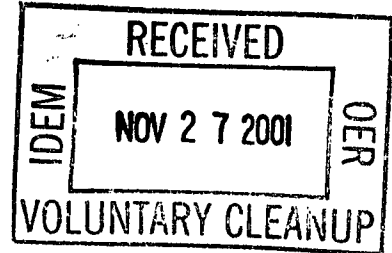




IDEM Office of Land Quality - Fileroom Stamp		Harding ESE, Inc. 46850 Magellan Drive Suite 190 Novi, MI 48377 Telephone: 248/926-4008 Fax: 248/926-4009 Home Page: www.mactec.com
VRP Project Name:	Honeywell Industrial	
VRP#:	6980601	File Code: 400
Description:	Groundwater o & m Plan	
Confidential?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
Deliberative?	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No

November 21, 2001

Indiana Department of Environmental Management
Voluntary Remediation Program
100 N. Senate Avenue
P.O. Box 6015
Indianapolis, IN 46206-6015



Attention: Chris Bower, Site Manager

Subject: Groundwater and Product Recovery Systems
Operation, Monitoring and Maintenance Plan
Honeywell Industrial Complex, South Bend, Indiana
IDEM Site No. 6980601

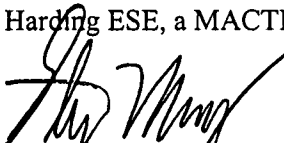
Mr. Bower:

Enclosed are two copies of the *Groundwater and Product Recovery Systems Operation, Monitoring and Maintenance Plan, Honeywell Industrial Complex, South Bend, Indiana*. As described in the facility-wide Remediation Work Plan, Honeywell has agreed to continue to control groundwater at the site and recover free product where technically feasible and practical. Harding ESE, a MACTEC Company, (Harding ESE) is under contract with Honeywell to assist with operation, maintenance and monitoring (OM&M) of the groundwater and product recovery systems. This document has been prepared to provide information necessary to perform OM&M for groundwater and product recovery systems active at the Honeywell Industrial Complex in South Bend, Indiana, as required by the Indiana Department of Environmental Management's Voluntary Remediation Program.

Please note that all communication should be initiated with Chuck Gadelmann at 952-830-3685. Please contact Mr. Gadelmann should you have any questions on this submittal.

Respectfully,

Harding ESE, a MACTEC Company


Steven Murray, OPG
Senior Project Manager

Enclosures

cc: Chuck Gadelmann, Honeywell
Craig Losee, Honeywell

**GROUNDWATER AND
PRODUCT RECOVERY SYSTEMS
OPERATIONS, MAINTENANCE, AND
MONITORING PLAN**

**HONEYWELL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA
VRP No. 6980601**

PREPARED BY:

**HARDING ESE, A MACTEC COMPANY
46850 MAGELLAN DRIVE, SUITE 190
NOVI, MICHIGAN 48377**

PROJECT NUMBER 50781-002

NOVEMBER 2001

**GROUNDWATER AND
PRODUCT RECOVERY SYSTEMS
OPERATIONS, MAINTENANCE, AND MONITORING PLAN**

**HONEYWELL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA
VRP No. 6980601**

Prepared for:

**HONEYWELL INTERNATIONAL, INC.
717 N. BENDIX DRIVE
SOUTH BEND, INDIANA 46620**

Prepared by:

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PROJECT NUMBER 50781-002

NOVEMBER 2001

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1. INTRODUCTION

Honeywell has entered into a voluntary remediation agreement with the Indiana Department of Environmental Management (IDEM) under the Voluntary Remediation Program (VRP). In April 2001, Honeywell received approval of the facility-wide remediation work plan (RWP) from IDEM. As described in the RWP, Honeywell has agreed to continue to control groundwater at the site and recover free product where technically feasible and practical. Harding ESE, a MACTEC Company, (Harding ESE) is under contract with Honeywell to assist with operation, maintenance and monitoring (OM&M) of the groundwater and product recovery systems. The purpose of this plan is to provide information necessary to perform OM&M for groundwater and product recovery systems active as of November 2001 at the Honeywell Industrial Complex in South Bend, Indiana, as required by the VRP. The plan includes an overview of the site history and environmental conditions. The plan then describes the operation and maintenance of the current systems, and provides details regarding sample collection, analysis, and reporting requirements.

1.1 SITE LOCATION AND MANUFACTURING HISTORY

The Honeywell Industrial Complex is located at 717 North Bendix Drive, South Bend, Indiana (Figure 1). The facility includes 26 primary buildings on 110 acres. Approximately 500,000 square feet of the Complex are occupied, while another 1 million square feet of manufacturing space are vacant. The properties around the Complex include mixed residential, commercial and industrial areas.

1.2 ENVIRONMENTAL HISTORY

In 1978, a free-phase plume of naphtha and stoddard solvent was discovered on the water table beneath the Plant 6/16 area (in the central portion of the facility). A naphtha recovery well system (consisting of a depression well, product recovery well E-3, and aboveground storage tank) was first installed at the Complex in 1978 for removal of naphtha free product from the top of the water table (see Figure 2). Four additional recovery well systems (RWB6, RWB16, RWB21, and RWB22) were installed in 1982.

Initially, free product recovery from all of the wells was greater than 1,000 gallons per day per well. In the early 1990s, product recovery became negligible. Two of the five naphtha recovery well systems (RWB6 and RWB21) were deactivated in the mid 1980s, because free product was no longer present in

these wells. Water level data obtained as part of on-going groundwater monitoring efforts indicated that naphtha wells E3, RWB16, and RWB22 provided sufficient groundwater containment. As a result, wells E3, RWB16, and RWB22 continued to operate as groundwater recovery wells.

In 1996 and 1997, 12 additional monitoring wells (designated MW-1 through MW-12) were installed to refine the groundwater monitoring network (see Figure 2). The interpretation of the groundwater flow directions using the additional water level data obtained from these new monitoring wells indicated that groundwater containment near Plant 3 required enhancement.

The 12 wells installed in 1996/1997 confirmed that the naphtha recovery well network had recovered the majority of the free product present on the water table. At the time of installation, Well MW-6, located northeast of Plant 6/16 and near Dock 10 (see Figure 2), was the only well to contain a significant quantity of free product. A 1- to 1.5-foot-thick layer of free product was measured in monitoring well MW-6. A dual-well recovery system was installed adjacent to MW-6 to recovery product and to enhance groundwater containment near Plant 3. This system (designated as RWB23) was installed and brought on-line in January 1999¹.

During quarterly groundwater monitoring activities, free product was observed in monitoring well MW-8 (located in the former Plant 1 Metal Stamping Area) and reappeared at recovery well E3. In the spring of 2000, the extent of free product in the Former Metal Stamping Area was delineated². In the fall of 2000, E3 was upgraded to re-establish product recovery at this location. In the spring of 2001, EW-4 dual well system was installed to begin product recovery adjacent to MW-8 in the former Metal Stamping Area³.

¹ Harding Lawson Associates, June 1999, Construction Report Naphtha Recovery System Enhancement.

² Harding Lawson Associates, April 2000, Supplemental Investigation Report – Voluntary Site Investigation.

³ Harding ESE, a MACTEC Company, June 2001, Construction Report Free Product Recovery System Enhancements.

SECTION 1

Groundwater beneath the South Bend Industrial Complex has been impacted by volatile organic compounds from historical operations at the site. Local groundwater flow is currently being controlled through the operation of several groundwater extraction and free product recovery wells. Extracted groundwater is discharged directly to combination storm/sanitary sewers under Wastewater Discharge Permit SB004:4 issued by the Department of Public Works, City of South Bend, Indiana. Product, which is recovered from the recovery wells and then stored in aboveground product storage tanks (ASTs), is disposed of at a Honeywell approved off-site disposal facility when the tank is full or at a maximum of every 90 days.

2. GROUNDWATER RECOVERY SYSTEMS

In general, shallow groundwater flow from the western and central portions of the site trends to the east toward the active naphtha recovery wells (E3, RWB16, RWB22 and RWB23). VOC recovery wells EW-1, EW-2 and EW-4 inhibit off-site migration of shallow groundwater from the Former Plant 1 and existing Plant 1 area. Northeast of Plant 1, shallow groundwater flow is generally to the north, toward Kennedy Park. VOC recovery well EW-3 limits off-site migration of shallow groundwater in the Plant 9 area.

The system components for the Naphtha and VOC recovery systems are described below.

2.1 NAPHTHA RECOVERY WELL SYSTEM

Currently, the naphtha recovery well system includes four groundwater depression wells (E3, RWB16, RWB22, and RWB23) as shown on Figure 2. Operation of the system is beneficial because it maintains an inward gradient of groundwater flow from the central and western portion of the site. At two of these locations (E3 and RWB23) product recovery systems are also operated, because of continued presence of free-phase product on the water table with in these wells. System construction details are documented in the following construction reports: "Naphtha Recovery System Enhancements," (Harding Lawson Associates, June 1999) and "Free Product Recovery System Enhancements," (Harding ESE, June 2001). General information on the groundwater depression well and product recovery systems is presented below.

2.1.1 Groundwater Depression Wells

Construction and operational details for the groundwater depression wells are presented on Table 1. Groundwater is extracted from the depression wells by 460 Volt, 3-phase electric submersible pumps. The pumps are controlled by a pump starter switch and regulated by a gate valve. RWB23, installed in 1999, also has a pump saver installed to protect the pump from dry run, power surges and overloads. To date electrical supply problems have not been observed at E3, RWB16 and RWB22.

Target pumping rates are obtained by regulating flow with a gate valve. Pump back-pressure is monitored with a pressure gauge, which is installed before the gate valve. Each well has a Sensus® in-line flow meter with totalizer to aid in monitoring compliance with discharge requirements for the naphtha recovery system. All the naphtha groundwater depression wells are completed above grade. Appendix A contains manufacturer cut sheets for individual components of the depression recovery wells.

At each groundwater depression well location, extracted groundwater is discharged into the combination storm/sanitary sewer in compliance with the wastewater discharge permit. The discharge permit for the naphtha recovery system has a daily discharge limit of 0.173 million gallons per day (mgd). Established flow rates from each well presented on Table 1 are in compliance with permit discharge limit.

2.1.2 Product Recovery Systems

Currently, product recovery systems are operating at two well locations, E3 and RWB23. The free-phase product at these locations consists of naphtha. Recovery rates range from 100 gallons to 200 gallons per month for E3 and RWB23. The product recovery systems consist of a pneumatic pumping unit that uses a skimmer pump with a hydrophobic screen that repels water, but allows products to be collected. Each product recovery point has been installed adjacent to groundwater depression well where free product is pooled on the depressed water table. Appendix B contains manufacturer cut sheets for individual components of the product recovery well systems.

Compressed air for the product recovery systems is provided by the facility at each location. System activation controls are located inside buildings to maintain appropriate operating temperatures for pneumatic controls. E3 controls are located in Plant 2 just south of the well location (see Figure 3). RWB23 dual well system controls are located just inside Dock 10 receiving area (see Figure 4). The systems consist of an air supply, pneumatically operated skimming pump, air supply lines, a 560-gallon steel aboveground product storage tank (AST), product lines, a pneumatically operated tank-full shutoff switch (TFSO), and an air supply/control panel. The secondary containment for the AST is monitored by an interstitial space monitor. This alarm will set off an audible alarm indicating release to secondary containment.

The skimming pumps are suspended in the product recovery wells with the intake at the approximate depth of the free product layer. The skimmer portion “floats”, at groundwater product interface and has a vertical float range of 20 inches. This means that as the water table and product surface fluctuates, the skimmer moves with the surface of the product. The skimming pump requires compressed air supplied at a minimum of 40 pounds per square inch (psi), and cycles at a rate that is adjustable, based on site conditions. Product is discharged from the pump into the AST. When the tank is full, the TFSO shuts off the compressed air supply to the pump and must be reset manually at the control box. Should the TFSO malfunction, and product continues to be pumped to a full tank, a product return hose sends the product back to the well. Product stored in the AST is disposed of when the tank is full or at a maximum of every 90 days. Facility personnel and Harding ESE monitor the product recovery systems weekly in compliance with established facility requirements.

2.2 VOC RECOVERY WELL SYSTEM

Currently, the VOC recovery well system includes four groundwater depression wells (EW-1, EW-2, EW-3, and EW-4) as shown on Figure 2. This system maintains an inward gradient of groundwater flow to limit off-site migration of VOC-impacted groundwater from Former Plant 1, Plant 1 and Plant 9 areas.

At the EW-4 location and product recovery system is also maintained due to the continued presence of free-phase product on the water table in this area. The free-product in this area is oil likely from former metal stamp operations, that operated in this area. System construction details are documented in the following construction reports: “Design and Installation Report-VOC Recovery System Rehabilitation,” (Harding Lawson Associates, September 1998) and “Free Product Recovery System Enhancements,” (Harding ESE, June 2001). General information on the groundwater depression wells and product recovery system is presented below.

2.2.1 Groundwater Depression Wells

Construction and operational details for the groundwater depression wells are presented on Table 2. Groundwater is extracted from the depression wells using 460 Volt, 3-phase electric submersible pumps. The pumps are controlled by a pump starter switch and regulated by a gate valve. Pump savers are installed to protect the pumps from dry run, power surges and overloads at each location. The

flowmeters, pump savers and discharge gate valves are located in separate manholes for wells EW-1, EW-2 and EW-3, due to below grade completions (see Figure 5).

Target pumping rates are obtained by regulating the flow with the gate valve. Pump backpressure is monitored with a pressure gauge, which is installed before the gate valve. Each well has a Sensus® in-line flow meter with totalizer to aid in monitoring compliance with discharge requirements for the VOC recovery system. Appendix A contains manufacturer cut sheets for individual components of the groundwater depression wells.

At each depression well location, extracted groundwater is discharged into the combination storm/sanitary sewer in compliance with the wastewater discharge permit. The discharge permit for the VOC recovery system has a limit daily wastewater discharge limit of 0.154 million gallons per day (mgd). Established flow rates from each well presented on Table 1 are in compliance with permit.

2.2.2 Product Recovery System

At the location of EW-4, a product recovery system is also operating using well EW-4P. The free-phase product at this location consists of an oil released from past metal stamping operations in the area. This product recovery system was brought on-line in April 2001. The product recovery system is the same setup as the naphtha recovery systems detailed in Section 2.1.2 of this document. The only difference is that due to the remote location a compressor trailer was setup to house controls and the supply air for the pneumatic pump. Figure 6 shows the layout of the recovery system. Appendix B contains manufacturer cut sheets for individual components of the product recovery well system. This product recovery well is positioned adjacent to groundwater depression well EW-4 where free product is pooled on the depressed water table.

Harding ESE monitors this remote product recovery system weekly in compliance with established facility requirements.

3. EXTRACTION SYSTEM OPERATION AND MAINTENANCE

This section describes operation and maintenance of the product recovery systems and the groundwater recovery system. Operation and maintenance is conducted in accordance with manufacturer recommendations and Harding ESE's experience with groundwater extraction systems. Harding ESE and approved contractors monitor the system through site inspections. All of the technicians performing the maintenance activities have completed 40-hour Hazardous Waste Operations and Emergency Response training in compliance with 29 CFR 1910.120 (including annual 8-hour refresher training). This training includes spill response procedures.

3.1 WEEKLY INSPECTION

Honeywell facility personnel inspect, typically on a daily basis, product recovery locations (E3 and RWB23). Due to the remote location of product recovery system EW-4, an OM&M contractor visits the site weekly to inspect the operation of the product recovery system at the EW-4 location. The inspections consist of observing system operation, inspecting product discharge lines for leaks, and checking product levels in the ASTs.

3.2 BI-WEEKLY MAINTENANCE

Harding ESE conducts routine OM&M work bi-weekly at the site at all groundwater depression wells and product recovery systems. During the bi-weekly OM&M event, a technician physically checks the groundwater and product recovery system components to ensure optimal performance. The on-site technician completes a well inspection report (included as Appendix C) to record measurements and document the OM&M work performed at each well location.

During the bi-weekly OM&M visits, the following tasks are performed:

- Inspect and document electrical and mechanical systems; measure and record flow rates, operating pressures, pump amperage draw on each phase, and depth to groundwater; make operational modifications to systems; and perform routine maintenance,

- Monitor the operation of three pneumatic controlled free product recovery systems; record product levels in ASTs, measure and record product thickness in recovery wells with an electronic interface probe; record pump cycle frequency, observe pump discharge, and work with engineer to make operational modifications to systems to optimize product recovery rate.
- Prepare well inspection reports after each visit to detail observations and measurements taken during biweekly OM&M visit.

3.3 SEMI-ANNUAL WELL REHABILITATION

As part of system maintenance, each groundwater depression well is chemically treated every six months to aid in the reduction of chemical and biological fouling of the groundwater recovery wells, which reduces the specific capacity of the wells. The current chemical treatment schedule is March and August. The wells are treated with sodium hypochlorite (NaOCl) and a chelating agent, and specific capacity tests are performed before and after chemical treatment. Detailed procedures are provided below.

The initial specific capacity tests are performed with the existing pump. The pump is deactivated to allow the water to return to a static level, and after the static water level is achieved, it is measured and recorded. Then the pump is activated, and the start time and flow rate are recorded. Groundwater levels are monitored until stabilization is observed. Stabilization time is also recorded. Both initial and post-treatment specific capacity tests are performed at the same flow rate and for the same duration. This allows for most accurate comparison of resulting specific capacity changes due to chemical treatment.

After the initial specific capacity test is completed, the well pump is idled and NaOCl is introduced into the well. The volume of NaOCl used for treatment at each well varies depending on the well screen length. A total of 1.5 gallons of NaOCl per foot of well screen is added into the idled well. The well is left idled to allow chemicals to reside in the screen interval and adjacent formation for a 24-hour period. Post-treatment specific capacity tests are then performed in the same manner as the initial tests (i.e., same pumping rate and for the same duration) to aid in the evaluation of the effectiveness of the treatment. A well treatment report is prepared by the O&M contractor documenting activities and measurements made during chemical treatment at each well location.

4. GROUNDWATER RECOVERY SYSTEM MONITORING

During operation of the groundwater recovery system, water level measurements are recorded and groundwater samples are collected from selected monitoring wells and active recovery wells. The monitoring is conducted to accomplish the following:

- Evaluate the effectiveness of the groundwater flow control at the site;
- Evaluate groundwater quality trends; and
- Comply with the wastewater discharge permit SB004:4 issued by the Department of Public Works, City of South Bend, Indiana.

A summary of the monitoring program conducted at the site is provided in Table 3. The rationale for groundwater sample collection locations is presented on Table 4. Currently, TriMatrix Laboratories, Inc. (TriMatrix) provides analytical services for Honeywell under the VRP program. TriMatrix, a Honeywell-approved laboratory, has been providing the analysis for the site's groundwater monitoring program since 1997 and is identified in the approved Quality Assurance Project Plan for the site (ABB, 1996).

4.1 QUARTERLY GROUNDWATER DISCHARGE SAMPLING

Groundwater discharge sampling is performed each quarter. During the quarterly event, a full round of groundwater levels in recovery wells and monitoring wells at the site are measured and recorded. Procedures are detailed below.

4.1.1 Water Level Measurements

Water levels are collected from 65 shallow monitoring wells, 4 intermediate monitoring wells screened in the deep portion of the shallow aquifer, 12 deep monitoring wells screened in the deeper aquifer system, and the 8 groundwater depression wells.

After opening the well and allowing the water level to equilibrate, the depth to groundwater is measured at each location to the nearest 0.01 foot using an electronic water level indicator. After each measurement, the water level indicator is washed with a solution of LiquiNox and distilled water and

rinsed with distilled water. Water level measurements are referenced to the top of the well casing. Groundwater elevations are calculated by subtracting the depth-to-groundwater at each well from the top-of-well casing elevation.

4.1.2 Groundwater Sampling Procedures

Table 5 describes the required analytical parameters and methods to be performed on each groundwater sample collected during each quarterly event. Sample container, handling and preservative requirements are also included. Specific wells to be sampled during each quarterly event are presented in the reference table below.

Groundwater Sampling Event	Well Type	Well Designations
1 st Quarter (March)	Active Groundwater Depression Wells	E3, RWB16, RWB22, RWB23, EW-1, EW-2, EW-3, and EW-4
2 nd Quarter (June)	Active Groundwater Depression Wells	E3, RWB16, RWB22, RWB23, EW-1, EW-2, EW-3, and EW-4
	Select Monitoring Wells	7-25, 7-50, 86-10, 86-15, 9-33, MW-2, MW-4, MW-5, MW-9, MW-10, MW-11, MW-12, MW-13, S3, S4A, S9, S15, S16, S17, S20, S21, S22, S23, S24, S25, S27, 8D, D5, D7, 2D, 5D, and 7D
3 rd Quarter (September)	Active Groundwater Depression Wells	E3, RWB16, RWB22, RWB23, EW-1, EW-2, EW-3, and EW-4
4 th Quarter (December)	Active Groundwater Depression Wells	E3, RWB16, RWB22, RWB23, EW-1, EW-2, EW-3, and EW-4
	Select Monitoring Wells	7-25, 7-50, 86-10, 86-15, 9-33, MW-2, MW-4, MW-5, MW-9, MW-10, MW-11, MW-12, MW-13, S3, S4A, S9, S15, S16, S17, S20, S21, S22, S23, S24, S25, S27, 8D, D5, D7, 2D, 5D, and 7D

Monitoring wells are purged of stagnant groundwater prior to sample collection. During purging, the pH, specific conductivity and temperature of the groundwater is measured in the field with a Horiba U10 Water Checker. Groundwater is purged from the monitoring wells until a minimum of three well volumes have been evacuated and the pH, specific conductivity, and temperature have stabilized (within

10 percent between the final two readings). Once purging is completed, a groundwater sample can be collected. Monitoring wells are purged and sampled with either dedicated bladder pumps, dedicated PVC bailers, disposable bailers, or a stainless-steel bailer, as detailed on Table 3. Non-dedicated equipment (i.e., the stainless-steel bailer) is washed with a solution of LiquiNox and distilled water and rinsed with distilled water before each use.

VOC and naphtha recovery wells are purged and sampled through existing spigots on discharge lines. In general, approximately 5 gallons of water are drained through spigots of each well prior to sampling. Prior to sample collection, the pH, specific conductivity and temperature of the groundwater are measured in the field with a Horiba U10 Water Checker.

In accordance with QC procedures, during each sampling event, duplicate samples are collected at a frequency of 10 percent.

Laboratory-prepared trips blank are included with each cooler containing samples for VOC analysis and the blanks are also analyzed for VOCs. Equipment rinsate blanks are collected during the March and December sampling events from the stainless-steel bailer used to sample well 9-33. The sample is collected prior to sampling by pouring distilled water into the bailer and then transferring the distilled water to the appropriate sample containers.

Samples are placed in insulated coolers with sealed bags of ice and delivered to TriMatrix Laboratories, Inc. of Grand Rapids, Michigan. Chain-of-Custody (COC) documentation accompanies each set of samples and includes the following information: date and time of sample collection, sample name, analysis method, and sampler's signature. Details of daily activities (including times, dates and methods of sample collection) are recorded in a site-specific field notebook. Details on the purging and sampling procedures are recorded on Groundwater Sample Record Sheets (included as Appendix D).

5. REPORTING REQUIREMENTS

This section describes the reporting requirements regarding the operation, maintenance, and monitoring of the groundwater depression wells at Honeywell's South Bend Industrial Facility. As required by the Industrial Wastewater Discharge Permit, discharge monitoring reports are prepared on a quarterly basis for submittal to the City of South Bend. At the end of the year, an annual groundwater monitoring report is prepared. The scope of these reports is described in the following sections.

5.1 QUARTERLY DISCHARGE REPORT

The Quarterly Discharge Report is a letter report that is submitted to the Department of Public Works, City of South Bend, Indiana. The report must include the following:

- A tabular summary of the volume of groundwater discharged from each well during that period and system totals comparison to established discharge limits;
- Analytical summary tables for groundwater samples collected from active naphtha and VOC recovery wells; and
- Shallow and deep groundwater flow maps, developed from groundwater elevation measurements, illustrating the effects of extraction on groundwater control.

The letter report is distributed to the City of South Bend, Honeywell Facilities personnel, and the Honeywell Corporate Site Remediation Team. The letter reports are issued within 30 days of the end of each quarter.

5.2 ANNUAL GROUNDWATER MONITORING REPORT

A comprehensive monitoring report is prepared annually after the analytical data is received and reviewed from the fourth quarter sampling event. At a minimum the annual groundwater monitoring report includes the following:

- Groundwater level measurements in table format for each quarterly sampling event collected throughout the year;

- Groundwater contour maps generated from quarterly groundwater level measurements (shallow and deep flow systems);
- Analytical summary data tables for the current year;
- Analytical summary data tables summarizing historical sample results back to 1997; and
- Chemical constituent concentration versus time trend graphs (up to 12 selected wells for VOCs).

The report includes an introduction, discussion of sampling methodologies and analytical procedures, and current analytical data summary tables grouped by shallow monitoring wells, deep monitoring wells, naphtha recovery wells, and VOC recovery wells. Groundwater sampling records, historical analytical data summary tables, and concentration versus time graphs will be appended to the report.

One copy of the draft report will be prepared for Honeywell's review. After comments are received and incorporated, four copies of the final report are distributed to the City of South Bend, IDEM VRP, Honeywell Facilities personnel, and the Honeywell Corporate Site Remediation Team. The Annual Report is issued by January 31st of each year.

6. POTENTIAL OPERATING PROBLEMS

Based on documentation and historical system operation and maintenance observations, a summary of potential operating problems is detailed below for both the groundwater depression wells and the product recovery well systems.

6.1 GROUNDWATER DEPRESSION WELL SYSTEMS

As discussed in Section 3.2, all of the groundwater extraction wells are equipped with 460 Volt, 3-phase electric submersible pumps. Historical problems, other than normal pump wear, have included power disruptions or loss of phase. Recovery wells with pump savers (RWB23, EW-1, EW-2, EW-3, and EW-4) will automatically idle and then re-start once normal power feed is restored. E-3, RWB16, and RWB22 require manual reset by resetting pump starter switch. These start switches have fuse disconnects, which require inspection after power disruption.

A new power supply was established for VOC recovery wells EW-1 and EW-2 in the spring of 2001. Electrical controls for these wells are located at EW-4 location. Figure 7 details new power supply coming from Building 501. A schematic of controls at EW-4 is also included in Appendix B. Since installation, EW-1 and EW-2 have not had any operational problems.

6.2 PRODUCT RECOVERY WELL SYSTEMS

As discussed in section 3.1, routine weekly inspections are performed at product recovery systems. Maintenance visits are conducted bi-weekly at the site to ensure optimal performance of the product recovery systems.

The skimmer pump intake can only travel approximately 20 inches (i.e., up or down 10 inches). If the water table rises and the pump intake becomes positioned below the product water interface, the pump will begin to pump water. During a drop in the seasonal water table, the pump intake can become suspended above the product causing no product removal. As indicated by liquid level measurements in the recovery wells, which are monitored bi-weekly, the skimmer pump may need to be adjusted up or down. For this reason, these pumps are attached to a hand crank for ease of adjustments.

Reduced product recovery yield has been observed during extreme cold conditions in the winter months, as a result of condensate in the product discharge line “slushing.” To reduce the potential for slushing, lines need to be inspected and adjusted to limit the amount of bends or loops in the tubing exposed at/or near grade.

6.3 NOTIFICATION PROCEDURES

As discussed in Section 3.1 and Section 3.2, well inspection reports are available to inform Harding ESE of any abnormal conditions within the recovery systems. In addition, Facility personnel perform visual inspections daily at on-site recovery well locations. In the event of groundwater depression well failure, Harding ESE has an approved local electrician and water well service company under contract to assist with needed repairs. Repairs are typically completed within 24 hours of notification.

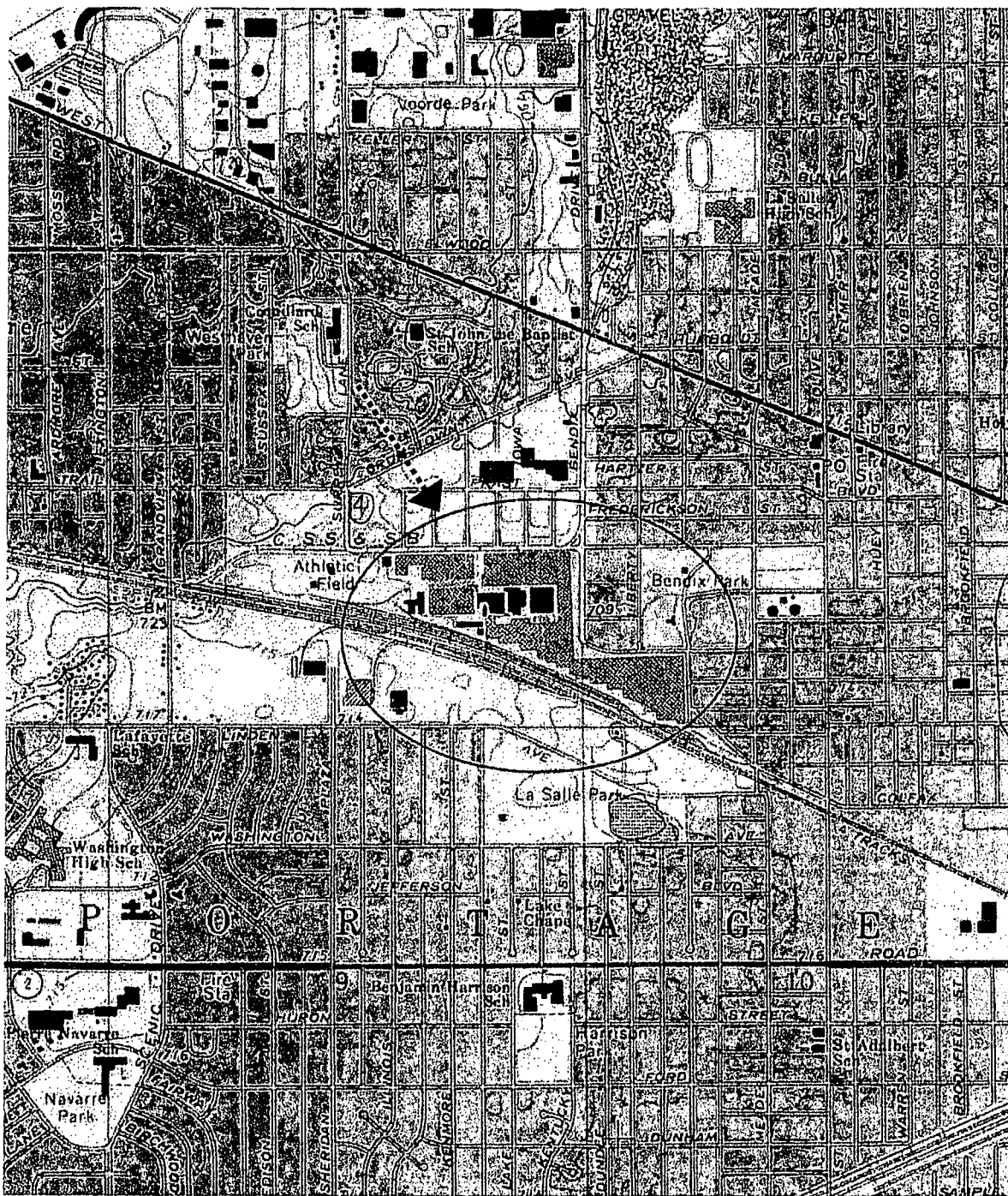
7. CONTINGENCY OPERATION AND MAINTENANCE

Each of the groundwater depression well locations are independent "stand alone" systems. Separate power feeds and controls exist for each groundwater depression well. As a result, it is not likely that all groundwater depression wells would go off-line at the same time. Each system (naphtha and VOC) consist of four groundwater depression wells. In the event of one well going off-line, other groundwater depression wells in the system will continue to operate. If product recovery systems go off-line, product just continues to pool in the localized cone of depression created by adjacent groundwater depression well.

Honeywell facility personnel visually observe recovery well operation during daily activities. If a well is observed to be off-line by Honeywell facility personnel or the O&M contractor, the engineer is notified. As part of the OM&M contract, approved local contractors (electrician and water well service company) have been established to perform on-call repairs. Contractors are local to the facility to provide for timely response. Under current contract, the following contractors have been approved to provide these repair/troubleshooting services:

<i>Three Star Electrical</i>	Mishawaka, Indiana	Mechanical Contractor
<i>Peerless Midwest</i>	Mishawaka, Indiana	Water Well Service Company
<i>Trans Tech Electric Inc.</i>	South Bend, Indiana	Electrical Contractor

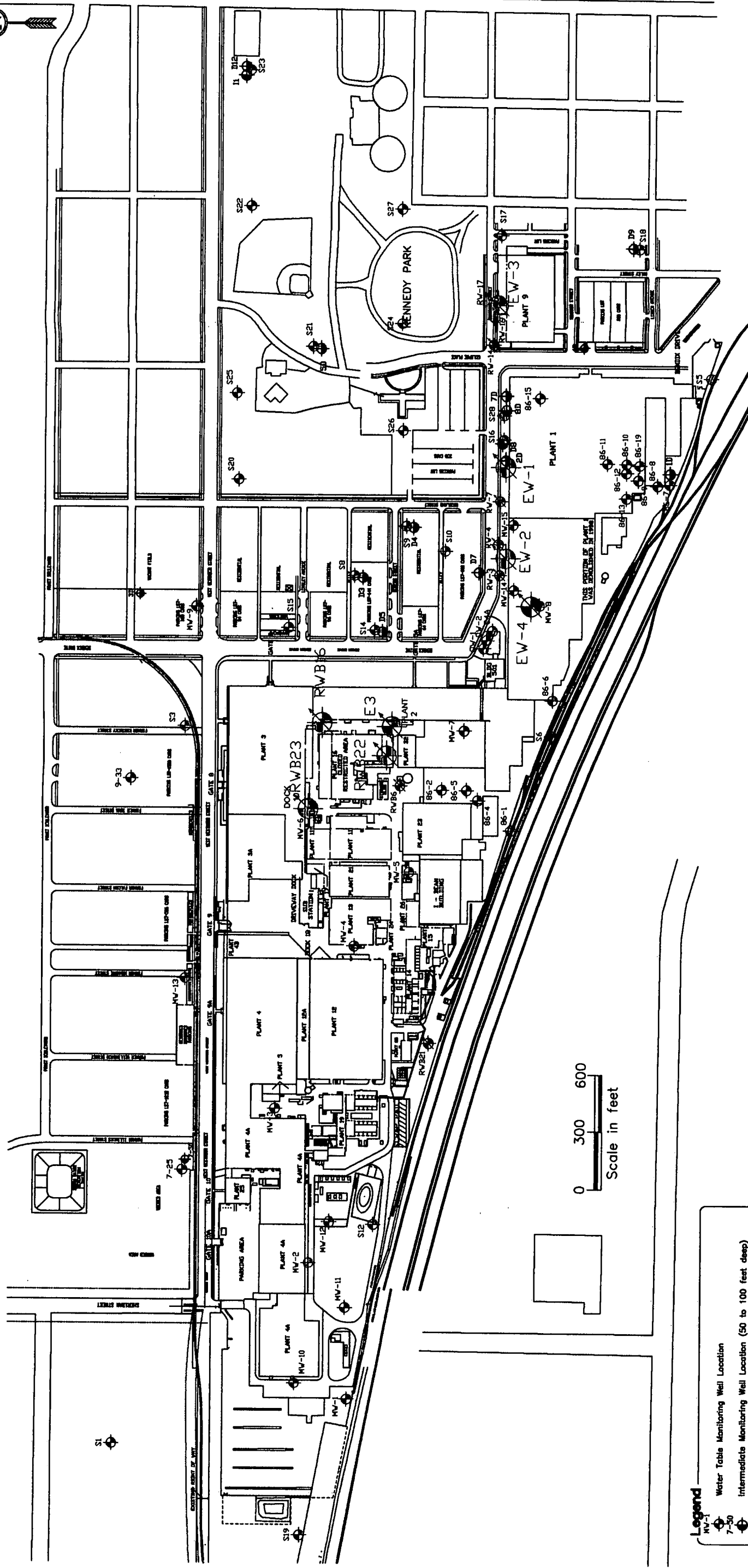
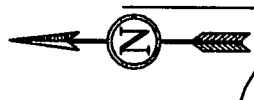
Once notified by the Harding ESE, on-call contractors generally are on-site performing repairs within 24 hours of notification. The Facility has in place a contingency plan that requires daily visual inspection of product accumulation areas. This procedure enables quick response to any observed malfunctions. Periodic well shut downs happen as part of normal operations. No new hazards are created by these shut downs, however Honeywell strives to minimize down time of groundwater depression wells.




