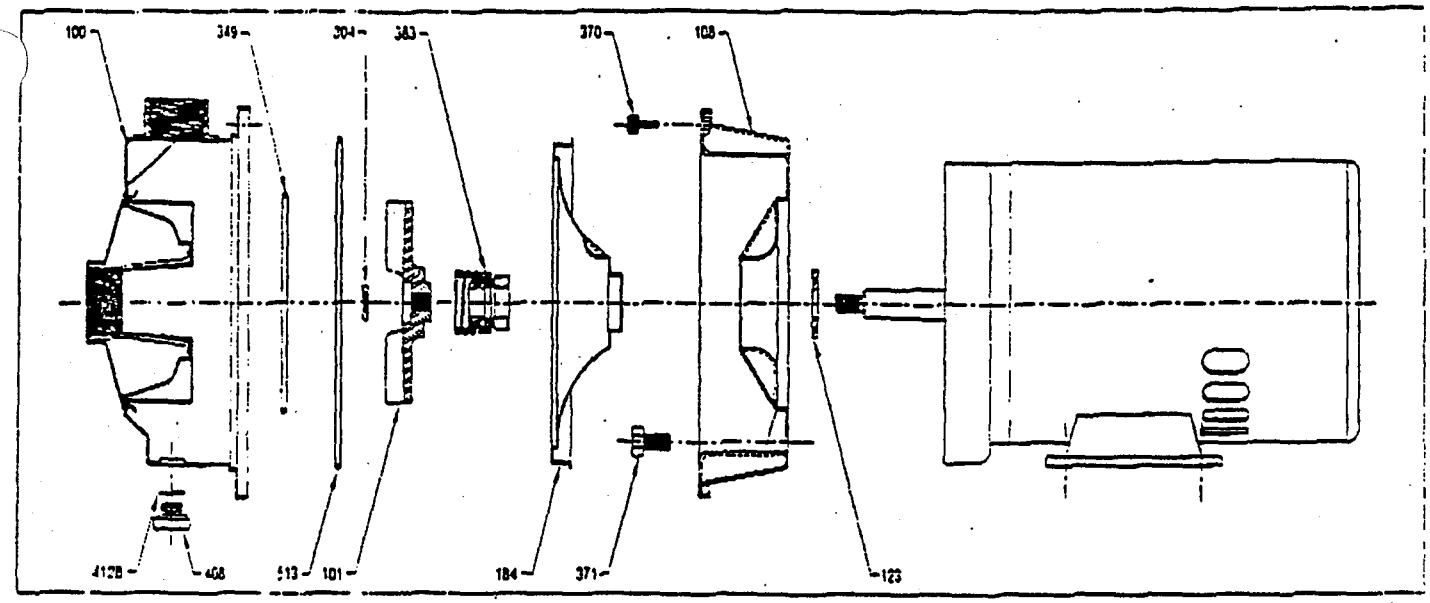
Driver: Hertz/Pole/RPM
1 = 60 Hz, 2 pole, 3500 RPM
2 = 60 Hz, 4 pole, 1750 RPM
3 = 60 Hz, 6 pole, 1150 RPM
4 = 50 Hz, 2 pole, 2900 RPM
5 = 50 Hz, 4 pole, 1450 RPM

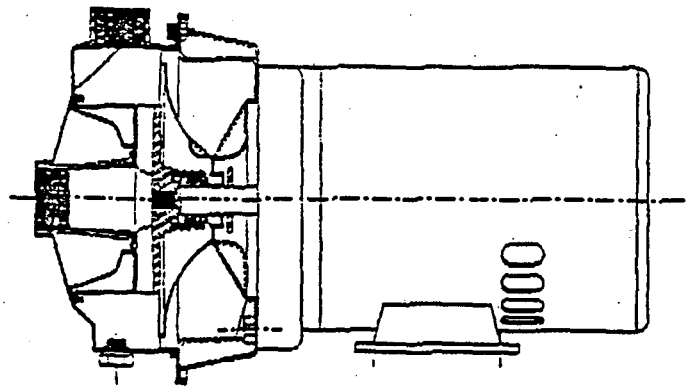
Material
NPO 316 open impeller

Pump Size
1 = 1 x 1½ – 6

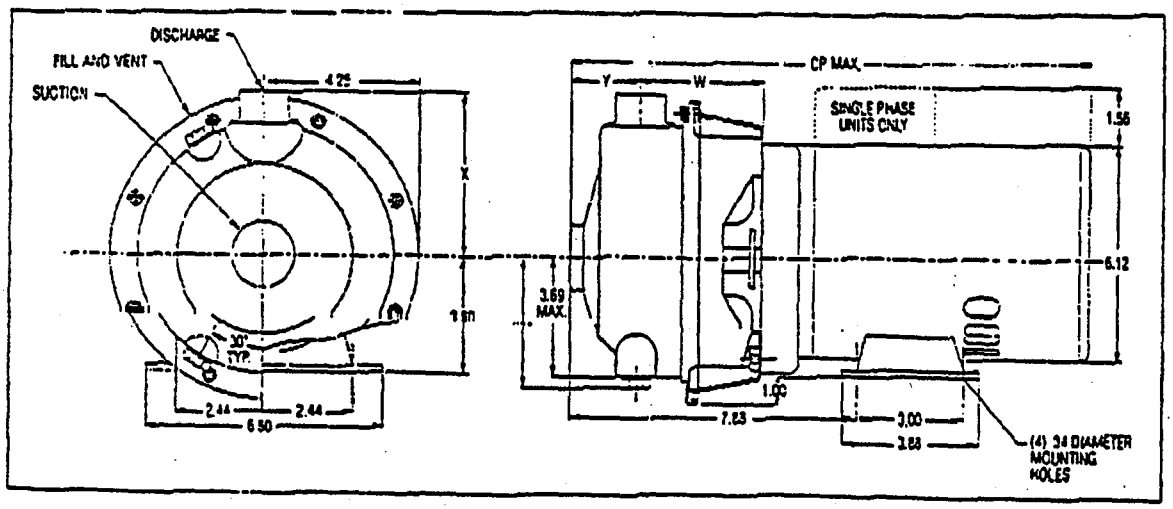
Dimensions and Weights

(All dimensions are in inches, weights are total unit weight.)





Item No.	Description	Materials of Construction
100	Casing	AISI 304 SS
101	Impeller	AISI 316 SS
	4.31" Diameter	
	4.00" Diameter	
	3.75" Diameter	
	3.50" Diameter	
	3.25" Diameter	
	3.00" Diameter	
304	Impeller Locknut	AISI 304 SS
108	Motor Adapter	AISI 304 SS
123	Deflector	BUNA-N
184	Seal Housing	AISI 304 SS
349	Impeller Casing O-Ring	Viton
370	Capscrew, Casing	AISI 400 SS
371	Bolts, Motor	Steel/Plated
383	Mechanical Seal	Carbon/Ceramic
408	Fill and Drain Plug	AISI 400 SS
412B	O-Ring, Drain Plug	Viton



Dimensions Determined by Pump (inches)							
Pump	Suction	Discharge	HP	W	X	Y	L
1SN	1.25	1	.5-2	3.31	4.38	2.00	4.56

Motor Weights (lbs.)					
HP	Motor Weights				CP Max. Length Inches
	One Phase		Three Phase		
	ODP	TEFC	ODP	TEFC	
.5	19	20	19	20	15.05
.75	22	24	22	21	15.05
1	25	26	24	23	15.05
1.5	31	35	27	28	15.05
2	35	39	39	33	15.73

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BGLNPO

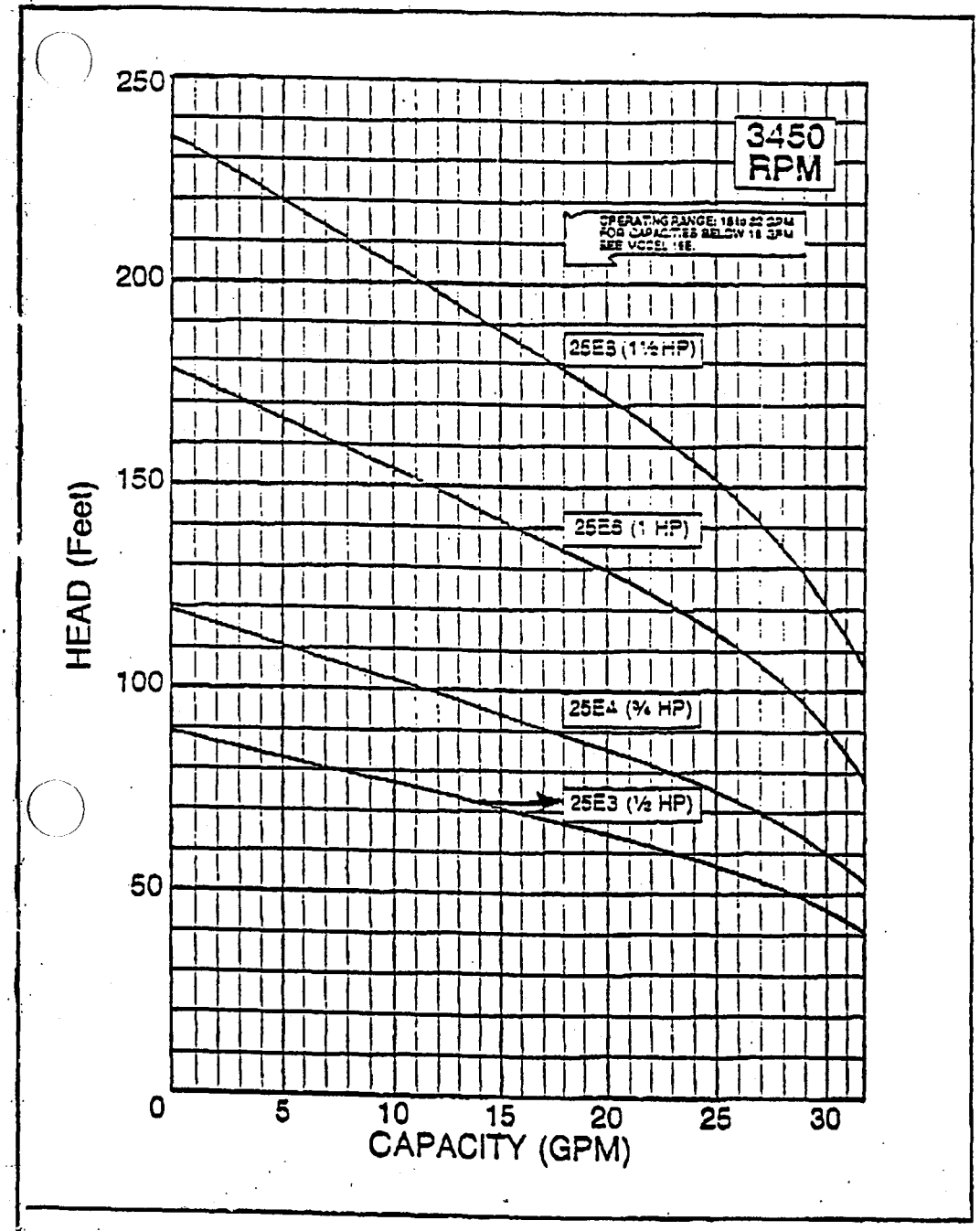
GRUNDFOS

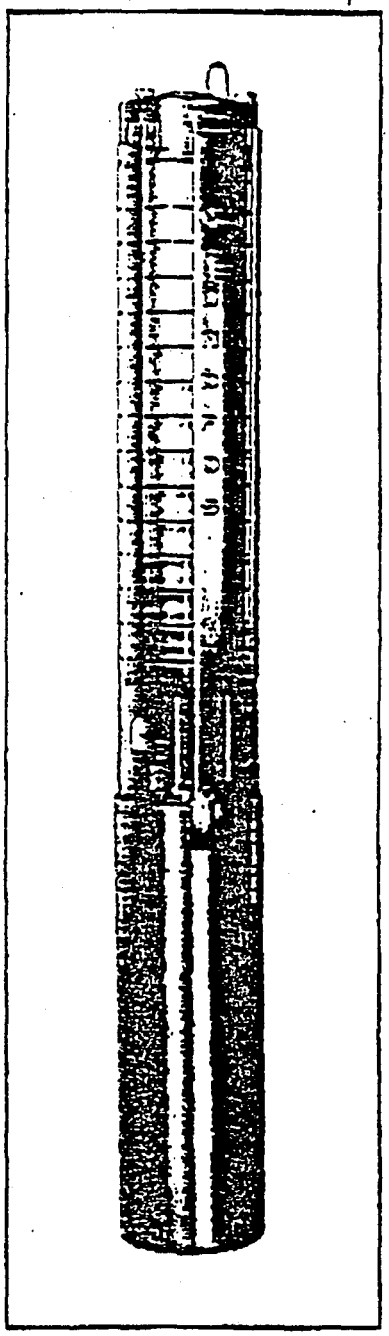
RW-1 AND RW-2
GROUND WATER RECOVERY PUMPS

RW-1

GRUNDFOS REDI-FLO4 25E3

Performance Curves





Materials of Construction

REDI-FLO4 PUMP END	
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Check Valve Seat	304 Stainless Steel & Teflon®
Diffuser Chamber	304 Stainless Steel
Impeller Seal Ring	Teflon®
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	304 Stainless Steel
Coupling	329/420/431 Stainless Steel
Bushings	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
Intermediate Bearings	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR	
Nema Top	304 Stainless Steel
Studs & Fasteners	304 Stainless Steel
Nuts	316 Stainless Steel
Sand Slinger	Viton®
Shaft Extension	431 Stainless Steel
Diaphragm	Viton®
Stator Housing	304 Stainless Steel
Fill Plug Screw	304 Stainless Steel
Fill Plug Washer	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR LEADS	
Connector Sleeve	304 Stainless Steel
Connector Potting	Scotch Cast #4® Epoxy w/Viton® Cap
Connector Plug	Viton®
Lead Insulation	Teflon®

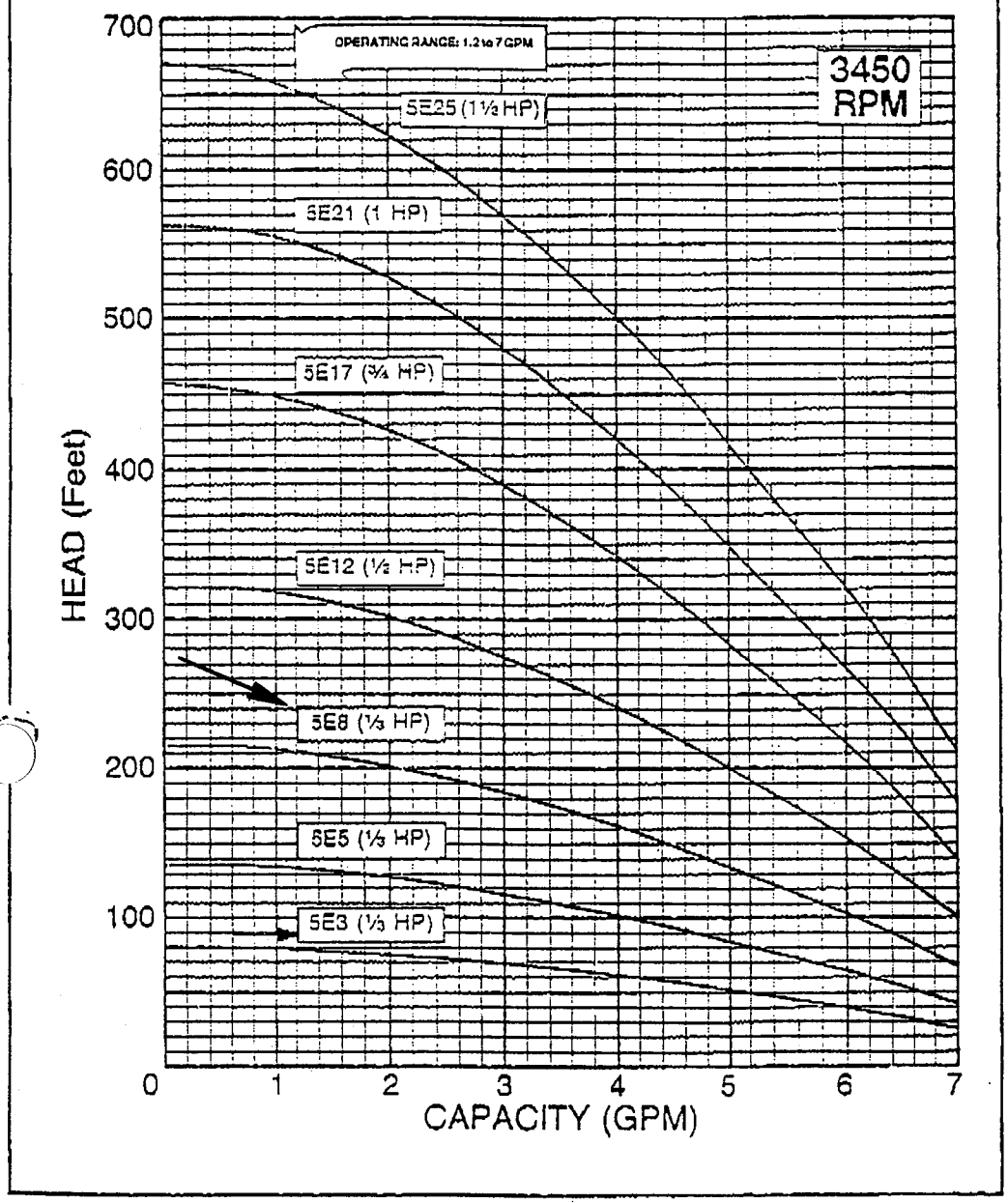
NOTE: Specifications are subject to change without notice.

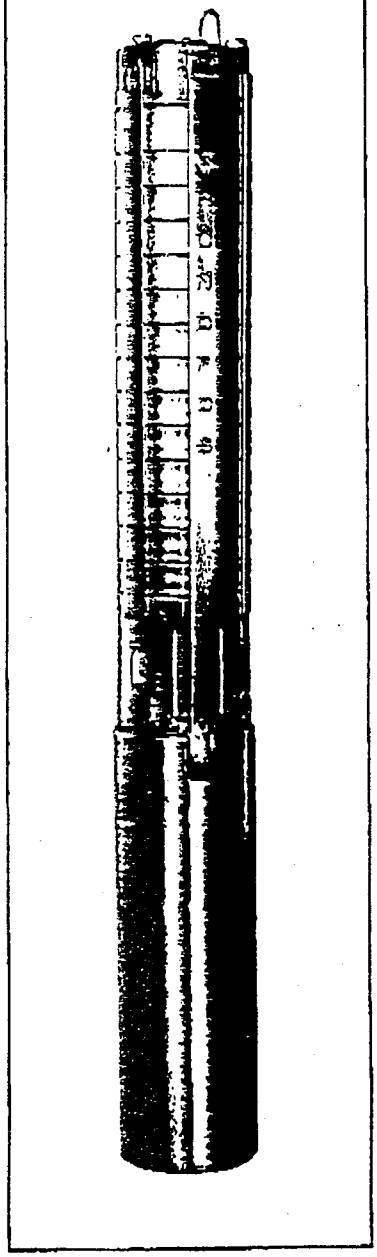
RW-2

GRUNDFOS REDI-FLO4 5E8

erformance Curves

Redi-Flo4 Environmental Pump





Materials of Construction

REDI-FLO4 PUMP END	
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Check Valve Seat	304 Stainless Steel & Teflon®
Diffuser Chamber	304 Stainless Steel
Impeller Seal Ring	Teflon®
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	304 Stainless Steel
Coupling	329/420/431 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
Intermediate Bearings	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR	
Nema Top	304 Stainless Steel
Studs & Fasteners	304 Stainless Steel
Nuts	316 Stainless Steel
Sand Slinger	Viton®
Shaft Extension	431 Stainless Steel
Diaphragm	Viton®
Stator Housing	304 Stainless Steel
Fill Plug Screw	304 Stainless Steel
Fill Plug Washer	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR LEADS	
Connector Sleeve	304 Stainless Steel
Connector Potting	Scotch Cast #4® Epoxy w/Viton® Cap
Connector Plug	Viton®
Lead Insulation	Teflon®

NOTE: Specifications are subject to change without notice.

HONEYWELL

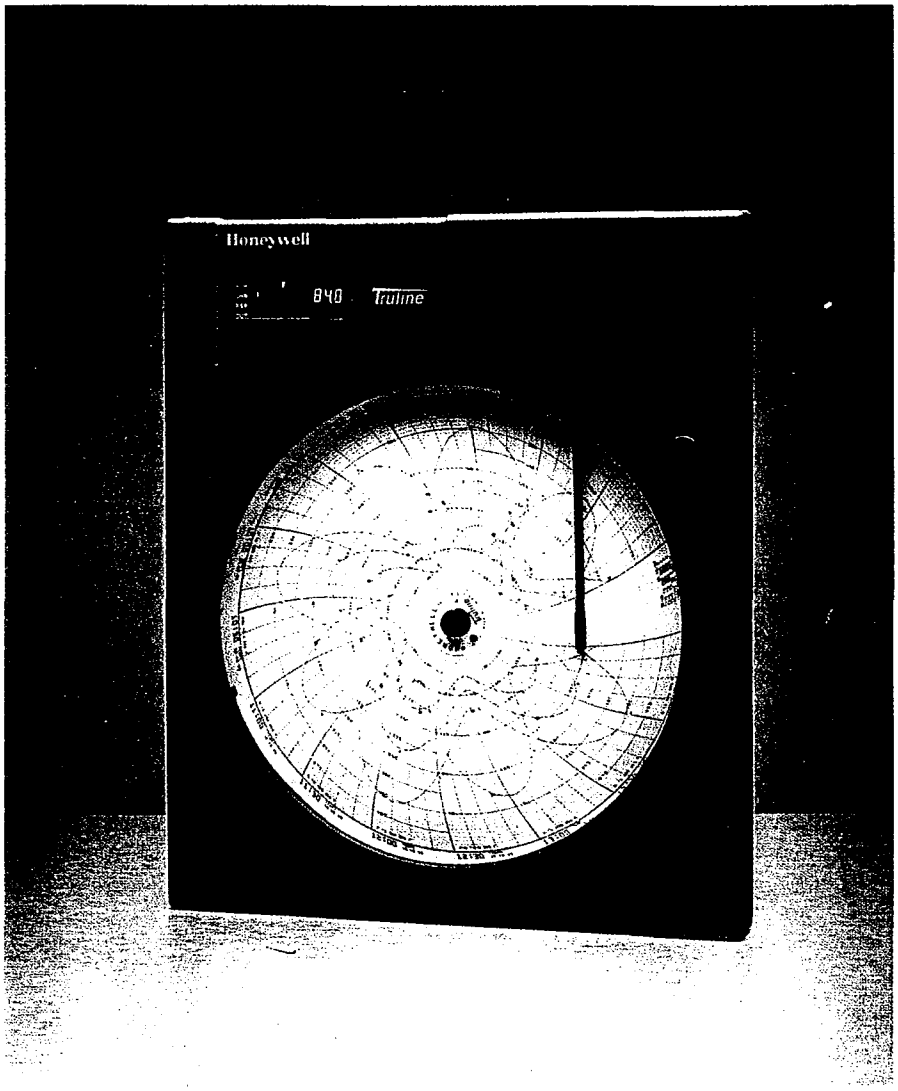
CHART RECORDER

DR 4500 Truline Digital Circular Chart Recorder with Innovative Smart Chart – Prints Its Own Chart!

Proven LeaderLine Quality, Accuracy, and Value

Ask for the "Truline"

Created to satisfy industry's demand for increasingly precise and accurate records, the DR 4500 Truline represents a quantum leap forward in circular chart recorder technology. This unique recorder is ideally suited for applications in food, water and waste water treatment, pharmaceuticals, environmental testing and metal-working — wherever process variables must be documented on a single chart and retained to meet industry requirements. Functionality of the Truline can be expanded by numerous available options including communications and control capability. Microprocessor-based and field configurable, the Truline is industrially hardened for use in plant and factory.



How It Records Is Why It's Better

The Truline is the only circular chart recorder which draws its own chart as it records your data. This technological innovation pays off in user benefits which make the Truline the most convenient and the most accurate circular chart recorder on the market today.

No More Preprinted Charts

A box of blank Truline charts is all you need to have a virtually infinite selection of charts at your command. You create the chart design when you input the operating parameters. The Truline puts an end to preprinted chart ordering, storage and inventory.

Unrivalled Accuracy

Although undetectable to the human eye, chart paper can move and distort due to ambient conditions of heat and humidity, environmental ingredients which are probably present where your recorders are in use. This paper movement can jeopardize the accuracy of your records. In situations involving close tolerances, the margin for error can make the difference between being in, or out, of specifications. Because the Truline prints its chart as it records data, the pinpoint accuracy seen on the digital indicator is precisely transcribed onto the blank chart paper.

Up to Four Variables on a Timeline

All other circular chart recorders use multiple pens to track multiple inputs, making it impossible to show more than one variable on a timeline. Records made this way are often difficult to interpret and leave the user uncertain about when a given event occurred. Since the Truline uses only one stylus to record data and print the chart, up to four variables can be conveniently monitored on the same timeline. This makes Truline records exceptionally easy to read, a valuable feature when stored records must be retrieved and reviewed.

Creates a Permanent, Reliable, Readable Document

With other circular chart recorders, an operator must write identifying information on completed charts, creating the possibility of confusion. The Truline automatically performs this function. On the border of the chart it prints pertinent identifying data including a listing of the variable being monitored, the range of each variable, totalized values, time references and alphanumeric messages. Having this information as an integral element of the chart itself adds authority to your records and makes them easier to read and use for reference.

Condensed Specifications

- ***Field configurable*** — The Truline offers simple English prompts which walk you through the setup process. It can be reconfigured any time so it is adaptable to changes in the range or input measurement and even to completely different applications.
- ***Extreme accuracy*** — Typically less than ±1°F for the usable thermocouple ranges; ±0.1% or better for voltage ranges.
- ***Universal inputs*** — Accepts all thermocouples (Types B, E, J, K, N Nicrosil/Nisi, R, S, T, W5W26); RTDs (100, 200, or 500 Ω Platinum); F_0 lethality calculation; voltage/current (0-10 mV, 10-50 mV, 0-5V, 0-10V, 4-20 mA); Open channel flow, all inputs are keyboard selectable without field calibration.
- ***Data brilliantly displayed*** — Bright, digital dual displays are easily read at a distance or in dim light.
- ***Your entire process at a glance*** — Selectable displays include indication of PV, SP, deviation, alarms, control mode (automatic, manual or remote), output level, temperature units (F or C), engineering units, totalized flow values, and setpoint program (run/hold).
- ***Power requirements*** — 120/240V, 60 or 50 Hz. A built-in standard 24 Vdc power supply will drive up to 2 transmitters.

It's Your Option

Expand the functionality of your DR 4500 Truline recorder with these options. Some options are restricted depending on base model.

- **Universal control output** — Configurable for on-off, PID-A, PID-B, or PD with manual reset. Two control loops available.
- **Chart illumination**
- **Alarms** — Up to 6 fully configurable alarms alert you to critical process changes.
- **Door lock**
- **Flow totalization** — Printed on chart, 4 totalizers possible.
- **Setpoint programming**
- **DMCS 3000 communications**
- **F_0 calculation** for the food and pharmaceutical industries.
- **HTST (High Temperature Short Time)** model for dairy industry applications.
- **Stainless steel door**
- **Abrasion-resistant pen** for harsh environments.
- **Open channel flow measurement** model for the water and waste industry
  - V-notch weir
  - Rectangular weir
  - Cipolletti weir
  - Parshall flume
- **UL listing and FM approved**

So Smart, It Writes

The Truline prints identifying information right on the chart for a record that's comprehensive and reliable. Identifying information includes:

- **Time**
- **Date**
- **Description of all measured processes**
- **Range of each parameter**
- **Alphanumeric messages**

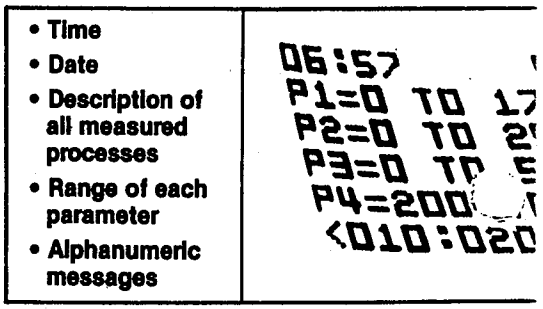
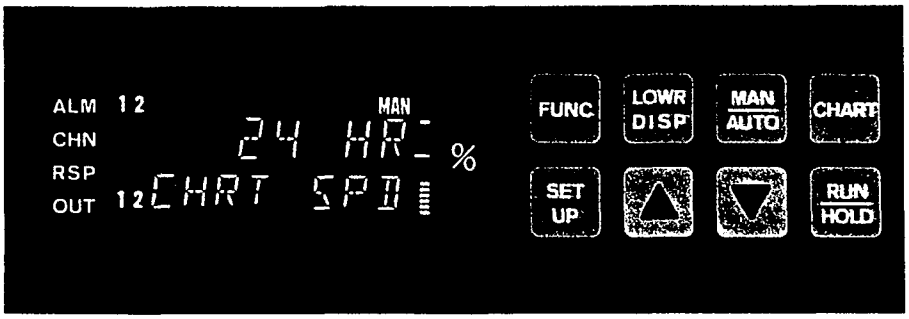
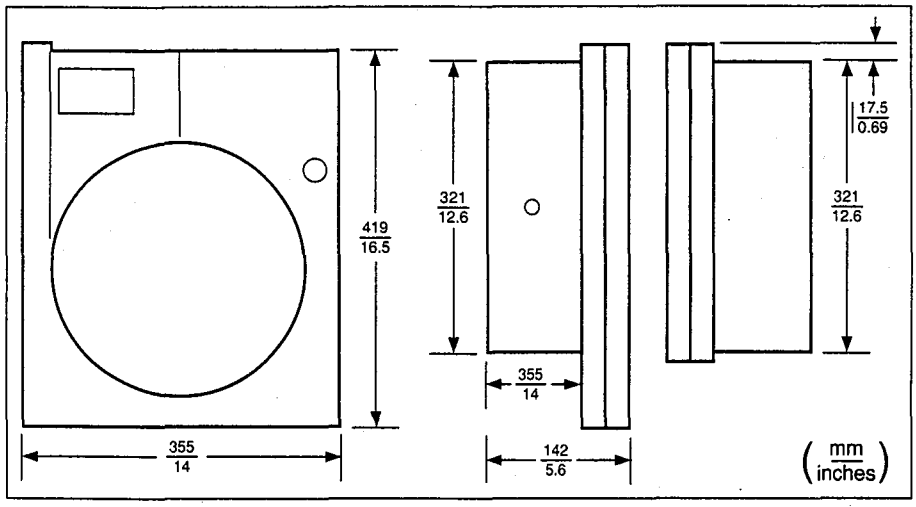


Chart shown actual size.

HONEYWELL
30755317
©1987
Truline
FT. WASHINGTON, PA. U.S.A.
09:01
10:01
11:01
TEMP4
TEMP3
FLOW2
04/17/90
TRULIN



Brilliant fluorescent displays and English language prompts not only simplify configuration but also keep you informed of process conditions at all times. Display shown indicates recorder for a chart speed of 24 hours; operation is manual.



Specifications subject to change without notice.

Honeywell Quality Assurance

The DR 4500 Truline carries a TWO YEAR WARRANTY backed by unmatched service and support capability you expect from the industry leader. There is also a toll-free 800 number for immediate technical assistance and problem resolution.

A Complete Product Offering

The DR 4500 Truline digital circular chart recorder is a member of Honeywell's extensive line of digital instrumentation. If the DR 4500 Truline doesn't meet your recording needs, Honeywell has a digital recorder that does. Contact your Honeywell distributor or sales representative for price and delivery information on the Truline and other Honeywell digital recorders.

If it's worth recording, it's worth specifying Honeywell.

Honeywell

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DR 4500A Truline Circular Chart Recorder

Specification

Function

Honeywell's Truline recorder is a one to four-channel, microprocessor-based, circular chart recorder. Its "one-pen" stylus printhead produces up to four analog traces and prints alphanumeric chart data on a blank heat-sensitive chart. All four traces share the *same time line* reference which the Truline prints. This eliminates the error caused by pen alignment offsets in conventional pen designs. Since the Truline prints the chart and generates the analog traces at the same time, there is no error due to variations in chart size caused by changes in temperature and humidity.

With microprocessor electronics and single printhead, the Truline recorder is easily configured by users to meet a variety of application requirements -- from metals to food processing. In addition to printing informative, accurate chart records, the Truline recorder alternately displays process variable values for all channels in the selected engineering units.

Models with up to four input channels accept inputs from any one of a variety of sensors or transmitters within the configurable range limits. Also, models are available with one or two independent digital controllers to generate controlled output signals which will operate valves, dampers, heating elements, etc. for process control.