QUADRANGLE LOCATION

Taken from the South Bend, Indiana 7.5
Series U.S.G.S. Topographic Quadrangle Map

Figure 1
Site Location Map
Operation, Monitoring and
Maintenance Plan
Honeywell Industrial Complex
South Bend, Indiana



- Legend**
- NV-1 Water Table Monitoring Well Location
 - 7-30 Intermediate Monitoring Well Location (50 to 100 feet deep)
 - 60 Deep Monitoring Well Location (100 to 210 feet deep)
 - RW B21 Former Recovery Well Location
 - EV-3 Existing Recovery Well Location



Harding ESE
A MACTEC Company

Monitoring Well and Recovery Well Network
Operation, Monitoring and Maintenance Plan
Honeywell Industrial Complex
South Bend, Indiana

FIGURE 2

APPROVED

JOB NUMBER 47971

DATE 01/22/2001

REVISED DATE

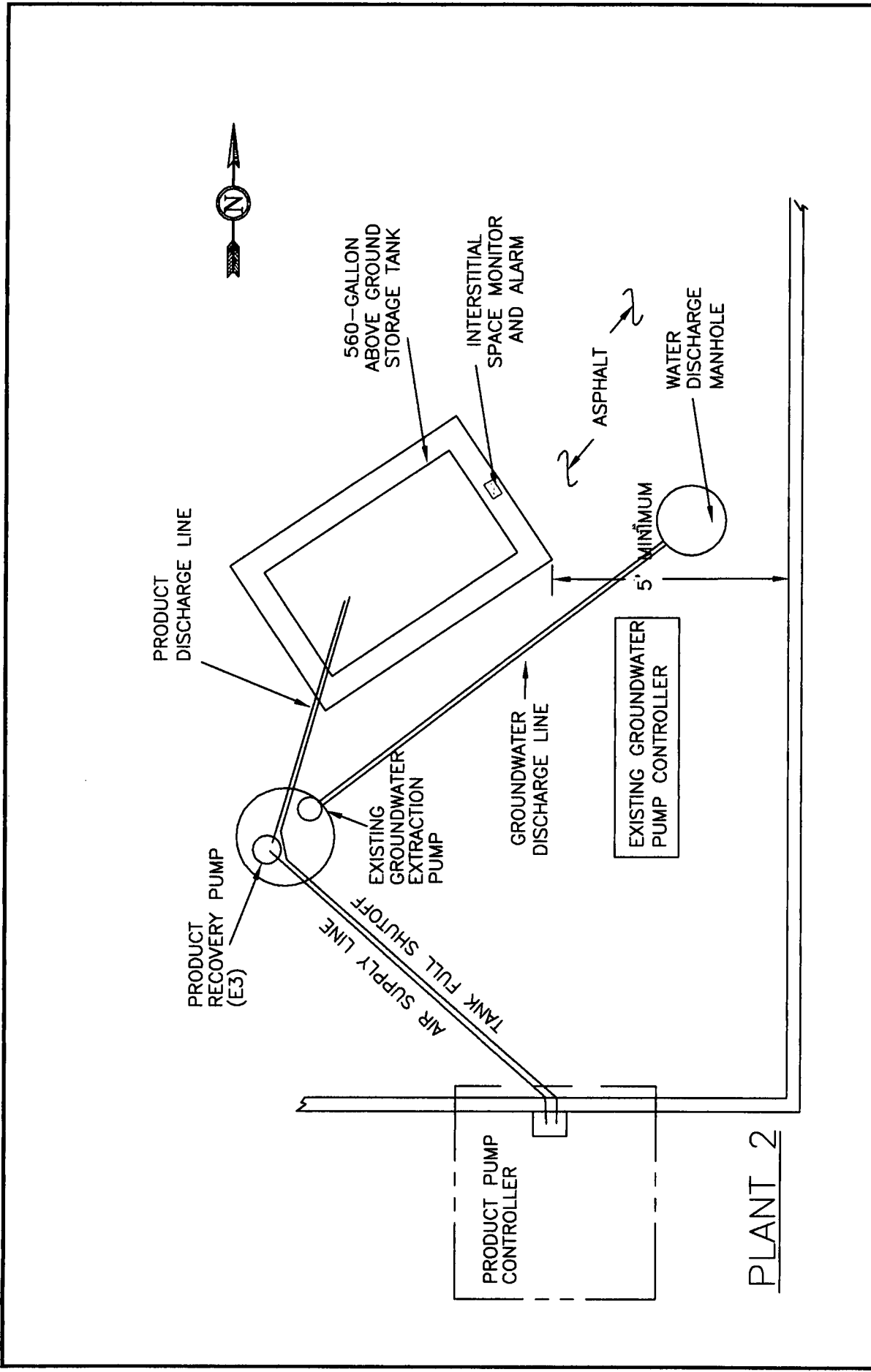



FIGURE 3
E3 PRODUCT RECOVERY
SYSTEM LAYOUT
HONEYWELL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA



Harding ESE
 46850 Magellan Drive, Suite 190
 Novi, MI 48377
 248-926-4008
 A MACTEC COMPANY

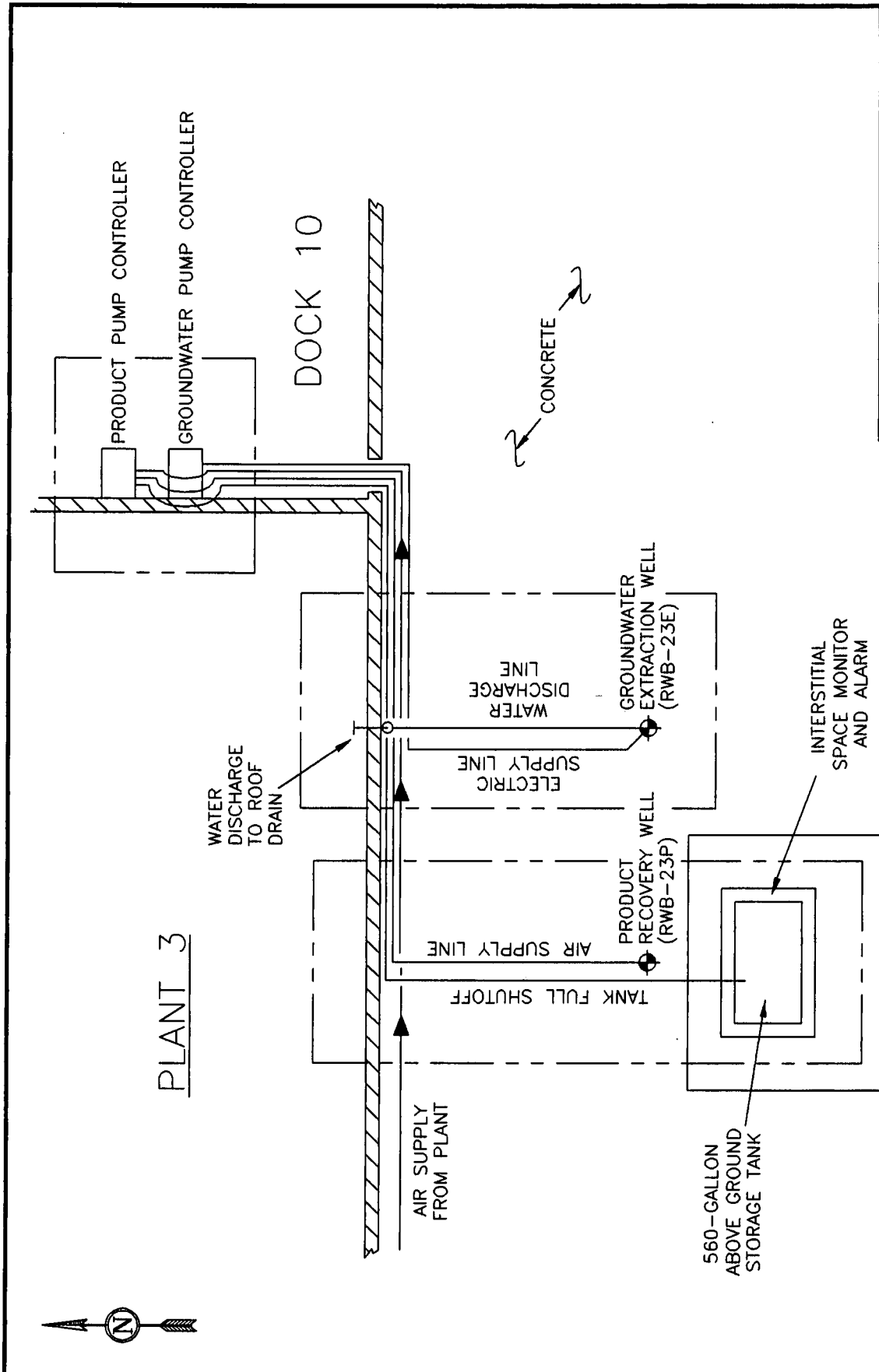


FIGURE 4
RWB23 PRODUCT RECOVERY
SYSTEM LAYOUT
HONEYWELL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

46850 Magellan Drive, Suite 190
 Novi, MI 48377
 248-926-4008

Harding ESE
 A MACTEC COMPANY

NOT TO SCALE

PLANT 3

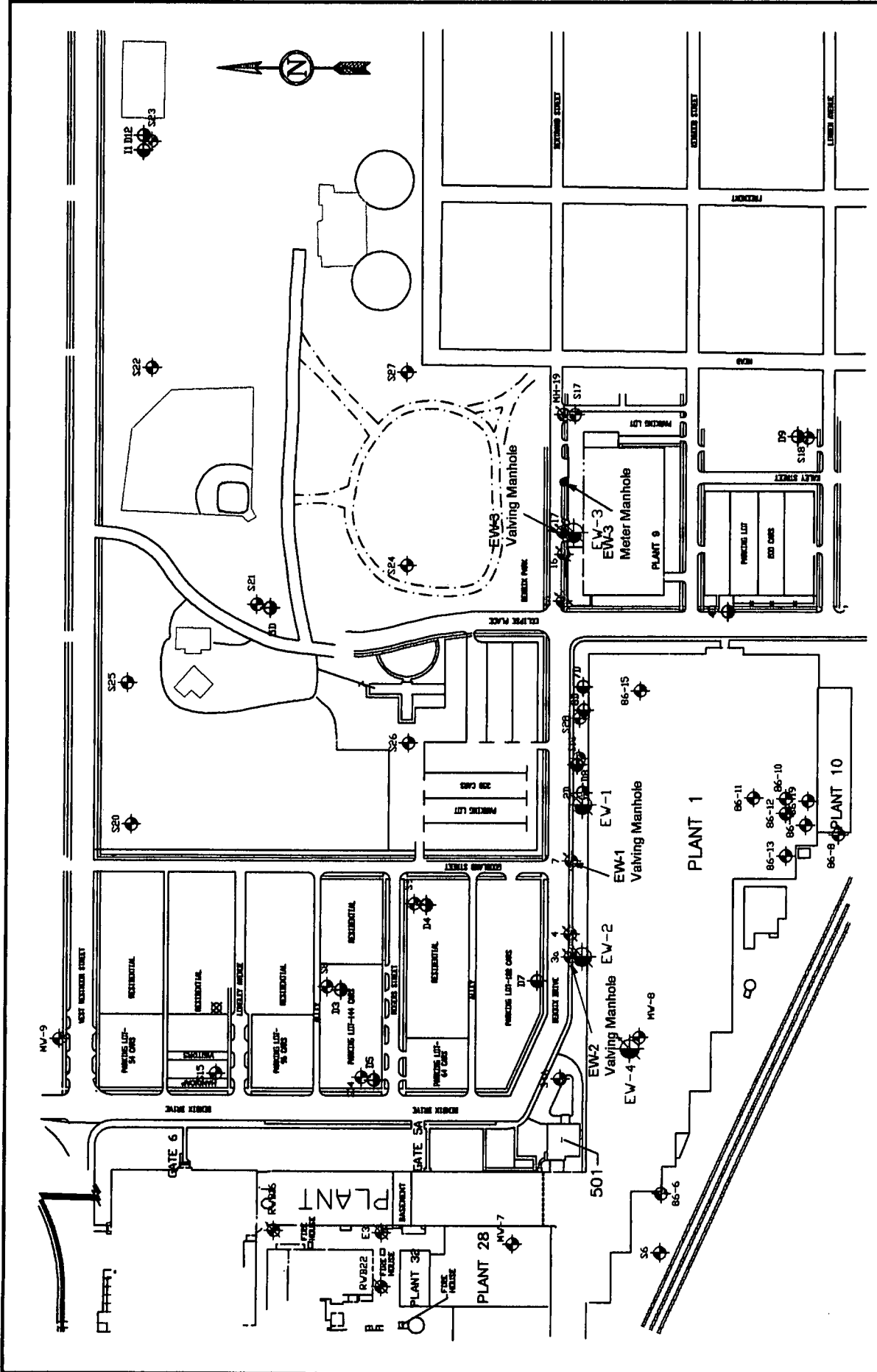


FIGURE 5
VOC RECOVERY WELL
SYSTEM LAYOUT
HONEYWELL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

NOT TO SCALE

Harding ESE 48850 Magellan Drive, Suite 190
 Novi, MI 48377
 248-926-4008

A MACTEC COMPANY

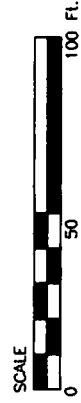
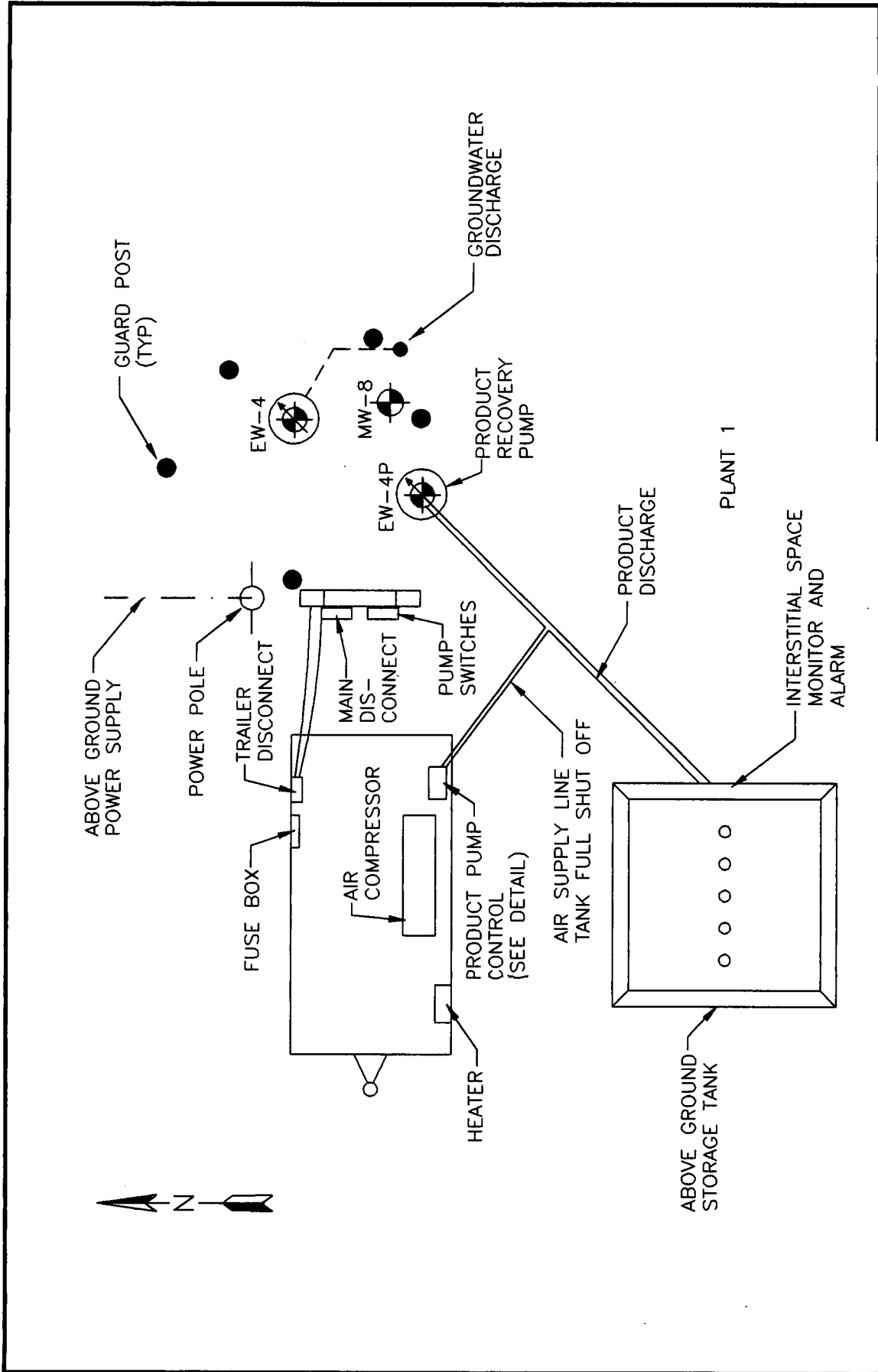
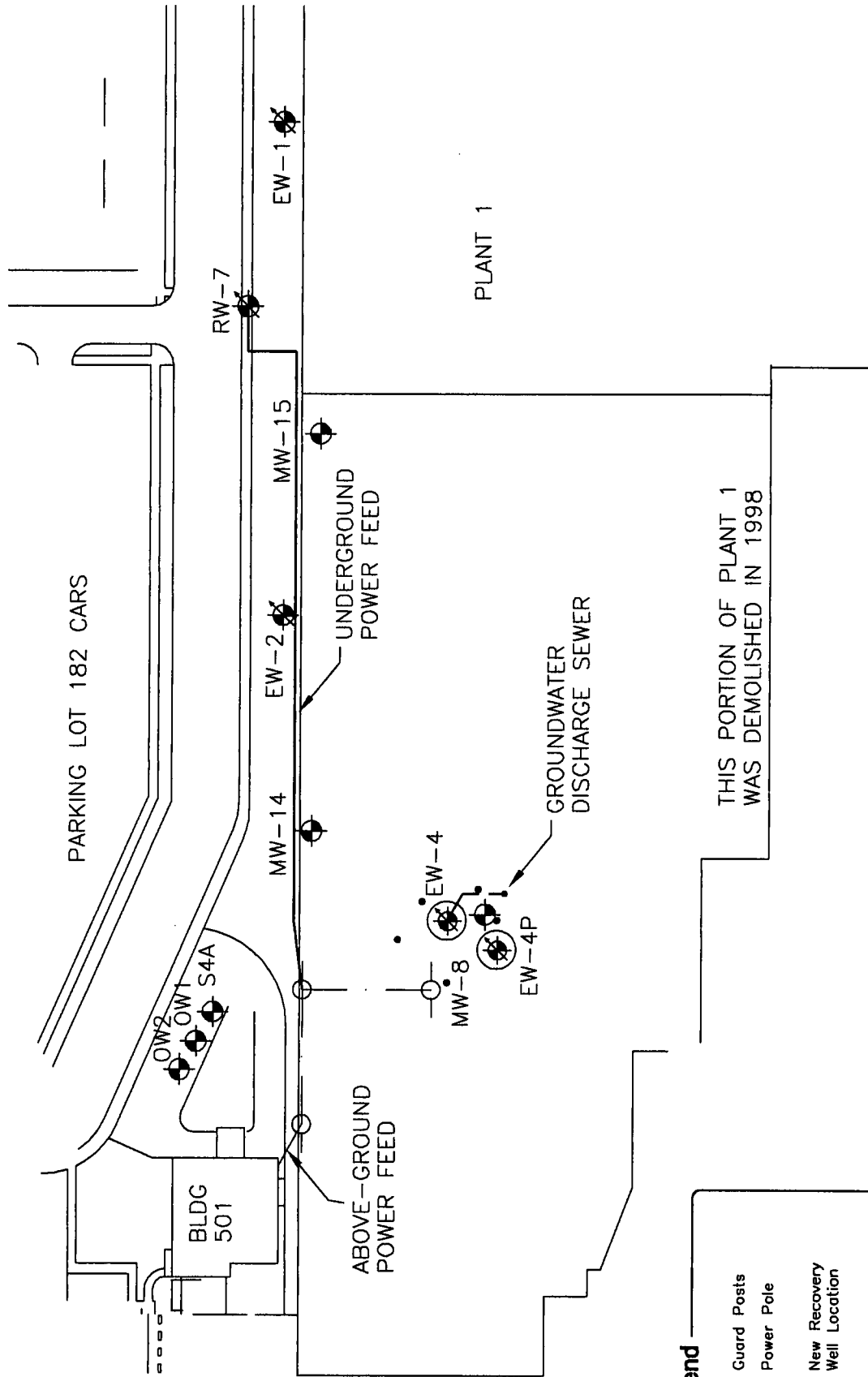


FIGURE 6
EW-4 PRODUCT RECOVERY
SYSTEM LAYOUT
HONEYWELL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

Harding ESE
 A MACTEC COMPANY

46850 Magellan Drive, Suite 190
 Novi, MI 48377
 248-926-4008



Legend

- Guard Posts
- Power Pole
- EW-4 New Recovery Well Location
- MW-8 Shallow Monitoring Well Location
- EW-4 VOC Extraction Well Location
- Underground Power Supply Line
- Aboveground Power Supply Line

NOTE: RW-7 Manhole Contains EW-1 Pump Controls.

FIGURE 7
UPDATED VOC RECOVERY WELL
SYSTEM ELECTRICAL LAYOUT
HONEYWELL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

Harding ESE
 A MACTEC COMPANY

46850 Magellan Drive, Suite 190
 Novi, MI 48377
 248-926-4008

Table 2
VOCs Recovery Well Systems Construction and Operation Data
Honeywell Industrial Complex - South Bend, Indiana

DESCRIPTION	Well Designations			
	EW-1	EW-2	EW-3	EW-4 Dual Well System
Depth to Static Water Level (feet below grade)	13.74	13.34	13.86	14.6
Type of Electric Submersible Pump	2 hp, Grundfos 40S 460V, 3-phase **	1.5 hp, Grundfos 40S 460V, 3-phase	0.5 hp, Grundfos 7S 460V, 3-phase	1.5 hp, Grundfos 40S 460V, 3-phase
Target Pumping Rate (gallons per minute)	30	20	9	45
Discharge Line Pressure Before Gate Valve (p.s.i.)	35	30	20	22
Depth to Pump Intake (feet below grade)	26	23	23.5	27
Well ID (inches)	6	6	6	6
Depth to Bottom of Well (feet below grade)	60	47	31	49
Depth to Top of Well Screen (feet below grade)	28	25	24	29
				14.6
				na
				na
				variable
				6
				23
				13

Notes: EW-1, EW-2, EW-3 and EW-4 have black iron riser pipes.

hp = Horse Power.

p.s.i. = pounds per square inch.

** = When pump is in need of replacement smaller pump (1.5 hp Grundfos 40S15-5) is recommended.
 VOC recovery system total discharge limit is 107 gallons per minute (0.154 million gallons per day).

Table 3
Groundwater Sample Collection Summary
Groundwater Monitoring Program
Honeywell Industrial Complex - South Bend, Indiana

Well No.	Well Depth (feet)	March Event	June Event	September Event	December Event	Sampling Method
Shallow Monitoring Wells						
7-25	26.6		X		X	Stainless -Steel Bailer
86-2	28.3					
86-4	23.8					
86-5	30.1					
86-6	25.9					
86-7	27.2					
86-8	28.5					
86-9	26.8					
86-10	27.1		X		X	Dedicated PVC Bailer
86-11	27.0					
86-12	25.4					
86-13	28.8					
86-15	25.3		X		X	Dedicated PVC Bailer
86-19	28.1					
9-33	27.3		X		X	Stainless-Steel Bailer
MW-1	25.3					
MW-2	15.4		X		X	Disposable Bailer
MW-3	17.2					
MW-4	21.0		X		X	Disposable Bailer
MW-5	20.8		X		X	Disposable Bailer
MW-6	18.0					
MW-7	18.2					Disposable Bailer
MW-8	19.0					
MW-9	19.8		X		X	Disposable Bailer
MW-10	19.4		X		X	Disposable Bailer
MW-11	21.7		X		X	Disposable Bailer
MW-12	13.8		X		X	Disposable Bailer
MW-13	18.8		X		X	Disposable Bailer
MW-14	25.0					
MW-15	24.8					
OW-1	37.4					
OW-2	35.0					
S1	35.6					
S3	24.6		X		X	Bladder Pump
S4A	31.6		X		X	Bladder Pump
S5	33.0					
S6	32.4					
S8	22.6					
S9	21.1		X		X	Disposable Bailer
S12	30.0					
S14	20.2					
S15	22.0		X		X	Disposable Bailer
S16	21.5		X		X	Dedicated PVC Bailer
S17	24.8		X		X	Bladder Pump
S18	32.4					
S19	36.4					
S20	18.8		X		X	Bladder Pump
S21	23.4		X		X	Bladder Pump
S22	26.0		X		X	Bladder Pump
S23	28.2		X		X	Bladder Pump
S24	21.4		X		X	Bladder Pump
S25	26.8		X		X	Bladder Pump
S26	26.9					
S27	27.9		X		X	Bladder Pump
S28	23.5					
Intermediate Monitoring Wells (50 - 75 feet)						
7-50	50.0		X		X	Dedicated PVC Bailer
8D	59.5		X		X	Bladder Pump
D8	61.9					
I1	47.6					

Table 3
Groundwater Sample Collection Summary
Groundwater Monitoring Program
Honeywell Industrial Complex - South Bend, Indiana

Well No.	Well Depth (feet)	March Event	June Event	September Event	December Event	Sampling Method
Deep Monitoring Wells (75 - 210 feet)						
D3	133.1					
D4	118.6					
D5	186.8		X		X	Bladder Pump
D7	78.4		X		X	Bladder Pump
D9	96.9					
D12	147.1					
1D	208.6					
2D	188.3		X		X	Bladder Pump
3D	196.9					
4D	192.7					
5D	192.2		X		X	Bladder Pump
7D	95.1		X		X	Bladder Pump
Recovery Wells						
Former VOC System:						
RW-3	30.7					
RW-4	24.4					
RW-7	21.6					
RW-14	28.8					
RW-16	22.1					
RW-17	28.8					
Naphtha System:						
E3	36.0	X	X	X	X	Spigot
RWB6	29.4					
RWB16	23.6	X	X	X	X	Spigot
RWB21	29.5					
RWB22	36.0	X	X	X	X	Spigot
RWB23	49.8	X	X	X	X	Spigot
VOC System:						
EW-1	56.3	X	X	X	X	Spigot
EW-2	43.2	X	X	X	X	Spigot
EW-3	30.6	X	X	X	X	Spigot
EW-4	49.0	X	X	X	X	Spigot

Note: Groundwater level measurements taken from each monitoring well and recovery well location listed above. QA/QC samples are collected at a frequency of one duplicate for every 10 samples. In addition, one sampler blank and one trip blank are collected for each VOC shipment.

Table 4
Rationale for Groundwater Sampling Locations
Groundwater Monitoring Program
Honeywell Industrial Complex - South Bend, Indiana

Well Number	Water Level Measurement	Groundwater Sampling	Purpose for Groundwater Sampling
Monitoring Wells in the Shallow Flow System			
7-25	✓	✓	Perimeter well -groundwater quality at leading edge of plume
7-50	✓	✓	Perimeter well -groundwater quality at leading edge of plume
9-33	✓	✓	Perimeter well -groundwater quality at leading edge of plume
86-1			Well abandoned
86-2	✓		
86-4	✓		
86-5	✓		
86-6	✓		
86-7	✓		
86-8	✓		
86-9	✓		
86-10	✓	✓	Interior Well - groundwater quality downgradient of Plant 10 Electroplating
86-11	✓		
86-12	✓		
86-13	✓		
86-15	✓	✓	Interior Well - groundwater quality downgradient of Plant 1 Degreasing Area
86-19	✓		
I-1	✓		
MW-1	✓		
MW-2	✓	✓	Interior well - groundwater quality downgradient of Transporation Area
MW-3	✓		
MW-4	✓	✓	Interior well - groundwater quality downgradient of Plant 12 Former Chromium Anodizing Operation
MW-5	✓	✓	Interior well - groundwater quality downgradient of I-Beam Building
MW-6			Product in well
MW-7	✓	✓	Interior well - groundwater quality downgradient of Plant 28 - Painting/Degreasing
MW-8			Product in well
MW-9	✓	✓	Perimeter well -groundwater quality at leading edge of plume
MW-10	✓	✓	Interior well - groundwater quality downgradient of Transporation Area Maintenance Building
MW-11	✓		
MW-12	✓	✓	Interior well - groundwater quality downgradient of Area 3/11
MW-13	✓	✓	Perimeter well -groundwater quality at leading edge of plume replace well 8-27.
MW-14	✓		
MW-15	✓		
S1	✓		
S3	✓	✓	Perimeter well -groundwater quality at leading edge of plume
S4A	✓	✓	Interior well - monitoring effectiveness of Naphtha/VOC Recovery Systems
S5	✓		
S6	✓		
S8	✓		
S9	✓	✓	Interior well - groundwater quality in off-site portion of VOC plume
S12	✓		
S14	✓		
S15	✓	✓	Interior well - groundwater quality in off-site portion of VOC plume
S16	✓	✓	Interior well - monitor effectiveness of VOC recovery system
S17	✓	✓	Interior well - monitor effectiveness of VOC recovery system
S18	✓		
S19	✓		

Table 4
Rationale for Groundwater Sampling Locations
Groundwater Monitoring Program
Honeywell Industrial Complex - South Bend, Indiana

Well Number	Water Level Measurement	Groundwater Sampling	Purpose for Groundwater Sampling
Monitoring Wells in the Shallow Flow System (continued)			
S20	✓	✓	Perimeter well -groundwater quality at leading edge of plume
S21	✓	✓	Interior well - groundwater quality in off-site portion of VOC plume
S22	✓	✓	Perimeter well -groundwater quality at leading edge of plume
S23	✓	✓	Perimeter well -groundwater quality at leading edge of plume
S24	✓	✓	
S25	✓	✓	Perimeter well -groundwater quality at leading edge of plume
S26	✓	✓	Interior well - groundwater quality in off-site portion of VOC plume
S27	✓	✓	Interior well - groundwater quality in off-site portion of VOC plume
S28	✓		
8D	✓		
D8	✓	✓	Interior well - monitor effectiveness of VOC recovery system on deeper portion of shallow flow system
Monitoring Wells in the Deep Flow System			
1D	✓		
2D	✓	✓	Interior well - confirm that VOC concentrations in the deep plume remain stable or are decreasing
3D	✓		
4D	✓	✓	Perimeter well - ensure that deep VOC plume is not spreading laterally
5D	✓	✓	Perimeter well - ensure that deep VOC plume is not spreading downgradient
7D	✓	✓	Interior well - confirm that VOC concentrations in the deep plume remain stable or are decreasing
D3	✓		
D4	✓		
D5	✓	✓	Perimeter well - ensure that deep VOC plume is not spreading laterally
D7	✓	✓	Interior well - confirm that VOC concentrations in the deep plume remain stable or are decreasing
D9	✓		
D10			Well abandoned
D12	✓		
Naphtha Recovery Wells			
E3	✓	✓	Meet POTW permit requirements
RWB16	✓	✓	Meet POTW permit requirements
RWB22	✓	✓	Meet POTW permit requirements
RWB23	✓	✓	Meet POTW permit requirements
VOC Recovery Wells			
EW-1	✓	✓	Meet POTW permit requirements
EW-2	✓	✓	Meet POTW permit requirements
EW-3	✓	✓	Meet POTW permit requirements
EW-4	✓	✓	Meet POTW permit requirements
Former VOC Recovery Wells			
RW-4	✓		
RW-7	✓		
RW-14	✓		
RW-16	✓		
RW-17	✓		

Table 5
Groundwater Analysis Summary
Groundwater Monitoring Program
Honeywell Industrial Complex - South Bend, Indiana

Event (Month)	Sample Description	Analytical Parameters	Analytical Methods	Handling, and Preservative Requirements						
1st Quarter (March)	Active Groundwater Extraction Wells	Volatile Organic Compounds *	SW-846 8260	(2) 40 ml glass vial w/HCL						
2nd Quarter (June)	Select Monitoring Wells	Volatile Organic Compounds	SW-846 8260	(2) 40 ml glass vial w/HCL						
					Metals (Cr, Pb, Ni), Dissolved	(1) 500 ml plastic bottle, field filtered, w/HNO3				
							Cyanide, Total	(1) 500 ml plastic bottle w/NaOH		
									Phenols, Total	(1) 1L amber glass
3rd Quarter (September)	Active Groundwater Extraction Wells	Volatile Organic Compounds *	SW-846 8260	(2) 40 ml glass vial w/HCL						
					Metals (Cr, Pb, Ni), Total *	(1) 500 ml plastic bottle w/HNO3				
							Cyanide, Total *	(1) 500 ml plastic bottle w/NaOH		
									Phenols, Total *	(1) 1L amber glass
4th Quarter (December)	Active Groundwater Extraction Wells	Volatile Organic Compounds	SW-846 8260	(2) 40 ml glass vial w/HCL						
					Volatile Organic Compounds	(2) 40 ml glass vial w/HCL				
							Volatile Organic Compounds *	(2) 40 ml glass vial w/HCL		
									Metals (Cr, Pb, Ni), Total *	(1) 500 ml plastic bottle w/HNO3
	Phenols, Total *	(1) 1L amber glass								

- Notes:**
- * - Required by Wastewater Discharge Permit.
 - pH, conductivity, and temperature are also required to be reported quarterly.
 - Required Quality Control samples include 10 percent duplicates, and one trip blank with each cooler shipment containing VOC samples.
 - Equipment blanks will be collected at a frequency of 10 percent on non-dedicated sampling equipment (i.e., small diameter stainless steel bailer).
 - Matrix spike/matrix spike duplicates samples do not require designation by sampling team with current Laboratory.

APPENDIX A
GROUNDWATER DEPRESSION WELL SYSTEMS –
COMPONENT MANUFACTURER CUT SHEETS

WELL PUMP

MAKE: GRUNDFOS

MODEL: 40S15-5

HORSE POWER:

VOLTAGE: 460

PHASE: 3

DROP PIPE SIZE: 2"

DROP PIPE TYPE: PVC SCHEDULE 80 T& C

PUMP SETTING DEPTH: 28.0'

WIRE SIZE: 12-3 WITH GROUND TWISTED

PITLESS MAKE: MERRILL/MAASS

Performance Curves

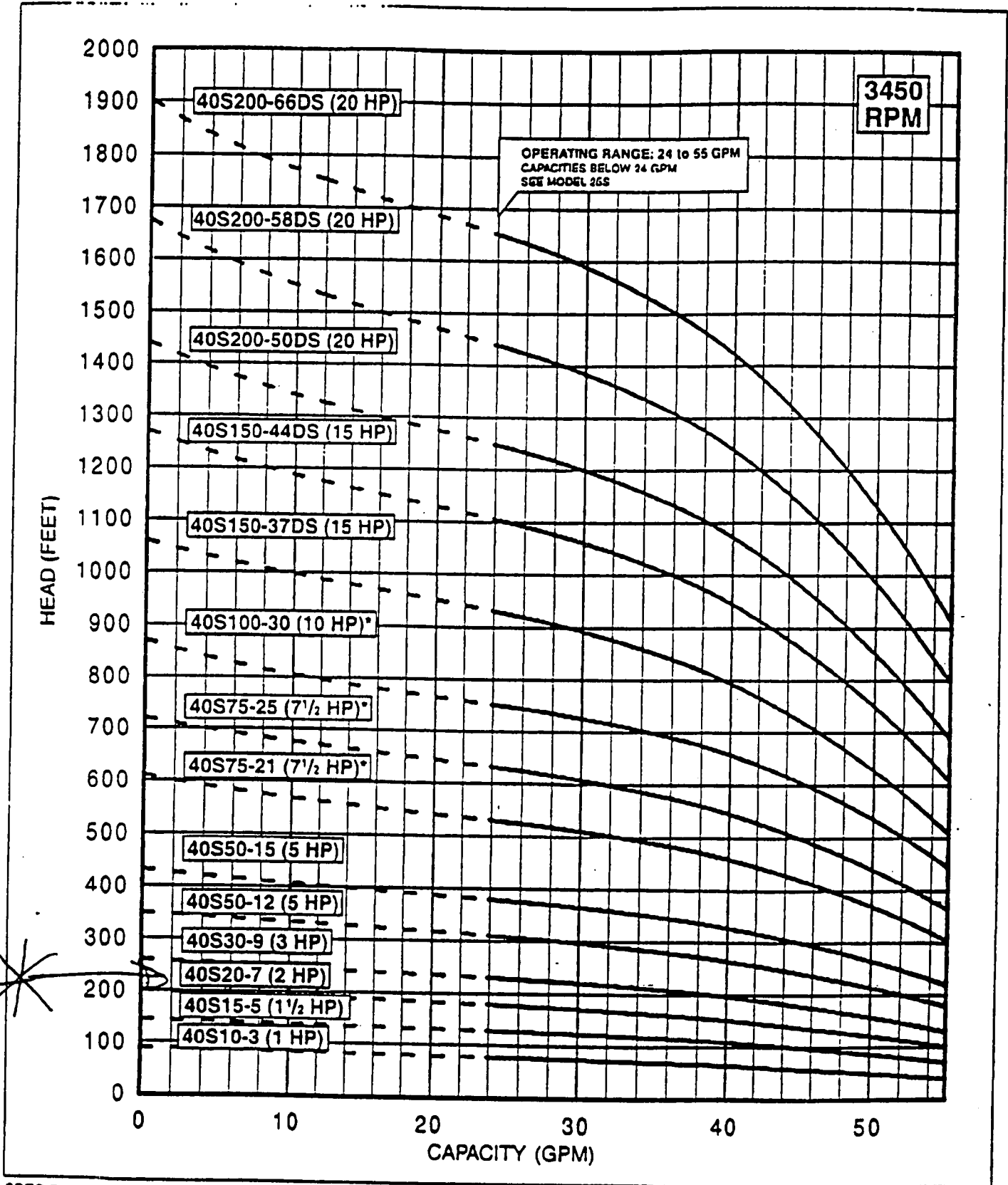
40 GPM

Model 40S

FLOW RANGE: 24 - 55 GPM

OUTLET SIZE: 2" NPT

NOMINAL DIA. 4"



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

4" MOTOR STANDARD, 1-10 HP/3450 RPM.

6" MOTOR STANDARD, 15-20 HP/3450 RPM.

* Also available with 6" motor.

Performance conforms to ISO 2548 Annex B

⊕ 5 ft. min. submergence.

GRUNDFOS

7 GPM

**MODEL
7S**

SELECTION CHARTS

(Ratings are in GALLONS PER HOUR - GPH)

FLOW RANGE
3 to 10 GPM

PUMPOUTLET
1" NPT

PUMP MODEL	HP	PSI	DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																								
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	340	400	480	520	600	700	800	900	1000	1100
7S03-8	1/2	0				581	537	484	447	401	328	258															
		20	602	669	624	480	432	385	302	219	110																
		30	659	518	473	427	387	308	154																		
		40	511	488	417	387	271	176	87																		
		50	458	412	348	280	140																				
		60	400	348	236	122																					
Shut-off PSI:			86	77	69	60	52	43	34	26	17	8															
7S05-11	1/2	0				593	668	538	504	470	437	400	382	301	239												
		20			685	558	528	484	480	427	387	348	278	210	105												
		30	807	583	552	522	488	465	420	385	333	281	172														
		40	577	549	618	483	450	416	374	333	255	178	89														
		50	543	511	478	445	408	372	315	258	129																
		60	506	473	439	405	380	316	228	140																	
Shut-off PSI:			122	113	105	98	87	79	70	61	53	44	35	27	18	10											
7S07-15	3/4	0						810	591	572	549	526	501	477	453	428	401	336	172								
		20				605	585	585	542	518	484	470	445	420	392	384	324	214									
		30			801	583	581	538	614	490	468	441	415	390	358	323	268	107									
		40		599	579	558	534	511	487	482	437	412	383	354	311	287	191	57									
		50	585	576	554	531	507	483	458	434	407	381	345	310	250	191	85										
		60	572	551	527	503	479	455	429	404	374	343	208	249	188	82											
Shut-off PSI:			170	161	153	144	135	127	118	110	101	92	84	75	66	58	49	32	0								
7S10-19	1	0								608	590	575	557	540	521	502	482	444	382	290							
		20						801	588	570	552	534	515	496	478	457	438	398	319	170							
		30					598	584	587	549	531	512	493	474	454	435	414	389	276	84							
		40				587	581	564	548	528	509	490	470	451	431	412	389	338	220								
		50		609	594	578	561	544	525	506	487	468	448	429	408	387	361	299	146								
		60	808	582	578	559	541	522	503	484	465	445	425	405	382	358	328	240									
Shut-off PSI:			218	209	200	192	183	174	166	157	148	140	131	123	114	105	97	79	53	27							
7S15-26	1 1/2	0											800	590	578	566	553	539	526	498	456	412	363	285			
		20											599	588	578	563	551	537	524	510	482	439	394	340	224		
		30							808	597	588	574	562	548	535	521	508	493	485	423	375	314	173				
		40							608	596	584	572	560	547	533	519	505	491	477	449	405	353	282	111			
		50						805	584	583	570	558	544	531	517	503	488	475	461	432	387	328	244				
		60																									
Shut-off PSI:			274	265	257	248	239	231	222	213	205	196	187	179	161	135	110	84	49								

Post-It® Fax Note 7671

Date 7-31-98 # of pages 3

To *Don Walsh* From *C. Lent*

Co./Dept. *Harding/Lawson* Co. *Peerless Midwest*

Phone # Phone #

Fax # *1-248-489-8048* Fax #

Model 40S

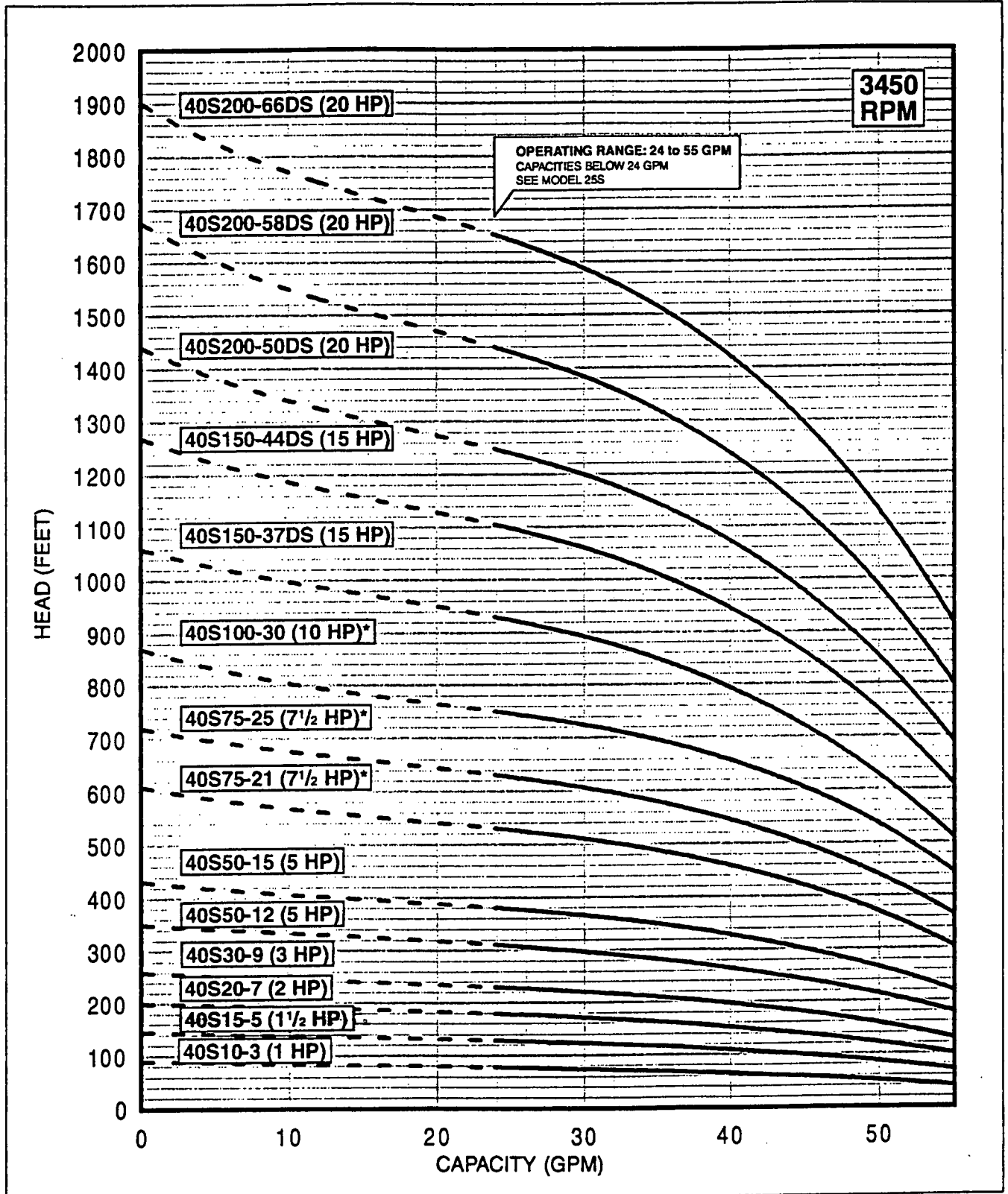
40 GPM

Performance Curves

FLOW RANGE: 24 - 55 GPM

OUTLET SIZE: 2" NPT

NOMINAL DIA. 4"



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 1-10 HP/3450 RPM.
6" MOTOR STANDARD, 15-20 HP/3450 RPM.
* Also available with 6" motor.

Performance conforms to ISO 2548 Annex B
@ 5 ft. min. submergence.



DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES					APPROX. SHIP WT.
					A	B	C	D	E	
40S10-3	A	1	4"	2" NPT	24.6	11.8	12.8	3.8	3.9	32
40S15-5	A	1 1/2	4"	2" NPT	29.7	13.6	16.1	3.8	3.9	37
40S20-7	A	2	4"	2" NPT	34.5	15.1	19.4	3.8	3.9	41
40S30-9	A	3	4"	2" NPT	43.3	20.6	22.7	3.8	3.9	65
40S50-12	A	5	4"	2" NPT	51.3	23.6	27.7	3.8	3.9	78
40S50-15	A	5	4"	2" NPT	56.2	23.6	32.6	3.8	3.9	84
40S75-21*	A	7 1/2	4"	2" NPT	74.6	29.6	45.0	3.8	5.4	120
40S75-25*	A	7 1/2	4"	2" NPT	81.2	29.6	51.6	3.8	5.4	124
40S100-30*	A	10	4"	2" NPT	103.7	43.9	59.8	3.8	5.4	181
40S150-37DS	A	15	6"	2" NPT	99.5	28.0	71.5	5.4	5.4	244
40S150-44DS	A	15	6"	2" NPT	111.0	28.0	83.0	5.4	5.4	340
40S200-50DS**	B	20	6"	2" MPT	136.0	30.6	105.4	5.4	5.5	319
40S200-58DS**	B	20	6"	2" MPT	149.2	30.6	118.6	5.4	5.5	334
40S200-66DS**	B	20	6"	2" MPT	162.4	30.6	131.8	5.4	5.5	394

NOTES: All models suitable for use in 4" wells, unless otherwise noted.

Weights include pump end with motor in lbs.

* Also available with 6" motor.

** Built into sleeve 2" MPT discharge, 6" min. well dia.

MATERIALS OF CONSTRUCTION

COMPONENT	CYLINDRICAL SHAFT (3-44 Stgs.)	DEEP SET (50-66 Stgs.)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel
Pump Shaft	431 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel
Priming Inducer	316 Stainless Steel	316 Stainless Steel
Coupling	329/420/431 Stainless Steel **	329/416 Stainless Steel
Check Valve Seat	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Intermediate Bearings	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Shaft Washer	LCP (Vectra®)	LCP (Vectra®)
Split Cone	304 Stainless Steel	304 Stainless Steel
Split Cone Nut	304 Stainless Steel	304 Stainless Steel
Sleeve	Not Required	316 Stainless Steel
Sleeve Flange	Not Required	Zinless Bronze*
Coupling Key	Not Required **	302/304 Stainless Steel

NOTES: Specifications are subject to change without notice.

Vectra ® is a registered trademark of Hoechst Calanese Corporation.

*Stainless Steel option available.

** If using 6" non-standard motors, refer to 416 Stainless Steel for coupling and 302/304 for the coupling key.

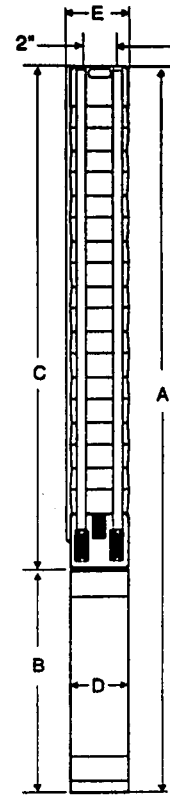


Fig. A

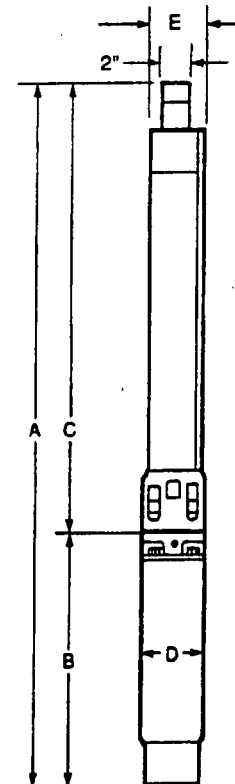


Fig. B

GRUNDFOS

GRUNDFOS PUMPS CORPORATION • 2555 Clovis Avenue • Clovis, CA • 93612
 Area Centers: Allentown, PA • Atlanta, GA • Chicago, IL • Clovis, CA • Dallas, TX • Seattle, WA
 (800) 333-1366 • FAX (800) 333-1363
 Canada: Mississauga, Ontario • Mexico: Apodaca, N.L.

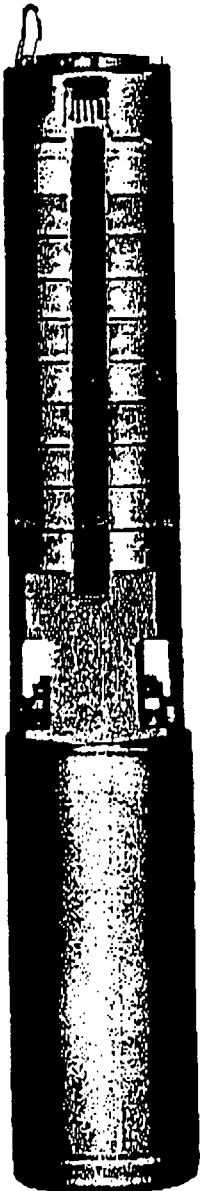
LSP-TL-1040 6/96
 PRINTED IN USA

**MODEL
7S**

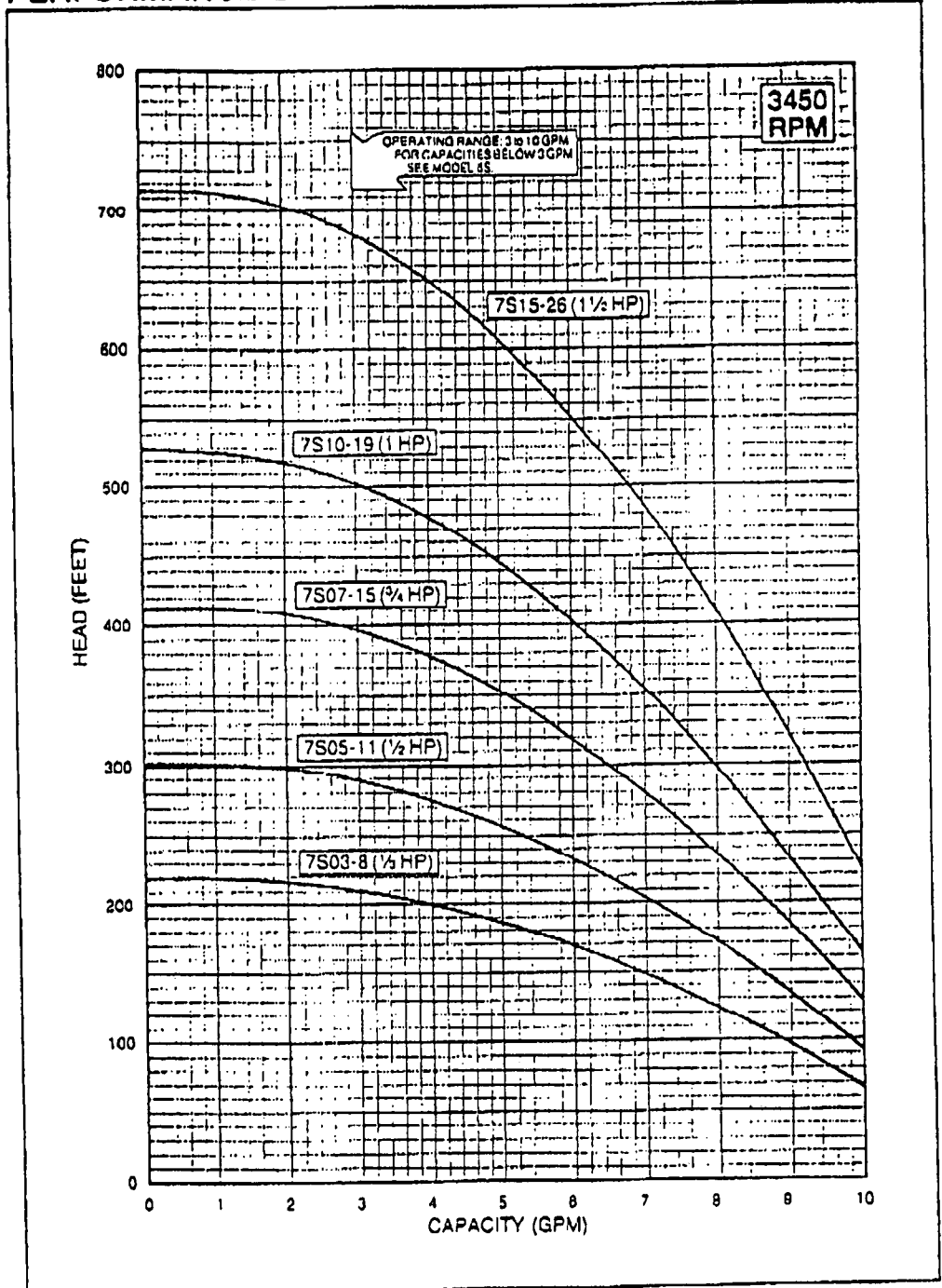
7 GPM

GRUNDFOS

FLOW RANGE
3 to 10 GPM
PUMP OUTLET
1" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
7S03-8	1/8	23 1/2	3 3/4	27
7S05-11	1/2	26 7/8	3 3/4	30
7S07-15	3/4	30 3/4	3 3/4	33
7S10-19	1	34 5/8	3 3/4	36
7S15-26	1 1/2	42	3 3/4	46

Specifications are subject to change without notice.

RED BRASS PITLESS ADAPTERS

QUALITY FEATURES/BENEFITS

- Brass male part of adapter is tapered. BENEFIT: Easy connection of female and male parts.
- Brass female part is also tapered. BENEFIT: Tight connection and easy removal.
- Replaceable O-ring seal in solid brass casting. BENEFIT: Easily replaced not a seal from factory only.
- Molded gasket for positive outside seal on discharge, plus O-ring or gasket glued in place, for seal on inside of casing. BENEFIT: Glued gasket does not fall off during installation.
- Solid brass collar made for perfect fit and positive seal between molded gasket to discharge and outside of casing. BENEFIT: Insures sanitary watertight seal to casing.
- Extra-wide solid brass nut. BENEFIT: To accommodate wrench for easier installation.

ONLY MERRILL STILL OFFERS HEAVY WEIGHT CASTINGS WITH THE QUALITY YOU NEED AT PRICES YOU WANT.

ORDER NO.	UPC BAR CODE (QTY. 1)	DROP & DISCHARGE	DISCHARGE LENGTH	CASING SIZES	WILL* SUPPORT	HOLE SAW	APPROX. WT./LBS.	CARTON QTY.	MODEL SERIES
MB50	6 42367 01799 6	1" (Brass)	1.8" (Long Model)	5" - 8"	300'	1 3/4"	2.4	4	IMPORTED 50 SERIES
MB200	6 42367 01797 2	1" (Brass)	1.8" (Long Model)	5" - 8"	400'	1 3/4"	2.8	4	IMPORTED 200 SERIES
MB1100	6 42367 04294 3	1"	1.8" (Long Model)	5" - 8"	400'	1 3/4"	3.0	4	IMPORTED 200 SERIES
MB225	6 42367 01798 9	1 1/4" (Brass)	1.8" (Long Model)	5" - 8"	300'	2 1/4"	4.6	2	IMPORTED 200 SERIES
MB1125	6 42367 04179 3	1 1/4"	1.8" (Long Model)	5" - 8"	300'	2 1/4"	5.0	2	IMPORTED 200 SERIES
MB60 (DPM No. 002 1/2 B)	6 42367 04271 4	1"	1.8" (Long Model)	5" - 8"	300'	1 3/4"	2.6	15	MERRILL-USA 60 SERIES
MB100 (DPM No. 002B)	6 42367 01791 0	1"	1.8" (Long Model)	5" - 8"	400'	1 3/4"	3.2	1	MERRILL-USA 100 SERIES
MB100N (No outside thread)	6 42367 04307 0	1"	1.8" (Long Model)	5" - 8"	400'	1 3/4"	2.5	1	MERRILL-USA 100 SERIES
MBP100	6 42367 01825 2	1" ILL CODE	1.8" (Long Model)	5" - 8"	400'	1 3/4"	3.2	12	MERRILL-USA 100 SERIES
MB125	6 42367 01794 1	1 1/4"	1.8" (Long Model)	5" - 8"	300'	2 1/4"	5.0	2	MERRILL-USA 100 SERIES
MB125N (No outside thread)	6 42367 04308 7	1 1/4"	1.8" (Long Model)	5" - 8"	300'	2 1/4"	3.8	2	MERRILL-USA 100 SERIES
MBP125	6 42367 01828 9	1 1/4" ILL CODE	1.8" (Long Model)	5" - 8"	300'	2 1/4"	5.0	12	MERRILL-USA 100 SERIES
MHB100 (DPM No. 001B)	6 42367 01883 2	1" HEAVY DUTY	1.8" (Long Model)	5" - 12"	800'	1 13/16"	5.7	1	MERRILL HEAVY DUTY SERIES
MHB125 (DPM No. 003B)	6 42367 01884 9	1 1/4" HEAVY DUTY	1.8" (Long Model)	5" - 12"	700'	2 1/4"	6.3	1	MERRILL HEAVY DUTY SERIES
MHB300 (DPM No. 004B)	6 42367 01885 6	2" HEAVY DUTY	1.7" (Long Model)	6" - 12"	600'	2 7/8"	12.5	1	MERRILL HEAVY DUTY SERIES
MHB400 (DPM No. 005B)	6 42367 01888 3	1 1/4" x 1" HEAVY DUTY	1.7" (Long Model)	5" - 8"	N/A	HOLE GUIDE	9.7	1	MERRILL HEAVY DUTY SERIES

* When properly installed, MERRILL PITLESS ADAPTERS will support a length of schedule 40 steel pipe full of water and pump indicated in table above. Other companies may claim more support - but have little or no safety factor.



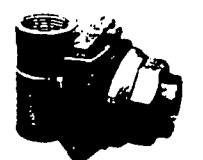
MB50



MB200/MB1100



MB225/MB1125



MB100



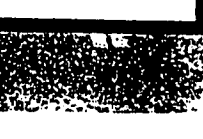
MBP100



MHB100



MHB300



MHB400

RED BRASS PITLESS ADAPTER PARTS

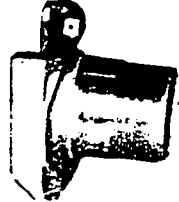
Merrill Brass Pitless Adapters have passed CERTIFIED WATERTIGHT STANDARDS PAS-1 established and regulated for the industry by the Pitless Adapter Division of Water System Council.



MALE PART



MALE PART O-RING



FEMALE PART



FEMALE PART O-RING



GASKET



COLLAR



NUT

MODEL NO.	MB50	MB200	MB1100	MB225	MB1125	MB60	MB100	MB125	MHB100	MHB125	MHB300	MHB400
PART NO.	MBM50	MBM20	MBIM10	MBM22	MBIM12	MBM60	MBM10	MBM12	MHM10	MHM12	MHM30	MHM40
APPROX. WT./LBS.	.96	1.17	1.23	2.01	2.06	1.09	1.23	2.06	2.33	2.59	5.54	3.82
UPC Bar	6 42367 04652 1	6 42367 04653 8	6 42367 04654 5	6 42367 01817 7	6 42367 01899 3	6 42367 01801 3						
Code (Qty. 1)	6 42367 01819 1	6 42367 01820 7	6 42367 04201 1	6 42367 01818 4	6 42367 01900 6	6 42367 01922 0						

MALE PART O-RING

PART NO.	OR222	OR326	OR326	OR326	OR326	OR222	OR326	OR326	OR326	OR327	OR332	OR326
APPROX. WT./LBS.	.004	.008	.008	.008	.008	.004	.008	.008	.008	.01	.012	(2) .008
UPC Bar	6 42367 06572 0	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7
Code (Qty. 1)	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7	6 42367 06573 7

PART NO.	MBF50	MBF20	MBIF10	MBF22	MBIF12	MBF60	MBF10	MBF12	MHF10	MHF12	MHF30	MHF40
APPROX. WT./LBS.	.91	1.09	1.04	1.74	1.81	.84	1.04	1.81	2.17	2.29	4.33	3.35
UPC Bar	6 42367 04658 3	6 42367 04659 0	6 42367 04660 6	6 42367 01604 7	6 42367 01891 7	6 42367 01893 1						
Code (Qty. 1)	6 42367 01806 1	6 42367 01807 8	6 42367 04204 2	6 42367 01805 4	6 42367 01892 4	6 42367 01934 8						

FEMALE PART O-RING

PART NO.	MBFG10	MBFR20	MBFR20	MBFR22	MBFR22	MBFG10	MBFR20	MBFR22	MBFR20	MBFG12	MBFG30	MBFG12
APPROX. WT./LBS.	.064	.020	.020	.022	.022	.064	.020	.022	.020	.033	.086	.033 Top .064 Bottom
UPC Bar	6 42367 01808 5	6 42367 01810 8	6 42367 03494 8	6 42367 01810 8	6 42367 01810 8	6 42367 01810 8	6 42367 01809 2	6 42367 06576 8	6 42367 01809 2	6 42367 01809 2	6 42367 01809 2	6 42367 01809 2
Code (Qty. 1)	6 42367 01810 8	6 42367 03494 8	6 42367 01808 5	6 42367 03494 8	6 42367 01808 5	6 42367 03494 8	6 42367 01809 2	6 42367 06576 8	6 42367 01809 2	6 42367 01809 2	6 42367 01809 2	6 42367 01809 2

PART NO.	MBG20	MBG20	MBG20	MBG22	MBG22	MBG20	MBG20	MBG22	MHG10	MBG22	MBFG30	MBFG12
APPROX. WT./LBS.	.032	.032	.032	.060	.060	.032	.032	.060	.032	.060	.086	.033 Top .064 Bottom
UPC Bar	6 42367 01815 3	6 42367 01815 3	6 42367 01816 0	6 42367 01815 3	6 42367 01815 3	6 42367 01895 5	6 42367 01816 0	6 42367 01816 0	6 42367 01816 0	6 42367 06576 8	6 42367 01808 5	6 42367 01808 5
Code (Qty. 1)	6 42367 01815 3	6 42367 01815 3	6 42367 01816 0	6 42367 01815 3	6 42367 01815 3	6 42367 01895 5	6 42367 01816 0	6 42367 01816 0	6 42367 01816 0	6 42367 06576 8	6 42367 01808 5	6 42367 01808 5

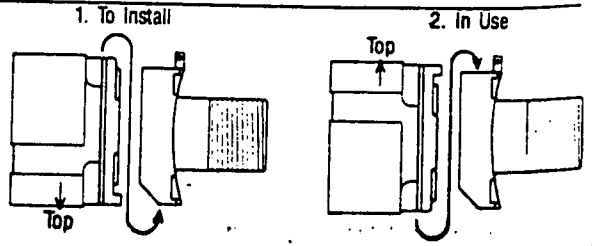
PART NO.	MBC20	MBC20	MBC10	MBC22	MBC12	MBC10	MBC10	MBC12	MHC10	MHC12	MHC30	MHC40
APPROX. WT./LBS.	.24	.24	.22	.34	.36	.22	.22	.36	.67	.73	1.20	1.16
UPC Bar	6 42367 01802 3	6 42367 01800 9	6 42367 01801 6	6 42367 01800 9	6 42367 01800 9	6 42367 01801 6	6 42367 01801 6	6 42367 01888 7	6 42367 01889 4	6 42367 01890 0	6 42367 01890 0	6 42367 01890 0
Code (Qty. 1)	6 42367 01802 3	6 42367 01800 9	6 42367 01801 6	6 42367 01800 9	6 42367 01800 9	6 42367 01801 6	6 42367 01801 6	6 42367 01888 7	6 42367 01889 4	6 42367 01890 0	6 42367 01890 0	6 42367 01890 0

PART NO.	MBN50	MBN20	MBIN10	MBN22	MBN12	MBN60	MBN10	MBN12	MHN10	MHN12	MHN30	MHN12
APPROX. WT./LBS.	.17	.23	.21	.46	.48	.20	.23	.48	.32	.52	.99	.52 Top .32 Bottom
UPC Bar	6 42367 04677 4	6 42367 04678 1	6 42367 01822 1	6 42367 01821 4	6 42367 01803 7	6 42367 01905 1	6 42367 01903 7	6 42367 01905 1	6 42367 01903 7	6 42367 01905 1	6 42367 01903 7	6 42367 01903 7
Code (Qty. 1)	6 42367 01823 8	6 42367 01824 5	6 42367 04206 6	6 42367 01822 1	6 42367 01803 7	6 42367 01905 1	6 42367 01822 1	6 42367 01903 7	6 42367 01905 1	6 42367 01903 7	6 42367 01903 7	6 42367 01903 7

NOTE:
For use with Concrete Tile -
no outside thread models.

- MB100N - MBM10 - MBR10 - MBF10N
- MB125N - MBM12 - MBR12 - MBF12N

NOTE: Merrill Pitless Adapters are designed for easier installation.



MODEL JX PITLESS UNITS

feature Maass non-rusting 304 s.s. and bronze

MODEL JX1 UNIT

Order JX1 units with thread end, plain end for welding, or compression coupling.

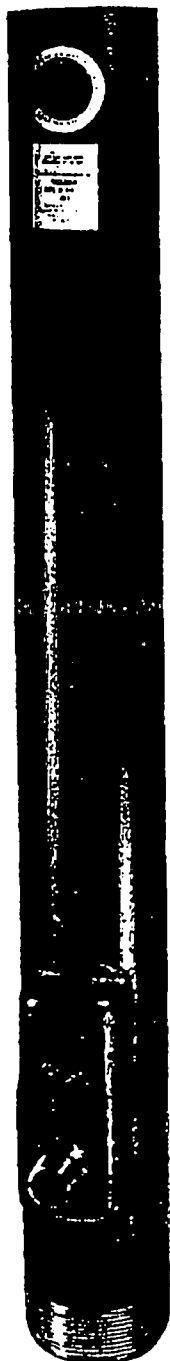
JX1 units, threaded or plain end, for 4", 5", 6", 7" O.D. and 8" and larger casing sizes, from one inch to four inch discharge. Discharges at any bury depth.

MODEL JX1-CC

Compression coupling end, Model CC, compression coupling available for 4 1/2" O.D. casing only.

MODELS JX and JXX

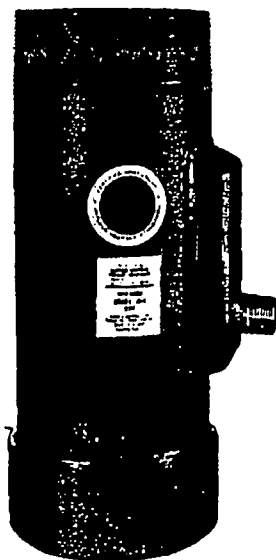
Units furnished with weld-on 1/2" coupling are standard.