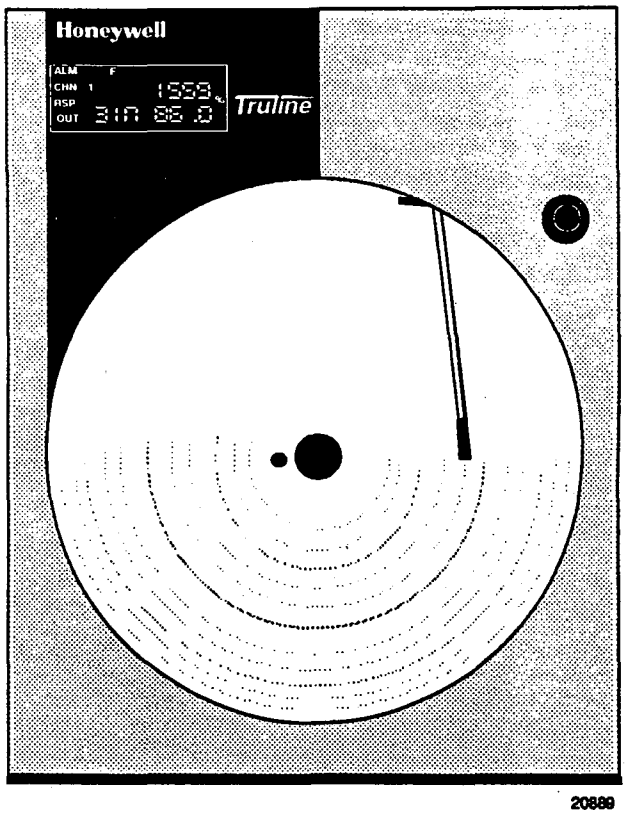


Figure1 - Truline recorder provides printed chart data and continuous digital indication of process variable value.

Features

- User configurable means that users can set and/or alter operating parameters to fit their requirements, including type of input, without recalibration.
- English language prompts, coupled with simple keystroke sequences, make configuring the recorder easy and straightforward.
- Comprehensive operator interface includes clear, brilliant alphanumeric displays; indicators; deviation bargraph; and keypad for visual and tactile interaction.
- One all-purpose, blank chart eliminates the need for ordering and stocking several types of charts. And, users can design the chart to match their specific application.
- Up to four channels that monitor process variables from a variety of sensor types help reduce panel space requirements.
- "One-pen" printer prints configurable alphanumeric chart data including time and trend lines. This automatically compensates for chart width variations caused by changes in the ambient relative humidity.

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eal-time, clock, dates, time of inting (hour, minutes, date and year) and any operator changes in real time guard against unauthorized chart advancement.

- Up to two versatile PID digital controllers let users configure the exact control action needed for their process.
- A single set point ramp is user programmable and is easily repeated and activated through the Run/Hold key.
- Up to six integral "soft" alarms are easily set by users to announce selected, out-of-limit conditions.
- Optional DMCS communication card supports bi-directional communication link between the recorder and host computer.

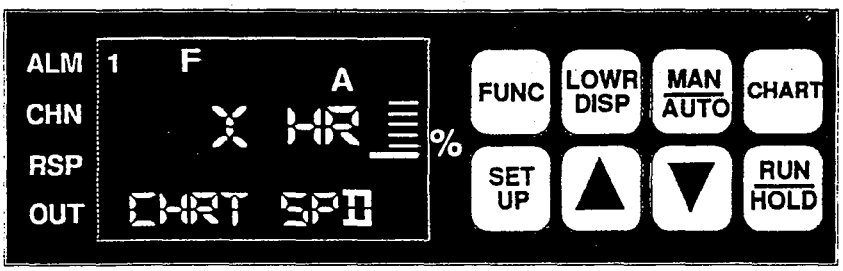


Figure 2 - Operator interface includes displays and keypad for comprehensive interaction with the recorder and the process.

User Configurable

In the DR 4500A Series recorder, microprocessor control replaces conventional electro-mechanical recording techniques. This means that the recorder's capabilities are ow primarily determined by its ftware. Since Honeywell has preprogrammed a variety of functional capabilities into the recorder, a user only has to configure those functions that are specific for the given application. The user configures the recorder by following English language prompts that appear in the digital displays. The configuration data (type of input, chart speed, chart range, alarm settings, tuning constants, etc.) are stored in nonvolatile memory for safe keeping in the event of a power failure.

Operator Interface

Two digital displays present the process variable (PV) value and by key selection, the controller set point; controller output; deviation from reference input; dry bulb temperature; totalization value; or engineering units as desired. In configuration mode, digital displays are pre-empted by English language prompts and values that ou use to enter configuration data. dicators light to show alarm condition, which channel PV is on display, use of remote set point, which output relay is on, selected temperature unit, and controller's mode of operation. A deviation bargraph lets operators tell at a glance if the process variable is at, above, or below the controller's set point.

The keypad through which configuration data is entered also serves as an integral automatic/manual station that provides bumpless transfer for controllers.

Microprocessor Controlled Recording and Printing

Both the chart and the printhead are driven by the stepper motors which are controlled by the microprocessor allowing precise maintenance free operation.

Since chart speed is configurable, users can easily alter the chart speed through the keypad. Gear changing or additional motors are no longer required.

The microprocessor uses the configured chart range data as well as the input data to determine the proper printhead position. The stepper motor accurately positions the printhead drive.

By using a "one-pen" printhead that is capable of printing alphanumeric characters, users can now set various "printed" chart data through configuration. This means that such chart data as range marking in engineering units, digital values for process variables, and trace identification are easily personalized for the application. This data, plus printed time lines and engineering units of scale, eliminate the need to maintain an inventory of a variety of preprinted charts.

The Truline recorder uses a dot fill technique from a microprocessor algorithm to produce a continuous analog trace of a process variable.

Time/Date

An integral real-time clock provides accurate timing for the recorder's time and date printing. A 10-year life battery backup assures correct timing even when power fails.

Input Processing

The input can be one of many standard low-level electrical signals. Since inputs are isolated, users can connect different types of input signals to multi-channel models in any combination. And, for models with 2 or more channels, a relative humidity (wet/dry bulb) actuation is available using 100 ohm platinum bulbs (α = 0.00385). The input type and range are user configurable for hassle-free actuation changes in the field. Ranges are easily expanded and compressed within their span limitations to meet specific measurement needs. Users can select upscale or downscale sensor break protection for many of the actuations.

Each input is sampled at a rate of 3 times per second for 1 or 2 inputs, or 3 times in 2 seconds for 3 or 4 inputs. Each sample is amplified and then converted to a digital signal which is isolated and passed to the microprocessor. A digital filter with configurable time constants lets users apply input signal smoothing as desired. All non-linear inputs are linearized by the microprocessor.

An integral 24 Vdc power supply, along with 4-20 mA input configuration, allows direct operation

with up to two transmitters without the need for any additional/external transmitter power supply.
To totalize a variable, such as a flow signal, users select the applicable input and set the digital display scaling factor through configuration. This eliminates the need for additional integration hardware including a mechanical counter. The totalizer has an eight digit display and 14 digit printing on the chart.

Digital Controller

The DR 4500A Series recorder controller includes an integral microprocessor-based, single-loop, PID controller. A variety of output types, including a duplex variation for heat-cool applications, lets users select the output that is right for their final control element. Depending on the output type users can configure the control action as On-Off, PID-A, PID-B, PD with Manual Reset, or 3 Position Step Control. As with the record functions, English language prompts quickly guide users through the entry of all the controller's configurable parameters.

Diagnostics

All DR 4500A Series recorders include self-diagnostic systems that check critical operations and provide error messages to alert users about detected faults. Power-up self-diagnostics is a microprocessor controlled diagnostic program that runs tests on selected circuitry when the recorder is powered up. A "key" test allows a user to initiate, on demand, a self-diagnostic routine that checks the keypad and front panel displays.

Construction

The DR 4500A Series recorder is housed in a molded case which can be panel or surface mounted. A glass or optional acrylic window, gasketed door protects internal components from harsh industrial environments while allowing easy access to the chart and operator interface. Circuitry is partitioned on printed circuit boards for ease of service. A NEMA 4X Stainless Steel door is available as an option.

Process Interface

Power, input, and output wiring connect to terminations inside the case. Knockouts in the sides and bottom of the case accept conduit connections for convenient wire entry.

Options*

- **Chart Illumination** -- Lights the chart area to improve readability in lower light areas.
- **Alarm Output** -- Ties "soft" alarms to up to six integral SPST relays to activate users external equipment.
- **Digital Input** -- Allows users to initiate from a remote location through two dry contact closures, selected recorder functions, such as switching from automatic to manual control mode, from direct to reverse controller action, or marking an event,
- **DMCS Communication** -- Allows integration between recorder and host computer.
- **Set Point Ramp/Soak Programming** -- Lets users program and store 6 ramp and 6 soak segments. Run or Hold of program is keyboard or remote switch selectable.
- **Control** -- Two digital controllers available
- **Acrylic Window**
- **Door Lock or Heavy Duty Latch**
- **NEMA 4X Door**
- **UL Listing, FM Approval**
- **Customer ID Tag**
- **DR45AR Model** for up to 6 relays and F_Q calculation
- **DR45AW Flow Model** for Weir and Parshall flume calculations and up to 4 totalizers
- **DR45AH High Temperature Short Time (HTST) Model** for the dairy industry with lead seal provisions and FDA compliance

*Restrictions apply -- Not all of the options can be supplied together.

Specifications

Design

Digital Indication Accuracy	1 digit
Minimum Input Span	Range is fully configurable with span limitation of the operating range selected
Input Impedance	*4-20 mAdc:* 250 ohms *0-10 Vdc:* 200K ohms *All others:* 10 Megohms
Source Impedance	*RTD:* 100 ohms per lead maximum
Span Step Response Time	6-seconds maximum with no filtering
Sampling Rate	Each input sampled 3 times a second (1 or 2 inputs); 3 times in 2 seconds (3 or 4 inputs).
Input Filter	*Software*: Single pole low pass section with selectable time constants (off to 120 seconds).
Digital Displays	Vacuum fluorescent, alphanumeric. A six digit display dedicated to the process variable. Alternate information displayed during configuration mode. An eight digit display shows key selected operating parameters. Also provides guidance during configuration.
Indicators	Channel PV display (CHN 1, 2, 3, or 4) Alarm status (ALM 1, 2) Controller Output (OUT 1 or 2) Remote Set Point (RSP) Temperature unit (F or C) or Engineering units Controller's mode (A or MAN)
Deviation Bargraph	21 segment, color coded deviation bargraph: Green (large) = On Control Green (Small) = Deviation to ± 10% of PV
Controller Modes of Operation	Manual Operation Automatic with local set point Automatic with remote set point
Transmitter Supply Voltage	22 to 26 Vdc at input terminals (50 mAdc at 24 Vdc)

Specifications Continued

Performance

Number of Inputs

One channel model: One input
Two channel model: Two inputs
Three channel model: Three inputs
Four channel model: Four inputs

Types of Input Actuation[1]	Range °F	Range °C	Reference Accuracy ± °F	Reference Accuracy ± °C	Temp. Stability ± Degrees Error Per 1 Degree ΔT
Thermocouples[2]	**105 to 3300**	**41 to 1816**			
B	105 to 150	41 to 66	42.00	23.00	2.00
	150 to 500	66 to 260	14.00	7.70	2.00
	500 to 1000	260 to 538	3.00	1.70	0.50
	1000 to 3300	538 to 1816	1.50	0.80	0.20
E	**-454 to 1832**	**-270 to 1000**			
	-454 to -202	-270 to -130	18.00	10.00	0.70
	-202 to 1832	-130 to 1000	1.00	0.55	0.35
E (low)	**-200 to 1100**	**-129 to 593**	0.50	0.30	0.20
J	**0 to 1600**	**-18 to 871**	0.40	0.22	0.06
J (low)	**20 to 770**	**-7 to 410**	0.20	0.11	0.04
K	**-320 to 2500**	**-196 to 1371**			
	-320 to 0	-196 to -18	1.25	0.70	0.18
	0 to 2500	18 to 1371	0.60	0.35	0.09
K (low)	**-20 to 1000**	**-29 to 538**	0.30	0.16	0.05
NNM (Ni Ni Moly)	**32 to 2500**	**0 to 1371**			
	32 to 500	0 to 260	0.75	0.40	0.09
	500 to 2500	260 to 1371	0.50	0.30	0.07
NIC (Nicrosil Nisil)	**0 to 2372**	**-18 to 1300**	1.0	0.55	0.01
R	**0 to 3100**	**-18 to 1704**			
	0 to 500	-18 to 260	2.00	1.10	0.25
	500 to 3100	260 to 1704	1.00	0.55	0.13
S	**0 to 3100**	**-18 to 1704**			
	0 to 500	-18 to 260	2.00	1.10	0.23
	500 to 3100	260 to 1704	1.00	0.55	0.13
T	**-300 to 700**	**-184 to 371**	0.60	0.35	0.07
T (low)	**-200 to 600**	**-129 to 316**	0.40	0.22	0.07
W5W26	**0 to 4200**	**-18 to 2315**			
	0 to 600	-18 to 316	1.40	0.77	0.17
	600 to 3600	316 to 1982	1.30	0.70	0.17
	3600 to 4200	1982 to 2315	1.60	0.90	0.29
W5W26 (low)	**0 to 2240**	**-18 to 1227**			
	0 to 600	-18 to 316	1.10	0.60	0.14
	600 to 2240	316 to 1227	1.00	0.55	0.10

Specifications Continued

Types of Input Actuation[1]	Range °F	Range °C	Reference Accuracy ± °F	Reference Accuracy ± °C	Temp. Stability ± Degrees Error Per 1 Degree ΔT
RTDs					
Platinum					
100 ohms	300 to 900	-184 to 482	0.40	0.22	0.05
200 ohms (High)**	32 to 752	0 to 400	0.30	0.16	0.05
200 ohms (Low)**	32 to 392	0 to 200	0.20	0.12	0.05
500 ohms	300 to 900	-184 to 482	0.20	0.11	0.05
Linear					
Milliamperes dc	4 to 20	--	0.10%	--	0.004% /°F
Millivolts dc	0 to 10	--	0.05%	--	0.004% /°F
	10 to 50	--	0.05%	--	0.004% /°F
Volts dc	1 to 5 (can be calibrated 0 to 5)	--	0.05%	--	0.004% /°F
	0 to 10	--	0.10%	--	0.004% /°F
Relative Humidity					
Platinum 100 ohm Wet/Dry	**Wet/Dry Input**				
Wet/Dry Bulb*	-130 to 392 %RH[3]	-90 to 200	0.30	0.03	0.03

Measured %RH[3]	Dry Bulb Range °F	Dry Bulb Range °C	Reference Accuracy ± °F	Reference Accuracy ± °C	Temp. Stability 53 to 104°F/ 12 to 40°C
0 to <20	-103 to 212	-75 to 100	2% RH		0.11% RH/°F
20 to 100	35 to 40	2 to 4	2% RH		0.11% RH/°F
	>40 to 100	>4 to 38	1% RH		0.06% RH/°F
	100 to 212	38 to 100	1% RH		0.03% RH/°F

[1]Not all Input Actuations are available on all models of the Truline Recorder. Consult Model Selection Guide for information.

[2]Includes reference junction calibration of ± 0.01degrees using standard "ice bath" method of calibration. Factory calibration at reference ± 1.2°F. Note that factory calibration may vary by as much as ± 10 microvolts or ± 0.3 ohms for RTDs which means recalibration may be required to achieve stated accuracy.

[3]The RH calculation is inoperative when temperature goes below 32°F (0°C)or above 212°F (100°C). However, the dry bulb temperature will be monitored to -103°F (-75°C). Accuracy stated is for Truline Recorder only and does not include remaining system accuracies.

*IEC Alpha (α) = 0.00385 Ω/Ω/°C

**Only available with Model DR45AR

Specifications Continued

Configurable Parameters: These parameters can be set through the keypad for Recorder DR45AT -- Different parameters apply for DR45AR, DR45AW and DR45AH Models.

Group	Parameters	Setting Range or Selection	Resolution
TUNING 1(2)	Gain (or Prop Band)	0.1 to 1000	0.1
	Rate Min (or RPM)	0.00 to 10.00	0.01
	Reset Min	0.02 to 50.00	0.01
	Man Rset	-100 to 100% output	1
	Cyc Sec	1 to 120 sec.	1
SPRAMP 1(2)	SP Ramp (1 or 2)	Disable or Enable	
	Time Min	0 to 255	
	Final SP	0 to 100% of Span	
	SP Program	Disable or Enable	
	Start Segment	1 to 12	
	End Segment	2, 4, 6, 8, 10, 12	
	Recycle (1 or 2)	0 to 99	
	Soak Deviation	0.0 to 99.0	
	Segment 1 Ramp (3, 5, 7, 9, 11)	0.00 to 99.59	
	Segment 2 Ramp (4, 6, 8, 10, 12)	0.0 to 500	
	Segment 2 Time (4, 6, 8, 10, 12)	0.00 to 99.59	
	Program End	Last SP or Failsafe	
	State	Disable or Hold	
	Ramp Unit	Time or Rate	
CHART	Chart speed	8 hrs, 24 hrs, 7 days, or selected hours per revolution	
	Hours per revolution	6 to 744 hrs	
	Time Div	8 to 24	
	Continue	Yes or No (Chart rotation beyond 360 degrees)	
	Chart Name	Up to six characters	
	Header	Yes or No	
	Rem Chart	None, Extsw1, Extsw2, Alarm1, Alarm2, Time, Shed.	
	Wake Minute	0 to 59	
	Wake Hour	0 to 23	
TIME	Minutes	1 to 59	
	Hours	0 to 23	
	Day	1 to 31	
	Month	1 to 12	
	Year	4-digits	
	Day	Monday to Sunday	
PEN 1	Pen 1	Disable or Enable	
	Pen 1 input	Input 1, Output, SP, Dgtl1 or Dgtl2	
	Chart 1 high range value	-999.0 to 9999	0.1
	Chart 1 low range value	-999.0 to 9999	0.1
	Major chart division	2 to 10	
	Minor chart division	2 to 10	
	Range 1 Tag	Up to five characters	
	Pen 1 On	0 to 100% of chart	1
	Pen 1 Off	0 to 100% of chart	1
PEN 2	Same as PEN 1 -- except for Input 2		
PEN 3	Same as PEN 1 -- except for Input 3		
PEN 4	Same as PEN 1 -- except for Input 4		

Specifications Continued

Group	Parameters	Setting Range or Selection	Resolution
INPUT 1	Decimal point location	None, 1 (XXX.X), 2 (XX.XX), or 3 (X.XXX) -- one decimal place only for non-linear inputs	
	Units	°F, °C or engineering units	
	Actuation type	See input types	
	Transmitter characterization	All non-linear input types, linear, square root	
	High range value	-999.0 to 9999	0.1
	Low range value	-999.0 to 9999	0.1
	Input compensation	-999.0 to 9999	0.1
	Filter 1	0 to 120	1
	Sensor break protection (burnout)	None, Up or Down	
INPUT 2	SAME AS INPUT 1		
INPUT 3	SAME AS INPUT 1		
INPUT 4	SAME AS INPUT 1		
TOTAL 1	Total	Read only	
	Reset total	Yes or No	
	Total 1	Disable or Enable	
	Total engineering units	Desired alphanumeric title	
	Rate	Second, Minute, Hour, Day or Million/Day	
	Scaling factor	1, 10, 100, 1000, 10,000, 100,000 or 1E6	
	Resettable	Yes or No	
TOTAL 2	SAME AS TOTAL 1 - except for INPUT 2		
Controller			
Control 1 (2)	PID tuning sets	1 or 2	
	Set point source	Local, Remote or 2 Local	
	Ratio (input 2)	-20.00 to 20.00	0.01
	Bias	-999 to 9999	1
	SP tracking	None to RSP	
	Power-up mode recall	Manual, Auto LSP, or Auto RSP	
	High and low SP limits	0 to 100% of span in engineering units	
	Action	Direct or reverse	
	High and low output limits	-5 to 105% of output	1
	Dropoff value	-5 to 105% of output	1
	Deadband	-5.0 to 25	
	Output Hyst	0.0 to 5.0	
	Failsafe output value	Within the output limits	1
	Remote Switching	None, ToMan, ToLSP, To2SP, ToDir, RN/HLD	
	Man Key	Disable or Enable	
	PB or Gain	Proportional band (%) or gain	1
	Reset units	Repeats/minute or minutes/repeat	
	Control 1 Algorithm	PIDA, PIDB, PD + MR, 3PSTEP, ON-OFF	
	Output 1 Algorithm	Current, Position Prop, TimeD, Cur TI, TI Cur, Time	
	*Shed Mode	To Manual, Failsafe or Last	
	*Shed SP	To LSP or To CSP	
Options	Input 1 (2,3,4)	Disable or Enable	
	Control 1 (2)	Disable or Enable	
	Reject Frequency	60 or 50 Hz	
	Relative Humidity	Yes or No	
	Atm. Pressure	590 to 800	
	Deviation	None, SetPnt, Chan 1	
	*COM State	Disable or Enable	
	*COM Address	0 to 99	
	*SHED Time	0 to 255	
	Units	Eng or Percent	

Specifications Continued

Controllers (continued)

Group	Parameters	Setting Range or Selection	Resolution
ALARMS (soft, indication only)	SP Value	0.0 to 9999	
	SP Type	None, Input 1 (2, 3, 4), RH, Dev, Output, Dev2, Out2, Shed, EV1 ON, EV1 OFF, EV2 ON, EV2 OFF	
	Alarm Type	High or Low	
	Alarm Hysteresis	0.0 to 5.0% of span	0.1
LOCKOUT	Password	Up to four characters	
	Lockout	None, Calib, +Conf, +View, Max	
	Change	Used if changing Password	
STATUS	Version	Latest Software Version	
	Failsafe	Yes or No	
	RAM Test	Pass or Fail	
	Configuration Test	Pass or Fail	
	Calibration Test	Pass or Fail	
	* Comm Test	Pass or Fail	
	Fact CRC (Factory Set Input Constants)	Pass or Fail	

Controller Output[1] (Optional)

- *On-Off or Time Proportional*
  One SPST electromechanical relay. Control action can be set for direct or reverse; N.O. or N.C. contact selectable.
- *On-Off Duplex, 3 position Step, or Time Proportional Duplex*
  Two SPST electromechanical relays. Control action can be set for direct or reverse; N.O. or N.C. contact selectable.
- *Current Proportional*
  21 mAdc maximum into a negative or positive grounded or non-grounded load of 0 to 1000 ohms. Output range can be set between 4 and 20 mA, and as direct or reverse action.
  Resolution: 10 bits
  Accuracy: 0.5% full scale
  FM Approved Output (Optional)
- *Position Proportional*
  Two SPST electromechanical relays operate motor having a 100 ohm to 1000 ohm slidewire.
- *Current/Time Duplex and Time /Current Duplex*
  Variation of time proportional duplex for Heat/Cool applications. Time proportional output (heat or cool) is a SPST electromechanical relay. Current proportional output (heat or cool) is a 4-20 mA signal that can be fed into a negative or positive grounded load of 0 to 1000 ohms and is operational over 50 % of range or the entire range.
  Time Proportional Relay Resolution: 4.4 mSec.
  Relay Contact Ratings:
  Resistive Load: 5A @ 120 Vac, 2.5A @ 240 Vac
  Inductive Load: 50 VA @ 120 Vac or 240 Vac
  Cycle Time: 1 to 120 seconds
  Current Proportional :
  - Resolution: 10 bits
  - Accuracy: 0.5% full scale

Case
Molded foamed-Noryl** with gasketed door to meet NEMA 3 enclosure requirements. Stainless Steel NEMA 4X door available as an option.

Chart
12-inch (304.8mm) diameter chart. Plain thermal-sensitive paper.

Wiring Connections
Terminals inside the case

Color
Case: Black
Door (standard): Caribbean blue or Gray

Approval Bodies
U.L. approval depending on model. Consult Model selection Guide for information.
FM approved for Class I, Div 2, Groups A, B, C, D areas depending on model.

* Communications only
** Registered Trademark -- General Electric Co.
1. Not all controller outputs are available on all models of the Truline Recorder. Consult Model Selection Guide for information.

Specifications Continued

Dimensions	See Figure 3
Weight	13.2 lbs (6 kg)
Mounting	Panel or surface mounted. Some adapter kits available for existing panel cutouts.
Options	
Alarm Output	Two SPST electromechanical relays on DR45AT & DR45AW Two, four or six relays available on DR45AR *Relay Contact Raings:* First Relays, Resistive Load: 1A @ 120 Vac, 1/2A @ 240 Vac. Relays 3 through 6, Resistive Load: 5A @ 120 Vac, 2.5A @ 240 Vac.
Digital Input	+20 Vdc source for external dry contact or isolated solid state contacts. Selects one configured input.
Totalizers	One or two totalizers on DR45A1, DR45A2, DR45AT and DR45AR Models. Up to four totalizers on DR45AW Model. Eight digit "totals" with multiplier on digital display; 14-digit totalization printout on chart.
Calculations	F_Q calculation available on DR45AR Model. Open channel flow calculations available on DR45AW Model.
Miscellaneous	• NEMA 4X Stainless Steel door with glass or acrylic window • Door Lock • Chart Illumination • U.L. Listing, FM Approval • Control • Plastic Window • Customer ID Tag • Pulse output counter alarm function on DR45AW Model • Lead seal provisions on DR45AH Model with FDA compliance
DMCS Communications	*Baud Rate:* 19,200 *Protocol:* DMCS *Length of Link:* 4000 ft (1,219 m) maximum *Link Characterics:* Two wire, multidrop

Specifications Continued

Environmental and Operating Conditions

Parameter	Reference	Rated	Extreme	Transport and storage
Ambient Temperature	67 to 77°F 19 to 25°C	58 to 131°F 15 to 55°C	32 to 131°F 0 to 55°C	-40 to 151°F -40 to 66°C
Relative Humidity (%RH)	0 to 55*	10 to 90*	5 to 90*	5 to 95*
Vibration				
Frequency (Hz)	0	0 to 70	0 to 200	0.20
Acceleration (g)	0	0.1	0.2	0.5
Mechanical Shock				
Acceleration (g)	0	1	5	20
Duration (ms))	0	30	30	30
Mounting Position from Vertical				
Tilted Forward	5°	5°	5°	Any
Tilted Backward	5°	30°	90°	Any
Tilted to Side (±)	5°	10°	20°	Any
Power Requirements				
Voltage (VRMS)	119 to 121 238 to 242	102 to 132 204 to 264	102 to 132 204 to 264	N/A N/A
Frequency (Hz)	49.8 to 50.2 59.8 to 60.2	49 to 51 59 to 61	48 to 52 58 to 62	N/A N/A
Power Consumption	24 watts maximum			

General Reference Data

Stray Rejection	*Common Mode Rejection Ratio:* 12dB or 1 LSB (whichever is greater) at 60 Hz with maximum source impedance of 100 ohms. *Normal Mode Rejection Ratio:* 60dB with a 100% span peak-to-peak maximum at 60 Hz.
Static Charge Effects	Exposed panel surfaces capable of withstanding a discharge from a 250pf capacitor charged to 10KV through 100 ohms.
RFI Susceptibility	Capable of withstanding an EMI-field generated from a 5-watt transmitter being held at 1 meter, and operating at 151.685 and 450 MHz.
Line Noise Effects	Field terminals for connecting power line to recorder can withstand the IEEE Surge Withstanding Capability Test to a level of 2.5KV.
Stylus Life	Typically capable of printing one chart per day for five years under clean room conditions.
Warranty and Technical Assistance	DR 4500A carries a 2-year warranty, and toll-free 800 number puts technical assistance only a phone call away.

* The maximum rating only applies up to 104°F (40°C). For higher temperatures, the RH specification is derated to maintain constant moisture content.

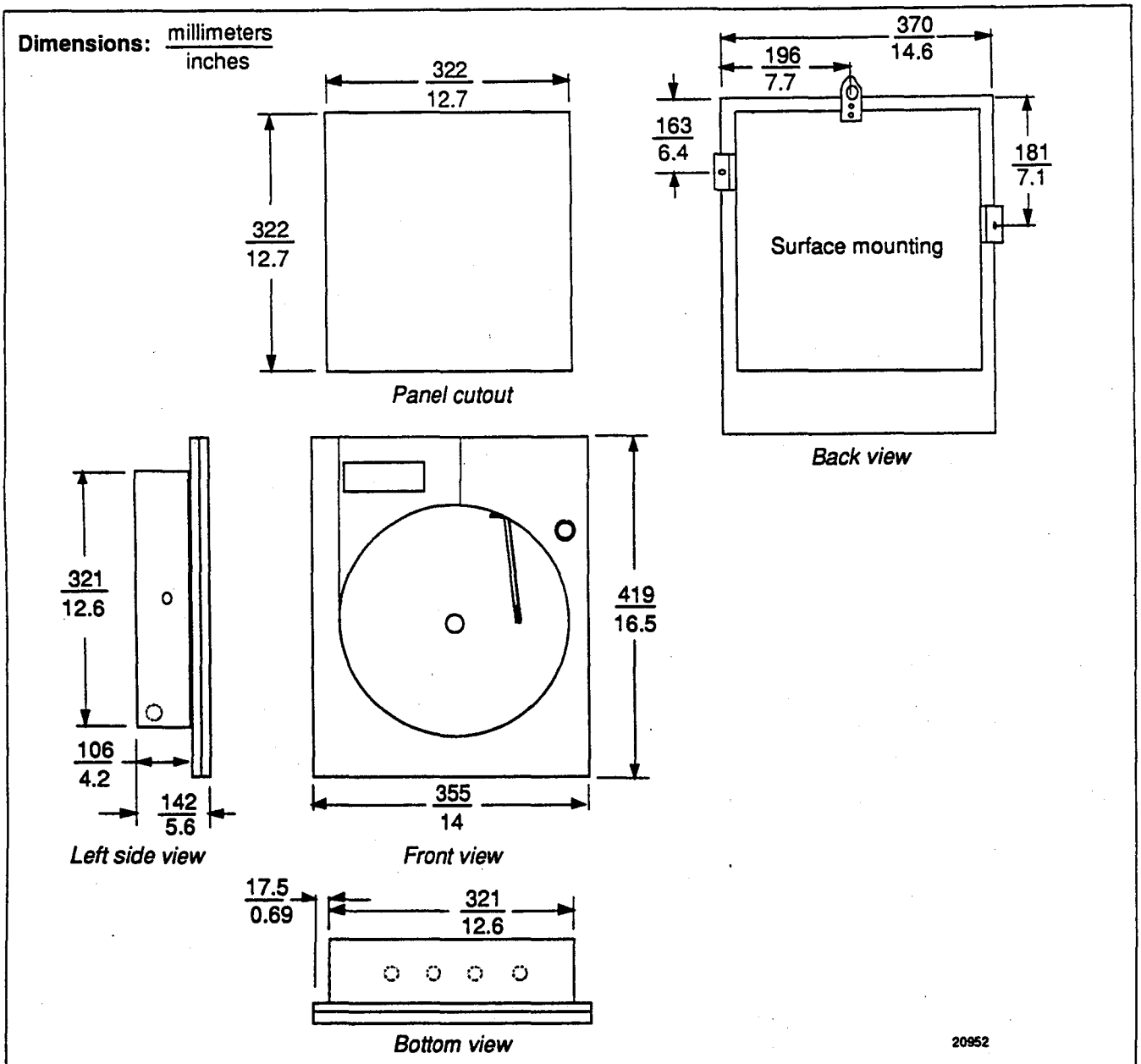


Figure 3— DR 4500A series recorder dimensions - for refence only

Ordering Information

For complete ordering information, request Model Selection Guide 44-45-16-07 for DR 4500A Series Circular Chart Recorder.
Honeywell offers a full line of sensors and transmitters that produce a compatible range of dc voltage or current signals which can be used as inputs to the DR 4500A Series Recorder.
These devices measure:
Temperature: (Thermocouple or RTD)
Pressure
Flow
Liquid Level
Relative Humidity
} 4 to 20 mA dc or 1 to 5 Vdc process transmitter

For more information, contact your nearest Honeywell Branch Office or

Honeywell Inc.
1100 Virginia Dr.
Fort Washington, PA 19034

In Canada:
Honeywell Limited
155 Gordon Baker Rd.
Willowdale, Ontario M2H 3N7

Specifications are subject to change without notice.