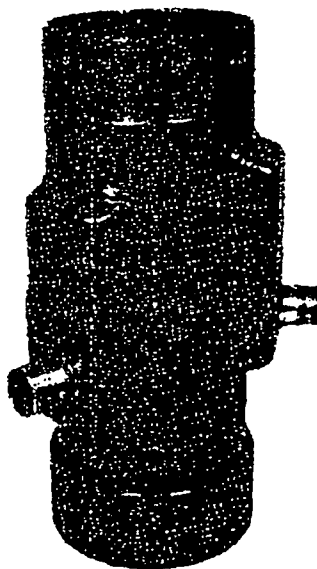
MODEL JX1
THREADED END



MODEL
JX1-CC
COMPRESSION
COUPLING



MODEL JX



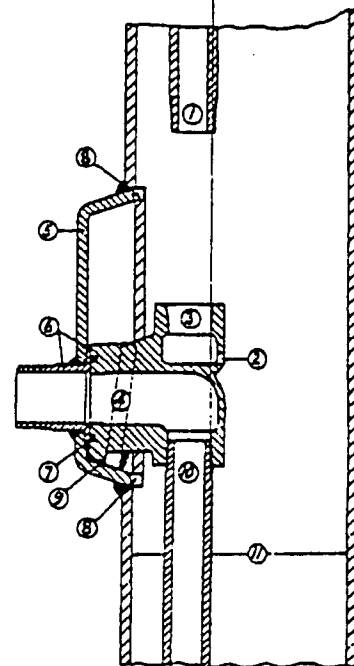
MODEL JXX

JX1 and JX Pitless Units are WISCONSIN STATE APPROVED for over 3-family dwellings, production of milk, food and public use.

Meets State of Missouri guidelines for public and semi-public installation.

New York State approved for public use.

Maass Pitless Units are made of schedule 40 pipe.



CROSS SECTION OF PITLESS

1. Removable drop pipe for installation or pulling pump.
2. Condensation drain from drop pipe cup.
3. Bronze casting threaded same as inlet and outlet of drop pipe.
4. Bronze casting held rigid by two 8 degree guides in housing.
5. Cast steel housing welded to well casing.
6. Stainless steel flange nipple non-magnetic 304 stainless steel eliminates electrolytic corrosion.
7. Neoprene O-ring seal.
8. Lock! Top and bottom housing lip sets into well casing for positive welding.
9. Angled seating lip eliminates condensation pockets.
10. Bronze casting holds pump pipe rigid and vertical for even strain on pipe threads.
11. Well casing. Note: No condensation crevice or pockets in pitless housing. No obstruction in well casing when bronze casting is removed.



MAASS
MANUFACTURING, INC.
MUSKEGO INDUSTRIAL PARK
S82 W19246 Apollo Drive
Muskego, WI 53150

SEE YOUR DISTRIBUTOR OR REPRESENTATIVE
FOR ADDITIONAL INFORMATION

PUMP STARTER

MAKE: FURNAS

MODEL: ESP 100

SIZE: NEMA

STARTER VOLTAGE: 460 VOLT

COIL VOLTAGE: 110 VOLT

Furnas

The Right Choice

Congratulations!

You have purchased the world's finest industrial motor starter—the Furnas ESP100. It's a state-of-the-art device offering extra starter performance by combining a rock-solid NEMA rated contactor with a solid state overload relay.

Development of ESP100 is based on years of research and experience in electronic, melting alloy and bimetal overload relays. The result is unprecedented motor protection.

This unique technology comes from our desire to provide you with the best possible control for heavy duty motor applications. This guide was written to help you take full advantage of the increased motor protection provided by ESP100—the first major advancement in NEMA rated starters in more than 20 years.

ESP100™

NEMA rated starter with a solid state overload for extra starter performance and even greater motor protection.

- Heaterless Construction
- True Phase Loss Protection
- 2:1 FLA Adjustment Range
- NEMA Sizes 0-6

Easily Replaces Sizes 0-1:

Cutler Hammer Allen Bradley
Square D Westinghouse
GE

Problem-Solving

... at a Glance

When the ESP100 Trips ...

When the 3 phase currents are balanced...

If trip is on start up...

If trip is during normal operation...

1. Check for proper class of overload. Class 20 is the recommended protection for most American motors (see below for more details).
2. Make sure load is not too heavy for motor to handle.
3. Adjustable frequency drives or DC injection (electronic) brakes will cause nuisance tripping.
4. The overload may be misadjusted (see below for the details).
5. Check for the correct overload adjustment when using the looping option. Multiply the FLA by the number of times the motor lead passes through the sensing window to determine the proper adjustment.

Always check for proper class of overload:

A key ingredient in protecting a motor is the selection of the class of overload relay for the acceleration time of the motor and its FLA (Full Load Amperage). An overload relay may trip before the motor accelerates to its full rated speed if starting current extends beyond the overload relay trip curve. Using a class of overload too fast to allow the motor to accelerate to full speed will cause nuisance tripping. Change to the correct class of overload relay (i.e. Class 10 instead of Class 20).

First, check amps in all 3 phases.

When the overload trips within 3 seconds on start up...

If there is current in 2 phases only...
If there is a severe phase imbalance...

6. Phase loss is in the motor branch circuit (the motor is single phased).
Restore 3 phase power.
7. Current is present in all 3 phases, but large differences (2:1) exist between the phases. This may indicate a loss of phase ahead of the motor branch circuit or a damaged motor.
Restore missing primary phase or repair/replace motor winding.

Tools needed:

Clamp-on ammeter, continuity checker and tools to tighten connections.

(For more detailed information, see following pages.)

When the overload is adjusted too low:

- A. ESP100 is very accurate, taking up to 6 or more clicks of the dial to cover the same range as one heater coil. Adjusting upward just one or two clicks may solve the problem.
- B. Some applications take advantage of the motor service factor, or a short load cycle versus a long unloaded cycle, to operate the motor at currents above the motor FLA. The NEC 430-34 allows an overload setting of up to 10% over motor FLA if the motor cannot be started or run at the motor FLA setting.

1. When ESP100 trips on startup

Various types of motors require different types of overload relays to provide adequate protection. There are three different levels of overload relay protection available. These levels are differentiated by the assignment of a trip "class" number as follows:

Class 20 is the designation assigned to a "standard trip" overload relay and is designed to protect standard industrial motors including T-frame motors. Most NEMA rated General Purpose motors will be protected by a Class 20 overload relay.

Class 10 or "quick trip" overload relays are designed to protect low thermal capacity motors. Examples would include motors used for hermetic refrigeration compressors, submersible pumps and similar applications.

Class 30 refers to "slow trip" overload relays which are designed to protect special motors driving high inertia loads (long start up times). Some examples include ball mills, reciprocating pumps, loaded conveyors, etc.

The time required for an overload relay to trip under locked-rotor (stalled) motor conditions is ideally the time that permits use of the available motor horsepower and starting torque. The overload must allow sufficient time for the motor and its load to accelerate to rated speed. Nuisance tripping occurs when an overload relay, or its adjustment, is selected that does not allow the motor to reach proper operating speed or performance ratings. This may cause the user to adjust the FLA upward, which will result in reduced protection.

Section 430-34 of the National Electric Code (NEC) permits a user to adjust the overload relay 10% higher than appropriate for the motor FLA, under certain conditions. These conditions include (a) when the properly adjusted overload relay trips before the motor can accelerate to its rated speed, and (b) provided the overload relay is adjusted no greater than 130% of motor FLA for service factor 1.0 motors, or not greater than 140% of motor FLA for motors with a service factor of 1.15. Rather than give up running protection by adjusting the FLA, a user should select a higher class of overload relay. This will provide more time for motor and load acceleration, yet retain the level of overload protection specified by the NEC. The graph (Fig. 1) illustrates the danger of an overload relay class that is too fast for its motor.

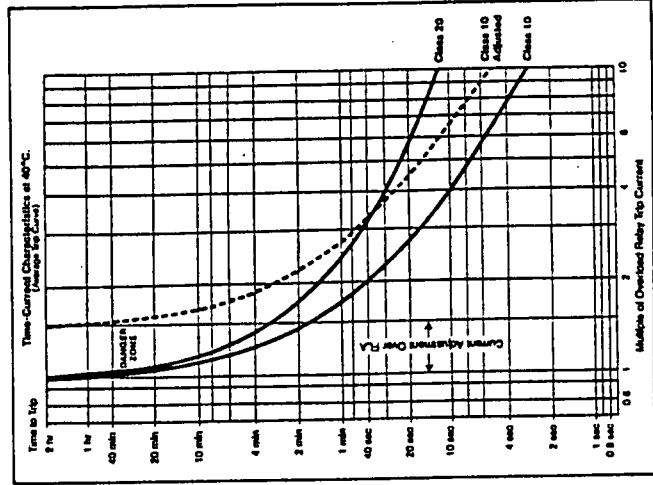


Fig. 1 Dangers of adjusting an overload relay above the FLA of the motor to prevent nuisance tripping on start up. Trip curve moves to the right and lessens or negates motor running protection.

2. Motor Overloaded

An electric motor is not capable of knowing when it is being worked too hard. If a load placed on a motor is too great, it will simply draw extra current and continue to handle the increased load. If this situation persists, it will eventually cause the overload to trip.

In contrast, temporary overloads may be handled easily if brief enough in duration to not cause overheating.

Typical overloading is caused by problems such as increased friction (bad bearings, poor lubrication, etc.), over feeding machinery (too heavy a cut, excess material, etc.) or too heavy a weight (conveyors, cranes, etc.).

The solution is to locate and remove the cause of the overload. The motor must also be allowed to cool down before a restart is attempted.

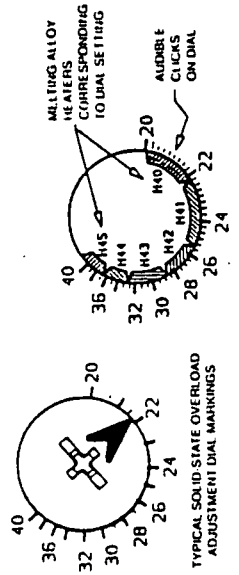
3. The ESP100 overload is rated 50/60 Hertz, AC only

Other frequencies will change the calibration of the overload relay and possibly cause nuisance tripping. A DC injection brake will be mistaken by the overload relay for a phase loss condition and will subsequently cause tripping. The ESP100 *should not* be applied on circuits containing adjustable frequency drives or DC injection brakes. The ESP100 can be applied with a soft start or solid state starter rated 50 or 60 Hertz.

4. Overload Misadjustment

There is a tendency to set the current adjustment of the ESP100 overload relay *too low*. This is contrary to most people's experiences with thermal overload relays, which if misadjusted tend to be set *too high*. In fact, on retrofit applications in which oversized heater coils are used to prevent nuisance tripping, there is still a tendency to adjust the overload to less than a motor rated full load current. *There seems to be a misconception that the high accuracy of a solid state overload relay necessitates setting the current adjustment below the motor's rated FLA.* This practice certainly protects the motor, but will not allow the motor to be used up to its rated horsepower.

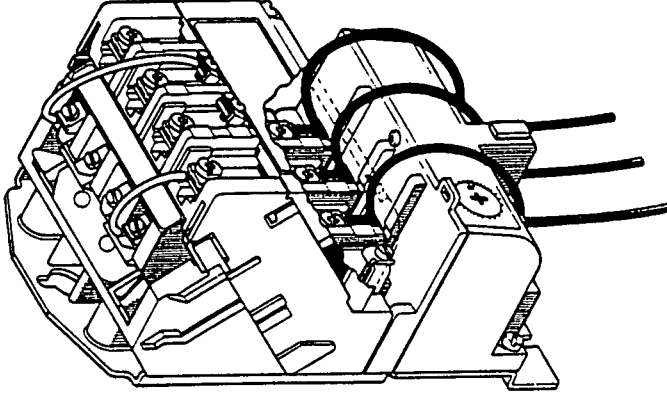
Heater coils for thermal overload relays are sized in 10% steps. The adjustable ESP100 can have as many as 6 or more settings (clicks) to cover the same current range as one heater element. Adjusting upward one or two clicks tends to solve a nuisance tripping problem. This has been found to be particularly true on punch presses and other types of machinery where die sizes can vary widely and jogging set up may be necessary.



Other factors to consider:

1. Was the overload relay set to the maximum motor load? It has been found that when the overload relay was initially set with a small die in a press, it later tripped when the largest die was in operation. Remember that as many as 6 clicks of the ESP100 adjustment dial equals the same current range as one heater coil.
2. Some machinery or applications make deliberate use of the service factor of the motor to operate the motor temporarily or continuously at currents above the motor's rated FLA. Theoretically a motor may be used continuously at its service factor without harm (i.e. a motor with a service factor of 1.15 being used at 115% of rated FLA). This type of motor application is found on conveyors, air compressors, and light duty machinery. The ESP100 overload must be set at the motor FLA actually being used.
3. The duty cycle of the application may have allowed the use of an undersized motor to withstand short overloads providing the loaded cycle is not long enough to overload the motor.

5. Correct overload relay adjustment when using the looping option



Math errors being common, it is always worth double checking to see that the ESP100 overload relay has been adjusted properly when using the looping option. By passing the current to the motor through the ESP100's sensing windows more than once the current range can be extended downward. This allows the overload relay to sense two, three, four, or more times the current which is actually flowing to the motor. Using this option does not decrease motor protection in any way.

6. Phase loss (only 2 of 3 phases present)

Phase loss as used in this guide refers to a loss of a single phase of a three phase motor branch circuit. The ESP100 is designed to react to phase loss within three seconds. A continuity check will normally pinpoint this problem quickly. The most typical cause of phase loss is a blown fuse. Single phasing is an important cause of motor failure and deserves immediate attention.

7. Severe Phase Imbalance

In this situation there will still be current in all three phases, but large differences (2:1) exist between the phases. The most likely two causes of this situation are:

A. Loss of phase in the primary of the circuit.

For example one of the test manufacturing plants was operating on a severe phase imbalance due to a loss of phase in the utilities power lines. The operating motors in the plant then acted as generators and produced some current in the missing phase. Overload relays are *not* designed to protect against phase imbalance. Various phase monitoring relays on the incoming power lines is perhaps the most popular way to provide this protection.

B. A damaged or defective motor winding can also be the cause of severe current imbalance.

During one in-plant test, two motors with damaged windings were found. One had a 51.5% current imbalance. These damaged motors were operating completely undetected by thermal overload relays. The ESP100 allowed the defective motors to be pinpointed and repaired or replaced before they could burn out at a critical time.

The easiest way to determine the correct ESP100 setting is to multiply the motor FLA by any whole number which falls within the current adjustment of the relay. For example, you have a motor rated at 5 full load amps and a 9-18 amp ESP100 overload relay. Five amps times two equals ten amps so that the motor loads can be looped once around the relay and the motor lead passes through the sensing window twice. The correct ESP100 setting would be 10 amps as the overload relay is sensing twice the 5 amps the motor is drawing. Using the same motor and relay as an example, the motor leads could be looped twice so that they pass through the sensing window three times (5 amps x 3 = 15 amp setting) and the correct ESP100 overload relay setting would be 15 amps.

The following table demonstrates how the looping process reduces the current setting of the overload by the number of times the wires pass through the windows of the overload.

All current values are expressed in Amps.

Overload Current Range	# of Wire Loops	# of Times Wire Passes Thru Window
Shown on label	9-18	0
	4.5-9.0	1
	3.0-6.0	2
	2.25-4.50	3
	1.80-3.60	4
	1.50-3.00	5
		6

NOTES

ESP100 Specifications

- Available in NEMA Sizes 0-6 (0-4 on self-reset)
- Dual voltage coils readily available
- Front mounted auxiliary contacts
- Common coil for Sizes 0-2½
- Snap-in coil through Size 4
- Encapsulated coils on all sizes
- Inspectable contacts through Size 4
- Replaceable contacts on all sizes
- Key hole/slot mounting through Size 4
- Trips in 3 seconds on phase loss condition
- Class 10, 20 or 30 overload protection
- NO or NC isolated alarm contacts for overload relay*
- Trip free overload mechanism*
- Overload contact test function*
- Tamper proof cover for overload dial
- 4:1 FLA adjustment range up to 10A, 2:1 above 10A
- Visible trip indication on overload relay*
- Overload relay is impervious to short circuit currents
- Thermal memory on overload relay
- NEMA A600 contacts on overload relay (NEMA B300 on self-reset)
- Sizes 0 & 1 provide mounting dimensions of competitive devices for easy retrofitting
- Heaterless construction
- Ambient insensitive
- Overload relay is close coupled to contactor
 - not panel mounted
- Overloads above 10A can be looped to extend range to 4:1 for more versatility
- Not available on self-reset versions

Furnas

ESP100TM

REPLACEMENT PARTS

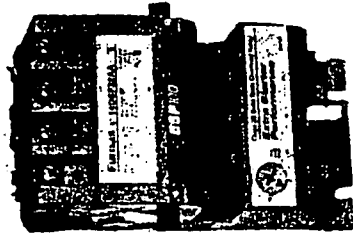
Class 14

Starters & Contactors

**Sizes: 0, 1 & 1 $\frac{3}{4}$
14CS, 14DS, 14ES**

Furnas

September, 1994
Supersedes issue of
July, 1993



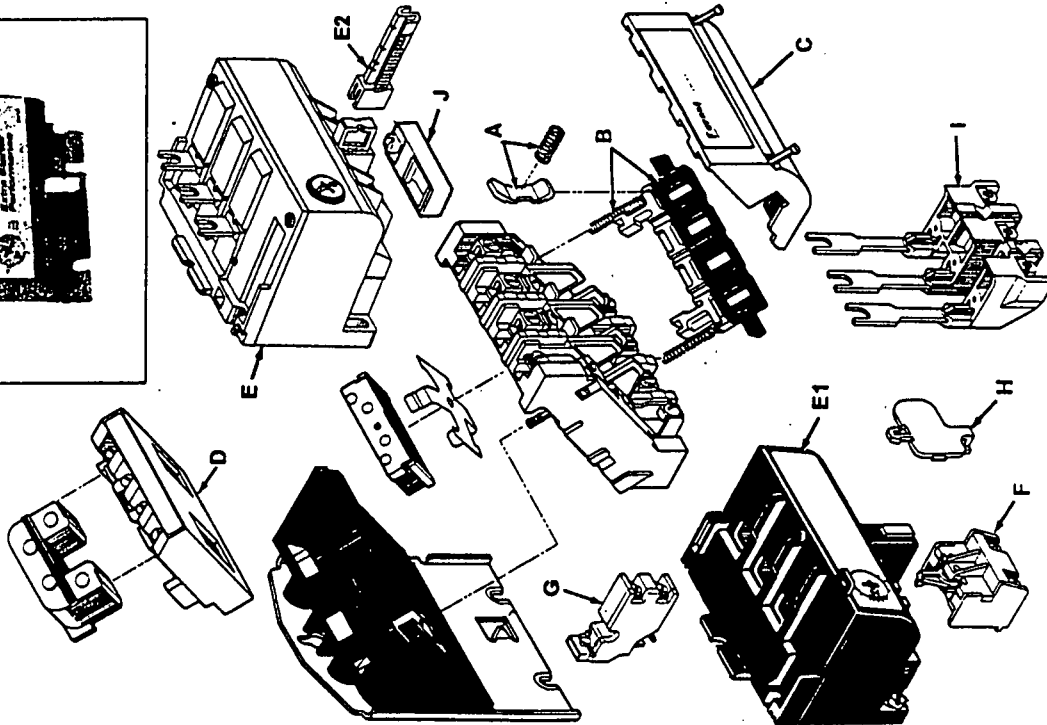
Replacement Parts

14-GE

9/94
Class 14
Starters & Contactors
0, 1 & 1 3/4
14CS, 14DS, 14ES

Item	Part Description	Part Number			
A	Contacts & Spring, One Complete Pole	0 75CF14			
	Power Pole	1 75DF14			
		1 3/4 75EF14			
B	Interlock Pole (includes spring retainer) All Sizes	75AF14			
	Cross Arm (less contacts) With Cross Arm Springs	75P1000			
	Contact Board Cover	D29079001			
	Coil				
	60 Hertz	50 Hertz			
	120V	110V			
C	110V/190-220V	75D73070F			
	220-240V/440-480V	75D73070A			
	190-220V/380-440V	75D73070C			
	550-600V	75D73070E			
<i>(For other voltages specify the number stamped on the coil)</i>					
E	Overload Relays - 3 Phase				
	Size Amps	Class 10	Class 20	Class 30	
	0, 1	0.25-1	48ASA3M10	48ASA3M20	48ASA3M30
	0, 1	0.75-3	48ASB3M10	48ASB3M20	48ASB3M30
	0, 1	2.5-10	48ASD3M10	48ASD3M20	48ASD3M30
	Overload Relays - Single Phase				
	0, 1	0.75-3	48ASB1M10	48ASB1M20	48ASB1M30
	0, 1	2.5-10	48ASD1M10	48ASD1M20	48ASD1M30
	0, 1	5.0-16	48ASE1M10	48ASE1M20	48ASE1M30
	Overload Relays - 3 Phase				
	Size Amps	Class 10	Class 20	Class 30	
	0, 1	3-6, 5-10	Old style (use styles on above table)		
0, 1	9-18	48ASE3M10	48ASE3M20	48ASE3M30	
1, 1 1/4	13-27	48ASF3M10	48ASF3M20	48ASF3M30	
1 3/4	20-40	48ASG3M10	48ASG3M20	48ASG3M30	
E2	Reset Extender	49ASRE			
	Auxiliary Contact Overload Kit-NO Contact	49ASNO			
	NC Contact	49ASNC			
	Front Mtg. Auxiliary Interlock SPST-NO	49AAFO			
	NC	49AAFC			
H	Tamper Resistant Cover	9-40A			
I	Lug Extender (Size 0, 1)	9-40A			
J	Dust Seal	49ASLE			
		49ASDS			

NOTE: When ordering replacement parts, give catalog number of control and part name and number



Furnas Electric Company 1000 McKee Street, Batavia, Illinois 60510

Furnas

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Batavia, Illinois 60510
(708) 879-6000
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FAX (416) 475-8630

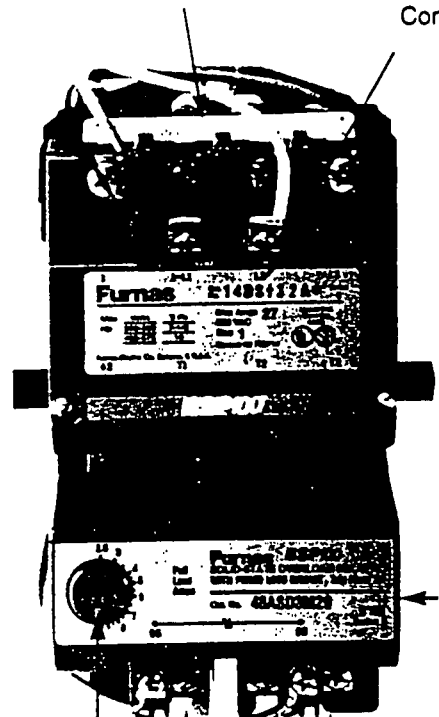


ESP100™

EASY TO INSTALL
EASY TO MAINTAIN

Molded, easy to
remove coil

NEMA
Rated
Contactor



Solid State
Overload
Relay

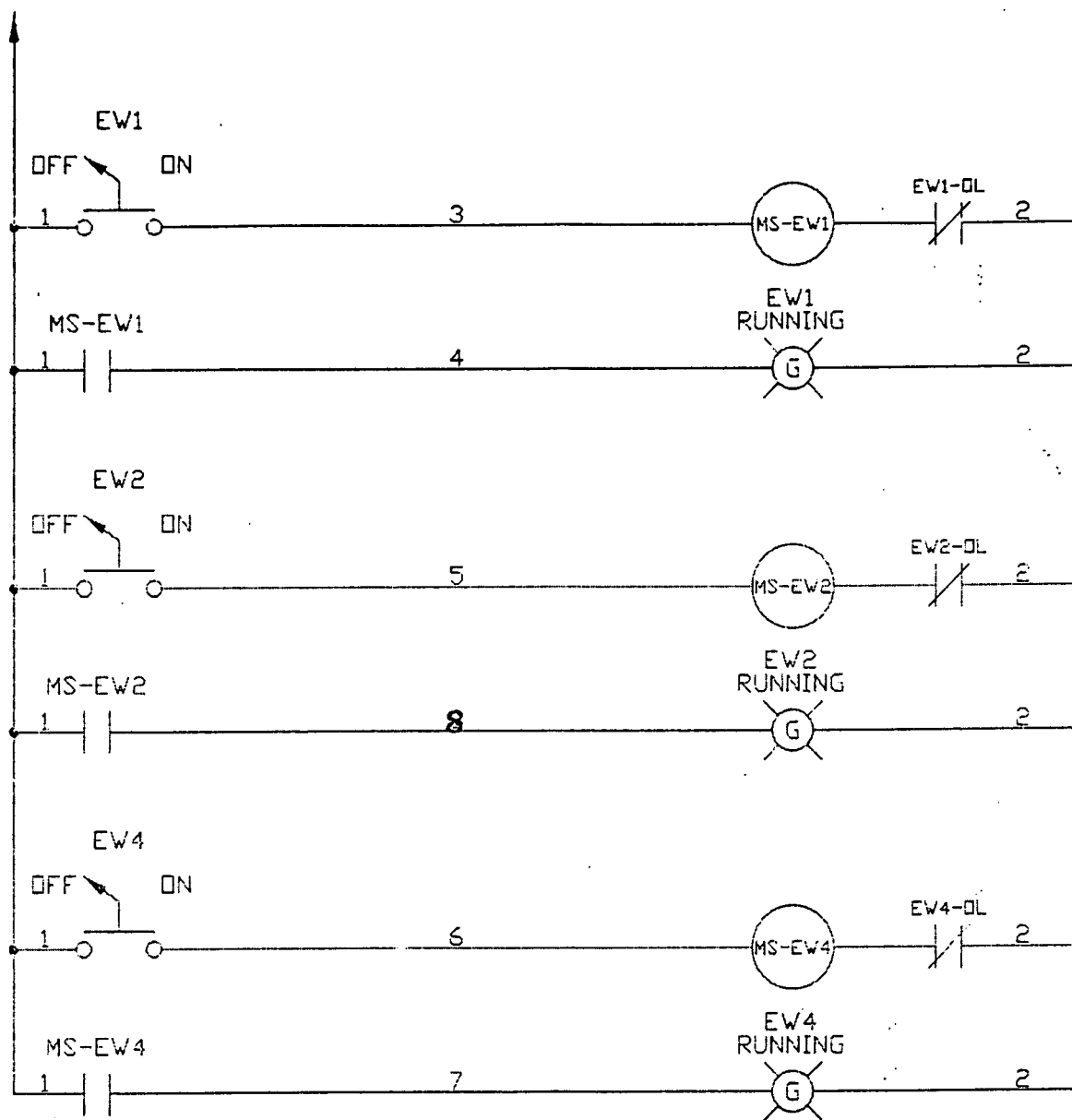
FLA
Adjustment
Dial

T1, T2, T3 Terminals

ELECTRIC SCHEMATICS

1

2



STATUS:
PLOT DATE:

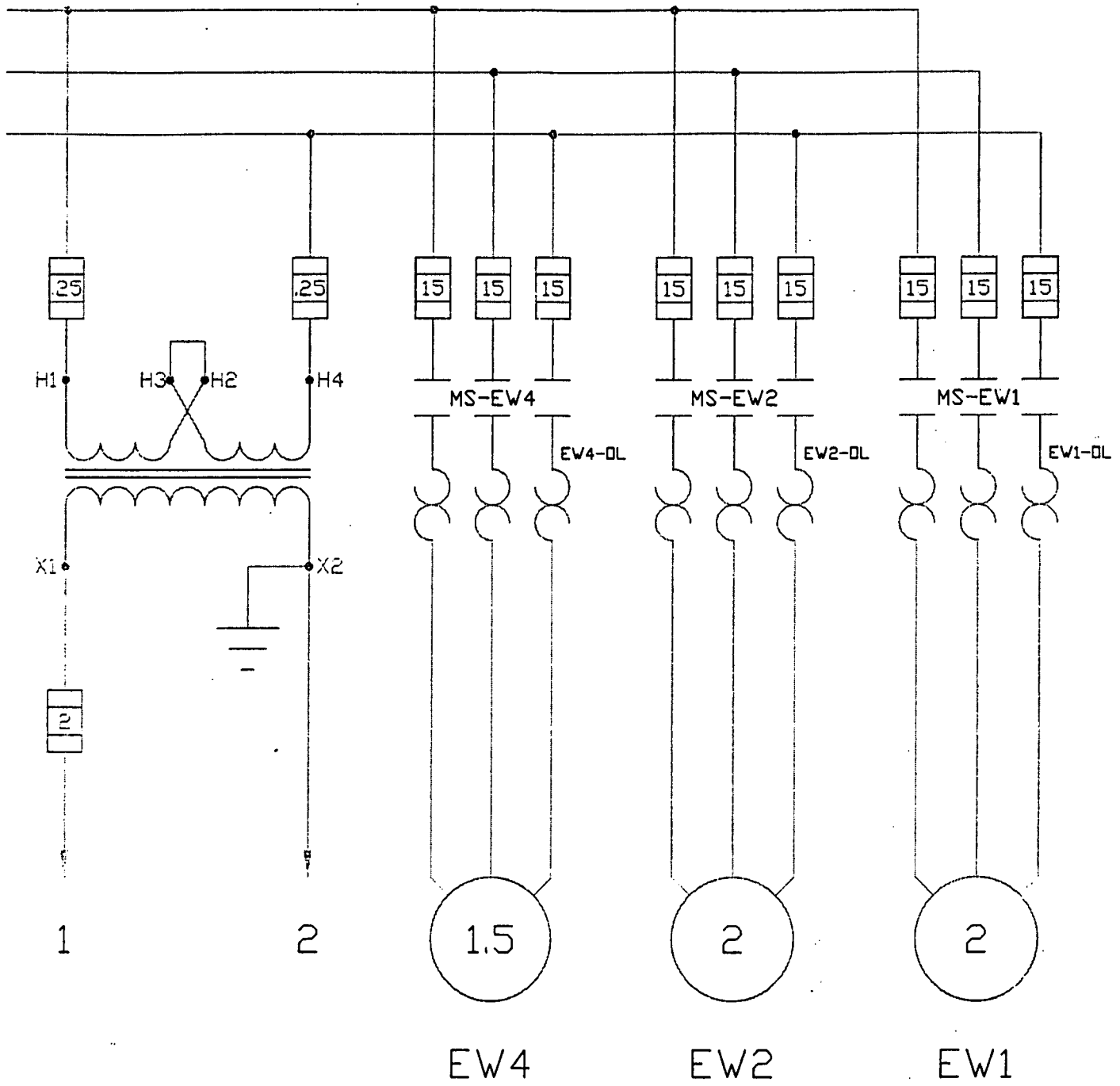
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 FUNCTIONAL 12/84
 MELLAR AT

TITLE				
CAD FILE NAME				
SCALE			JOB NO.	
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— SHEET ON/FRM — SHEET ON/FRM

TOLERANCES UNLESS OTHERWISE SPECIFIED
 DIM. — .005
 HOLE — .005
 FRACTIONAL — 1/64
 ANGULAR — .1°

TITLE:

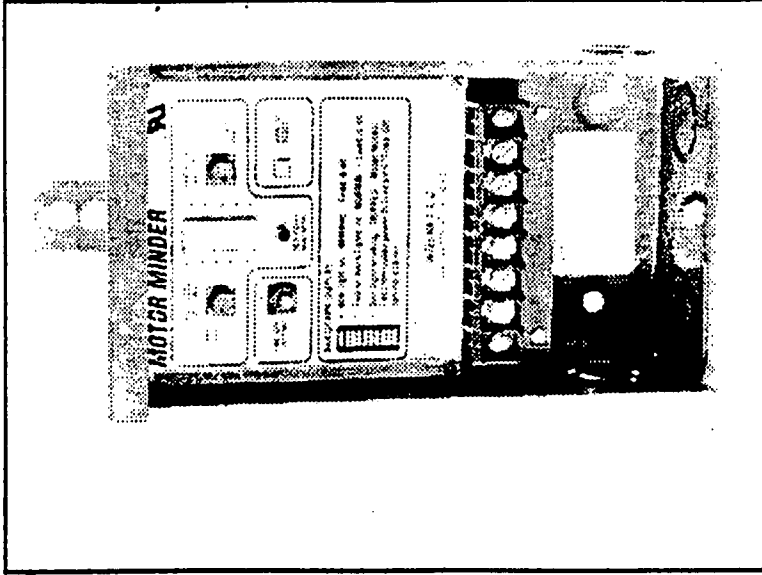
CAD FILE NAME				SCALE	JOB NO.
REV	DATE	DEPT.	DISC.	SIZE	ENTITY
SHT. NO. OF		PREVIOUS DRAWING	NEXT DRAWING		DRAWING NO.

REVISIONS

PUMP CONTROLLER

MAKE: INTEGRA

MODEL: MOTOR MINDER



MOTOR MINDER™

Installation Manual

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Installation Guide

Thank you for purchasing the Motor Minder. The first step for a successful installation is to verify that you have selected the appropriate Model for your installation. You will need to verify the model number, voltage, phase and horsepower. The first step in verifying the model number is to remove the cover. Loosen the screw at the bottom of the unit until you can lift the cover up and slide out. Upon having removed the cover, look at the UL sticker on the bottom of the base unit, check the model number and rating for voltage, phase, and horsepower (see Diagram 1). Verify that the load of your motor matches the Motor Minder horsepower rating, phase and voltage rating. In the event that it does not match-up with your unit, please immediately contact the company you purchased the unit from. **DO NOT INSTALL UNLESS YOU HAVE PURCHASED THE PROPER MODEL.**

Note: If you have purchased a panel mount version of the Motor Minder (no enclosure), the UL sticker is on the top bracket.

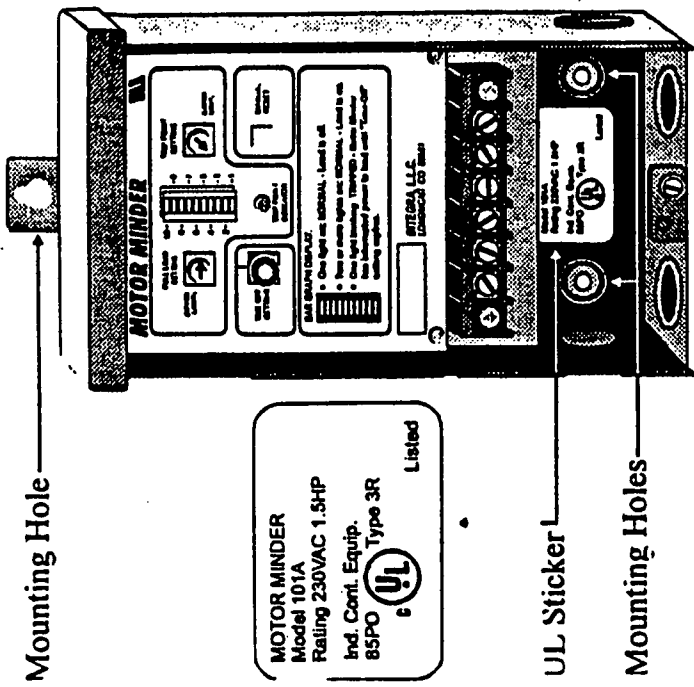


Diagram 1 — Motor Minder

Single Phase Installation

Upon verifying that the unit you have purchased is correct, select a suitable location for mounting your Motor Minder. This unit is in a UL type enclosure and is suitable for mounting outdoors. Two mounting holes are on the bottom next to the UL label and one is on top of the unit (see Diagram 1). Once you've completed mounting the unit, connect the appropriate conduit and pull in the line, load, and ground wires.