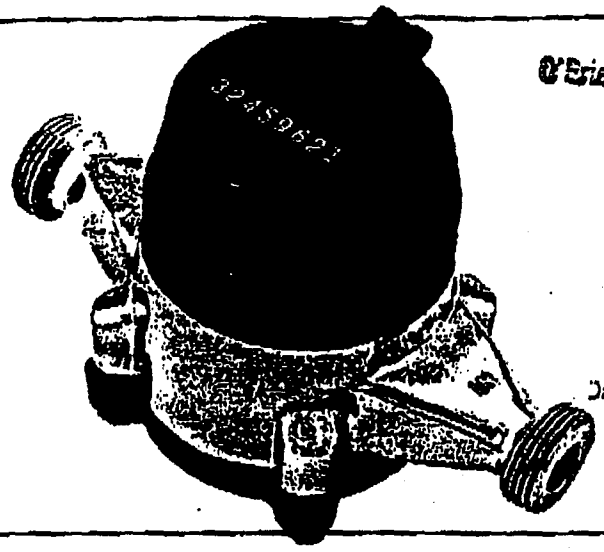
NEPTUNE T-10

FLOWMETER

Schlumberger

Water Division

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Syracuse, N. Y.



Neptune® T-10®

REVIEWED
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O'BRIEN & GERE ENGINEERS, INC
Date 6/22/94 By

Water Meter
Sizes: 5/8", 3/4", & 1"

Features and Benefits

Roll-Sealed Register

- Magnetic drive, low torque registration ensures accuracy
- New impact resistant register design with flat glass for legibility
- 1:1 Ratio, low flow indicator detects leaks
- Bayonet mount allows in-line serviceability
- Tamperproof seal pin deters theft
- Date of manufacture, size, and model stamped on dial face

Cast Bronze Maincase

- Sturdy, durable corrosion resistant
- Resists internal pressure stresses and external damage
- Handles in-line piping variations and stresses
- Residual value

Nutating Disc Measuring Chamber

- Positive displacement
- Widest effective flow range for greater utility revenue
- Extended low flow accuracy
- Corrosion resistant
- Floating chamber design is unaffected by meter position or in-line piping stress

Systems Compatibility

- Adaptability to all Neptune Systems provides flexibility

Performance

Every Neptune T-10 water meter meets or exceeds the latest AWWA Standard, C700-90. Its nutating disc, positive displacement principle is time proven for accuracy and dependability since 1892, ensuring maximum utility revenue.

Construction

The Neptune T-10 water meter consists of three major assemblies: a roll-sealed register, a cast bronze maincase, and a nutating disc measuring chamber.

The roll-sealed register eliminates lens fogging, uses naturally lubricated, molded gears, and contains a low flow indicator for leak detection. For reading convenience, the register can be mounted in any one of four positions on the meter. All T-10 water meters can accommodate standard registers or remote reading registers for the Neptune ARB® (Automatic Reading and Billing) System, Pulser-RM visual remote system, and Tricon™/S and Tricon/E systems.

The corrosion-resistant cast bronze maincase will withstand most service conditions: internal water pressure, rough handling, and in-line piping stress. For frost protection, synthetic polymer or cast iron bottom caps are available.

The innovative floating chamber design of the nutating disc measuring element protects the chamber from frost damage while the unique chamber seal extends the low flow accuracy by bonding the chamber outlet port to the maincase outlet port. The nutating disc measuring element utilizes corrosion resistant materials throughout and a thrust roller to minimize wear.

Warranty and Maintenance

Neptune T-10 water meters are warranted by Schlumberger for performance, materials, and workmanship. Schlumberger further offers an optional post-warranty factory "Revenue Asset Maintenance" (RAM) program for extended service life.

When desired, owner maintenance is easily accomplished either by unitized replacement of major components or repair of an individual component's part.

Guaranteed Systems Compatibility

All Neptune T-10 meters are guaranteed adaptable to Pulser-RM, ARB®, ARB® ProRead™, CMR®, Tricon/S, Tricon/E, NMR, and Unigun™ Systems without removing the meter from service.

Schlumberger

Water Division

Specifications

Application
Cold water measurement of flow in one direction

Maximum Operating Pressure
150 psi (1034 kPa)

Register
Direct reading, center sweep, roll-sealed, magnetic drive, with low flow indicator

Measuring Chamber
Nutating Disc, synthetic polymer

Options

Sizes
5/8", 5/8" x 3/4"
3/4", 3/4" SL, 3/4" x 1"
1", 1" x 1 1/4"

Units of Measure
U.S. Gallons
Imperial Gallons
Cubic Feet
Cubic Metres

Register Types
Direct Reading:
Synthetic polymer box and cover
Bronze box and cover
Remote Reading:
ARB, ARB ProRead
Pulser-RM
Tricon/S
Tricon/E

Bottom Caps
Synthetic polymer
(5/8" only)
Cast Iron
Bronze

Connections
Bronze, straight or bent

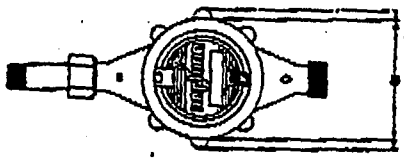
Operating Characteristics

Meter Size	Normal Operating Range @ 100% Accuracy ± 1.5%)	AWWA Standard	Low Flow @ 85% Accuracy
5/8"	1/2 to 20 US gpm 0.11 to 4.5 m³/h	.1 to 20 US gpm 0.23 to 4.5 m³/h	1/8 US gpm 0.03 m³/h
3/4"	3/4 to 30 US gpm 0.17 to 6.8 m³/h	2 to 30 US gpm 0.45 to 6.8 m³/h	1/4 US gpm 0.06 m³/h
1"	1 to 50 US gpm 0.23 to 11.4 m³/h	3 to 50 US gpm 0.68 to 11.4 m³/h	3/8 US gpm 0.09 m³/h

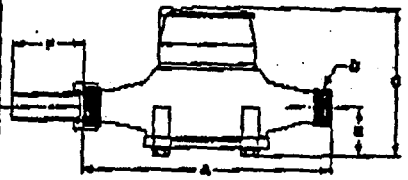
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O'BRIEN & GERE ENGINEERS, INC
Date 6/22/94 By MRE

Registration

Registration (per sweep hand revolution):		5/8"	3/4" & 1"
10	US Gallons	✓	✓
10	Imperial Gallons	✓	✓
1	Cubic Feet	✓	✓
0.1	Cubic Metres	✓	✓
0.01	Cubic Metres	✓	



Register (6-wheel odometer):		5/8"	3/4" & 1"
10,000,000	US Gallons	✓	✓
10,000,000	Imperial Gallons	✓	✓
1,000,000	Cubic Feet	✓	✓
100,000	Cubic Metres	✓	✓
10,000	Cubic Metres	✓	



Dimensions

Meter Size	A in/mm	B in/mm	C Std in/mm	C ARB in/mm	C Pul in/mm	D Threads per inch	D OD in/mm	E in/mm	F in/mm	Approx Weight lbs/kg
5/8"	7 1/2 191	3 5/8 92	4 7/8 124	5 3/8 137	6 3/4 171	14	1.030 26	1 5/8 41	2 1/2 64	3 3/4 1.7
5/8" x 3/4"	7 1/2 191	3 5/8 92	4 7/8 124	5 3/8 137	6 3/4 171	11 1/2	1.290 33	1 5/8 41	2 5/8 67	4 1.8
3/4"	9 229	4 3/8 111	5 1/2 140	5 13/16 148	7 3/8 187	11 1/2	1.290 33	1 7/8 48	2 5/8 67	6 2.7
3/4" SL	7 1/2 191	4 3/8 111	5 1/2 140	5 13/16 148	7 3/8 187	11 1/2	1.290 33	1 7/8 48	2 5/8 67	5 1/2 2.5
3/4" x 1"	9 229	4 3/8 111	5 1/2 140	5 13/16 148	7 3/8 187	11 1/2	1.626 41	1 7/8 48	2 3/4 70	6 1/2 2.9
1"	10 3/4 273	6 1/2 165	6 3/8 162	6 5/8 168	8 3/16 208	11 1/2	1.626 41	2 1/8 54	2 3/4 70	9 3/4 4.4
1" x 1 1/4"	10 3/4 273	6 1/2 165	6 3/8 162	6 5/8 168	8 3/16 208	11 1/2	1.865 47	2 1/8 54	2 13/16 71	10 1/4 4.6

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  (313) 995-6770
- SOUTHEAST: Hwy. 229 South
  Tallassee, AL 36078
  (205) 283-6555
- SOUTHWEST: 14285 Midway Rd.
  Suite 170
  Dallas, TX 75244
  (214) 404-8251
- WEST: 11725 Willake St.
  Santa Fe Springs, CA 90670
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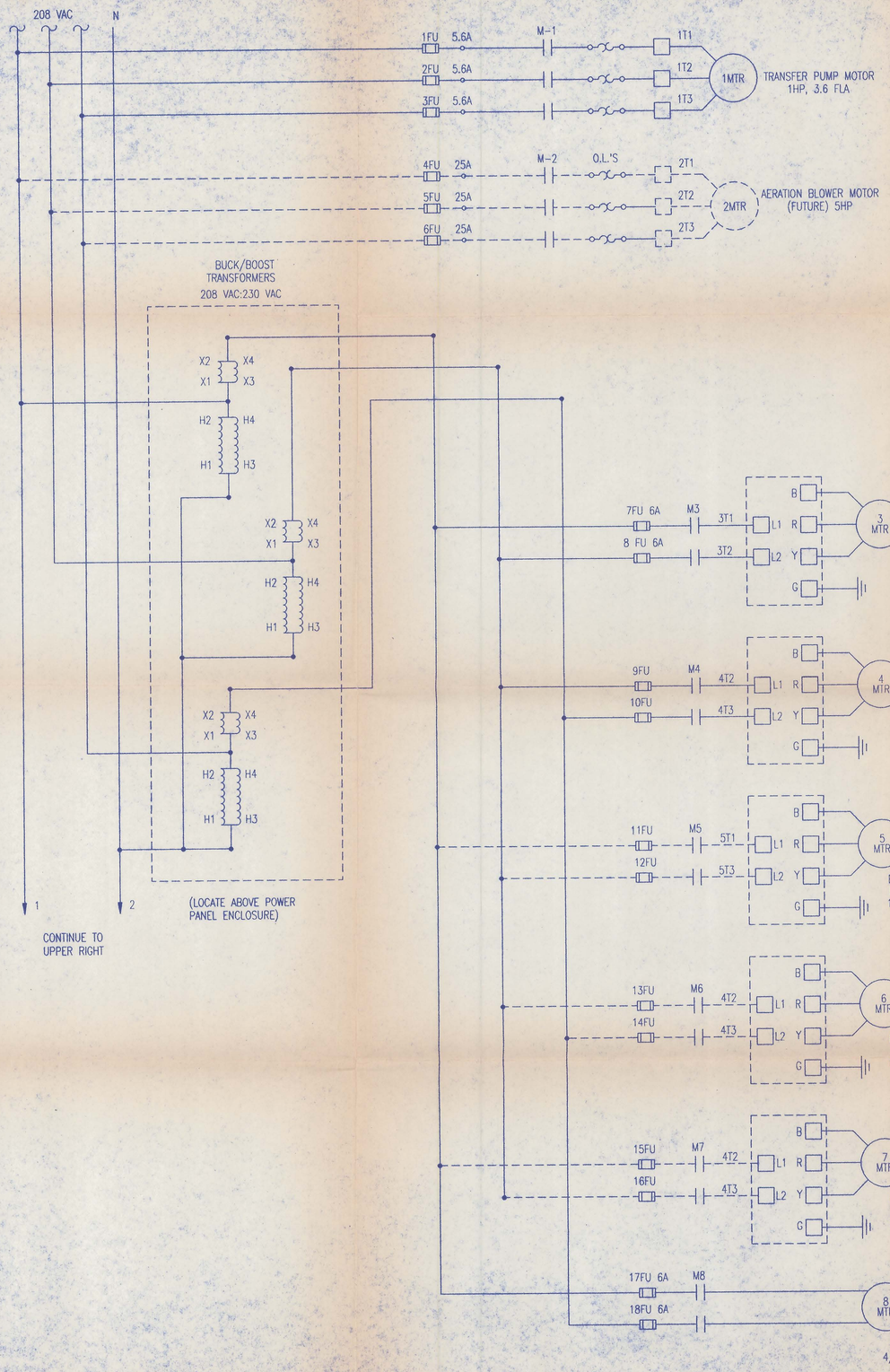
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OBG MANUFACTURING

CONTROL SCHEMATIC



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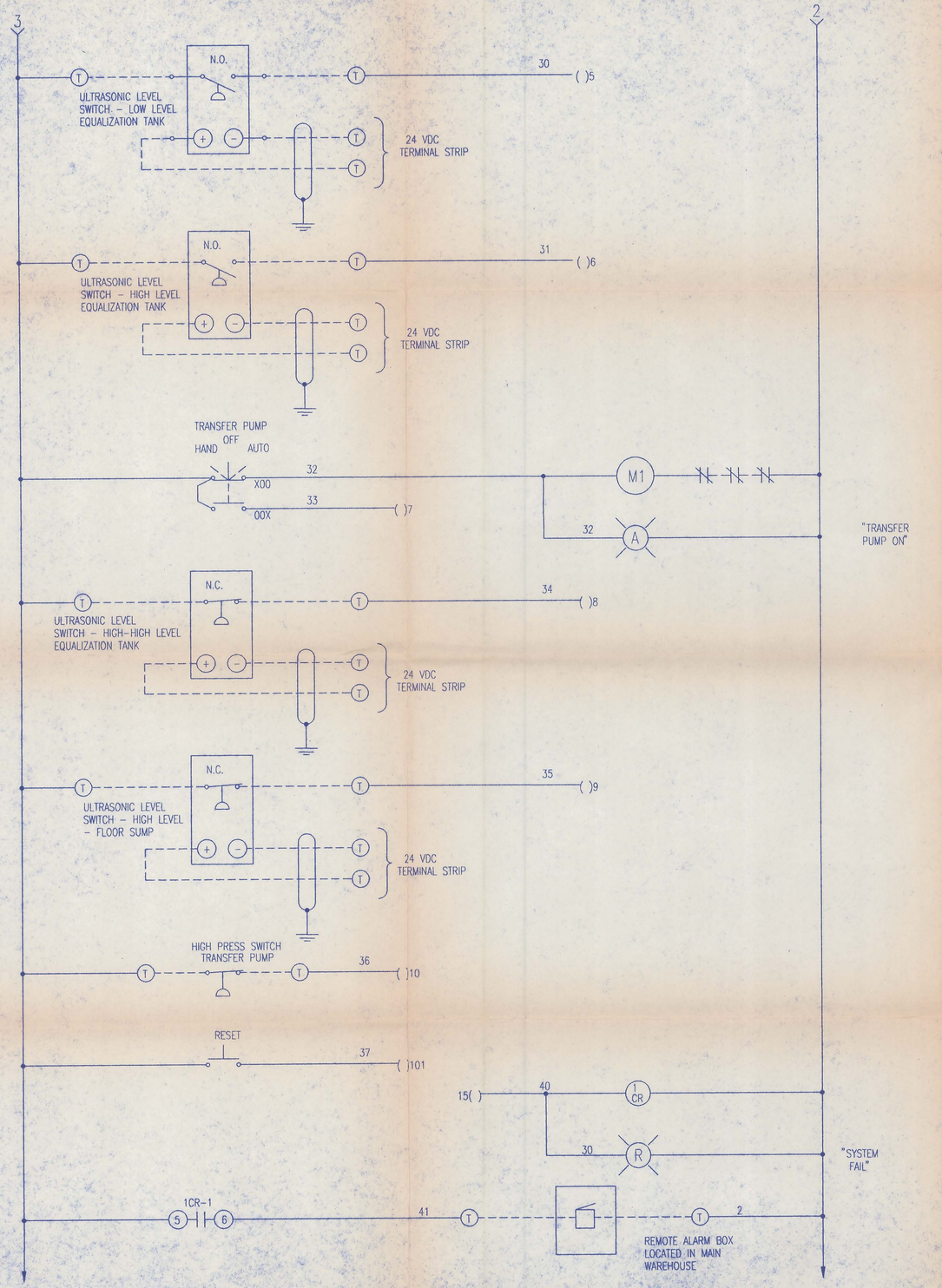
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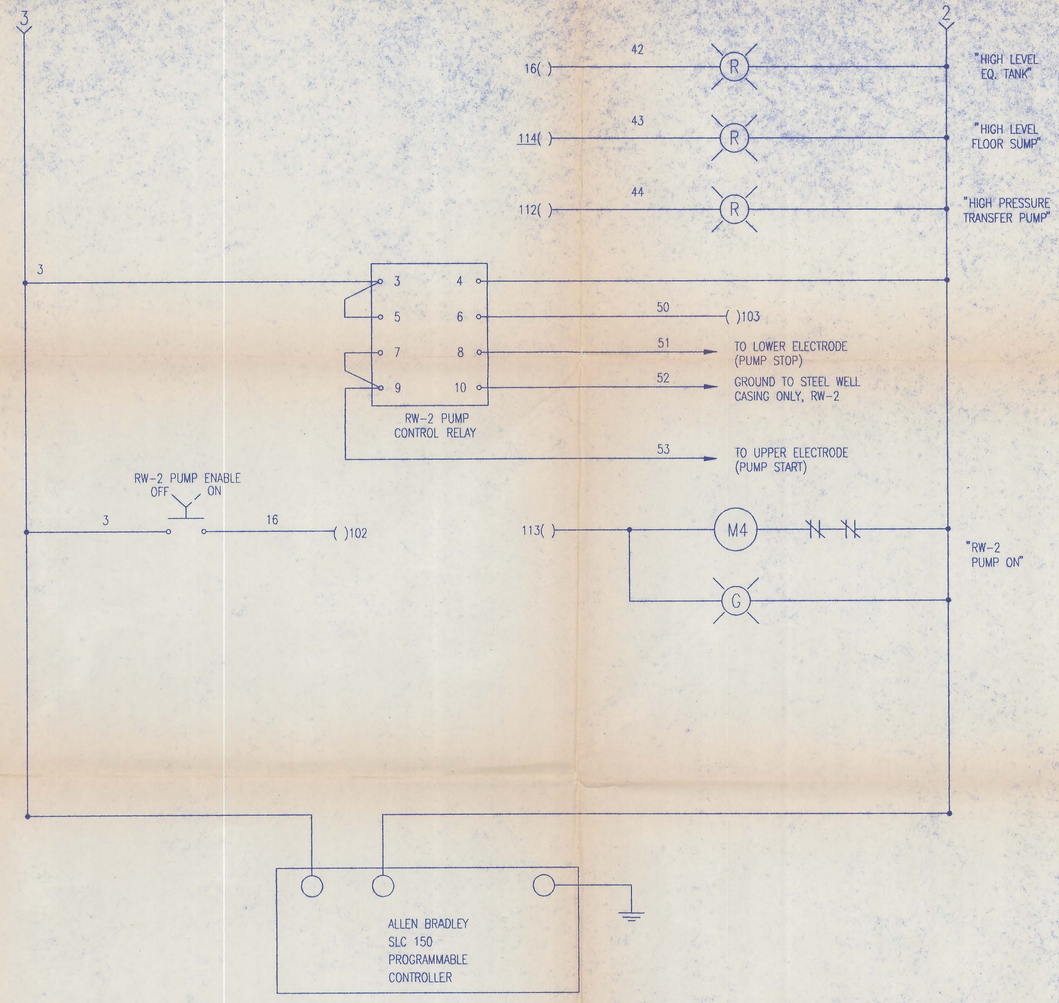
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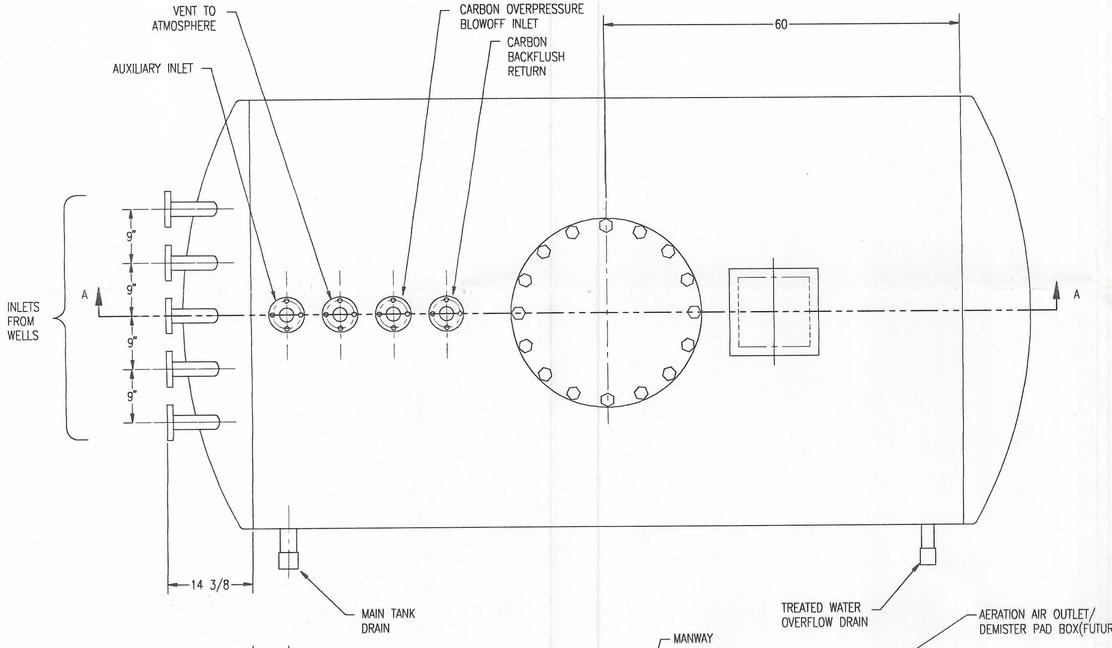
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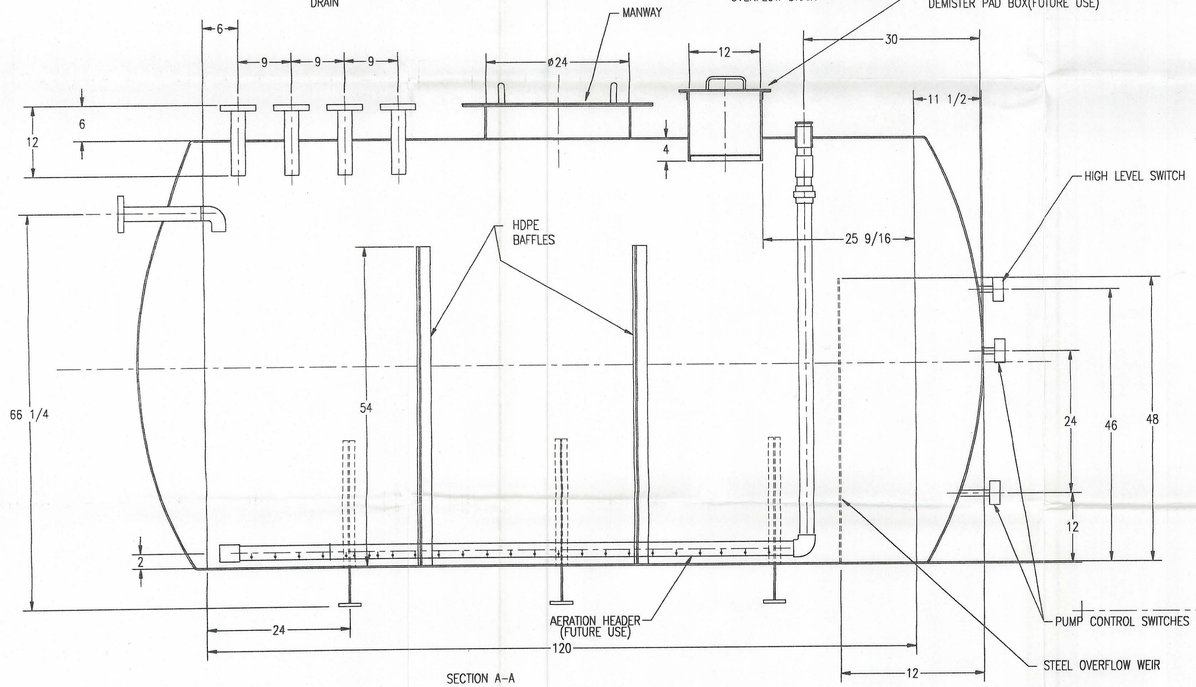
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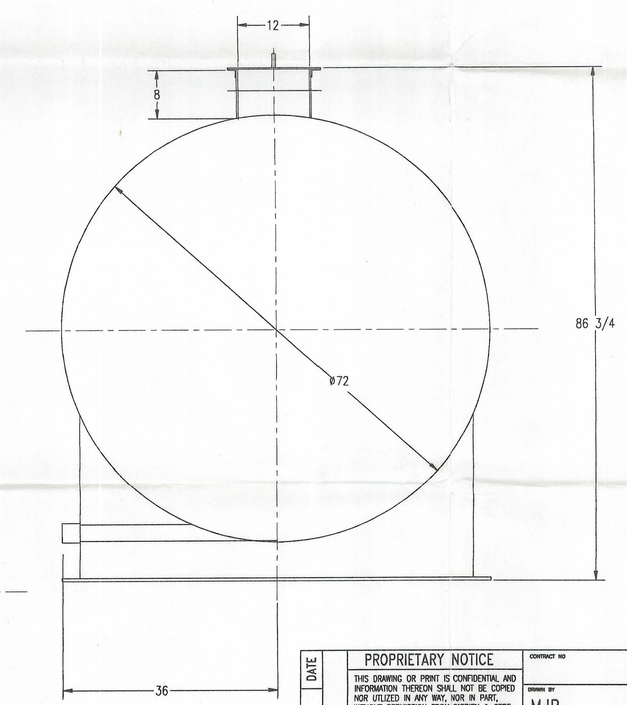
EQUALIZATION TANK

BILL OF MATERIALS





SECTION A-A



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ENGINEER: J.GIFFORD

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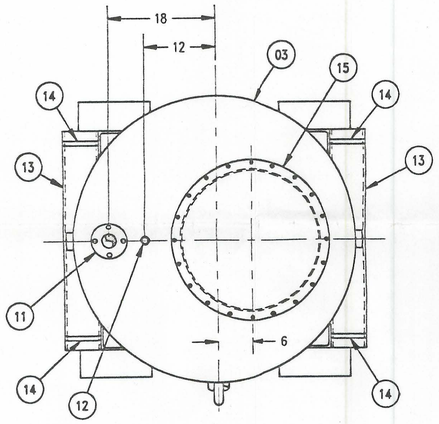
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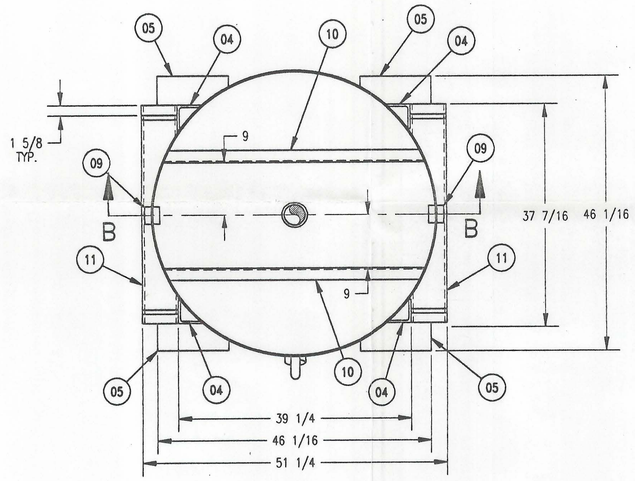
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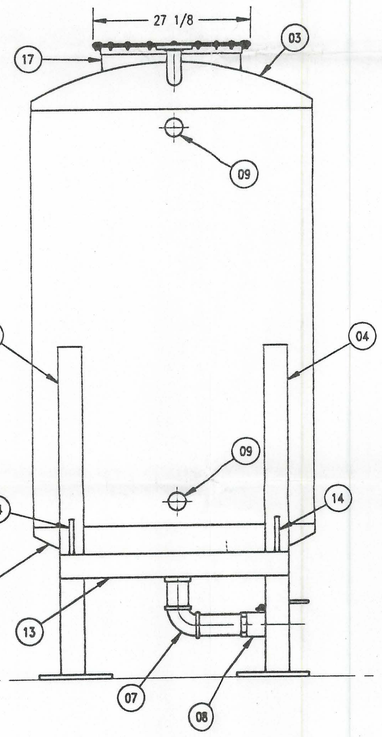
GAC TANKS

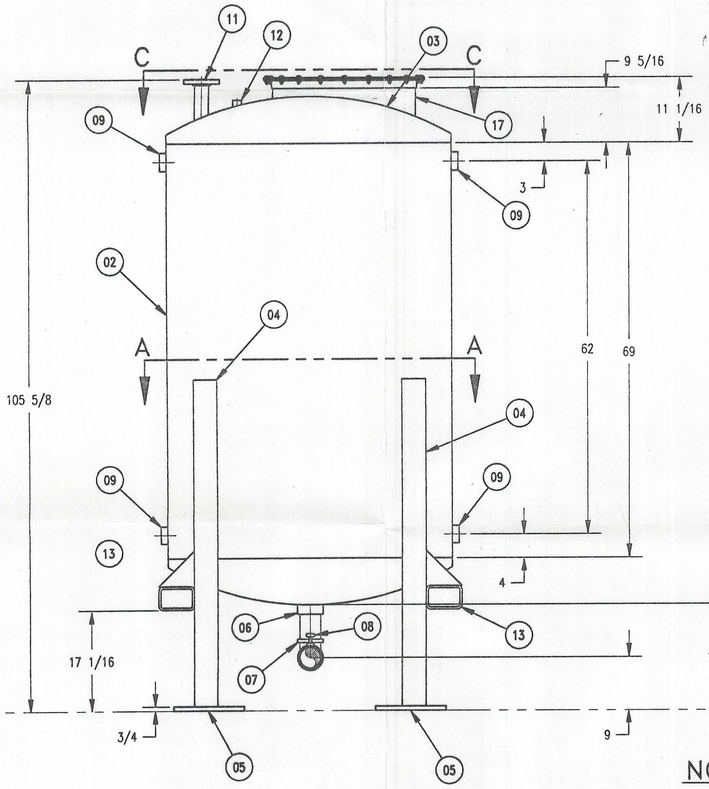


VIEW C



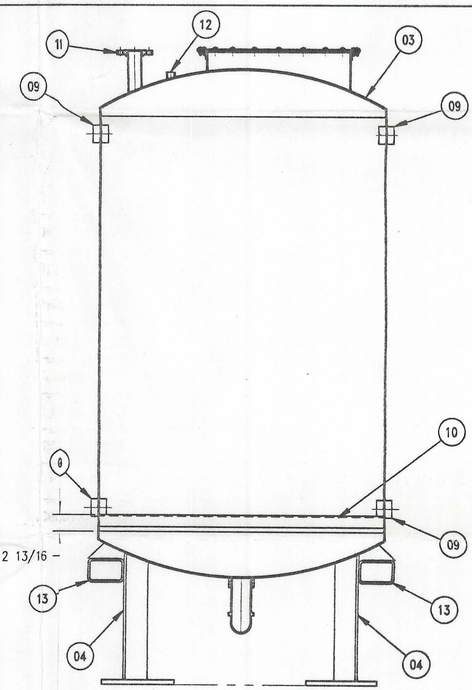
SECTION A–A





01 GAC TANK ASSEMBLY

BILL OF MATERIALS			
ITEM	QTY	DESRIPTION	STOCK NUMBER
01	2	GAC TANK ASSEMBLY	
02	2	GAC TANK BODY 48"ø O.D. x 69" LONG x 1/4" THK. / HRS	
03	4	COMMERCIAL SHEARING NON CODE DISH HEAD TYPE F&D 46"ø O.D. x 1/4" THK. P/N #418-970-0007	
04	8	4" x 4" x 3/8" THK. x 60" LG. ANGLE / HRS	
05	8	12" x 12" x 3/4" THK. PLATE / HRS	
06	2	3" STEEL HALF COUPLING	
07	2	3" 90° ELBOW THREADED	
08	2	3" APOLLO THREADED BRONZE BALL VALVE	
09	8	2" FULL COUPLING	
10	4	ANGLE 2" x 2" x 1/4" THK. x 43 15/16" LONG / HRS (CUT TO FIT INSIDE DIA. OF TANK)	
11	2	2" 150# SLIP ON FLANGE	
12	2	3/4" HALF COUPLING	
13	4	RECTANGLE TUBING 6" x 4" x 3/8" THK. x 37 7/16" LONG	
14	8	GUSSET 5" x 6" x 3/4" THK. / HRS	
15	2	ROLLED ANGLE RING 1 1/2" x 1 1/2" x 3/16" THK./HRS 24 1/8" ID, 20 HOLES 7/16"ø ON A 26 1/8" B.C.	
16	2	COVER PLATE 27 1/8"ø x 1/4" THK. / HRS 20 HOLES 7/16"ø ON A 26 1/8" B.C.	
17	2	ROLLED RING 24 1/6" O.D. x 6 3/16" LG. x 1/4" THK. (CUT TO FIT CONTOUR OF ITEM 03)	



SECTION B–B

NOTES

1) VESSEL INTERIOR TO BE COATED WITH DUPONT 25-P EPOXY.