115 VAC Installation

If you are installing a 115 volt unit refer to Diagram 2 and/or the wiring diagram on the inside cover of the unit you purchased.

Connect 115 volt wire to terminal #1 and the neutral (white) wire connects to terminal #2.

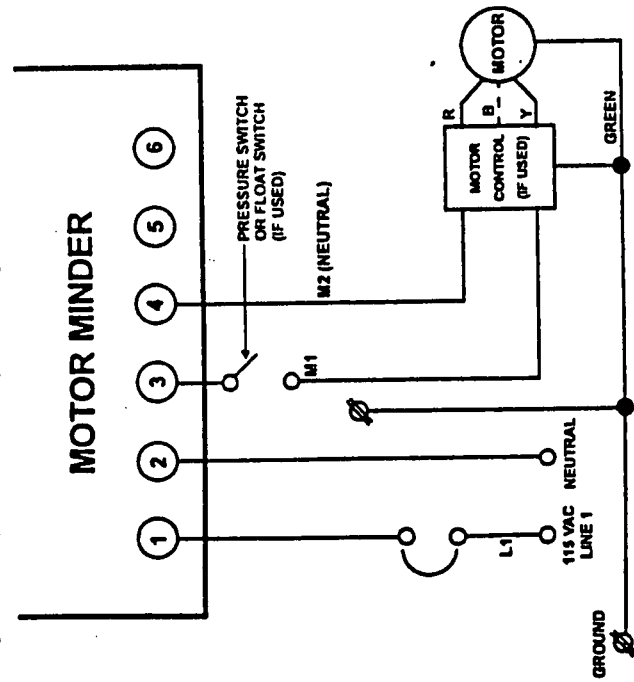


Diagram 2 — Single Phase Installation 115 VAC Wiring

Terminal #3 connects to the hot side of the motor (M1).
Terminal #4 connects to the neutral side of motor (M2).

Connect the ground wire to the green ground screw located on the tab at the bottom of the enclosure.

Note: In our standard models there are no connections required for terminals #5 and #6, these are reserved for other options.

230 VAC Installation

If you are installing a 230 volt system refer to diagram #3 and/or the wiring diagram on the inside cover of the unit you purchased.

Connect 230 volt line to terminals #1 and #2.

Terminal #3 connects to motor (M1) and terminal #4 connects to motor (M2).

Connect the ground wire to the green ground screw located on the tab at the bottom of the enclosure.

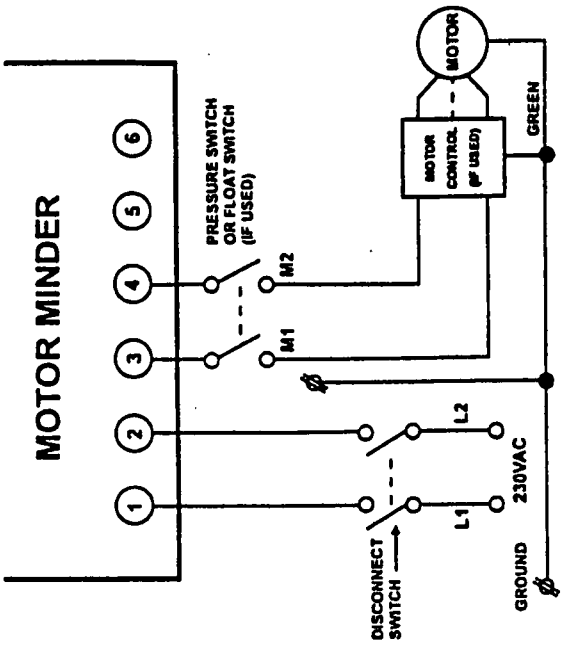


Diagram 3 — Single Phase Installation 230 VAC Wiring

Three Phase Installation

Upon verifying that the unit you have purchased is correct for the installation you plan to do, verify that the control voltage matches the voltage rating on the motor starter coil. Select a suitable location for mounting your Motor Minder. This unit is in a UL type enclosure and is suitable for mounting outdoors. The mounting holes are on the bottom next to the UL label at the top of the unit. Following Diagram 4, the control voltage connects to terminals #1 and #2 and to one side of the magnetic starter coil; terminal #3 on the Motor Minder connects to the other side of the magnetic starter coil.

Remove the protective foam from the current transformer. Find one of the three phase wires that are going to the motor and pass this wire through the hole in the current transformer, as Diagram 5 indicates: If you have a 1-1/2 to 3 horsepower motor make two passes (loops) of this wire through the hole; for 3/4 to 1 horsepower motor make three passes (loops) of this wire through the hole in the current transformer, for 5 horsepower and above motor, make only one pass (loops) through the current transformer. After the proper turns through the current transformer, connect the wire to the remaining phase on the motor starter.

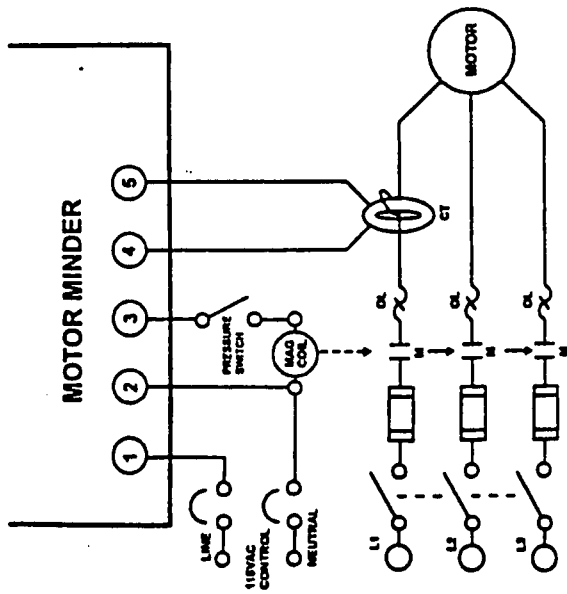


Diagram 4 — Three Phase Installation

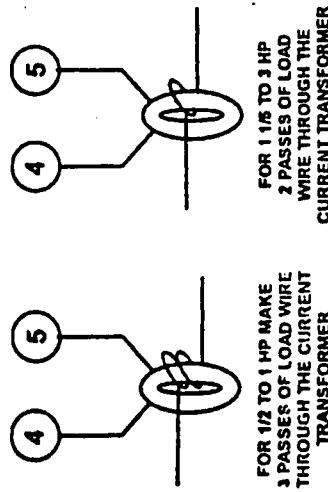


Diagram 5 — Current Transformer

You have now completed Installation. Please double check all connections, maximum terminal torque is 15 in/oz. You are now ready for set-up and calibration.

Set-up and Calibration

Move the "Full Load" adjustment knob clockwise until you feel the stop point. DO NOT try to move the adjustment knob past this point as you will break the knob (refer to Diagram 6).

Adjust the "Trip Point" knob counter clockwise until you feel the stop position, again DO NOT try to force the unit past the stop position (refer to Diagram 6).

Start motor and run under normal load conditions, if the motor is on and correctly running the top light of the bar graph will be lit. The light will be on at the Number 10 position which is full scale. Turn the "Full Load" knob counter clockwise slowly until the top light drops into the 6 to 9 range (refer to Diagram 7).

Slowly turn the "Trip Point" knob clockwise until you notice a second light coming up the scale. Continue to turn the knob upscale until the "Trip Point" indicator light begins to glow (refer to Diagram 7).

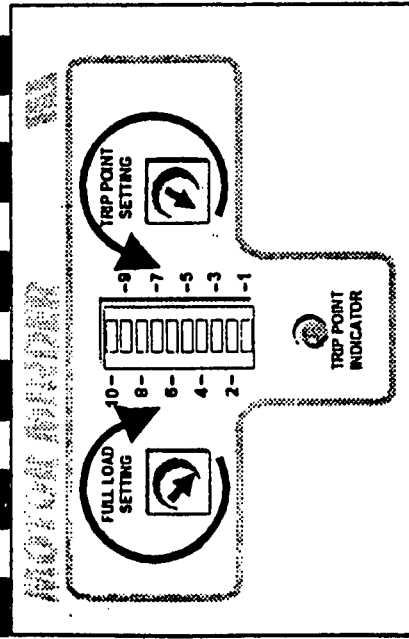


Diagram 6 — "Full Load" and "Trip Point" Initial Settings

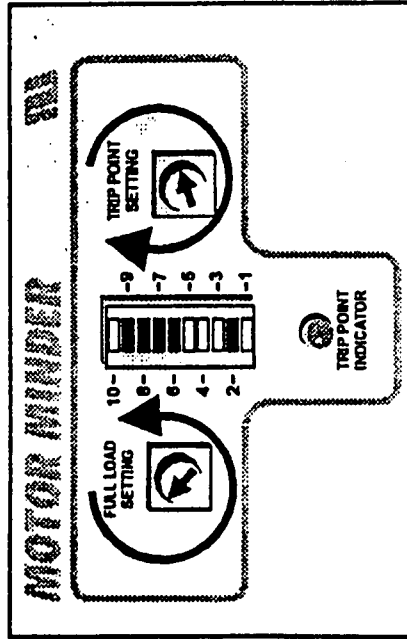


Diagram 7 — "Full Load" and "Trip Point" Settings

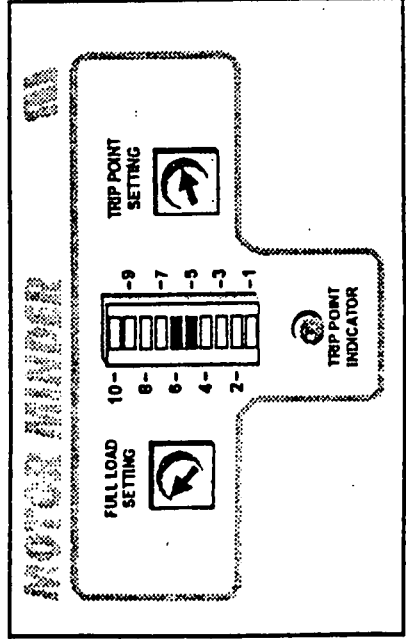


Diagram 8 — Motor Minder's most sensitive position

Once you've got the "Trip Point" indicator light to glow, you will now need to back-off that setting slightly until the light no longer glows. At this point you have reached the most sensitive setting. In the event that you desire the setting not to be at its most sensitive point, continue to back-off (Counter Clockwise) the "Trip Point" setting. You will notice the two lights on the bar graph begin to indicate greater distance between the two points. If it is possible to simulate an under load condition, do so at this time, the "Trip Point" indicator light (the small red one at the bottom) should come on and the Motor Minder should trip and shut off the motor. If the light does not come on, increase your sensitivity (trip point knob) until the Motor Minder trips and the motor shuts off. In the event you cannot simulate the under load condition, we recommend using the most sensitive condition when you do your installation. Again the most sensitive position would be "Trip Point" light setting on #5 and the "Full Load" light setting to #6 (see Diagram 8). When the Motor Minder trips, the "Full Load" setting light will run down off the scale and the "Trip Point" setting light will blink indicating that the Motor Minder is counting down to re-start.

If the unit trips, the light will "blink". Manually restart the unit by pushing the Reset button or auto restart by setting the "Time Off" switch to the desired restart time.

Operational Status from the Motor Minder

The following Diagrams are the Operational Status provided by the Motor Minder (Diagrams 9 - 13).

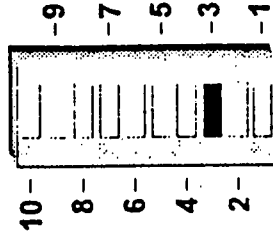


Diagram 9 — Normal, Unit Powered

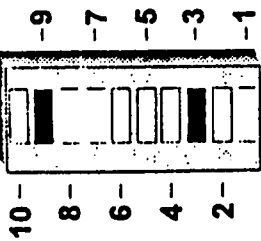


Diagram 10 — Normal, Unit Powered, Motor Running

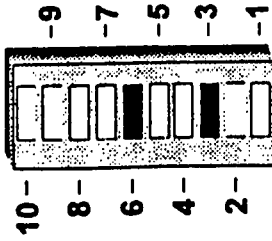


Diagram 11 — Conditions Changing, Unit Powered, Motor Running

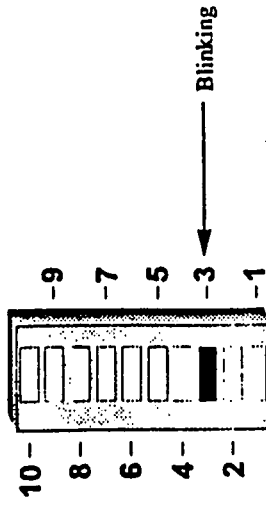


Diagram 12 — Tripped, Motor Minder has Shut System Down

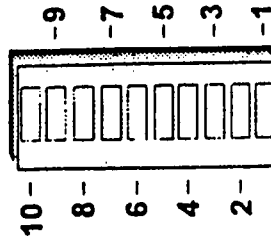


Diagram 13 — No Power, Unit and Pump are not powered or Motor Minder is set in by-pass mode (trip point knob set fully counter clockwise) and motor is off.

Time Off Switch Settings

There are sixteen setting points on the Time Off Switch Setting. These settings range from numbers 1 through 9 and then settings A, B, C, D, E, and F. Finally there is a zero (0) setting point for manual restart. When the unit is set to the zero setting, the unit will not restart until you manually restart it. Each setting allows for the load to be in a time out mode for a different length of time. Referring to our Time Off Switch Diagram 14 you will notice the amount of time that the load will be off based upon the setting that you select. As an example, if you select setting 1 the unit will be off for nine minutes. If you select setting 5, the unit will be off for one hour and twenty two minutes and if you select setting A the unit will be off for three hours and two minutes during normal operation.

In the event that you desire to manually reset the unit at any point in time, simply press the Manual Reset button located on the middle right hand side of the unit or turn off power for 15 or more seconds. Select the proper setting for your Time Off Switch. You are now ready to put the cover back on.

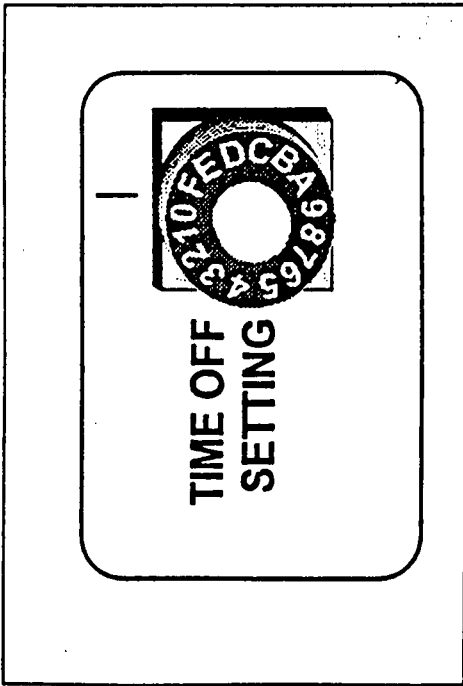


Diagram 14 — Time Off Switch (shown in position "0")

Switch Settings

Switch Settings	Time Off Hr./Min.	Switch Settings	Time Off Hr./Min.
1 —	0:09	9 —	2:35
2 —	0:36	A —	3:02
3 —	0:45	B —	3:11
4 —	1:12	C —	3:38
5 —	1:22	D —	3:47
6 —	1:48	E —	4:15
7 —	2:00	F —	4:15
8 —	2:34	0 —	Manual Reset

Trouble Shooting Guide

CAUTION: *Electrical shock hazard may exist. Trouble shooting electrical control systems should only be performed by qualified personnel.*

What to do if there is no power?	
	Check for blown fuses or tripped circuit breaker. Check fuses for recommended size. Check all power source connections. Repair or replace loose, dirty or corroded connections. Check for faulty wiring. Using a volt meter, check for proper incoming line voltage from power company.

<p>What to do if there is power to the Motor Minder but the motor will not run</p>	<p>Check all connections on the Motor Minder terminal block. Check for proper voltage at the Motor Minder terminal block and on the terminals feeding the load.</p> <p>A) If there is no voltage on these terminals Motor Minder is defective and will need repair or replacement.</p> <p>B) If there is the proper voltage on these terminals then check the following:</p> <p>Open or faulty wiring between Motor Minder and the motor.</p> <ul style="list-style-type: none"> ✓ Defective pressure or float switch. ✓ Defective motor starter or control box. ✓ Defective motor.
<p>What to do if the motor starts and immediately shuts down</p>	<p>When the motor starts, watch for the top light on the Motor Minder bar graph to come on and then immediately and rapidly descend down and off scale. This indicates that the motor is trying to start but is tripping. Check for the following:</p> <ul style="list-style-type: none"> ✓ Locked rotor caused by seized bearing or jammed impeller. ✓ Defective starter winding. ✓ Defective control box on 3 wire submersible pumps. ✓ Defective motor starter. ✓ Short or grounded wiring in starting circuit. <p>(Check for the above per the motor manufacturers instruction).</p>

<p>What to do if the motor starts and the Motor Minder trips immediately</p>	<p>Start the motor and observe the "Trip point indicator light". If the trip point indicator light comes on immediately, the sensitivity is set to tight. Back off (turn counter clockwise) the "trip point setting control" or recalibrate per the instruction manual.</p>
<p>What to do if the motor starts and stops several times in rapid succession and the Motor Minder trips?</p>	<p>In a pressurized system, this is known as rapid cycling where the pressure switch oscillates on and off due to loss of air in the pressure tank. The Motor Minder is designed to detect this condition and shut down the pump to prevent system damage. To restore the system to normal, check for a defective bladder and/or recharge pressure tank per manufacturers instructions.</p>
<p>What to do to by-pass the Motor Minder</p>	<p>At times it may be desirable to by-pass the Motor Minder to trouble shoot other parts of the system. This can be accomplished by turning the "trip point control" fully counter clockwise until the bottom light on the bar graph display goes down and off scale. At this setting, the Motor Minder will not trip and can be considered to be in the by-pass mode.</p> <p>CAUTION: Be sure to return the trip point setting to it's original setting when finished.</p>

MOST COMMONLY ASKED QUESTIONS

QUESTION ANSWER

What to do if the Motor Minder will not automatically reset

Check to see if the trip point setting light is blinking. The blinking light indicates that the Motor Minder has tripped and activated the internal count down timer. Check the setting on the rotary restart timer switch. If the switch is in any position other than "zero", the Motor Minder should reset within plus or minus 20 seconds of the time setting. (See timer chart, page 12). If it does not reset, the unit is defective and will need repair or replacement. If the timer switch is in position "zero", the automatic re-start mode is ignored (inactive). Re-start can only be done manually.

Can the Motor Minder be installed outdoors.	Yes, the standard Motor Minder comes mounted in a NEMA 3R enclosure.
Is the Motor Minder available without an enclosure.	YES, a stand alone panel mount model is available that meets the UL 508 Industrial Control Standards and is listed as a UL Recognized component that can be mounted in panels containing other UL Recognized electrical devices.
Will the Motor Minder work on 2 or 3 wire submersible pumps.	YES.
Is the Motor Minder UL Listed and CSA approved.	YES. Meets UL 508 and CSA Industrial Control Standards
Can the Motor Minder be manually reset other than pushing the reset button.	YES. Manual reset can be accomplished by disconnecting power for 15 or more seconds.
Can the Motor Minder be electrically installed before or after the pressure switch.	YES.
Are there accessories or options available to the standard unit.	YES. Consult factory.
Are any special tools required for installation and/or calibration.	NO.
Is the set up and calibration of the 3 phase Motor Minder different from the single phase unit.	NO.
Does the Motor Minder have to be re-calibrated after a power failure.	NO.

SAFETY WARNING



MAKE SURE ALL POWER IS TURNED OFF BEFORE INSTALLATION. DO NOT EXCEED #8 COPPER WIRE ON THE TERMINAL BLOCK. USE COPPER CONDUCTORS ONLY. MOUNT THE UNIT USING QTY. (3) #8 SCREWS APPROPRIATE FOR THE TYPE OF MATERIAL THE UNIT IS BEING MOUNTED ON. ALL UNITS MUST BE GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE. USE THE GREEN GROUND SCREW PROVIDED IN THE UNIT FOR GROUNDING.

Tools Required for Installation

- ✓ Flat Head Screwdriver
- ✓ Wire Strippers
- ✓ Drill for mounting unit

If Using Conduit

- ✓ 1/2" or 3/4" conduit bender

Other Required Materials

- ✓ Conduit fittings (1/2" to 3/4") depending upon installation
- ✓ Appropriate size wire is required in accordance with the National Electrical Codes standards.

REQUIRED: Appropriate overload protection in accordance with the national electrical codes (NEC) standards.



LIMITED WARRANTY

INTEGRA, LLC, warrant each new product against defects in material or workmanship for a period of one year from date of installation or 18 months from date of manufacture. This warranty excludes all other warranties, expressed or implied, and no liability is assumed for damage due to accident, abuse, lack of reasonable care, loss of parts, or subjecting the instrument to input values of a magnitude in excess of those specified.

This warranty is in lieu of any other expressed or implied warranties including warranty of merchantability or fitness for a particular purpose and of any other obligation on the part of the seller. INTEGRA, LLC neither assumes nor authorizes any person to assume for it any other liability in connection with the sale of its equipment. This warranty will not apply to any equipment which shall have been repaired or altered outside of INTEGRA, LLC, factory in any way so as, in INTEGRA, LLC, judgment, to affect its stability, or reliability, nor which has been subject to misuse, negligence, or accident.

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.

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

Toll Free: (800) 208-3008

Motor Minder

The Smart Way to Protect Your Pump Investment

	<input checked="" type="checkbox"/> 301B-CT1 3 PHASE	<input type="checkbox"/> 301B-CT2 3 PHASE
MODEL		
301B	UP TO 7.5 H.P. 208/230/460/575 VAC LOAD	10 TO 30 H.P. 208/230 VAC LOAD
CONTROL or PILOT VOLTAGE 115 VAC	10 TO 20 H.P. 460/575 VAC LOAD	20 TO 100 H.P. 460/575 VAC LOAD

SET-UP AND CALIBRATION:

1. Set "FULL LOAD" adjustment knob clockwise, and the "TRIP POINT" knob counter-clockwise.
2. Start motor and run under normal load conditions. The top light of the bar graph should come on. Turn the "FULL LOAD" knob counter-clockwise until light is below full-scale but above half-scale of the bar graph indicator.
3. Turn "TRIP POINT" knob clockwise until second light comes up towards, but below the "FULL LOAD" light setting. Slowly continue rotating the "TRIP POINT" knob clockwise until the "TRIP POINT INDICATOR" light starts to glow: this is close to the trip point. Back off the "TRIP POINT" setting slightly. Repeat this step (Step #3) until desired sensitivity is obtained.
4. If unit trips, the light on the bar graph will blink. Reset the unit manually by pressing the "MANUAL RESET" button, or allow the unit to Auto Restart by setting the "TIME-OFF" switch to the desired recovery time.

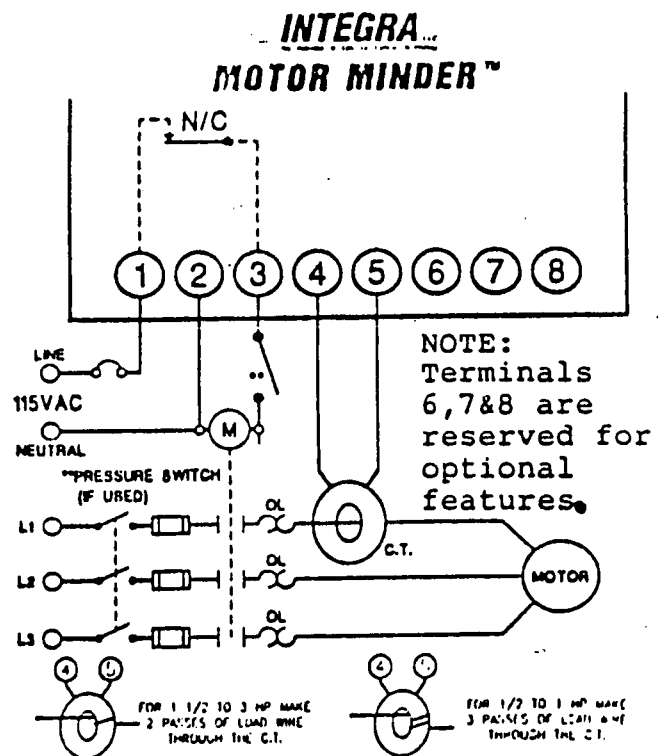
TIME-OFF SWITCH SETTINGS:

(Switch settings in hr:min)

1 - 0:09	5 - 1:22	9 - 2:35	D - 3:47
2 - 0:36	6 - 1:48	A - 3:02	E - 4:15
3 - 0:45	7 - 2:00	B - 3:11	F - 4:24
4 - 1:12	8 - 2:34	C - 3:38	0 - Manual

INSTALLATION:

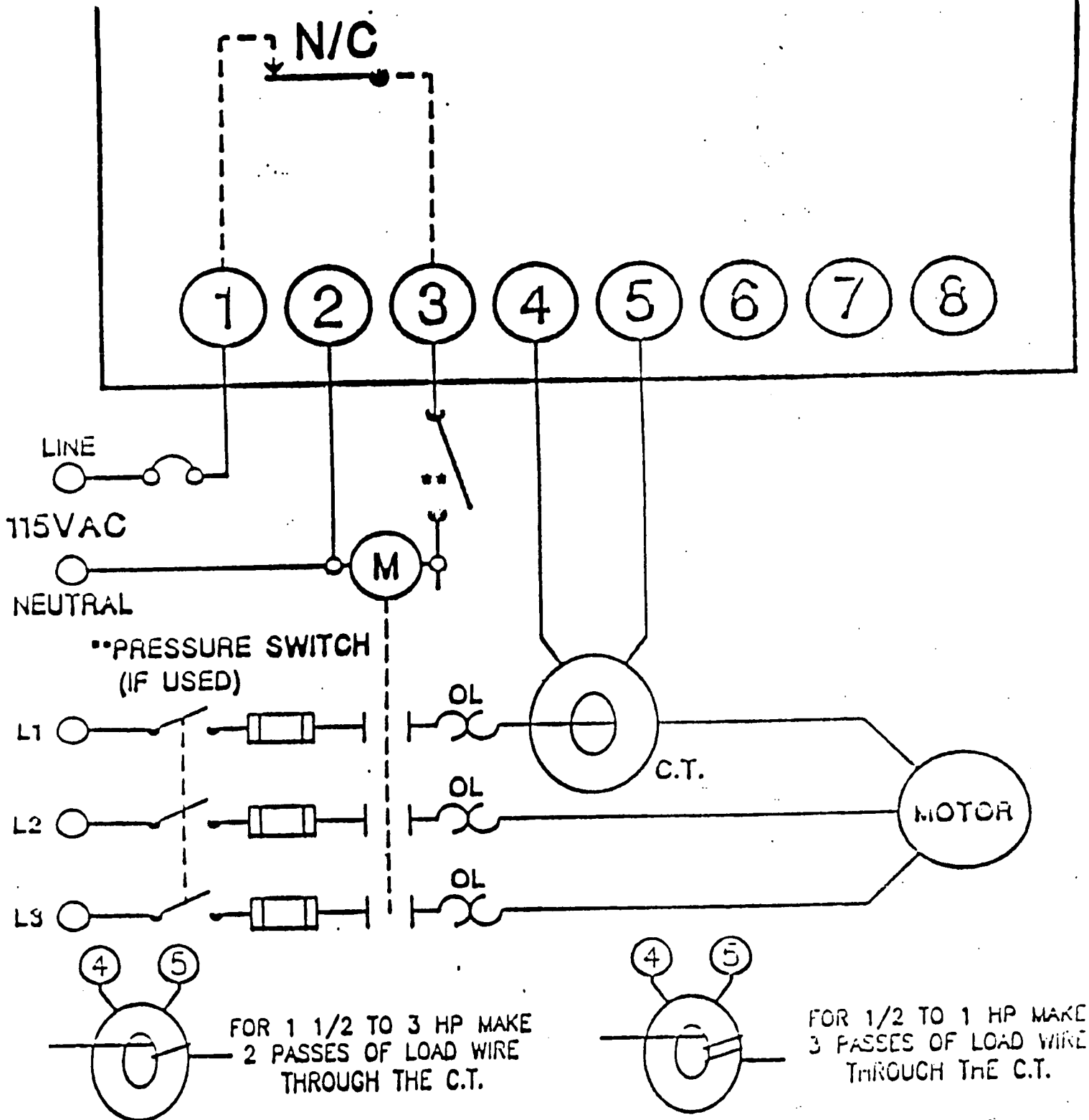
1. Follow the wiring diagram below.
2. Use copper conductors ONLY.
3. Overload protection in accordance with NEC is required.
4. Terminal torque is 15 in/oz.



Wiring Diagram:
Motor Minder Model 301B

INTEGRATM UC

MOTOR MINDER™



Wiring Diagram:
Motor Minder Model 301B

Motor Minder

The Smart Way to Protect Your Pump Investment



301B-CT1 3 PHASE



301B-CT2 3 PHASE

**MODEL
301B**

**CONTROL or PILOT
VOLTAGE 115 VAC**

**UP TO 7.5 H.P.
208/230/460/575 VAC LOAD**

**10 TO 20 H.P.
460/575 VAC LOAD**

**10 TO 30 H.P.
208/230 VAC LOAD**

**20 TO 100 H.P.
460/575 VAC LOAD**

SET-UP AND CALIBRATION:

1. Set "FULL LOAD" adjustment knob clockwise, and the "TRIP POINT" knob counter-clockwise.
2. Start motor and run under normal load conditions. The top light of the bar graph should come on. Turn the "FULL LOAD" knob counter-clockwise until light is below full-scale but above half-scale of the bar graph indicator.
3. Turn "TRIP POINT" knob clockwise until second light comes up towards, but below the "FULL LOAD" light setting. Slowly continue rotating the "TRIP POINT" knob clockwise until the "TRIP POINT INDICATOR" light starts to glow: this is close to the trip point. Back off the "TRIP POINT" setting slightly. Repeat this step (Step #3) until desired sensitivity is obtained.
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TIME-OFF SWITCH SETTINGS:

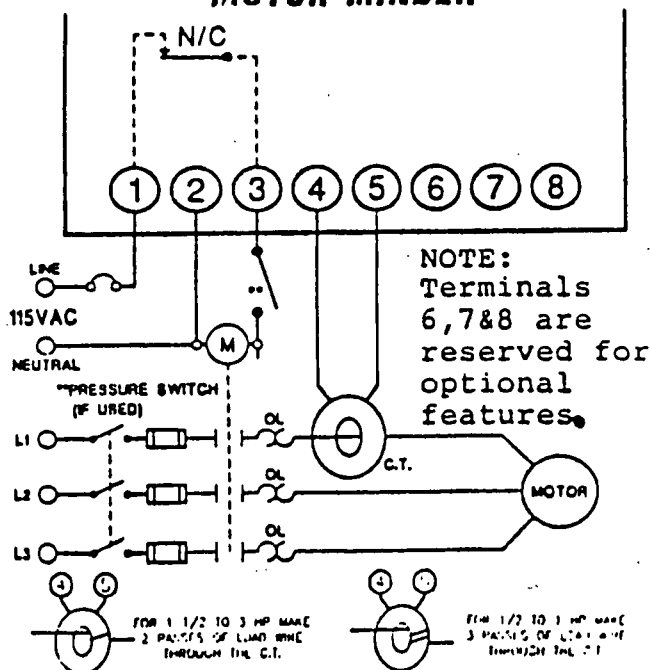
(Switch settings in hr:min)

- 0:09	5 - 1:22	9 - 2:35	D - 3:47
- 0:36	6 - 1:48	A - 3:02	E - 4:15
0:45	7 - 2:00	B - 3:11	F - 4:24
1:12	8 - 2:34	C - 3:38	0 - Manual

INSTALLATION:

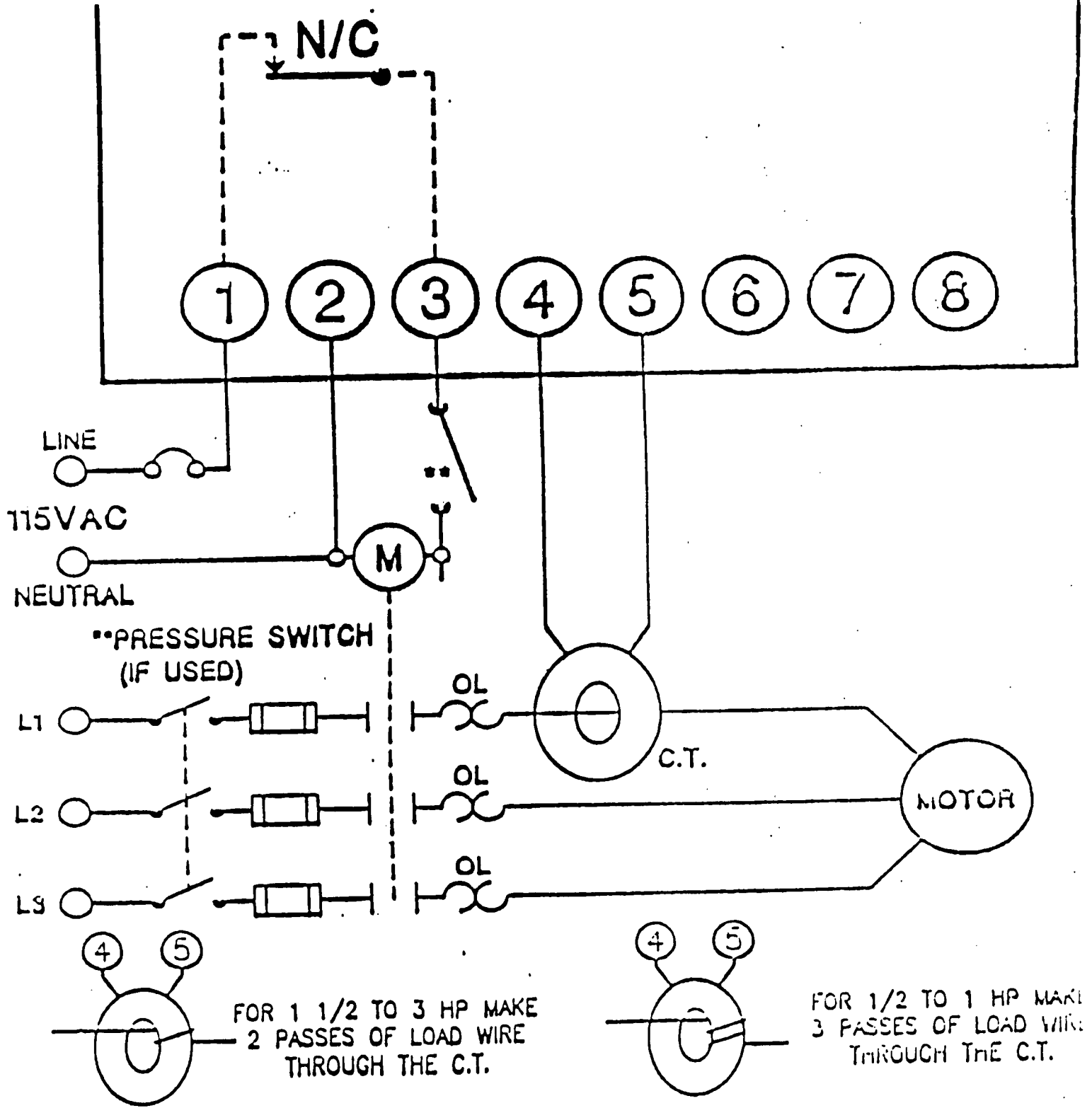
1. Follow the wiring diagram below.
2. Use copper conductors ONLY.
3. Overload protection in accordance with NEC is required.
4. Terminal torque is 15 in/oz.

INTEGRA... MOTOR MINDER™



Wiring Diagram:
Motor Minder Model 301B

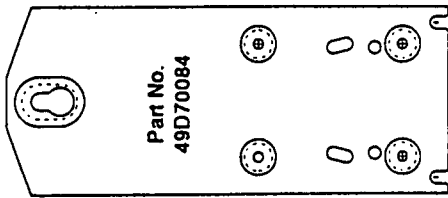
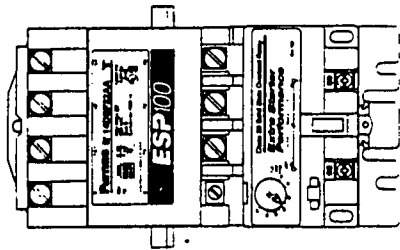
MOTOR MINDER™



Wiring Diagram:
Motor Minder Model 301B

1 MOUNTING

No drilling required for retrofitting:



The Furnas ESP100 FVNR size 0-1½ have as standard universal mounting which fits the following:

Cutler Hammer-
Citation Series
Freedom Series

GE- 300 Line

Square D- Type S

An additional adapter plate is required to retrofit the following:

Allen Bradley Bulletin 509
Bulletin 709

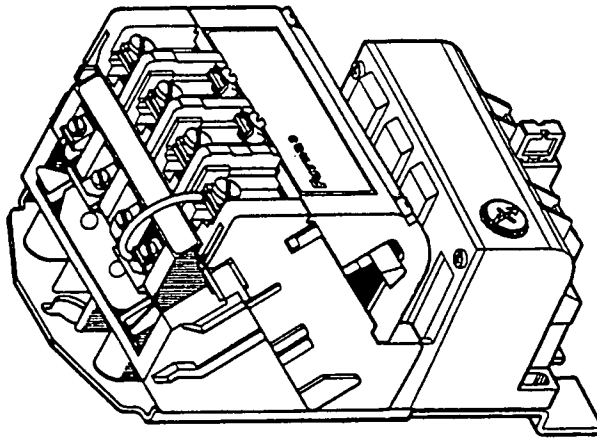
Westinghouse- Series A200

The ESP100 with its existing backplate mounts onto the piggy back mounting plate and is secured in place with three mounting screws.

2 WIRING

Connect the motor leads to terminals T1, T2, and T3 on the ESP100 overload.

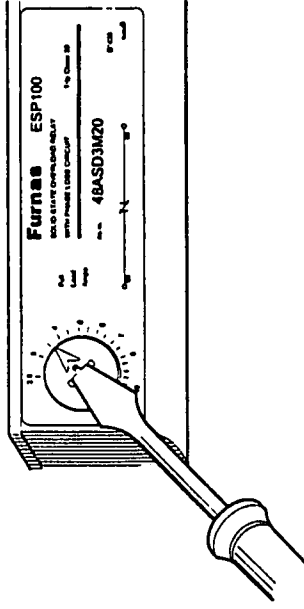
For contactor, wire per the enclosed wiring diagram. Use with motors at 50 or 60 Hz.



3 FLA ADJUSTMENT

Set the adjustment dial on the overload to the Full Load Amps on the motor nameplate.*

In addition to the markings on the dial there are audible clicks which allow for extremely fine tuning. Note that while thermal overloads require a heater selection based on a relatively wide ampere range, the overload on the ESP100 will have many clicks covering the same ampere range.



After the correct Full Load Amps have been selected, the gray adjustment cap can be removed to resist unwanted tampering with the setting. Pull the adjustment cap tab directly out from the face of the overload. To reinstall the cap, line up the arrow on the cap with the line on the red disk and push into place. The setting can then be adjusted.

*Service factor 1.0 = amps x 0.9

Single Phase versions are also available.

PUMP CONTROLLER

MAKE: COYOTE

MODEL: MOTOR MINDER

COYOTE

PROTECTS THREE PHASE PUMPS and MOTORS from

UNDERLOAD

running dry
gas locking
air locking
clogged inlet
frozen discharge line

PHASE

phase loss
phase reversal

OVERLOAD

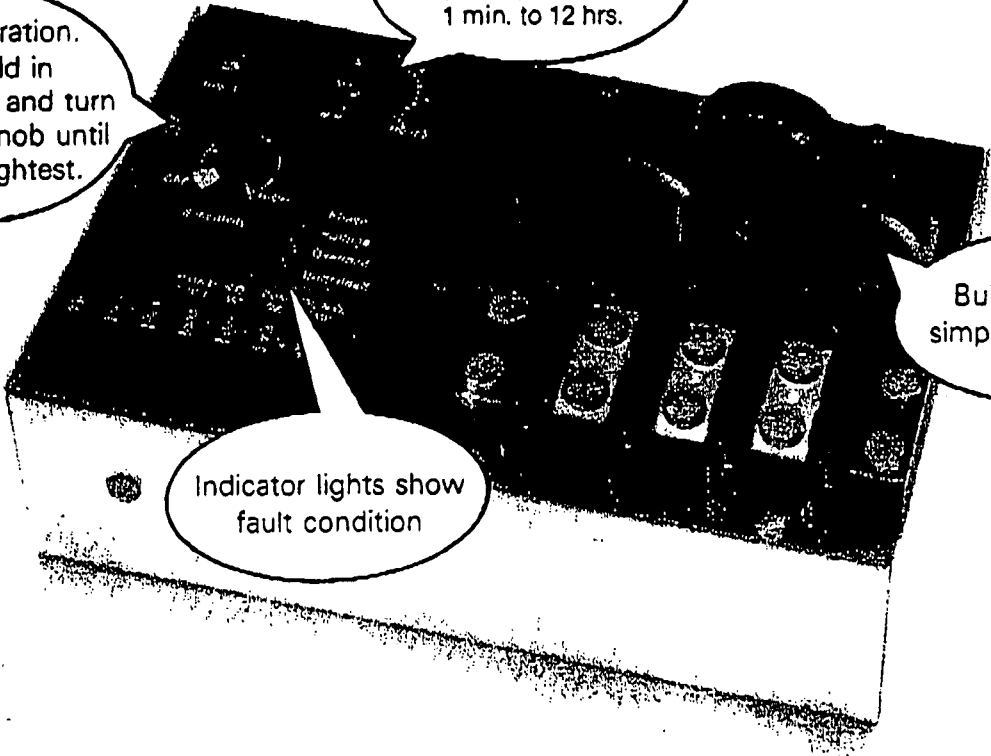
excessive current draw
sand locking
broken wire to motor

VOLTAGE

high voltage
low voltage
voltage imbalance

Easy calibration.
Just hold in
reset button and turn
sensitivity knob until
light is brightest.

If pump
underloads restart
delay is adjustable from
1 min. to 12 hrs.



Built-in sensors
simplify installation

Indicator lights show
fault condition

NO PLUMBING • NO PROBES • FULLY AUTOMATIC

FIVE MODELS

- 208V
- 230V
- 380V
- * 460V *
- 575V



AVAILABLE OPEN CHASSIS
(AS PICTURED) OR IN
RAINPROOF ENCLOSURE

(Add "3R" to model number to order
rainproof enclosure)

No need to specify horsepower
when ordering. Each voltage model
will operate any horsepower motor
in its range.

COYOTE

MANUFACTURING, INC.

ROUTE 66 • DRAWER 910, TIJERAS, NM 87059

800-468-1177 • 505-281-1177

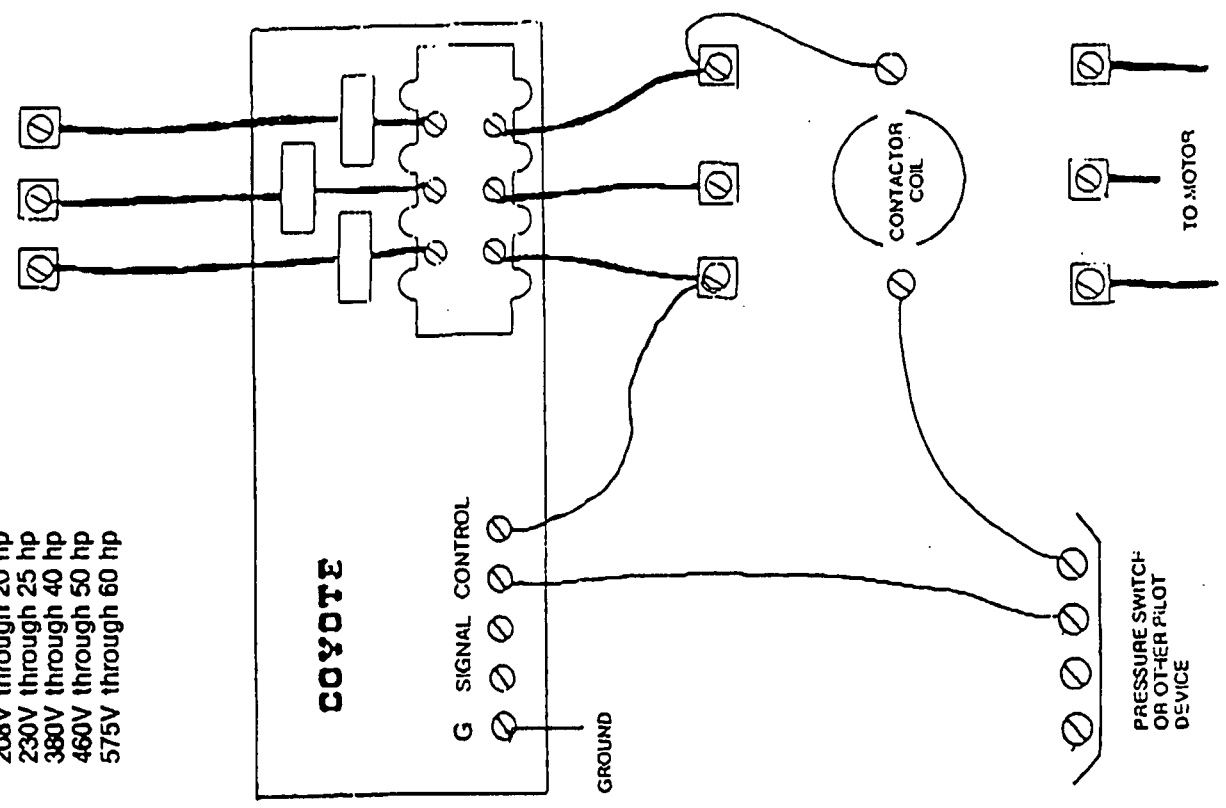
FAX 505-281-3053

**TYPICAL INSTALLATION
LOW HORSEPOWER**

model

- 208V through 20 hp
- 230V through 25 hp
- 380V through 40 hp
- 460V through 50 hp
- 575V through 60 hp

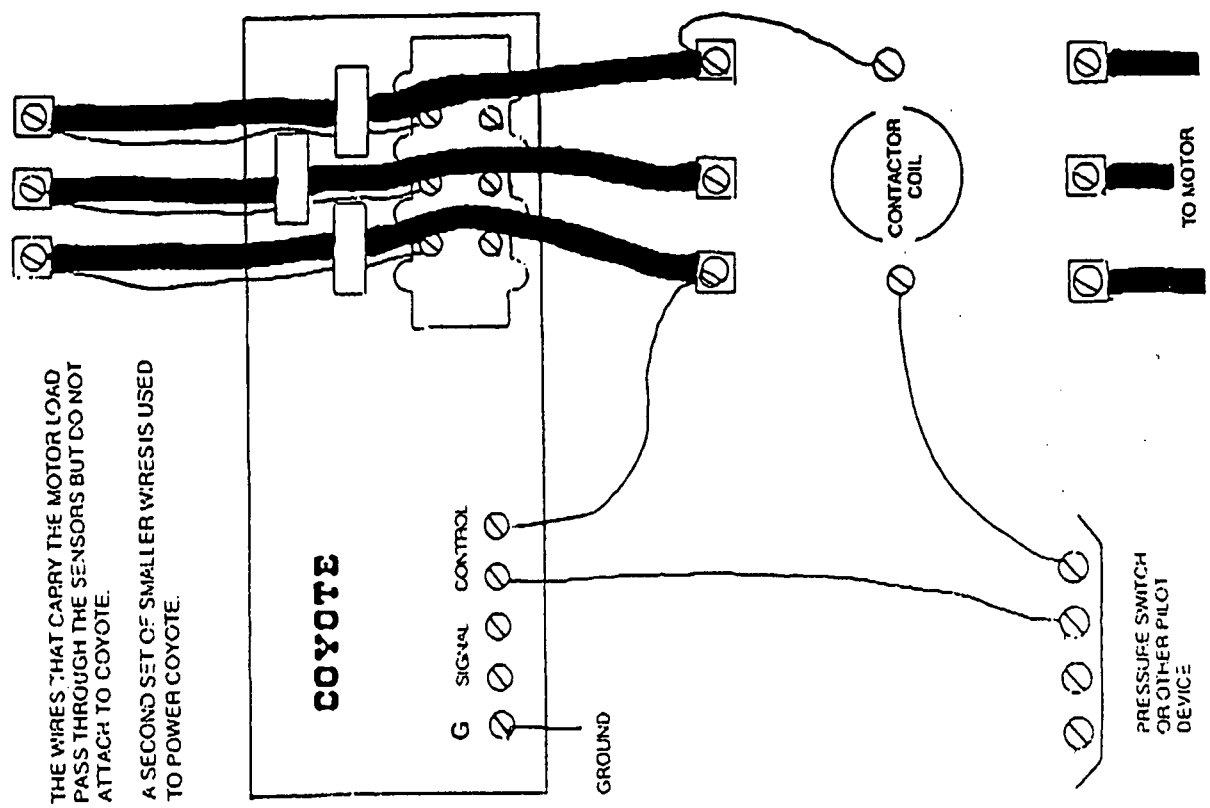
CIRCUIT BREAKER
OR
FUUSED DISCONNECT



**TYPICAL INSTALLATION
HIGH HORSEPOWER**

THE WIRES THAT CARRY THE MOTOR LOAD
PASS THROUGH THE SENSORS BUT DO NOT
ATTACH TO COYOTE.
A SECOND SET OF SMALLER WIRES IS USED
TO POWER COYOTE.

CIRCUIT BREAKER
OR
FUUSED DISCONNECT



THREE PHASE COYOTE TECHNICAL DATA

OPERATING RANGE

120° TO +70° C temperature
0% to 95% humidity noncondensing

HORSEPOWER RANGE

208V model	1/3 - 75 hp
230V model	1/3 - 100 hp
380V model	1/3 - 150 hp
460V model	1/3 - 200 hp
575V model	1/3 - 250 hp

RANDOM START

When energizing Coyote by turning on power at circuit breaker or fused disconnect there is a delay of 4 to 10 seconds before Coyote turns on the pump. This "random start" feature is designed to prevent many pumps served by a single power source from all restarting at the same instant when power is restored after a power outage.

VOLTAGE FAULT

	low voltage		high voltage	
	trip	reset	reset	trip
208V model	172V	181V	235V	244V
230V model	190V	200V	260V	270V
380V model	340V	350V	410V	420V
460V model	380V	400V	520V	540V
575V model	475V	500V	650V	675V

voltage imbalance 14% any line from the average of the three lines.

trip delay	reset delay
2 seconds	60 seconds

Plus or minus 2%. If three voltage faults occur within a fifteen minute period while pump is running, Coyote locks out pump and voltage light blinks.

PHASE LOSS OR REVERSAL

trip delay	reset delay
1 second	60 seconds

OVERLOAD

trip amps	trip delay	reset delay
150% of normal	1/4 second	60 seconds

Tries two times to restart then Coyote locks out pump and overload light blinks.

UNDERLOAD OR LACK OF FLUID

trip delay	reset delay
1 second	adjustable
	1 minute - 12 hours

On motor start-up, circuitry waits two seconds before monitoring for lack of fluid.

Underload sensitivity adjustable plus or minus 20% from point at which tune-in light is brightest.

SIGNAL

Normally open dry contact closes to activate alarm on any fault condition.

DIMENSIONS OVERALL

7 1/2" high, 10 1/4" wide, 4 1/2" deep

ALL ABOUT THREE PHASE COYOTES

What does it do?

Coyote shuts off the pump:

- if the pump fails to pump fluid because there is no fluid available to it, or because it is gas locked or air locked, or because the Inlet is clogged;
- If the power supplied to the pump is improper, e.g., phase reversed or missing, voltage too high or too low, etc.;
- If the motor draws excessive current or if there is a broken wire to the motor.

For how long does it shut down?

- If the pump runs out of fluid, Coyote restarts it after waiting the interval you choose on the timer.
- If the incoming power goes bad, Coyote restarts the pump when proper power is restored.
- If the motor draws excessive current, Coyote will try three times to restart it. If the overcurrent condition is not cured, Coyote locks out the pump, and the overcurrent light blinks.

What if there is not enough fluid to pump when the pump restarts?

Coyote will let it run just one second, shut it off, wait the same amount of time and try again, wait and try again, until there is enough to pump.

What if I want to turn on the pump before the timer has run its cycle?

Just push the RESET button or turn the power off and then on again at the circuit breaker and the pump will restart.

How does it work?

Coyote monitors the incoming power and the electrical characteristics of the motor. When the pump quits pumping fluid, those characteristics change, and Coyote shuts it off.

Will it operate on power supplied by generators and phase converters?

Yes.

On what kinds of pumps does it work?

Submersibles, centrifugals, jets, and sumps.

In what kinds of applications?

Water wells, oil wells, booster and lift stations, chemicals transfer, mine dewatering, sewage treatment, solution mining, food processing, construction dewatering, and clean-up of aquifers contaminated by hydrocarbons are the most common.

What about protection from the environment?

The Insides of Coyote are sealed in plastic to keep out moisture, insects, and blowing sand and dust.

How about power outages?

When the power is out, the pump won't run. When it comes back on, Coyote automatically resets itself. There is no need to touch anything.

What about lightning induced power surges?

Rugged and effective protection for the electronics of Coyote is built-in.

How is it installed?

Coyote is installed between the circuit breaker and magnetic contactor in minutes with a standard screwdriver.

What if I need something a little different from the standard unit?

Please call us. It is likely we have already made for someone else what you have in mind. Controls also available for single phase motors.

LIMITED WARRANTY

Coyote products are warranted against faulty materials or workmanship for one year from date of manufacture. Coyote's liability under this warranty is limited to repairing, replacing, or at its option issuing credit for any product returned during this period, and provided that any such defect has not been caused by misuse, neglect, improper installation, repair, or alteration. Coyote will not be liable and specifically disclaims responsibility to any party for loss, direct or indirect, for costs, expenses, or for consequential damage of any nature.

PUMP CONTROLLER

MAKE: RED JACKET

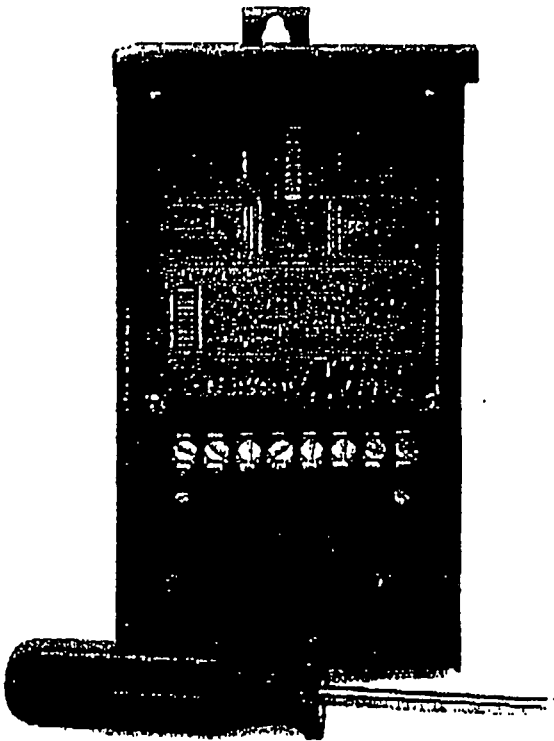
MODEL: MOTOR MINDER



REDJACKET[®]

Motor Minder

MODELS RJ101, RJ201 & RJ301



Effective Protection From Damage Caused By:

- Plugged Suction
- Dry Well
- Slow Recovery
- Cavitation or Airlock
- Loss of Flow
- Rapid Cycling
- Frozen Discharge Line
- Broken Shaft or Drive Coupling

Pump Monitoring System

The Red Jacket Motor Minder is a heavy duty motor control that protects pumps from burnouts caused by underload or rapid cycle conditions. When it detects an underload condition, the Red Jacket Motor Minder will automatically shut off the pump to prevent burnout and unnecessary wear to the pumping mechanism. The system will restart automatically after a set period, or it can be restarted manually.

System Sentinel

With Motor Minder's exclusive System Sentinel feature, you can easily diagnose the condition of your pumping system. The System Sentinel uses a series of lights which are visible through the panel cover. Two lights indicate the pump is in a normal operating condition. When one light is blinking, Motor Minder has turned off the pump. When no lights are on, you have a power failure, blown fuse, or a tripped circuit breaker. Now you can instantly determine your pump's operating status and prevent unnecessary service calls.

Features Benefits

Full Adjustability	Adjust the "Load Setting" and "Trip Point" to meet specific pump and application requirements. "Automatic Restart Timer" adjustable from 15 to 60 minutes.
Light Bar Display	Used for calibration and monitoring load status. When load drops, the light bar indicates your pre-set threshold. If the system is about to go out, the light bar will flash.
Easy to Install	Installs in minutes on new or existing systems. No plumbing required. Rain-tight housing.
Linear Toroid Sensing	Red Jacket uses an exclusive linear toroid which senses current. It is more reliable under locked rotor or other high current conditions.
Built-in Transient Protector	Protects the control from damage caused by lightning or line-voltage surges.
Choose from six models	Available in single- and three-phase models, from 115V to 575V. Also available in code-approved enclosure or panel mount.
Warranty	We are committed to ensuring your total satisfaction by offering a one-year warranty from date of installation, or 18 months from date of manufacture.

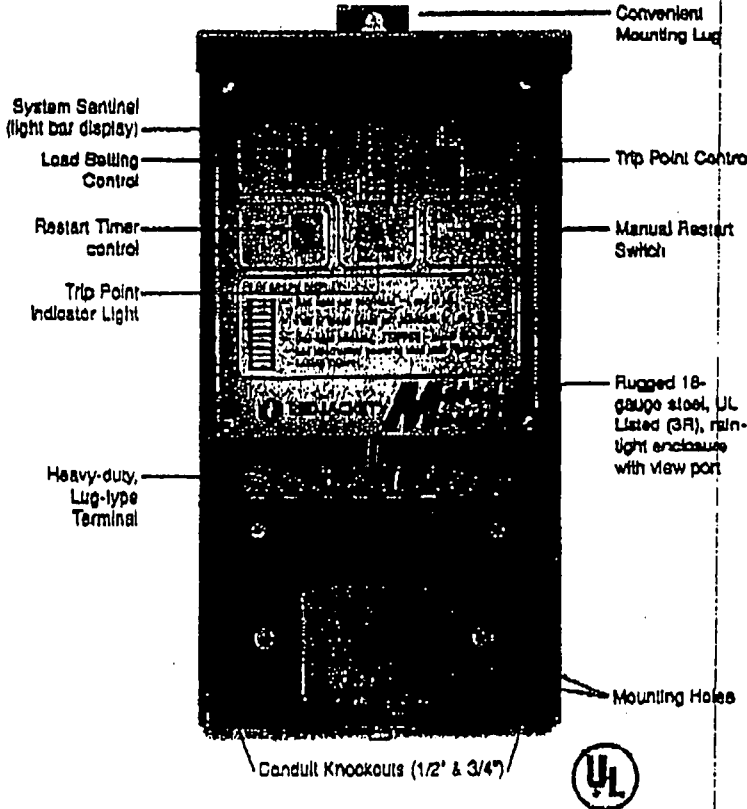
Motor Minder

Post-It® Fax Note	7671	Date	11-13-98	# of pages	3
To	JASON BELL	From	C. Kent		
Co./Dept.	H+L	Co.	PEERLESS MIDWEST		
Phone #		Phone #	219-254-9050		
Fax #	248-489-8048	Fax #	219-254-9650		

MODELS RJ101, RJ201 & RJ301

Options

- An optional relay can be added to automatically start a back-up pump or trigger an alarm when the primary system is shut off.
- A restart probe can be added to override the timer.
- An automatic counter can be added to check the number of "trip" cycles.
- Optional restart timers are available to customize timer needs.
- A logic output can be added for computer interface.
- A remote reset button can be placed off site.
- Optional panel-mount design available.



Specifications

Power consumption	3 watts (max)
Control Voltage (+/- 10%)	115/230 VAC
Response Times:	
1. Dry Well	3 sec. (max)
2. Air Lock	30 sec.
3. Rapid Cycle (2 sec. start/stop)	6 cycles
Pilot Duty Rating	960 VA
Term Block Rating	230 V, 28 Amp
Output contact Rating	2.0 HP @ 230 VAC
Horsepower Range	(See model listing)
Operating Temperature	-20°C to 85° C
Weight and Dimensions:	
Panel Mount	1.5 lbs., 7.125" x 4.1" x 2.5"
With 3R Enclosure	3.5 lbs., 8.5" x 4.5" x 3"

Model Information

Model	Control Voltage	Load Voltage	Phase	Horsepower
RJ101A	230	230	Single	to 2
RJ101B	115	115	Single	to 1.0
RJ201A	230	230*	Single	2 to 5
RJ201B	115	230*	Single	2 to 5
RJ301A	230	460*	Three	up to 15** 20 to 50**
RJ301B	115	460*	Three	up to 15** 20 to 50**

*Used on loads requiring mag starter/contactor.
**Includes external CT sensor. Specify CT1 5 to 15 HP or CT2 20 to 50 HP

Red Jacket Motor Minder is manufactured by INTEGRA, LLC, Longmont, CO, and distributed under license by Marley Pump, a United Dominion company. Direct product inquiries to:

Marley Pump, USA Tel: 800/282-7639
Fax: 913/498-5853

Available from:



7401 W. 129th St. • Overland Park, KS 66213 • 913/498-6700
Marley Pump reserves the right to make design improvements and pricing modifications as necessary and without notice. © 1994 Marley Pump Printed in USA

FLOW METER

MAKE: SENSUS

MODEL: SR 11

SIZE: 1"



SR II® Water Meters

DISPLACEMENT TYPE MAGNETIC DRIVE
COLD WATER METERS

5/8" (DN 15mm) 3/4" (DN 20mm) 1" (DN 25mm)

DESCRIPTION

APPLICATIONS: Measurement of cold water where flow is in one direction only; in residential, commercial and industrial services.

CONFORMANCE TO STANDARDS: Sensus SR II® Water Meters comply with ANSI/AWWA Standard C700-latest revision. Each meter is tested to insure compliance.

CONSTRUCTION: Sensus SR II® Water Meters consist of three basic components: maincase; measuring chamber; and sealed register. Maincases are of bronze with externally-threaded spuds. Registers are housed in a bronze bonnet, a bonnet of synthetic polymer is available as an option. Measuring chambers are of Rocksyn® a corrosion-resistant, tailored thermoplastic material formulated for long-term performance and especially suitable for aggressive water conditions. Maincase bottom plates are available in bronze or, if frost protection is desired, in cast iron or synthetic polymer.

REGISTER: Hermetically sealed; proven magnetic drive design eliminates dirt and moisture contamination, tampering and lens fogging problems. Standard register includes a straight-reading, odometer-type totalization display: a 360° test circle with center sweep hand; and a low flow (leak) detector. Gears are self-lubricating, molded plastic for long life and minimum friction.

No change gears are required for accuracy calibration. Generator and TouchRead System remote reading systems are available for all SR II Water Meters. (See other side of sheet for additional information.)

TAMPER RESISTANT FEATURE: A unique locking system prevents customer removal of the register to obtain free water. A special tool, available only to water utilities, is required to remove the register bonnet. When the optional plastic register bonnet is selected, a tamper detection seal is available.

MAGNETIC DRIVE: The SR II® features a hydrodynamically cushioned design that eliminates premature wear of components. The meter utilizes a positive, reliable drive coupling. (Patent pending.) The high-strength magnets used will eliminate "drive slip" in normal use and also provide adequate strength to drive remote register units.

OPERATION: Water flows through the meter's strainer and into the measuring chamber where it drives the piston. The hydrodynamically balanced piston oscillates around a central hub, guided by the division plate.

A drive magnet transmits the motion of the piston to a driven magnet located within the hermetically sealed register. The driven magnet is connected to the register gear train. It reduces the piston oscillations into volume totalization units displayed on the register dial face.

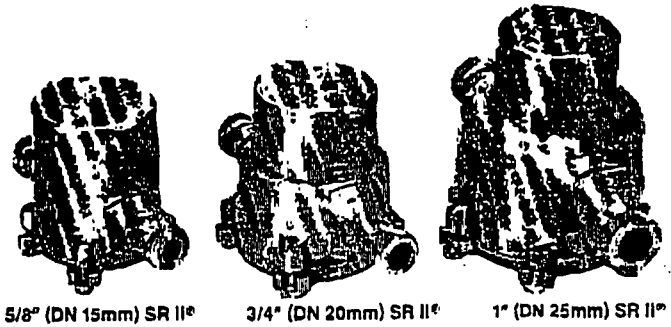
MAINTENANCE: Sensus SR II® Water Meters are engineered to provide long-term value and virtually maintenance-free operation. Simplicity of design and precise machining of components allows interchangeability of parts of like-size meters, reduced parts inventory requirements, and ease of maintenance. The register can be removed without relieving the water pressure or removing the maincase from the installation.

As an alternative to utility repair, Sensus offers maintenance programs to provide factory reconditioning of the maincase and replacement components at low fixed prices. See bulletin PD-301.

CONNECTIONS: Tailpieces/Unions for installing the meters on a variety of pipe types and sizes are available.

GUARANTEE: Sensus SR II® Water Meters are backed by the exclusive "Bronze-Clad SR II Guarantee." Ask your Sensus representative for details or see Bulletin PD-302.

SPECIFICATIONS



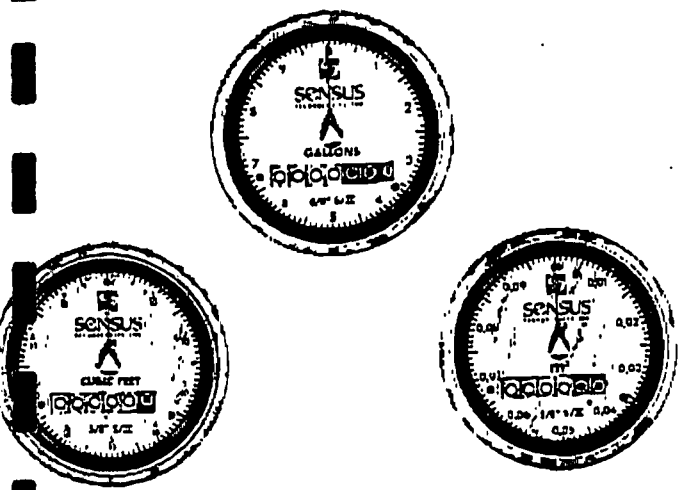
5/8" (DN 15mm) SR II® 3/4" (DN 20mm) SR II® 1" (DN 25mm) SR II®

SERVICE	Measurement of cold water with flow in one direction only.
*NORMAL OPERATING FLOW RANGE	5/8" (DN 15mm) size: 1 to 20 gal/min. (0.25 to 4.5 m³/h) 3/4" (DN 20mm) size: 2 to 30 gal/min. (0.45 to 7.0 m³/h) 1" (DN 25mm) size: 3 to 50 gal/min. (0.7 to 11.0 m³/h)
ACCURACY	100% ± 1.5% of actual thruput
LOW FLOW REGISTRATION	5/8" size: 95% at 1/4 gal/min. (0.06 m³/h) 3/4" size: 85% at 1/2 gal/min. (0.10 m³/h) 1" size: 95% at 3/4 gal/min (0.15 m³/h)
MAXIMUM PRESSURE LOSS	5/8" size: 7.0 psi at 20 gal/min. (0.5 bar at 4.5 m³/h) 3/4" size: 9.0 psi at 30 gal/min. (0.6 bar at 7.0 m³/h) 1" size: 7.3 psi at 50 gal/min. (0.5 bar at 11.0 m³/h)
MAXIMUM OPERATING PRESSURE	150 psi (10.0 bar)
MEASURING ELEMENT	Oscillating piston
REGISTER	Straight reading, hermetically sealed, magnetic drive. Remote reading unit optional.
REGISTRATION	10 gallons, 1 cubic foot or 0.1 m³/awEEP hand revolution. 10,000,000 gallons, 1,000,000 cubic feet or 100,000 m³ capacity. 8 odometer wheels.
**METER CONNECTIONS	5/8" (DN 15mm) size: 3/4" (26.4mm) threads 5/8" x 3/4" (DN 15mm x 33mm) size: 1" (33.25) threads 3/4" (DN 20mm) size: 1" (33.25) threads 3/4" x 1" (DN 20mm x 42mm) size: 1 1/4" (41.91mm) threads 1" (DN 25mm) size: 1 1/2" (41.91mm) threads (All threads are straight pipe, external type, conforming to ANSI B2.1 or ISO R226, if specified.)
MATERIALS	Maincase—Bronze Register box—Bronze (standard), synthetic polymer (optional) Measuring chamber—Rocksyn® Bottom plate—Bronze, cast iron or synthetic polymer Magnets—Plasticized material Casing bolts—Stainless steel Strainer—Synthetic polymer

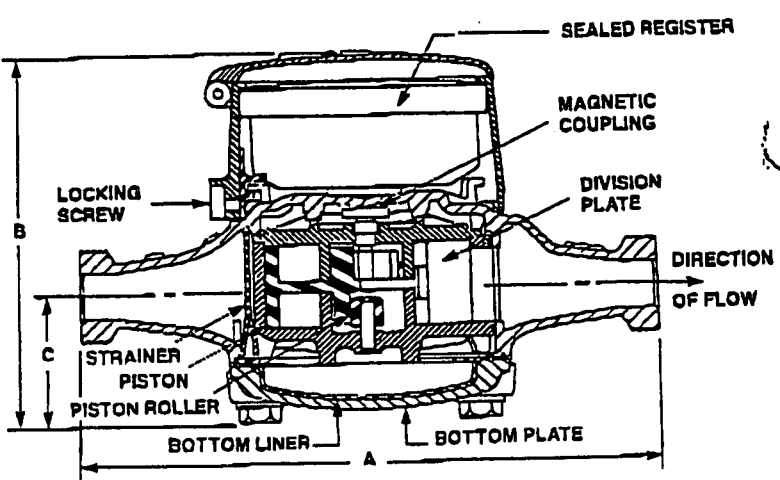
*Maximum rates listed are for intermittent flow only. Maximum continuous flow rates as specified by AWWA are:
5/8" (DN 15mm)—10 gal/min (2.3 m³/h)
3/4" (DN 20mm)—15 gal/min (3.4 m³/h)
1" (DN 25mm)—25 gal/min (5.7 m³/h)

**Unless otherwise noted, 5/8" size and 5/8" x 3/4" characteristics are identical. (5/8" x 3/4" designates 5/8" with 3/4" connection thread.) Also unless otherwise noted 3/4" size and 3/4" x 1" size characteristics are identical. (3/4" x 1" designates 3/4" with 1" connection thread.)
Metric designation is the nominal bore x the outside diameter.