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DECIMALS .XX ± .06 .XXX ± .010
ANGULAR ± 1°
FRACTIONAL ± 1/16

DO NOT SCALE

REV.	DESCRIPTION	DATE
	REVISIONS	

CONTRACT NO. CONTRACT NO.

DRAWN BY BULISCHECK 04/04/95

MANUFACTURING ENGINEER

ENGINEER J. GIFFORD 04/04/95

APPROVED BY

O'BRIEN & GERE MANUFACTURING, INC.
555 EAST GENESEE STREET
FAYETTEVILLE, NEW YORK 13066
(315) 637-2234

CLIENT INFORMATION
O'BRIEN & GERE TECH. SERVICES
SYRACUSE
NEW YORK

DRAWING TITLE GAC TANK ASSEMBLY

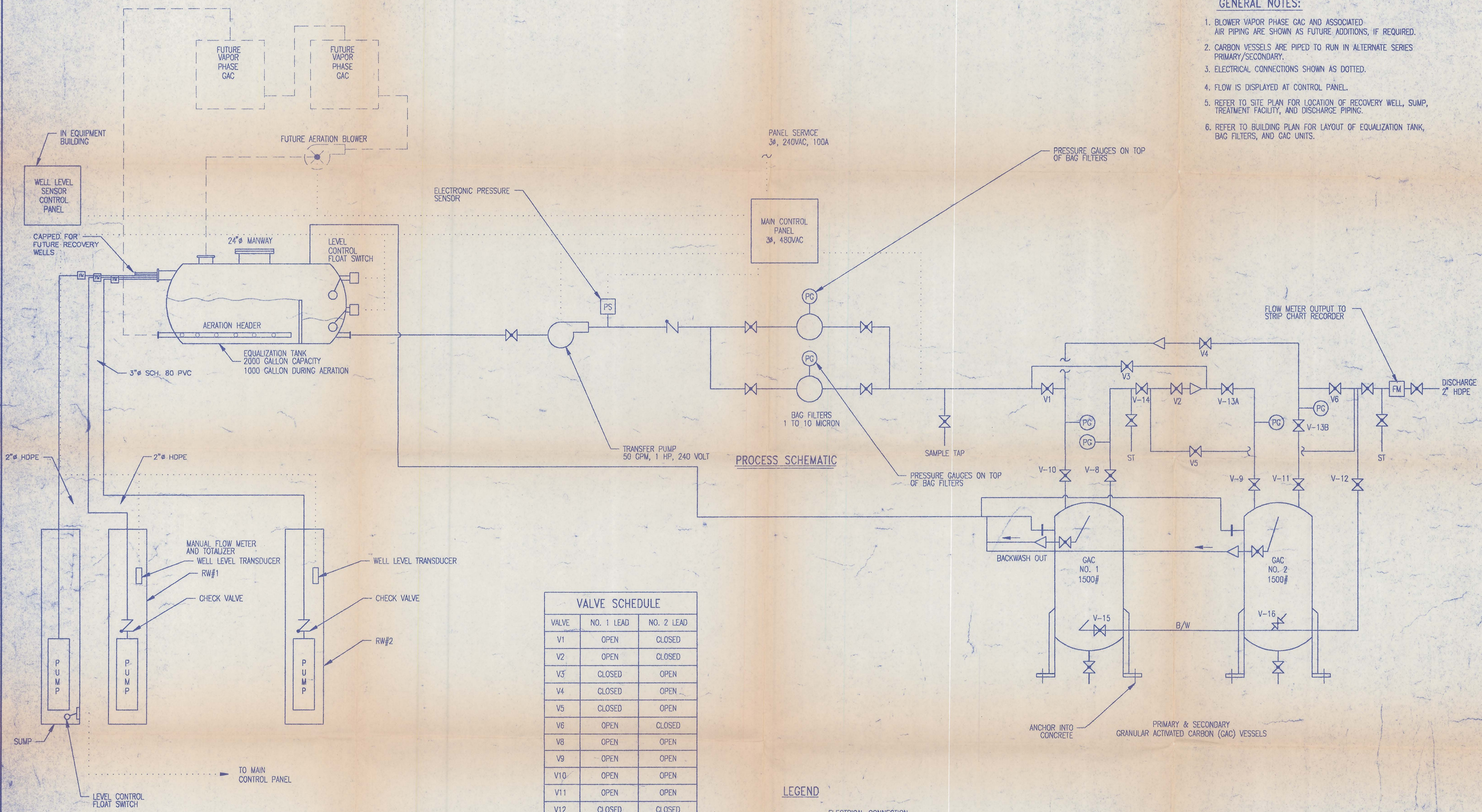
SIZE D

DRAWING NUMBER HE440-S1

SCALE 1=12 WEIGHT N/A SHEET 01 OF XX REVISION

OBG MANUFACTURING

WATER TREATMENT SYSTEM SCHEMATIC



PROCESS SCHEMATIC

GENERAL NOTES:

1. BLOWER VAPOR PHASE GAC AND ASSOCIATED AIR PIPING ARE SHOWN AS FUTURE ADDITIONS, IF REQUIRED.
2. CARBON VESSELS ARE PIPED TO RUN IN ALTERNATE SERIES PRIMARY/SECONDARY.
3. ELECTRICAL CONNECTIONS SHOWN AS DOTTED.
4. FLOW IS DISPLAYED AT CONTROL PANEL.
5. REFER TO SITE PLAN FOR LOCATION OF RECOVERY WELL, SUMP, TREATMENT FACILITY, AND DISCHARGE PIPING.
6. REFER TO BUILDING PLAN FOR LAYOUT OF EQUALIZATION TANK, BAG FILTERS, AND GAC UNITS.

VALVE SCHEDULE		
VALVE	NO. 1 LEAD	NO. 2 LEAD
V1	OPEN	CLOSED
V2	OPEN	CLOSED
V3	CLOSED	OPEN
V4	CLOSED	OPEN
V5	CLOSED	OPEN
V6	OPEN	CLOSED
V8	OPEN	OPEN
V9	OPEN	OPEN
V10	OPEN	OPEN
V11	OPEN	OPEN
V12	CLOSED	CLOSED
V13A	OPEN	OPEN
V13B	OPEN	OPEN
V14	OPEN	OPEN
V15	CLOSED	CLOSED
V16	CLOSED	CLOSED

LEGEND

- ELECTRICAL CONNECTION
- FUTURE EQUIPMENT CONNECTION (IF REQ'D)
- (PG) PRESSURE GAUGE
- ST SAMPLE TAP
- RUPTURE DISK

REVISIONS

REV.	DESCRIPTION	DATE

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TOLERANCES
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES ARE AS FOLLOWS
DECIMALS .XX ± .06 .XXX ± .010
ANGULAR ± 1°
FRACTIONAL ± 1/16

DO NOT SCALE

CONTRACT NO. CONTRACT NO.

DRAWN BY	BULISCHECK	03/15/95
MANUFACTURING ENGINEER		
ENGINEER	J. GIFFORD	03/15/95
APPROVED BY		

O'BRIEN & GERE MANUFACTURING, INC.
555 EAST GENESEE STREET
FAYETTEVILLE, NEW YORK 13066
(315) 637-2234

CLIENT INFORMATION
O'BRIEN & GERE TECH. SERVICES
FORMER ACCURATE DIE CAST FACILITY
GROUNDWATER TREATMENT

DRAWING TITLE: WATER TREATMENT SYSTEM SCHEMATIC
SIZE: D
DRAWING NUMBER: JL0080-11
SCALE: 1=1
HEIGHT: N/A
SHEET: 01 OF 01

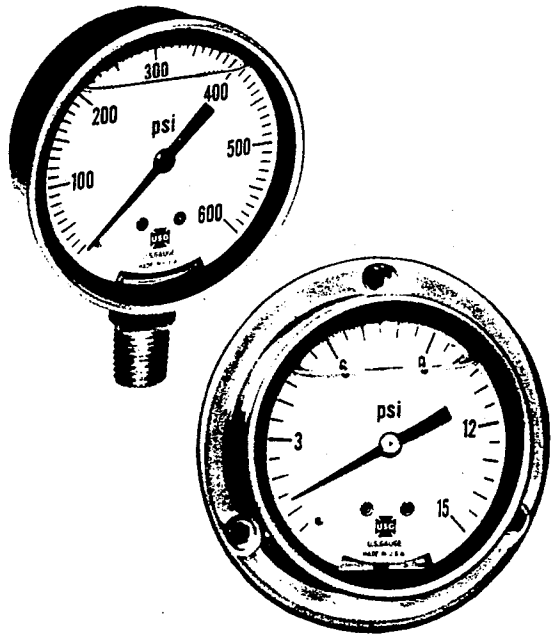
PLOTTED: 13-MAY-95 15:11 BY: JAMES H. HAMM
N:\PROJECT\JL0080\JL0080-11.DWG

US GAUGE

PRESSURE GAUGE

SERIES 500 63mm AND 100mm PRESSURE GAUGES

Series 530/550 (63mm) Liquid-Filled Gauges



U.S. Gauge Series 500 liquid-filled gauges are designed to resist pulsation, shock, vibration, weather and most corrosive atmospheres. These gauges are ideally suited to a broad range of plant, process, hydraulic and fluid power applications.

U.S. Gauge Series 530 liquid-filled pressure gauges incorporate a brass case, phosphor-bronze or beryllium-copper bourdon tube, and lower connect brass socket for stem mounting.

Series 550 liquid-filled gauges feature a stainless steel case and a wide choice of bourdon tube and connection materials to meet specific requirements. A variety of case configurations also provide mounting versatility; LM-low connect for stem mounting; CBM-center back connect for stem or U-clamp panel mounting; LBM- low back connect for front-flange or U-clamp panel mounting.

Series 530/550 pressure gauges also feature a unique multi-function plug which serves as a vent, pressure relief, and liquid-fill access. Socket connections are sealed to the case with a BUNA-N gasket.

Series 530/550 pressure gauges are also available dry (unfilled) from stock, through local U.S. Gauge Distributors.

SPECIFICATIONS

DIAL SIZE: 63mm (2½")

CASE AND RING:

FOR STEM MOUNTING–
300 Series stainless steel, solid back case with crimped stainless steel ring. BUNA-N multi function plug with removable nipple for venting, pressure relief and liquid-fill access. **(FIGURES 550L &555L)** FIG. 559L, CBM may also be stem mounted. FIG. 535L has brass case and ring.

FOR FRONT FLANGE PANEL MOUNTING–
Same construction as above except unit incorporates stainless steel front flange (3 hole DIN) for flush panel mounting. **(FIGURES 551L & 556L).**

FOR U-CLAMP PANEL MOUNTING–
Same construction as stem mount except unit incorporates stainless steel U-clamp. Accessory U-clamp kit available for panel mounting **FIG. 559L** (CBM) gauge **(FIGURES 552L & 557L).**

WINDOW: Polycarbonate, sealed to case with BUNA-N gasket and secured with permanent "crimped" ring.

DIAL: White-painted aluminum.

POINTER: Black coated aluminum.

MOVEMENT: Brass (except FIG. 550L, 551L, 552L use Glasstuf® with stainless steel link and link rivets).

BOURDON TUBE: Phosphor bronze, beryllium copper or 316 stainless steel (see model selection chart).

SOCKET CONNECTION: Stainless steel or brass (see model selection chart).

RESTRICTOR: Push type.

RANGE: 30" -0 Hg. Vac.(ccw rotation with increased vacuum) COMPOUND–30" Hg VAC-0-15, 30, 60, 100, 150 psi GAUGE–0-15, 30, 60, 100, 160, 200, 300, 400, 600, 1000, 1500, 2000, 3000, 4000, 5000, 6000, 10000 psi.

ACCURACY: ±3-2-3% of span

SEALS: BUNA-N

LIQUID FILL: Standard liquid fill is glycerin, but silicone and mineral oils are available. Dry gauges are available as off-the-shelf stock through local distributors.

MODEL SELECTION CHART

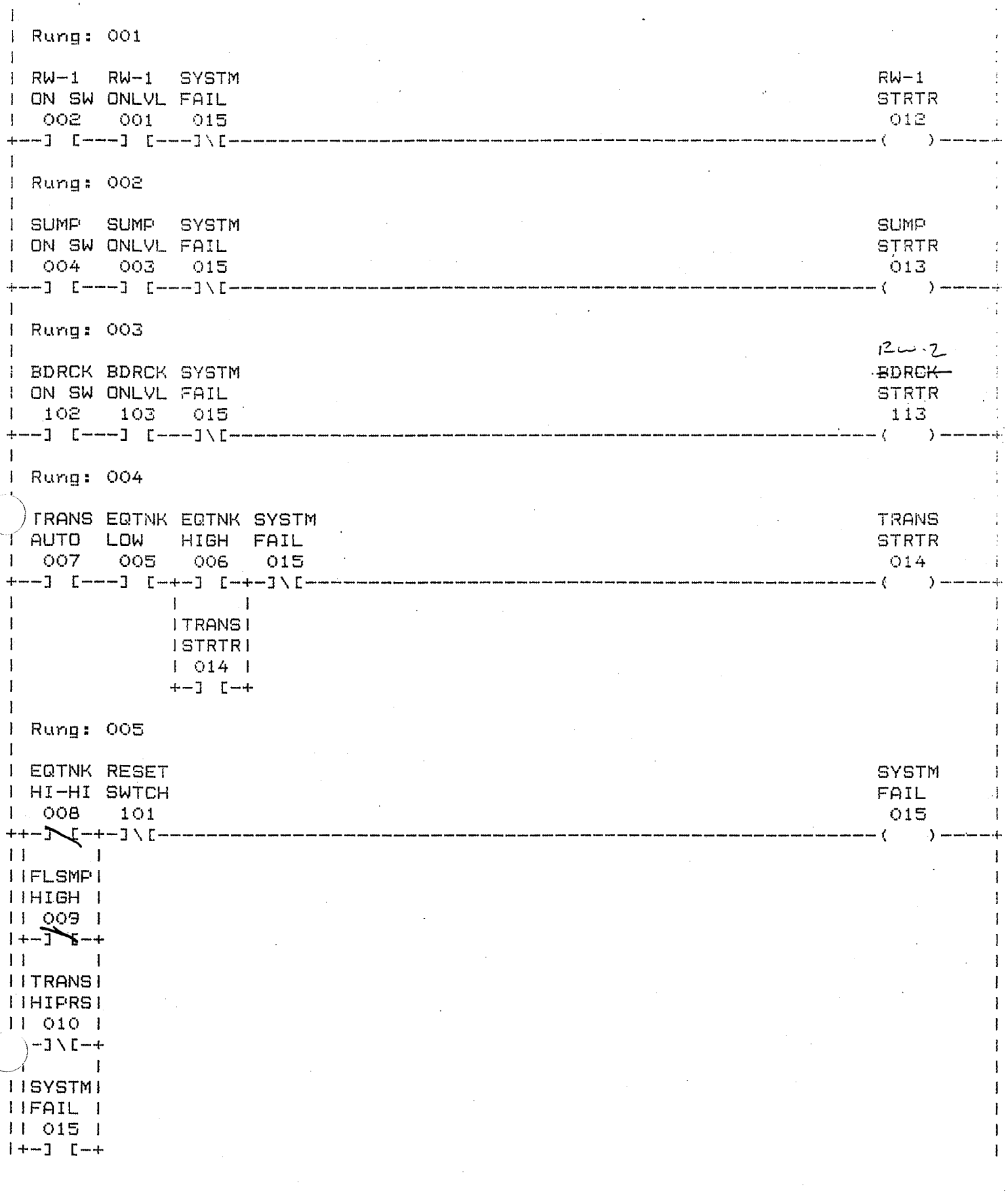
FIGURE NUMBER	MOUNTING	CONNECTION	SOCKET	BOURDON TUBE	CASE	RING
535L	Stem	¼" NPT LM	Brass	Phosphor Bronze*	Brass	Crimped Brass
550L	Stem	¼" NPT LM	316 SST	316 SST	Stainless Steel	Crimped SST
555L	Stem	¼" NPT LM	Brass	Phosphor Bronze*	Stainless Steel	Crimped SST
559L	Stem†	¼" NPT CBM	Brass	Phosphor Bronze*	Stainless Steel	Crimped SST
551L	Front Flange Panel	¼" NPT LBM	316 SST	316 SST	Stainless Steel	Crimped SST
552L	U-Clamp Panel	¼" NPT LBM	316 SST	316 SST	Stainless Steel	Crimped SST
556L	Front Flange Panel	¼" NPT LBM	Brass	Phosphor Bronze*	Stainless Steel	Crimped SST
557L	U-Clamp Panel	¼" NPT LBM	Brass	Phosphor Bronze*	Stainless Steel	Crimped SST

†559 can be panel mounted using accessory U-clamp kit. *Bourdon tube is beryllium copper in vacuum, 0-15 psi, 0-1500 psi and 0-5000 psi thru 0-10,000 psi ranges.

EXHIBIT C

PLC LADDER LOGIC DIAGRAM

Date: 10-02-95 Time: 08:54:31 Filename: ACCURATE
ACCURATE DIE CAST GROUND WATER CLEAN UP PROJECT
PC Personal Computer Software Ladder Diagram Page



```
|
| Rung: 006
|
| EQTNK RESET                                                    EQTNK
| HI-HI SWTCH                                                    HILVL
|  008   101                                                      016
++-]/[-+-]\[-----------------------------------------------------(   )-----+
||     |
||EQTNK|
||HILVL|
|| 016 |
|+-] [-+
|
| Rung: 007
|
| FLSMP RESET                                                    FLSMP
| HIGH  SWTCH                                                    HIALM
|  009   101                                                      114
++-]/[-+-]\[-----------------------------------------------------(   )-----+
||     |
||FLSMP|
||HIALM|
|| 114 |
|+-] [-+
|
| Rung: 008
|
| TRANS RESET                                                    TRNHI
| HIPRS SWTCH                                                    PRSAL
|  010   101                                                      112
++-]\[-+-]\[-----------------------------------------------------(   )-----+
||     |
||TRNHI|
||PRSAL|
|| 112 |
|+-] [-+
|
+---------------------- End of Ladder --- Words used = 00053 ----------------+
```

INPUT

Address	Element	Rung Number(s)	Instruction Comment
001	-] [-	001	RW-1 ONLVL: RECOVERY WELL LEVEL PERMISSIVE
002	-] [-	001	RW-1 ON SW: RECOVERY WELL SELECTOR SWITCH ON
003	-] [-	002	SUMP ONLVL: SUMP PUMP LEVEL PERMISIVE
004	-] [-	002	SUMP ON SW: SUMP PUMP SELECTOR SWITCH ON
005	-] [-	004	EQTNK LOW : EQUALIZATION TANK LOW LEVEL ULTRASONIC SWITCH
006	-] [-	004	EQTNK HIGH : EQUALIZATION TANK HIGH LEVEL ULTRASONIC SWITCH
007	-] [-	004	TRANS AUTO : TRANSFER PUMP SELECTOR SWITCH IN AUTOMATIC
008	-] [-	005, 006	EQTNK HI-HI: EQUALIZATION TANK HIGH HIGH LEVEL ULTRASONIC SWITCH
009	-] [-	005, 007	FLSMP HIGH : FLOOR SUMP PUMP HIGH LEVEL SHUT DOWN (SWITCH)
010	-]\[-	005, 008	TRANS HIPRS: TRANSFER PUMP OUTLET HIGH PRESSURE ALARM (PRESSURE SWITCH)
101	-]\[-	005, 006, 007, 008	RESET SWTCH: SYSTEM ALARM RESET SWITCH
102	-] [-	003	BDRCK ON SW: BEDROCK WELL SELECTOR SWITCH ON
103	-] [-	003	BDRCK ONLVL: BEDROCK WELL LEVEL PERMISSIVE

OUTPUT

Address	Element	Rung Number(s)	Instruction Comment
012	-( )-	001	RW-1 STRTR: RECOVERY WELL PUMP STARTER
013	-( )-	002	SUMP STRTR: SUMP PUMP MOTOR STARTER
014	-] [-	004	TRANS STRTR: TRANSFER PUMP MOTOR STARTER
014	-( )-	004	TRANS STRTR: TRANSFER PUMP MOTOR STARTER
015	-] [-	005	SYSTM FAIL : SYSTEM FAILURE LIGHT AND RELAY (1-CR)
015	-]\[-	001, 002, 003, 004	SYSTM FAIL : SYSTEM FAILURE LIGHT AND RELAY (1-CR)
015	-( )-	005	SYSTM FAIL : SYSTEM FAILURE LIGHT AND RELAY (1-CR)
016	-] [-	006	EQTNK HILVL: EQUALIZATION TANK HIGH LEVEL ALARM LIGHT
016	-( )-	006	EQTNK HILVL: EQUALIZATION TANK HIGH LEVEL ALARM LIGHT
112	-] [-	008	TRNHI PRSAL: TRANSFER PUMP OUTPUT HIGH PRESSURE ALARM LIGHT
112	-( )-	008	TRNHI PRSAL: TRANSFER PUMP OUTPUT HIGH PRESSURE ALARM LIGHT
113	-( )-	003	BDRCK STRTR: BEDROCK WELL PUMP MOTOR STARTER
114	-] [-	007	FLSMP HIALM: FLOOR SUMP PUMP HIGH LEVEL ALARM LIGHT
114	-( )-	007	FLSMP HIALM: FLOOR SUMP PUMP HIGH LEVEL ALARM LIGHT

APPENDIX A

INSPECTION/MAINTENANCE REPORT FORM

Former Accurate Die Casting Facility
Fayetteville, New York

INSPECTION/MAINTENANCE REPORT FORM

Date:_____

Name:(print)_____

Work performed:_____
_____
_____

Date when inspection/maintenance last performed:_____
_____

Remarks/Comments:
_____
_____
_____
_____
_____
_____
_____

Signature: _____

sc:2488396\5\11

APPENDIX B

DAILY OPERATIONS LOG SHEET

Former Accurate Die Casting Facility
Fayetteville, New York

DAILY OPERATIONS LOG SHEET

Date:_____ Name (print):_____

Time:_____AM/PM Signature:_____

Date/Time of previous report:_____/_____

Hours past since last report:_____hours (1)

Flow meter reading (while transfer pump is operating):_____g.p.m.

Current/Previous Totalizer Readings:	Volume of Water Collected Since Last Report:
Sump:_____/_____gallons	Sump:_____gallons
RW-1:_____/_____gallons	RW-1:_____gallons
RW-2:_____/_____gallons	RW-2:_____gallons
Outlet:_____/_____gallons	Outlet:_____gallons (2)

Calculated 24-hour volume estimate ((2)/(1)x24 hours): _____gallons

pH:_____

East bag filter pressure gauge reading (while transfer pump is operating):_____psi

West bag filter pressure gauge reading (while transfer pump is operating):_____psi

Lead GAC unit (circle one): GAC#1/GAC#2

GAC#1 inlet/outlet pressure gauge reading:_____/_____psi

GAC#2 inlet/outlet pressure gauge reading:_____/_____psi

Remarks/Comments:_____

_____

_____

_____

sc:2488396\5\10

APPENDIX C

SAMPLING AND ANALYSIS CHECKLIST

Former Accurate Die Casting Facility
Fayetteville, New York

SAMPLING AND ANALYSIS CHECKLIST

Date:_____

Name(print):_____ Signature:_____

Check when completed (if applicable)	Required Measurement Frequency	Effluent Parameter	Sample Type	Results (include units)
	Weekly	Total Suspended Solids	3-hr comp.	
	Weekly	Total Dissolved Solids	3-hr comp	
	2 /month	Metals (twelve)	3-hr comp	
	2 /month	VOCs	Grab	
	Monthly	$CBOD_5$	3-hr comp	
	Monthly	TKN	3-hr comp	
	Monthly	TOD	Calculated	
	Monthly	Dissolved Oxygen	Grab	

APPENDIX D

SPDES PERMIT FACT SHEET

File: 24/88.651 A2

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010

John P. cahill
Commissioner

November 21, 1997

Mr. David S. Towers, P.E.
Project Associate
O'Brien and Gere Engineers Inc.
5000 Brittonfield Parkway
P.O. Box 4873
Syracuse, NY 13221

Dear Mr. Towers:

RE: Accurate Die Casting Site, SPDES Permit, Site ID # 7-34-052

As requested in your letter dated August 29, 1997, the Department has reviewed the July and September 1997 monitoring data submitted along with the monthly report. The data indicates that the discharge does not have a significant impact on the Bishop Brook. Therefore, page 2 of the SPDES permit has been revised to indicate that the TDS stream sampling is no longer required. A revised page 2 of the discharge authorization is enclosed for your reference.

If you need additional information or have any questions please contact me at (518) 457-0315.

Sincerely,

Vivek Nattanmai, P.E.
Project Manager
Bureau of Western Remedial Action
Div. of Environmental Remediation

enclosure

cc: H. Hamel, NYSDOH, Syracuse

(Modified November 18, 1997)

Special Conditions:

Authorization is valid only for the period noted above but may be renewed if appropriate. A request for renewal must be received 6 months prior to the expiration date to allow for a review of monitoring data and reassessment of monitoring requirements.

Only site generated wastewater is authorized for treatment and discharge.

Discharge is not authorized until such time as an engineering report, plans and specifications are submitted detailing the proposed method of treatment and approval is granted by the Department.

*TOD = 1.5 x $CBOD_5$ + 4.5 x TKN.

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010

John P. cahill
Acting Commissioner

January 31, 1997

Mr. David S. Towers, P.E.
Senior Project Engineer
O'Brien and Gere Engineers Inc.
5000 Brittonfield Parkway
P.O. Box 4873
Syracuse, NY 13221

Dear Mr. Towers:

RE: Accurate Die Casting Site, SPDES Permit, Site ID # 7-34-052

As requested in your letter dated December 2, 1996, the Department has evaluated the monitoring details submitted by you. Based on this evaluation, the Department has eliminated the Total Dissolved Solids (TDS) limit established by the SPDES Fact Sheet (# 734052) for the above site. Per the modified SPDES Fact Sheet (enclosed), TDS shall only be monitored. Additionally, seasonal stream sampling is now required as specified on page 2 of the modified SPDES Fact Sheet.

If you need additional information or have any questions please contact me at (518) 457-0315.

Sincerely,

Vivek Nattanmai, P.E.
Project Manager
Bureau of Western Remedial Action
Div. of Environmental Remediation

enclosure
cc: H. Hamel, NYSDOH, Syracuse

astewater Discharge Fact Shee

Prepared by: Shayne Mitchell

Date: 1/27/97

Company: Accurate Die Casting DER No.: 734052

Location: Onondaga County, Fayetteville Industrial Code No.: 9511

Industrial Segment: NA 40CFR Part No.: NA

Type of Processing & Production Rate:

Site Remediation.

Basis for Technology Effluent Limitations:

Best Professional Judgement (BPJ)

PARAMETER	BASIS FOR CONDITION*
Outfall No.: 001 : Remedial	Discharge: Nominal Flow: 0.15 MGD
Flow	BPJ
pH	WQ
TSS	BPJ
TDS	Monitor
CBOD	Monitor
TKN	Monitor
TOD	WQ
DO	WQ
Aluminum	WQ
Antimony	BPJ
Chromium	BPJ
Cobalt	WQ
Copper	BPJ
Iron	WQ
Lead	WQ
Mercury	WQ/Detection Limit
Nickel	BPJ
Silver	BPJ
Vanadium	WQ
Zinc	WQ
Cis-1,2-DCE	BPJ
Trans-1,2-DCE	BPJ
Methylene Chloride	BPJ
1,1,2,2-PCA	BPJ
PCE	WQ
Toluene	BPJ
TCE	BPJ
Acetone	BPJ
2-Hexanone	BPJ
4-Methyl-2-Pentanone	BPJ

* NYS Water Quality Regulations (for surface water) are implemented by applying the Total Maximum Daily Load (TMDL) process (ref.: Section 303(d) of the Clean Water Act; 40CFR Part 130 and USEPA Guidance for Water Quality-Based Decisions: The TMDL Process) to watersheds, drainage basins or waterbody segments on a pollutant specific basis. The analysis determines if there is a "reasonable potential" that the discharge of a pollutant will result in exceedance of ambient water quality standards. The TMDL is used to establish waste load allocations for point sources and load allocations for nonpoint sources of the pollutant. For point sources, the waste load allocations are translated to Water Quality Based Effluent Limits (WQBELs). OTHER REFERENCES: For effluent conditions based on BPT, BCT, BAT OR New Source requirements, see Code of Federal Regulations (40CFR) at the Part Number listed above. For BPJ determinations see 40CFR Part 125.3.d. For discharges to groundwater, see NYS regulations 6NYCRR, Chapter 10, Part 703.6.

ACCURATE DIE CASTING SITE, ONONDAGA COUNTY
EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning December 1, 1993 (Modified February 1, 1997)

and lasting until December 1, 1998

the discharges from the facility shall be limited and monitored by the discharger specified below:

Outfall Number & Effluent Parameter	Discharge Limitations Daily Avg.	Daily Max.	Units	Minimum Monitoring Requirements Measurement Frequency	Sample Type
Remedial Discharge to Bishop Brook (0-66-11-P26-37-6-2-4), Class C (TS)					
Flow	Monitor	150,000	GPD	Continuous	Meter
pH	(6.5-8.5)		SU	2/week	Grab
Solids, Total Suspended	Monitor	20	mg/l	Weekly	3-hr. comp.
Solids, Total Dissolved	Monitor	Monitor	mg/l	Weekly	3-hr. comp.
$CB0D_5$	Monitor	Monitor	mg/l	Monthly	3-hr. comp.
TKN	Monitor	Monitor	mg/l	Monthly	3-hr. comp.
TOD*	Monitor	15	mg/l	Monthly	Calculated
Dissolved Oxygen	Monitor	7 min.	mg/l	Monthly	Grab
Aluminum, Dissolved	Monitor	200	µg/l	2/month	3-hr. comp.
Antimony, Total	Monitor	100	µg/l	2/month	3 hr. comp.
Chromium, Total	Monitor	500	µg/l	2/month	3-hr. comp.
Cobalt, Total	Monitor	10	µg/l	2/month	3-hr. comp.
Copper, Total	Monitor	100	µg/l	2/month	3-hr. comp.
Iron, Total	Monitor	300	µg/l	2/month	3-hr. comp.
Lead, Total	Monitor	20	µg/l	2/month	3-hr. comp.
Mercury, Total	Monitor	0.8	µg/l	2/month	3-hr. comp.
Nickel, Total	Monitor	200	µg/l	2/month	3-hr. comp.
Silver, Total	Monitor	100	µg/l	2/month	3-hr. comp.
Vanadium, Total	Monitor	30	µg/l	2/month	3-hr. comp.
Zinc, Total	Monitor	300	µg/l	2/month	3-hr. comp.
Cis-1,2-Dichloroethylene	Monitor	10	µg/l	2/month	Grab
Trans-1,2-Dichloroethylene	Monitor	10	µg/l	2/month	Grab
Methylene Chloride	Monitor	50	µg/l	2/month	Grab
1,1,2,2-Tetrachloroethane	Monitor	30	µg/l	2/month	Grab
Tetrachloroethylene	Monitor	20	µg/l	2/month	Grab
Toluene	Monitor	20	µg/l	2/month	Grab
Trichloroethylene	Monitor	10	µg/l	2/month	Grab
Acetone	Monitor	1000	µg/l	2/month	Grab
2-Hexanone	Monitor	1000	µg/l	2/month	Grab
4-Methyl-2-Pentanone	Monitor	1000	µg/l	2/month	Grab

Special Conditions:

Authorization is valid only for the period noted above but may be renewed if appropriate. A request for renewal must be received 6 months prior to the expiration date to allow for a review of monitoring data and reassessment of monitoring requirements.

Only site generated wastewater is authorized for treatment and discharge.

Discharge is not authorized until such time as an engineering report, plans and specifications are submitted detailing the proposed method of treatment and approval is granted by the Department.

*TOD = 1.5 x $CBOD_5$ + 4.5 x TKN.

Bishop Brook Sampling - Each year, Bishop Brook must be sampled for TDS during the months of July, August and September. Weekly 3 hour composite samples shall be collected immediately upstream of the discharge and at the first downstream location where complete mixing of effluent has occurred. The distance between the discharge and the downstream location shall be noted on the monitoring report. Stream sampling shall be coordinated with effluent sampling in order to accurately represent the discharges impact on the stream. Based on the data collected the Department may require additional studies and/or modify discharge requirements in the future.

APPENDIX E

RECOMMENDED SPARE PARTS LIST

Recommended spare parts list

- Circular charts
- Filter bags
- Flow meters
- Pressure gauges
- Rupture disks