†Synthetic polymer maincase bottom plate available on 5/8" meter only.



5/8" (DN 15mm) DIALS SHOWN



Dimensions and Net Weights

METER SIZE	A	B	C	WIDTH	NET WEIGHT*
5/8" (DN 15mm)	7-1/2" (190mm)	5.0" (127mm)	1-3/4" (44mm)	3-7/8" (98mm)	4.3 lb. (1.97 kg)
5/8" x 3/4" (DN 15mm x 33mm)	7-1/2" (190mm)	5.0" (127mm)	1-3/4" (44mm)	3-7/8" (98mm)	4.4 lb. (2.00 kg)
3/4" (DN 20mm)	9" (229mm)	5-1/2" (140mm)	2-3/16" (56mm)	4-1/2" (114mm)	6.4 lb. (2.90 kg)
3/4" x 1" (DN 20mm x 42mm)	9" (229mm)	5-1/2" (140mm)	2-3/16" (56mm)	4-1/2" (114mm)	6.6 lb. (2.99 kg)
3/4" short (DN 20mm)	7-1/2" (190mm)	5-1/2" (140mm)	2-3/16" (56mm)	4-1/2" (114mm)	6.2 lb. (2.81 kg)
1" (DN 25mm)	10-3/4" (273mm)	6-13/16" (173mm)	2-3/4" (70mm)	6-5/8" (168mm)	11.9 lb. (5.4 kg)

*with Rocksyn® measuring chamber.

Remote Systems—For use with all sizes of Sensus Water Meters

The TouchRead® Automated Meter Reading and Billing System—is a multi-purpose encoded remote system suitable for indoor and/or outdoor use. The Electronic Communications Register (ECR) uses a wired connection between the meter and an outside remote TouchPad data transfer module.

With a TouchRead PitLid (TR/PL) module, pit-set meters can be read automatically without lifting the meter box lid. The meter register, factory sealed to the PitLid module, is interrogated by touching a PitProbe to a lid mounted module to read and store meter data, even in flooded pits.

A non-remote version of the TouchRead® System is also available

for pit-set meters. It uses a data transfer module factory sealed to the top of the register. The TouchRead Convertible (TRC) register can later be field converted to be compatible with centralized automatic meter reading. All versions can be read with a visual reading device, and/or a TouchRead System Interrogator/Recorder. For detailed information on TouchRead System equipment refer to bulletins RS-983, TR-984, RS-990 and TR-995.

Self Generating Remote (GTR)—In the GTR remote system a meter generates and transmits an electrical pulse via a wired connection to a remote totalizer. The meter's generator unit is submersible. See data sheet RS-966.



Sensus Technologies, Inc.
450 N. Gallatin Avenue
Uniontown, PA 15401
TOLL FREE HOTLINE
1-800-METER-IT
1-800-638-3748

Authorized Distributor

FLOW METER

MAKE: NEPTUNE

SIZE: 1 1/2"

Schlumberger

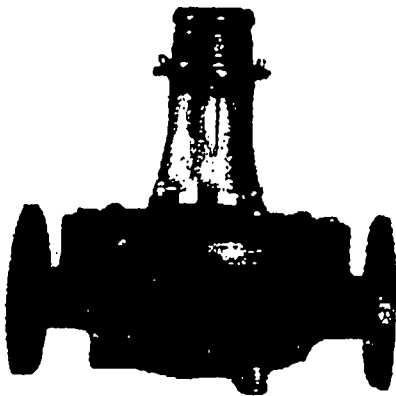
neptuna®

25 mm (1 in), 38 mm (1-1/2 in) & 50 mm (2 in) TYPE S FLOWMETERS WITH MODEL 157 AND 800 SERIES REGISTERS

TS-105

Rev. 0-98-03-03

1", 1-1/2", and 2" Type S Flowmeters	
25 mm (1 in)	090003
38 mm. (1-1/2 in)	090004
50 mm (2 in)	090005



1-1/2" Type S with
Model 157 Register



1" Type S with
Model 832 Register

- * Nutating Disc Positive-Displacement Disc Principle
- * Ideal for Continuous Operation
- * Change Gears for Positive Calibration
- * Repeatability $100 \pm 0.1\%$ of Rate
- * Minimal Maintenance
- * Compatible with Hundreds of Non-Acidic Liquids

SPECIFICATIONS

DESCRIPTION

The 1", 1-1/2", and 2" Type S flowmeters utilize the nutating disc positive displacement measuring chamber technology. This design results in an extremely accurate flowmeter that is insensitive to small changes in viscosity and flow profile disturbances. Each flowmeter includes a base unit, that houses and protects the measuring chamber, and a gear train. Registers provide record of delivery and totalization. A wide variety of pulse transmitters permit remote operation and monitoring.

DESIGN FEATURES

SUSTAINED ACCURACY

The SCHLUMBERGER nutating disc measuring chamber is both accurate ($100\% \pm 1.0\%$) and dependable, with repeatability of $100 \pm 0.1\%$. For specific flow ranges, accuracies of $100\% \pm 0.5\%$ are easily obtained. In addition, the disc design permits accurate measurement of liquids with non-abrasive, solid particles (up to 0.22 mm/0.009 in.) without major damage or erosion to the measuring chamber for intermittent (i.e., batching) operations.

FLEXIBILITY

The rugged bronze outer body components are compatible with hundreds of non-acidic liquids. Flanged

end connections allow rapid conversion from right to left hand flow. Pulse transmitters, when used with the BATCHMATE (electronic batch control) and a locally acquired solenoid valve, result in an economical and dependable local or remote batching system.

LONG SERVICE LIFE

Rugged construction of Type S flowmeters assure a system that is simple to operate and economical to use. Furthermore, Type S flowmeters have been proven through more than 100 years of manufacturing experience.

EASE OF MAINTENANCE

Type S flowmeters do not require elaborate timing gears or difficult adjustment procedures. Replacement of a worn or damaged measuring chamber, gear train, or register is both simple to accomplish and requires minimal time.

POSITIVE AND ACCURATE REGISTRATION

Positive adjustment through patented SCHLUMBERGER calibration (change) gears allow changes down to 0.15% increments and reduce errors caused by vibration and tampering.

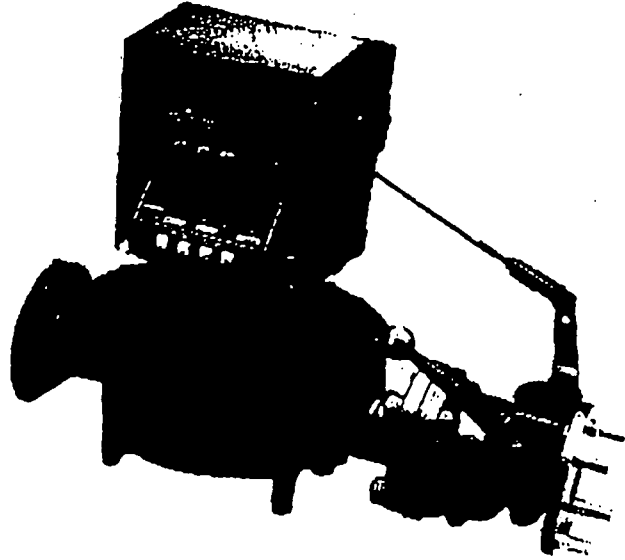
MECHANICAL PRESET VALVES

Schlumberger 1- and 2- stage mechanical auto-stop valves are available for all 1", 1-1/2", and 2" Type S Flowmeters. They must accompany an appropriate 800 Series mechanical preset register.

Single Trip preset valves are either fully open or fully closed. They may be specified for flow rates up to 190 LPM (50 GPM) where hydraulic shock is not a factor. Single trip valves are also used with larger flowmeters to measure liquids that have viscosities over 10,000 SSU/1400 cPs.

Double Trip preset valves permit controlled valve closing. Controlled valve closing reduces the potential for hydraulic shock on both the dispensing lines and the meter itself. Double trip valves are recommended when measuring liquids with viscosities less than 10,000 SSU/1400 cPs that have either high operating pressures or flow rates exceeding 190 LPM (50 GPM).

Preset valves may be installed on either the inlet or the outlet of the flowmeter. However, installation on the outlet side is preferred in order to keep the flowmeter full and to maintain accuracy. A fine mesh line strainer should be installed upstream of the flowmeter and valve combination. The purpose of the strainer is to prevent foreign particles from damaging both the measuring chamber in the flowmeter and the piston/cylinder assembly in the preset valve.



2" Type S with 800 Series Register and Auto-Stop Valve

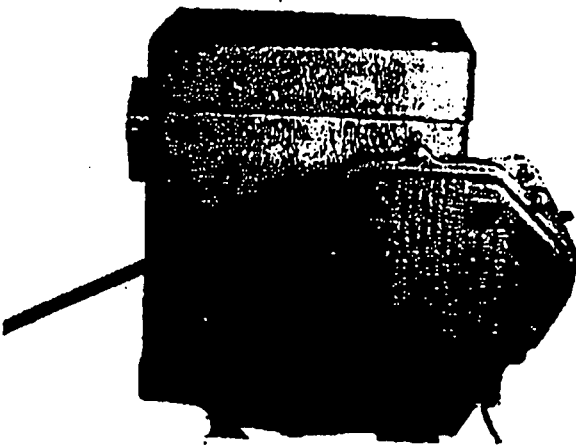
MECHANICAL REGISTER SWITCHES

Schlumberger Model 23 Auto-Switches are micro switch devices that attach to 800 Series Preset Registers. They control pump and/or solenoid valves that are used in place of mechanical auto-stop valves. Upon completion of delivery, the auto-switch provides contact closures to close the valve stages and finally de-energize the pump. This orderly system shutdown reduces wear, saves energy, and alleviates hydraulic shock on the system.

Model 23A switches are Double-Pole Double-Throw (DPDT). They provide two (2) switch closures for 2-stage valve shut down, with the final closure de-energizing.

Model 23B switches are Single-Pole Double Throw. They provide one (1) switch closure for single stage valve shut down and pump de-energizing.

Both Models 23A and 23B switches are U.L. listed for hazardous location usage Class I, Group D; at 15 amps at 125 to 250 VAC; 0.5 amps at 125 VDC; and 0.25 amps at 250 VDC.



Model 23 Auto-Switch on Back of 800 Series Preset Register

FLOWMETER OPERATING SPECIFICATIONS

CATEGORY	1" TYPE S	1-1/2" TYPE S	2" TYPE S
Type of Measuring Element	Positive Displacement Double Case Nutating Disc		
End Connections (Threaded)	1-1/2" NPT threaded coupling with Model 157 Register	Not Applicable	
End Connections (Flanged)	1-1/2", 2 bolt oval, 150#	2", 4 bolt round, 125#	
Temperature Rating (T Max)	121°C (250°F)		
Pressure Ratings	10.34 bar (150 psi) @ 121°C	8.6 bar (125 psi) @ 121°C	
Flow Range (Q Max) (Q Min)	189 LPM (60 GPM) 19 LPM (5 GPM)	379 LPM (100 GPM) 38 LPM (10 GPM)	616 LPM (160 GPM) 62 LPM (16 GPM)
Totalized Units	10 Litres, 10 Kilograms, 10 Pounds, 1 US Gallon, or 10 US Gallons		
Enclosure Class	Totally mechanical. If interfaced with a pulse transmitter, the rating of the device applies.		
Power Supply	None, unless fitted with a pulse transmitter, then the rating of the installed device applies.		
Main Body Material	Bronze (over 75% Cu)		
Main Body Cover Material	Bronze (over 75% Cu)		
Nutating Disc	Ryton		
Shaft Material	Stainless Steel		
Packing Gasket Material	Viton Klingsail		
Type of Coupling	Mechanical		
Register Type	Model 157 Register: Non-Resettable, 7 digit Totalizer Capacity: Totalizer 9999999 800 Series Register: Resettable (5 digit), 8 digit Totalizer Capacity: Totalizer 99999999; Reset 99999		
Alternate Units of Measure	Only with pulse transmitter and BATCHMATE (Batch Control Computer)		
Auto Stop Valve	Single and Double Trip (Mechanical)		
Switch a. Single Stage h. Double Stage	Model 23B Model 23A		
Transmitter Type	Consult Form TS-510		
Transmitter Output	Consult Form TS-510		
Air Eliminator	Optional		
Strainer Size and Mesh	Recommend 20 mesh minimum		
Manufacturer	Schlumberger Industries, Measurement Division		
Model Number	090003-XXX	090004-XXX	090005-XXX

METER

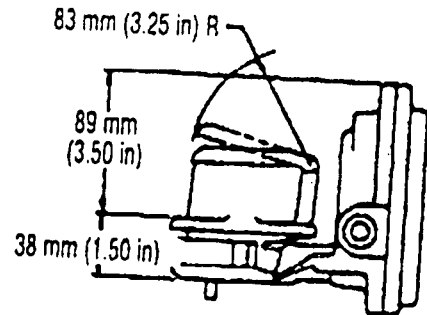
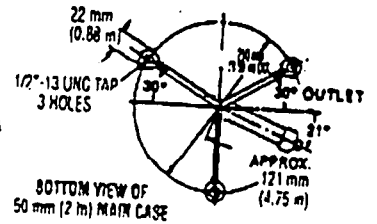
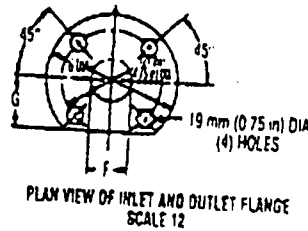
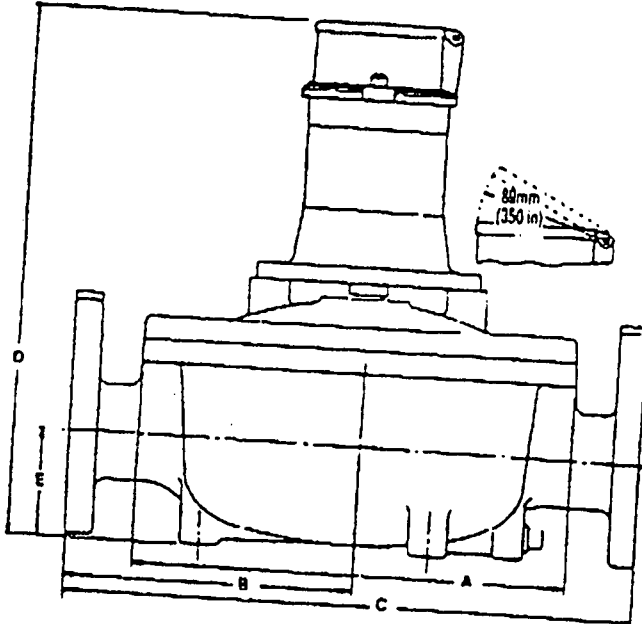
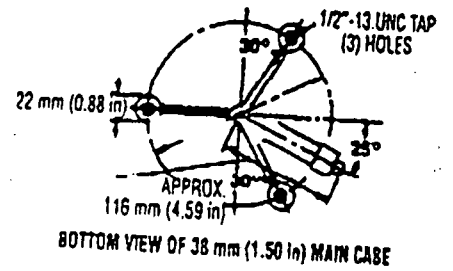
COUNTER AND OPTIONS

DIMENSIONAL DATA

DIMENSIONS - Millimeters (Inches)

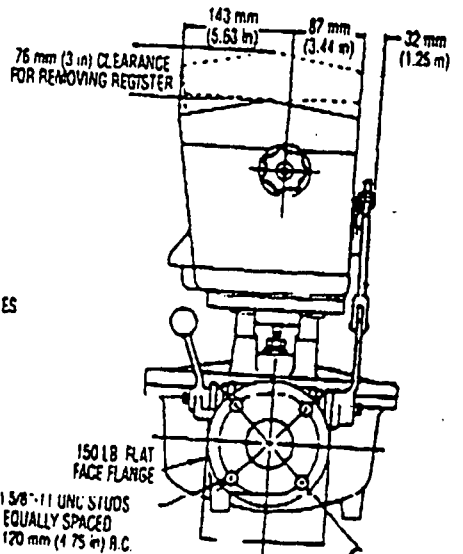
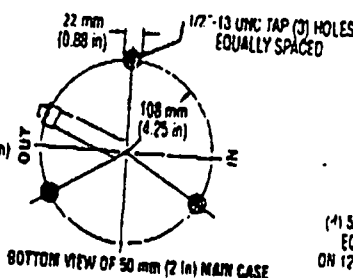
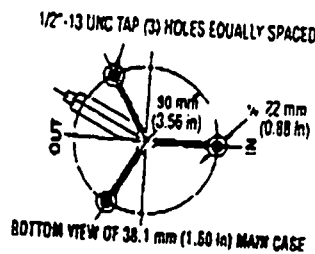
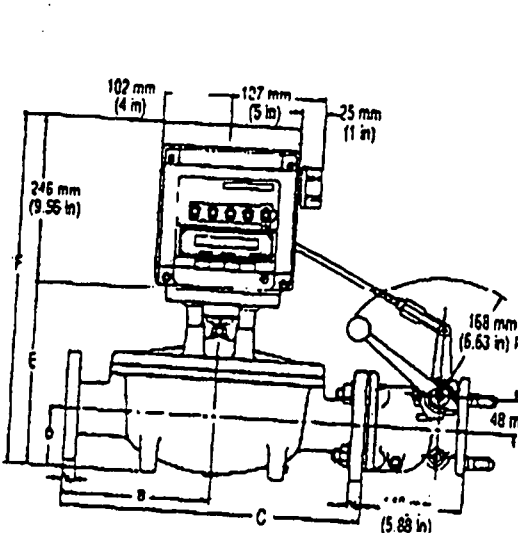
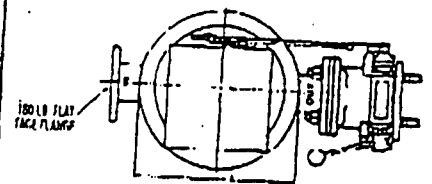
**38 mm (1-1/2 in) and 50 mm (2 in)
Type S with Model 157 Register**

Flowmeter Size	A	B	C	D	E	F	Weight kg (lb)
38 (1-1/2)	256 (10.06)	165 (6.50)	330 (13.00)	60 (2.38)	181 (7.13)	441 (17.38)	42.2 (93)
50 (2)	311 (12.25)	216 (8.50)	432 (17.00)	92 (3.63)	232 (9.13)	473 (18.63)	55.3 (122)



**38 mm (1-1/2 in) and 50 mm (2 in)
Type S with 800 Series Register**

Flowmeter Size	A	B	C	D	E	F	G	Weight kg (lb)
38 (1-1/2)	258 (10.06)	165 (6.50)	330 (13.00)	3.18 (12.44)	60 (2.38)	41 (1.63)	65 (2.56)	21.3 (47)
50 (2)	311 (12.25)	216 (8.50)	432 (17.00)	349 (13.75)	89 (3.50)	54 (2.13)	59 (2.31)	32.7 (72)

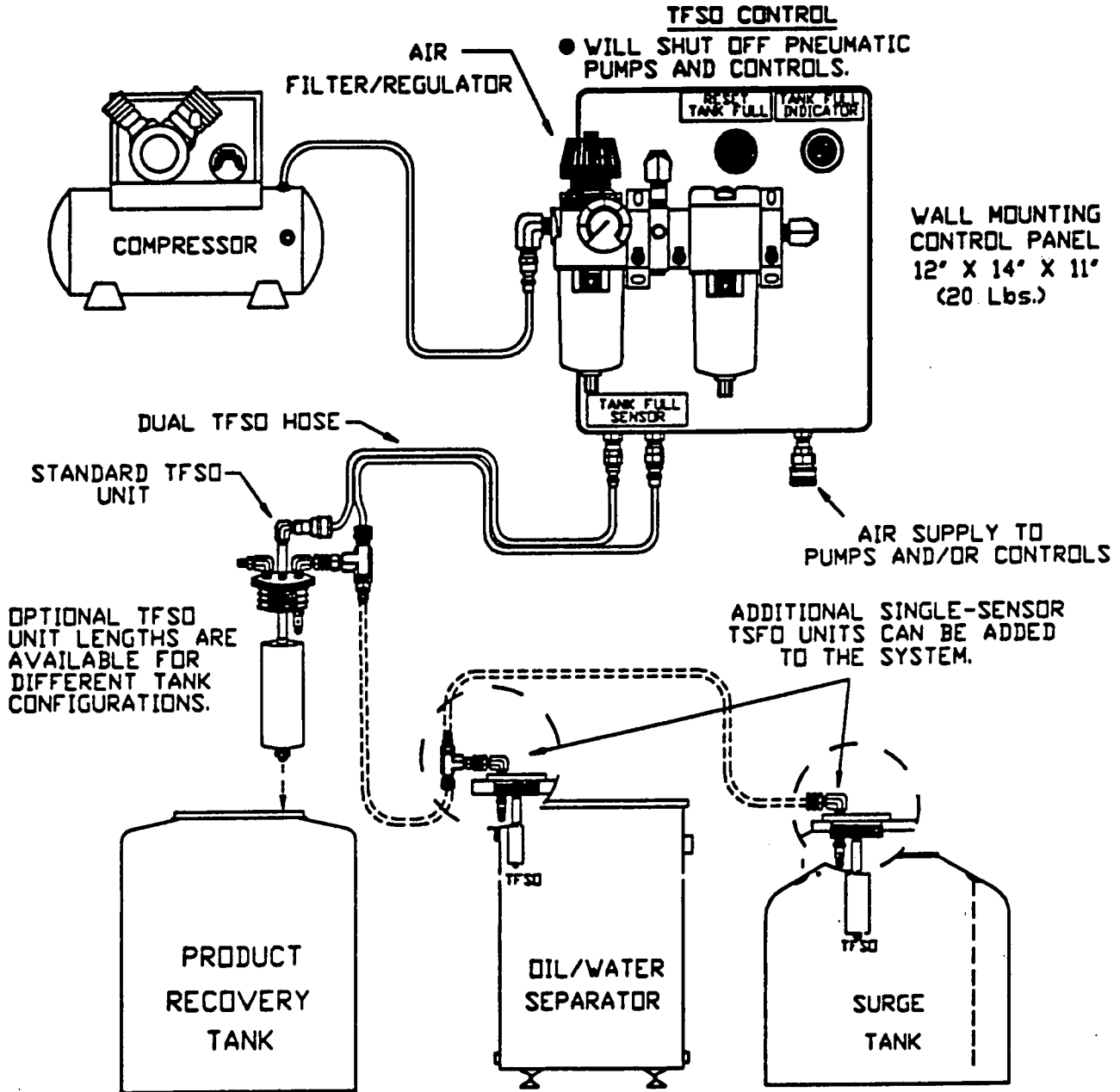


APPENDIX B
PRODUCT RECOVERY SYSTEMS – COMPONENT
MANUFACTURER CUT SHEETS

**PNEUMATIC SELECTIVE OIL SKIMMER SYSTEM –
MANUFACTURES CUT SHEETS**

DUAL TANK FULL SHUT OFF (TFSO) SENSOR SYSTEM

THE CEE TFSO SYSTEM PROTECTION EXTENDS BEYOND THE CLASSIC PRODUCT TANK-FULL CONDITION. IT ALSO INCLUDES THE SENSOR HOSES FOR ADDED SITE SAFETY. IN ADDITION, ALL EQUIPMENT RECEIVING AIR THAT IS FED BY, AND DOWNSTREAM OF, THE TFSO CONTROL, INCLUDING FLUID EXTRACTION PUMPS AND SKIMMERS, WOULD ALSO BE SHUT DOWN.



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

CLEAN ENVIRONMENT ENGINEERS, INC.



EQUIPMENT FOR FUEL SPILL REMEDIATION AND GROUNDWATER CLEAN-UP

5835 DOYLE STREET, SUITE 102
ENERGYVILLE, CA 94608

(510) 654-4240 (800) 537-1767 FAX (510) 654-4193

TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR : 30°		APPROVALS	DATE	TITLE DUAL TANK FULL SHUT OFF (TFSO) SENSOR SYSTEM	
FRAC : JOK : 805 JOK : 81 JOKK : 8005		DRAWN TONY RAMIREZ	25-19-92	DESIGNER	MODEL No.
MATERIAL		CHECKED		REV	
FINISH		APPROVED		SCALE	DWT OF
				NONE	1 1

CLEAN ENVIRONMENT EQUIPMENT

SOS SELECTIVE OIL SKIMMER (FOR 2" AND 4" WELLS)

FUNCTION:

The Selective Oil Skimmer can essentially remove all free floating hydrocarbon on groundwater without removing any water. It can remove the hydrocarbon to a sheen or about two-hundredths (.02") of an inch. Alternate size SOS skimmers are available for operating in 2" (5 cm) and 4" (10 cm) diameter wells to a depth of 250 feet.

METHOD OF OPERATION:

The skimmer float slides up and down on a guide tube which serves to center the device in the well and also carry oil from the skimmer up out of the well. The skimmer float can then follow the fluctuation of water level in the well and maintain its designed inlet level at the oil/water interface. A semi-permeable screen inside the skimmer float allows oil to pass into the skimmer, but repels water. Water will be excluded unless the skimmer float is forcibly submerged 2 inches beneath the water.

There are no electrical switches or sensors in or around the skimmer. When the oil has been removed to a sheen, the skimmer merely passes air to the pumps, which are designed to be able to run dry without damage. Air-driven double diaphragm pumps or SOS product bladder pumps can be used with this skimmer. The SOS skimmer can be used with water draw-down to draw more oil into the well.

The skimmer can be steam cleaned without damage.

FLOW RATE:

2" Skimmer: 0.25 gallons (0.9 liters) per minute / 360 gpd

4" Skimmer: 0.7 gallons (2.6 liters) per minute / 1000 gpd

SIZE:

2" Skimmer: Floating skimmer head at 1.75" (4.4 cm) in diameter and 8" (20 cm) in height

The full skimmer is 36" (91 cm) long including a 30" (76 cm) guide tube and 1.8" (4.6 cm) diameter centering disk

SOS Selective Oil Skimmer (cont'd)

SIZE (cont'd):

4" Skimmer: Floating skimmer head at 3.7" (9.4 cm) in diameter and 6" (15 cm) in height
The full skimmer is 48" (122 cm) long including a 30" (76 cm) guide tube and 3.8" (9.6 cm) diameter centering disk

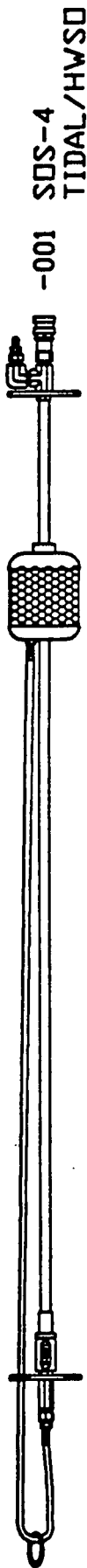
WEIGHT:

2" Skimmer: 2 pounds (.9 kg)
4" Skimmer: 3.5 pounds (1.6 kg)

MATERIAL OF CONSTRUCTION:

Stainless Steel, Brass, Aluminum, Polymer Plastics, Delrin and Nylon

→ 5' ←



-001 SDS-4
TIDAL/HWSO



-002 SDS-4 TIDAL



-003 SDS-4
STANDARD/HWSO



-004 SDS-4
STANDARD



-005 SDS-4
SHORT TRAVEL



-006 SDS-4
BOTTOM SKIMMER

	FLOAT RANGE	MINIMUM WATER REQ'D	FULLY EXTENDED LENGTH	WEIGHT Lb. (Kg)
-001	51' (130 cm)	45' (114 cm)	102' (259 cm)	5 Lbs (2.25 Kg)
-002	51' (130 cm)	45' (114 cm)	101' (257 cm)	5 Lbs (2.25 Kg)
-003	21' (53 cm)	30' (76 cm)	59' (150 cm)	4 Lbs (2 Kg)
-004	23' (58 cm)	30' (76 cm)	59' (150 cm)	4 Lbs (2 Kg)
-005	9' (23 cm)	22' (56 cm)	37' (94 cm)	3 Lbs (1.5 Kg)
-006	9' (23 cm)	5' (13 cm)	24' (61 cm)	3 Lbs (1.5 Kg)

CLEAN ENVIRONMENT ENGINEERS, INC.
EQUIPMENT FOR FUEL SPILL REMEDIATION
AND GROUNDWATER CLEAN-UP



5805 BOTLE STREET, SUITE 102
EMERYVILLE, CA 94608

CSID 634-4248 (800) 537-1767 FAX CSID 634-4193

TOLERANCES UNLESS OTHERWISE SPECIFIED		APPROVALS		DATE		TITLE	
FRACTION	ANGULAR	DESIGNED BY	DATE	DESIGNED BY	DATE	DESIGNED BY	DATE
IN	DEG	JOHN RAMIREZ	2-22-91	JOHN RAMIREZ	2-22-91	JOHN RAMIREZ	2-22-91
DECIMAL	INCHES	CHECKED BY	DATE	CHECKED BY	DATE	CHECKED BY	DATE
FRAC	INCHES	W. E. BROWN	2-22-91	W. E. BROWN	2-22-91	W. E. BROWN	2-22-91
SCALE	SCALE	APPROVED BY	DATE	APPROVED BY	DATE	APPROVED BY	DATE
1" = 1'	1" = 1'						
MATERIAL				4" SELECTIVE OIL SKIMMERS			
FRESH				MODEL No. SDS-4's			
				REV			
				DATE			
				NO. OF			
				1 1 1			

CLEAN ENVIRONMENT EQUIPMENT

SOS PRODUCT BLADDER PUMP

FUNCTION:

This pump operates inside a well and draws oil up, out of the skimmer and pushes it to the surface. It can operate at depths of 0 to 250 feet. The SOS bladder pump can operate in wells as small as 2" (5 cm) in diameter. The pump is designed to meet stringent air quality standards. Hydrocarbon never comes in contact with the air inside the pump. Therefore, the exhausted air is very clean compared to that exhausted from a direct contact pump.

METHOD OF OPERATION:

Compressed air is introduced to the pump which collapses a bladder inside the pump. When the air is released the bladder expands drawing oil inside. Check valves at the inlet and outlet prevent oil from flowing back down towards the skimmer.

The pumps can be steam cleaned without damage.

FLOW RATES:

PP2-24

- 160 gallons per day with a cycle rate of 4 times per minute
- **Size:** The body is 24" long; however, with the check valves and hoses extends to a full 70" (5'10"long)
- **Diameter:** 1.5" (3.8 cm)
- **Weight:** 4 pounds (1.8 kg)

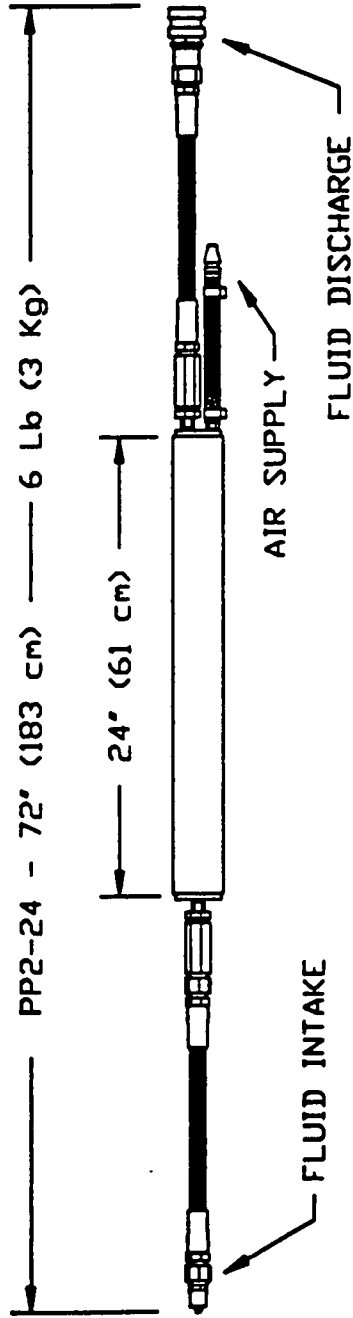
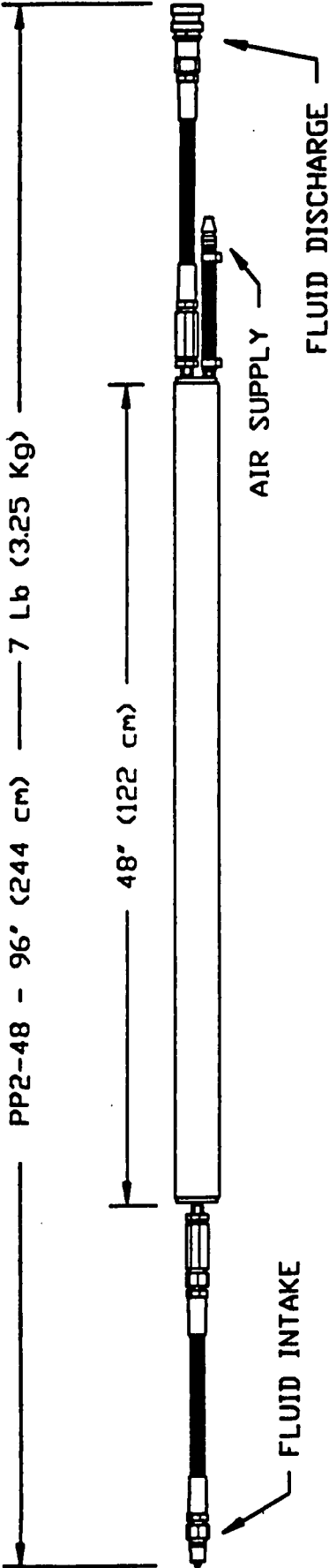
PP2-48

- 320 gallons per day with a cycle rate of 4 timer per minute
- **Size:** The body is 48" long; however, with the check valves and hoses extends to a full 96" (8 ft)
- **Diameter:** 1.5" (3.8 cm)
- **Weight:** 6 pounds (2.7 kg)

MATERIALS OF CONSTRUCTION:

Stainless Steel, Brass, Teflon and Viton

DEEP WELL PRODUCT BLADDER PUMPS



CLEAN ENVIRONMENT ENGINEERS, INC.
 EQUIPMENT FOR FUEL SPILL REMEDIATION
 AND GROUNDWATER CLEAN-UP



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 EMERYVILLE, CA 94608

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TOLERANCES UNLESS OTHERWISE SPECIFIED		APPROVALS		DATE		TITLE	
FRAC :	.XXX : .005	DRAWN	TONY RAMIREZ	10-3-91		DEEP WELL PRODUCT	
XX :	.01	DESIGNER				BLADDER PUMPS	
MATERIAL		CHECKED				MODEL No.	PP2-24 AND PP2-48
FINISH		APPROVED				REV	
						SCALE	NONE
						SMT	DF 1 1

INGERSOLL-RAND®

AIR COMPRESSORS

Ingersoll-Rand Company
Reciprocating Compressor Division
Small Compressor Business Unit
Campbellsville, KY 42718



Important information!
Read and follow these
instructions. Retain for
reference.

Owner's Manual

Installation, Operation and Maintenance Instructions for T30 Models 2340, 2475 and 2545

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WARRANTY

An extended, two-year warranty is available for compressors that use All Season T30 Select® synthetic compressor lubricant from start-up and continue operating solely with All Season T30 Select for the entire two-year period. This warranty applies to the bare compressor pump only. The use of other lubricants limits warranty to one year.

Other components on packaged compressors (motor, engine, etc.) are subject to the component manufacturer's warranty.

Warranties or other terms and conditions of sale shall be in accordance with Ingersoll-Rand's standard terms and conditions of sale for such products which are outlined in the warranty registration card provided with each compressor.

SAFETY

DEFINITIONS

DANGER! WILL cause DEATH, SEVERE INJURY or substantial property damage.

WARNING! CAN cause DEATH, SEVERE INJURY or substantial property damage.

CAUTION! WILL or CAN cause MINOR INJURY or property damage.

BREATHING AIR PRECAUTION

Ingersoll-Rand air compressors are not designed, intended or approved for breathing air. Compressed air should not be used for breathing air applications unless treated in accordance with all applicable codes and regulations.

GENERAL SAFETY PRECAUTIONS

- Do not directly inhale compressed air.
- Follow precautions on container labels before spraying materials such as paint, insecticide and weed killer.
- Wear a respirator and safety glasses when spraying.
- Do not over-pressurize the receiver tank or similar vessels beyond design limits.
- Do not use a receiver tank or similar vessels that fail to meet the design requirements of the compressor. Contact your distributor for assistance.
- Do not drill into, weld or otherwise alter the receiver tank or similar vessels.

- Do not remove, adjust, bypass, change, modify or make substitutions for safety/relief valves, pressure switches or other pressure control related devices.
- Do not use air tools or attachments without first determining the maximum pressure recommended for that equipment.
- Do not point air nozzles or sprayers toward anyone.
- Do not touch the compressor pump, motor or engine or discharge tubing during or shortly after operation. These parts become hot.
- Wear eye protection when operating or servicing compressor.
- Do not operate where flammable or explosive liquids or vapors such as gasoline, natural gas and solvents are present.
- Do not operate with guards or shields removed, damaged or broken.
- Do not remove, paint over or deface decals. Replace any missing decals.

RECEIPT & INSPECTION

Ensure adequate lifting equipment is available for unloading and moving your compressor to the installation site.

NOTE: Lifting equipment must be properly rated for the weight of the compressor.

Lift the compressor by the shipping skid only.

CAUTION! Do not work on or walk under the compressor while it is suspended.

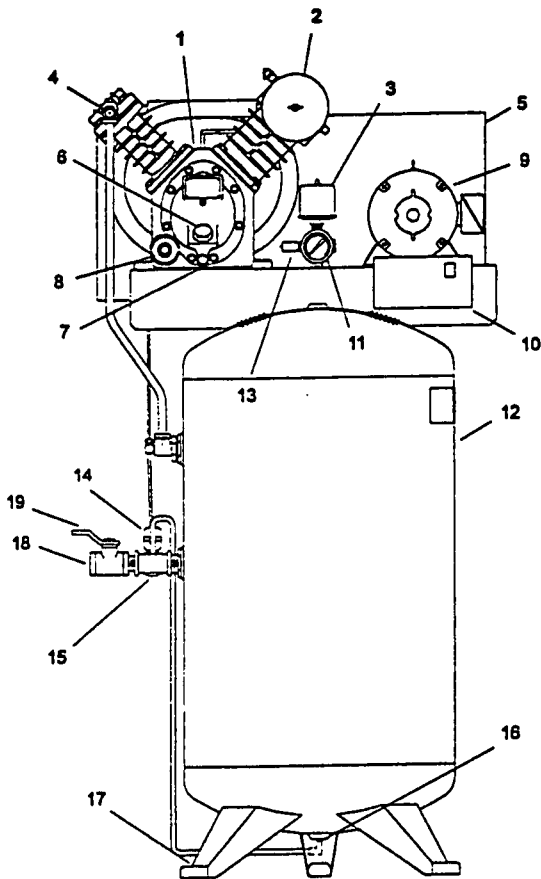
Before signing the delivery receipt, inspect for damage and missing parts. If damage or missing parts are apparent, make the appropriate notation on the delivery receipt, then sign the receipt. Immediately contact the carrier for an inspection. All material must be held in the receiving location for the carrier's inspection. Delivery receipts that have been signed without a notation of damage or missing parts are considered to be delivered "clear." Subsequent claims are then considered to be concealed damage claims. Settle damage claims directly with the transportation company.

If you discover damage after receiving the compressor (concealed damage), the carrier must be notified within 15 days of receipt and an inspection must be requested by telephone with confirmation in writing. On concealed damage claims, the burden of establishing that the compressor was damaged in transit reverts back to the claimant.

Read the compressor nameplate to verify it is the model ordered, and read the motor nameplate to verify it is compatible with your electrical conditions. Make sure electrical enclosures and components are appropriate.

Typical Receiver Tank Mounted, Electric Motor Driven Model. Gasoline engine driven models also available.

Component locations and appearance may vary. Designs and specifications are subject to change without notice or obligation.



- (1) Bare compressor pump
 - (2) Air inlet filter assembly
 - (3) Pressure switch
 - (4) Discharge safety/relief valve
 - (5) Beltguard
 - (6) Lubricant fill
 - (7) Lubricant drain
 - (8) Low oil level switch (if provided)
 - (9) Electric motor
 - (10) Motor starter (if provided)
 - (11) Pressure gauge
 - (12) Air receiver tank
 - (13) Air receiver tank safety/relief valve
 - (14) Automatic drain valve (if provided)
 - (15) Manual drain valve (location when supplied with automatic drain valve)
 - (16) Manual drain valve (location when not supplied with automatic drain valve)
 - (17) Mounting holes
 - (18) Air outlet
 - (19) Service valve
- * Air-cooled aftercooler in back, if provided (not shown)

INSTALLATION

SELECTING A LOCATION

General. For electric motor driven models, select a well-lighted indoor area with plenty of space for proper cooling air flow and accessibility. Locate the compressor at least 15 inches (38 cm) from walls, and make sure the main power supply is clearly identified and accessible.

For gasoline engine driven models, keep the engine at least 3 feet (1 m) away from building walls and other equipment. Do not install or operate in a confined area.

Temperature. Ideal operating temperatures are between 32°F and 100°F (0°C and 37.8°C). If temperatures consistently drop below 32°F (0°C), install the compressor inside a heated building. If this is not possible, you must protect safety/relief valves and drain valves from freezing. If temperatures are consistently below 40°F (4.4°C), consider installing a crankcase heater kit, especially if the compressor has difficulty starting.

CAUTION! Never operate in temperatures below -15°F (-26.1°C) or above 125°F (51.0°C).

Humid Areas. In frequently humid areas, moisture may form in the pump and produce sludge in the lubricant, causing running parts to wear out prematurely. Excessive moisture is especially likely to occur if the compressor is located in an unheated area that is subject to large temperature changes.

Two signs of excessive humidity are external condensation on the compressor when it cools down and a "milky" appearance in petroleum lubricant.

You may be able to prevent moisture from forming in the pump by increasing ventilation, operating for longer intervals or installing a crankcase heater kit.

Noise Considerations. Consult local officials for information regarding acceptable noise levels in your area. To reduce excessive noise, use vibration isolator pads or intake silencers, relocate the compressor or construct total enclosures or baffle walls. Contact your Distributor for assistance.

MOUNTING

WARNING! Remove the compressor from the skid before mounting.

Bolt the compressor to a firm, level foundation (such as a concrete floor). Do not bolt uneven feet tightly to the foundation, as this will cause excessive stress on the receiver tank. Use metal shims under the "short" feet if necessary.

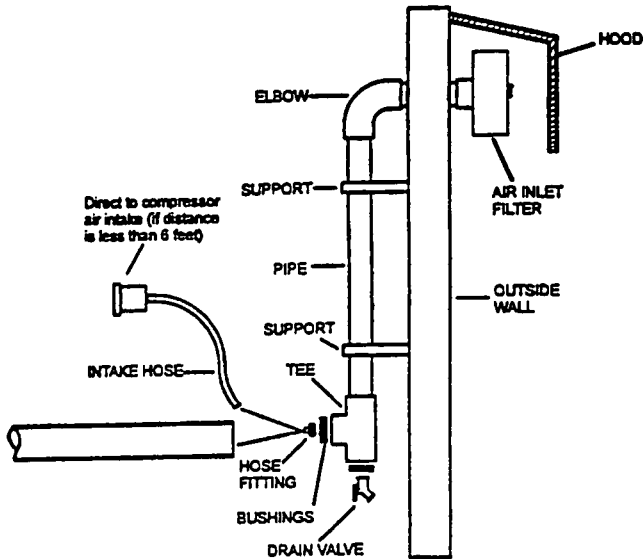
Gasoline engine driven models mounted on truck beds must be fastened securely without applying excessive stress on the receiver tank. We recommend installing a vibration isolator kit.

INSTALLING REMOTE AIR INLET PIPING

CAUTION! Do not operate without air inlet filter.

If the air around the compressor is relatively free of dirt, install the air inlet filter at the inlet connection at the pump. If the air is dirty, pipe the filter to a source of clean air. Use PVC plastic tubes. Do not use black pipe or galvanized pipe, as these promote sweating and rust. Consider installing an in-line type filter for ease of cleaning and replacement. Make the line as short and direct as possible and as large, or larger, than the diameter of the inlet connection on the pump. Do not install piping with a diameter lower than that of the compressor intake.

Typical Remote Air Inlet Piping.



Increase the pipe diameter one size for every 10 feet (3 m) of length or every 90° bend. Make sure the piping is adequately braced.

If you pipe the filter outdoors, cover it with a hood to prevent the entrance of rain or snow.

Heavy duty filter elements and filtration equipment for fine airborne dust, such as cement and rock dust, are available through your Distributor.

INSTALLING DISCHARGE PIPING

WARNING! Do not use plastic pipe, soldered copper fittings, rubber hose, or lead-tin soldered joints anywhere in the compressed air system.

CAUTION! If you will be using All Season T30 Select lubricant, all downstream piping material and system components must be compatible. Refer to the following material compatibility list. If there are incompatible materials present in your system, or if there are materials not included in the list, contact your Distributor.

Suitable

Viton®[®], Teflon®[®], Epoxy (Glass Filled), Oil Resistant Alkyd, Fluorosilicone, Fluorocarbon, Polysulfide, 2-Component Urethane, Nylon, Delrin®[®], Celcon®[®], High Nitrile Rubber (Buna N, NBR more than 36% Acrylonitrile), Polyurethane, Polyethylene, Epichlorohydrin, Polyacrylate, Melamine, Polypropylene, Baked Phenolics, Epoxy, Modified Alkyds
(® indicates trademark of DuPont Corporation)

Not Recommended

Neoprene, Natural Rubber, SBR Rubber, Acrylic Paint, Lacquer, Varnish, Polystyrene, PVC, ABS, Polycarbonate, Cellulose Acetate, Low Nitrile Rubber (Buna N, NBR less than 36% Acrylonitrile), EPDM, Ethylene Vinyl Acetate, Latex, EPR, Acrylics, Phenoxy, Polysulfones, Styrene Acrylonitrile (San), Butyl

NOTE: All compressed air systems generate condensate which accumulates in any drain point (e.g. tanks, filters, drip legs, aftercoolers, dryers). This condensate contains lubricating oil and/or substances which may be regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

General Requirements. The piping, fittings, receiver tank, etc. must be certified safe for at least 250 psig (18 kg/cm²) working pressure. Use hard-welded or threaded steel or copper pipes and cast iron fittings that are certified safe for the compressor's discharge pressure and temperature. **DO NOT USE PVC PLASTIC.** Use pipe thread sealant on all threads, and make up joints tightly to prevent air leaks.

Main Air Distribution Line. The main compressed air distribution line should be of sufficient pipe size to minimize the pressure drop between the air supply and the point of use. Slope the piping downward in the direction of air flow to aid in the removal of condensation at all drain points along the line. The piping must be as short and direct as possible, and adequately braced.

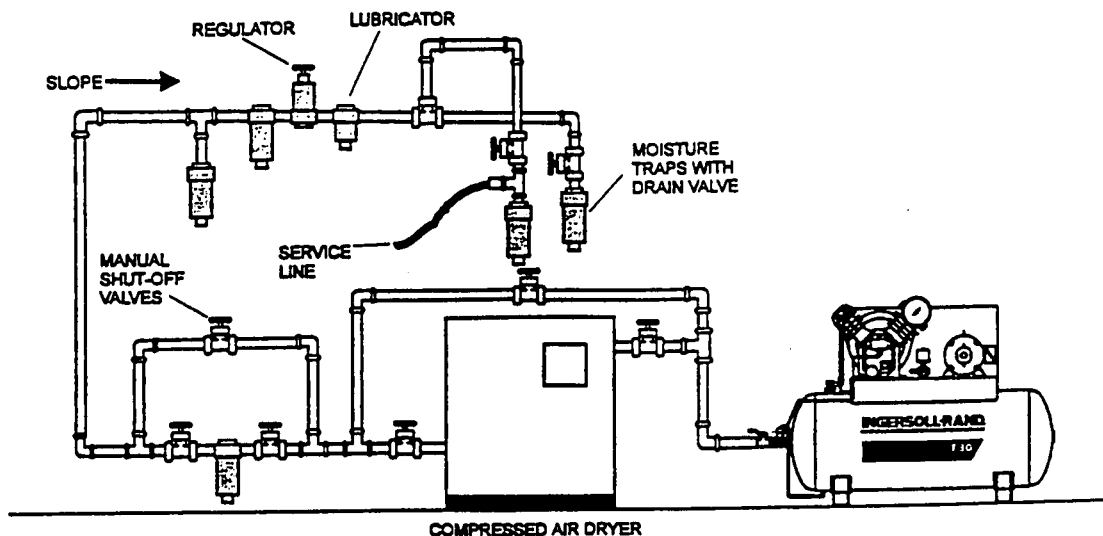
Drip Legs. A drip leg is a pipe extending downward from the main line to collect condensation. Drip legs should be installed at the lowest points in the air line and at any point where the line goes around an obstruction. A drain valve should be installed on the bottom of each drip leg.

Drop Legs. A drop leg is a pipe originating from the main air distribution line that feeds air to an outlet for air tools or other air operated devices. Drop legs are taken off the top of the main line so that condensation does not easily flow into them. Drop legs should be designed so that the air outlet comes off the side of the drop leg, rather than the bottom. By doing this, condensation which is carried from the main line collects below the outlet and prevents moisture from entering the tool or device using the air. A drain valve should be installed on the bottom of each drop leg.

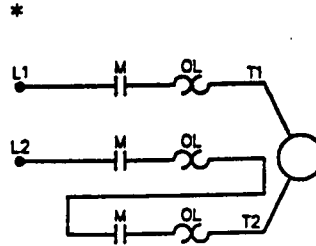
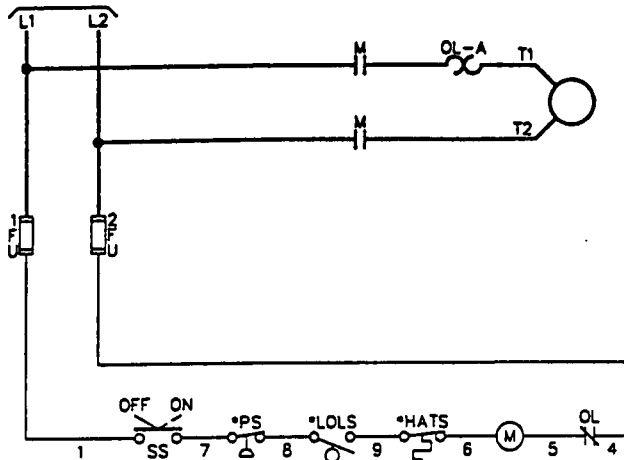
Condensate Discharge Piping. If installing a condensate discharge line, the piping must be at least one size larger than the connection, as short and direct as possible, secured tightly and routed to a suitable drain point. Condensate must be disposed of in accordance with local, state, and federal laws and regulations.

WARNING! If an aftercooler, check valve, block valve, or any other restriction is added to the compressor discharge, install a properly-sized ASME approved safety/relief valve between the compressor discharge and the restriction.

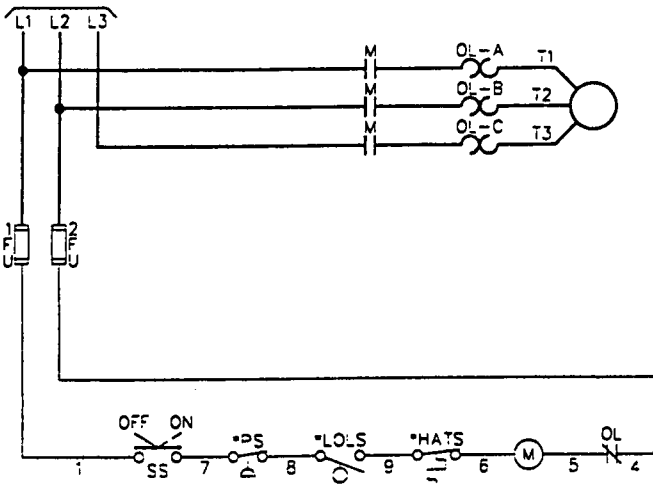
Typical Compressed Air System.



Single Phase Wiring



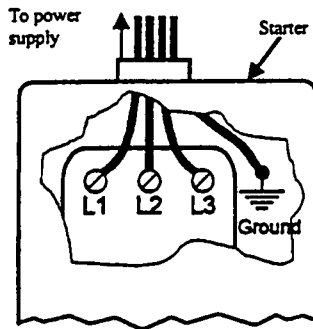
Three Phase Wiring



T	Supply Line Terminal
L	Load Terminal
FU	Control Circuit Fuse
HATS	High Air Temperature Switch (#)
LOLS	Low Oil Level Switch (#)
M	Motor Starter Coil
OL	Motor Starter Overload
PS	Pressure Switch
SS	Selector Switch (#)
*	Alternate wiring for converting 3 phase starter to 1 phase application
(#)	= if provided

NOTE: ON UNITS REQUIRING A STARTER, CONNECT LINE POWER TO THE STARTER. DO NOT CONNECT LINE POWER TO THE PRESSURE SWITCH.

- Connect ground wire to ground lug
- L3 used for 3-phase motors & starters only



motor. If other electrical equipment is connected to the same circuit, the total electrical load must be considered in selecting the proper wire size. Do not use undersize wire.

Magnetic Starter. If the motor installed on your compressor has a motor reset button, it does not require a magnetic starter. If the motor does not have this button and the compressor does not have a factory-installed starter, install a magnetic starter with thermal overload protection. Follow the manufacturer's instructions for installation. Ingersoll-Rand cannot accept responsibility for damages arising from failure to provide adequate motor protection.

Fuses. Refer to the National Electric Code to determine the proper fuse or circuit breaker rating required. When selecting fuses, remember the momentary starting current of an electric motor is greater than its full load current. Time-delay or "slow-blow" fuses are recommended.

Pressure Switch. On compressors without a factory-installed pressure switch, wire a pressure switch in accordance with the appropriate wiring schematic in this manual. Mount the pressure switch in accordance with the manufacturer's recommendations. The connecting line to the receiver tank must be as short and direct as possible, and certified safe for at least 250 psig (18 kg/cm²).

WIRING (ELECTRIC MOTOR DRIVEN MODELS)

WARNING! Electrical installation and service should be performed by a qualified electrician who is familiar with all applicable local, state and federal laws and regulations.

General. The motor rating, as shown on the motor nameplate, and the power supply must have compatible voltage, phase and hertz characteristics.

Wire Size. The electrical wiring between the power supply and electric motor varies according to motor horsepower. Power leads must be adequately sized to protect against excessive voltage drop during start-up. Information for selecting the proper wire size and securing connections should be provided with the

CONNECTING A BATTERY (GASOLINE ENGINE DRIVEN MODELS)

NOTE: If you will be making connections to a remote battery, the compressor engine must be equipped with an alternator.

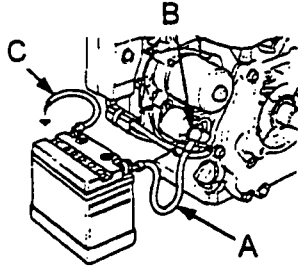
Battery. A 12 volt battery with a minimum current rating of 250 CCA (cold cranking amps) and minimum ampere-hour rating of 24 Ah should be sufficient for cranking most electric start engines.

Battery Cables. Refer to the following table for size and length recommendations.

Cable Size (GA)	Maximum Length
6	5' (1.5 m.)
4	7'-2.5" (2.1 m.)
2	12' (3.6 m.)

Connection Procedures. (1) Connect the battery positive (+) cable (A) to the starter solenoid terminal (B). (2) Connect the battery negative (-) cable (C) to an engine mounting bolt. Secure the wire in place by screwing a suitably-sized nut onto the bolt and down onto the terminal. (3) Connect the battery positive (+) cable (A) to the battery positive (+) terminal. (4) Connect the battery negative (-) cable to the battery negative (-) terminal. (5) Coat the terminals and cable ends with corrosion-preventive grease.

Battery Connections.



WARNING! Remove the cable from the negative (-) side of the battery before servicing.

Refer to the engine manufacturer's instructions for more information.

FUEL PUMP INSTALLATION (GASOLINE ENGINE DRIVEN MODELS)

Some engines use an optional fuel pump to supply gasoline to the engine directly from a vehicle's onboard fuel system. Install the fuel pump within 12 inches of the bottom surface of the vehicle's fuel tank. Protect the pump from contamination by installing a fuel isolation valve and an inline filter between the pump fuel system.

COMPRESSOR LUBRICATION

CAUTION! Do not operate without lubricant or with inadequate lubricant. Ingersoll-Rand is not responsible for compressor failure caused by inadequate lubrication.

All Season T30 Select. Ingersoll-Rand recommends All Season T30 Select synthetic lubricant from start-up. See the WARRANTY section for extended warranty information.

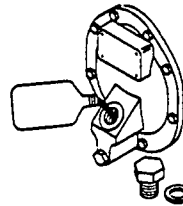
Alternate Lubricants. You may use a petroleum-based lubricant that is premium quality, does not contain detergents, contains only anti-rust, anti-oxidation, and anti-foam agents as additives, has a flashpoint of 440°F (227°C) or higher, and has an auto-ignition point of 650°F (343°C) or higher. Remember using a lubricant other than All Season T30 Select from start-up limits warranty to one year.

See the petroleum lubricant viscosity table below. The table is intended as a general guide only. Heavy duty operating conditions require heavier viscosities. Refer specific operating conditions to your Distributor for recommendations.

Temperature Around Compressor	Viscosity @ 100°F (37.8°C)		Viscosity Grade	
	SUS	Centi-stokes	ISO	SAE
40°F (4.4°C) & below	150	32	32	10
40°F to 80°F (4.4°C to 26.7°C)	500	110	100	30
80°F to 125°F (26.7°C to 51.0°C)	750	165	150	40

If you use a petroleum-based compressor lubricant at start-up and decide to convert to All Season T30 Select later on, your compressor must be decarbonized by your Distributor before conversion.

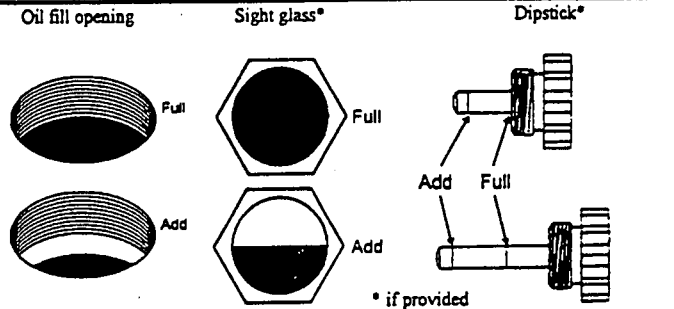
Filling Procedures. (1) Unscrew and remove the oil fill plug. (2) Fill the crankcase with lubricant.



Refer to the following table for crankcase capacity.

Model	Crankcase Capacity
2340	28 oz. (827 ml.)
2475	41 oz. (1212 ml.)
2545	73 oz. (2158 ml.)

Use one of the following methods illustrated to determine when the crankcase is full.



(3) Replace the oil fill plug **HAND TIGHT ONLY**.

OPERATION

START-UP (ELECTRIC MOTOR DRIVEN MODELS)

(1) Release pressure by opening the service valve. (2) Close the service valve and start the compressor.

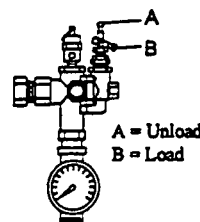
CAUTION! Unusual noise or vibration indicates a problem. Do not continue to operate until you identify and correct the source of the problem.

NOTE: Ensure direction of rotation is correct per the arrow cast on the beltwheel. Compressors with a sheetmetal type beltguard also have a directional arrow decal applied to the beltguard side facing the front of the unit. If rotation is incorrect on three-phase units, interchange any two of the three leads.

START-UP (GASOLINE ENGINE DRIVEN MODELS)

WARNING! Do not operate gasoline engine driven units in an enclosed area.

Unloader.



(1) Release pressure by opening the service valve. (2) Turn on engine gasoline supply. (3) Put choke in "on" position. (4) Close service valve and put unloader lever in "unload" (A) position for Kawasaki and Honda engine driven models, "load" (B) position for Kohler engine driven models. (5) Start engine, release choke, and allow engine to warm up for two to three minutes. (6) Return unloader lever to "load" (B) position on Kawasaki and Honda engine driven models.

NOTE: Turn gasoline supply off when compressor is not being used.

NOTE: Some gasoline engine driven compressors require 5-8 break-in hours of operation before reaching full capacity and speed.

NOTE: After 20 hours of operation, engine idle speed may increase slightly. If this should happen, your Distributor may need to make a slight adjustment.

COMPRESSOR CONTROLS

Automatic Start & Stop Control. This type of control applies to electric motor driven models 2340, 2475, and some 2545 units.

NOTE: Automatic Start & Stop Control is intended for use when the motor will start no more than 6 times per hour.

When the receiver tank pressure reaches the factory pre-set maximum pressure (usually 175 psig), the pressure switch stops the compressor. When the receiver tank pressure drops below the factory pre-set minimum (usually 135 psig), the pressure switch resets and restarts the compressor.

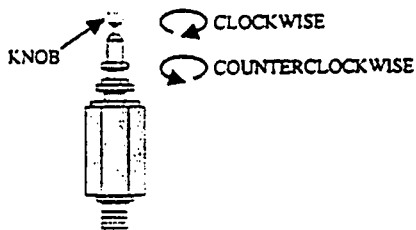
Constant Speed Control. This type of control applies to gasoline engine driven model 2475.

When the receiver tank pressure reaches the factory pre-set maximum pressure (usually 175 psig), the unloader slows down the engine and the compressor stops pumping. When the receiver tank pressure drops to the factory pre-set minimum (usually 145 psig), the unloader resets, the engine returns to full speed, and the compressor resumes pumping.

Dual Control. This type of control applies to some Model 2545 units. Select either automatic start and stop control or constant speed control by adjusting the knob on the auxiliary valve. For automatic start and stop control, turn the knob on the auxiliary valve fully clockwise to disable the auxiliary valve. The pressure switch will then start and stop the compressor.

NOTE: For dual control models, automatic start and stop is preferred.

Auxiliary Valve.



Select constant speed control if the compressor restarts in less than 10 minute intervals or runs more than 40 minutes per hour. Turn the knob fully counterclockwise to run the compressor continually. When the receiver tank pressure reaches 170 psig, the compressor runs but does not pump.

NOTE: The auxiliary valve is factory pre-set at 5 psig lower than the factory pressure switch setting.

CAUTION! Running unloaded for more than 20 minutes per hour or more than 15 minutes continually with the use of constant speed control will cause oil pumping and should be avoided.

PRESSURE SWITCH ADJUSTMENT

WARNING! High voltage is present at the pressure switch contacts when the power supply is connected. Disconnect, lock and tag main power supply before making adjustments.

CAUTION! Do not adjust the pressure switch to exceed the maximum discharge pressure of the compressor.

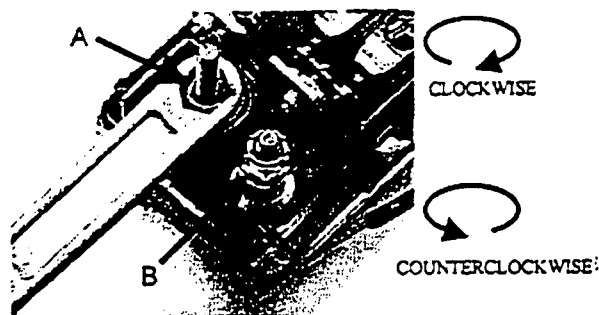
NOTE: Adjust the pressure switch only if adjustments are absolutely necessary.

Cut-In & Cut-Out. The cut-out (compressor shut-down) is the pressure at which the switch contacts open, and the cut-in (compressor restart) is the pressure at which the switch contacts close. See COMPRESSOR CONTROLS.

Adjustment Controls. All pressure switches have a range adjustment control (A). Some pressure switches also have a differential adjustment (B) control. On switches without a differential adjustment control, the span between cut-in and cut-out pressure levels switches is factory set for 40 ± 4 PSIG and cannot be adjusted.

NOTE: Some pressure switches are equipped with an on-off lever used to open and close the electrical contacts inside the switch. **THIS LEVER IS NOT A DIFFERENTIAL ADJUSTMENT CONTROL.** The pressure switches with the on-off lever do not have a differential adjustment control.

Pressure Switch Adjustments.



Adjustment Procedures (Switches without differential adjustment control).
 (1) Remove the pressure switch cover. (2) Adjust the range by turning the range adjustment nut clockwise (in) to increase the cut-out point or counter-clockwise (out) to decrease the cut-out point. **NOTE:** One full turn changes the setting approximately 2 psig. (3) Replace cover, reconnect power supply and start the compressor. (4) Note the pressure gauge reading at which the compressor cuts out. (5) Repeat adjustment procedure if necessary.

Adjustment Procedures (Switches with differential adjustment control).
 (1) Remove the pressure switch cover. (2) Set the cut-in pressure with the range adjustment nut. Turn the nut clockwise (in) to increase the pressure or counter-clockwise (out) to decrease the pressure. **NOTE:** One full turn changes the setting approximately 2 psig. (3) Set the cut-out pressure with the differential adjustment. Turn the differential adjustment nut clockwise (in) to increase the pressure or counter-clockwise (out) to decrease the pressure. **NOTE:** One full turn changes the setting approximately 2 psig. (4) Replace cover, reconnect power supply and start the compressor. (5) Note the pressure gauge reading at which the compressor cuts out. (6) Repeat adjustment procedure if necessary.

The minimum possible differential is approximately 20% of cutout pressure. It is advisable to have as wide a differential as possible to avoid frequent starting and stopping of the compressor. Note the pressure gauge reading at which the compressor cuts-out and re-establish this point if necessary.

Note the interaction between the range and differential adjustments, i.e., if the cut-out is increased, the differential will also increase, or if the differential is narrowed, the cut-out will be reduced, etc. These factors must be considered when adjusting the switch and compensated for accordingly.

MAINTENANCE

WARNING! Disconnect, lock and tag main power supply and release air pressure from system before performing maintenance.

NOTE: All compressed air systems contain maintenance parts (e.g. lubricating oil, filters, separators) which are periodically replaced. These used parts may be, or may contain, substances that are

regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

NOTE: Take note of the positions and locations of parts during disassembly to make reassembly easier. The assembly sequences and parts illustrated may differ for your particular unit.

**Daily or Before
Each Operation**

- Check lubricant level. Fill as needed.
- Drain receiver tank condensate (if automatic drain valve is not provided). Open manual drain valve and collect and dispose of condensate accordingly.
- Check for unusual noise and vibration.
- Ensure beltguards and covers are securely in place.
- Ensure engine (if supplied) is filled with fuel and lubricant according to the manufacturer's recommendations.

Weekly

- Ensure area around compressor is free from rags, tools, debris, and flammable or explosive materials.
- Clean screen in automatic drain valve (if provided). Open manual drain valve at bottom of automatic drain valve to blow out debris. Collect and dispose of condensate accordingly.

Monthly

- Check safety/relief valves by pulling rings. Replace safety/relief valves that do not operate freely.
- Inspect air filter element(s). Clean if necessary.
- Inspect for air leaks. Squirt soapy water around joints during compressor operation and watch for bubbles.
- Check tightness of screws and bolts. Tighten as needed.

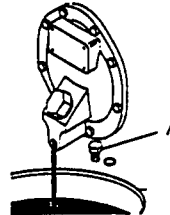
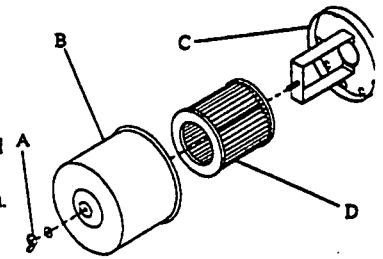
3/500 *
12/2000 *

- Clean exterior.
- Change petroleum lubricant while crankcase is warm.
- Install maintenance pak
— or —
- Change All Season T30 Select lubricant while crankcase is warm.
- Replace filter element.

* indicates months/operating hours, whichever occurs first.

**FILTER INSPECTION &
CLEANING**

- (1) Unscrew and remove the wing nut (A) securing the filter housing (B) to its base (C). (2) Remove the filter housing and withdraw the old filter element (D). Clean the element with a jet of air or vacuum. (3) Replace the filter element and

**OIL CHANGE**

- (1) Remove the oil drain plug (A) and allow the lubricant to drain into a suitable container. (2) Replace the oil drain plug. (3) Follow the filling procedures in OPERATION section.

KITS & SERVICE PARTS**RECOMMENDED KITS & SERVICE PARTS**

Keep these kits and service parts on-hand to avoid prolonged down time for routine maintenance or service. Consider purchasing extra kits and service parts for applications in which interruptions in service are not acceptable. Detailed instructions for inspection and service are included with each kit.

Start-Up Kits. Each start-up kit contains the necessary quantities of All Season T30 Select lubricant and air filter element(s) to start-up and maintain your compressor for the first year. Start-Up kits for gasoline engine driven models also include a replacement engine air filter, engine oil filter, and engine lubricant. See the engine manufacturer's instructions for more detailed engine care information.

PART NO.	DESCRIPTION
32305880	KIT, START-UP — 2340
32305880	KIT, START-UP — 2475 WITH ELECTRIC MOTOR
32305872	KIT, START-UP — 2475 WITH KOHLER ENGINE
32498511	KIT, START-UP — 2475 WITH KAWASAKI ENGINE

Maintenance Paks. Maintenance paks contain all the parts necessary for one complete 12 month/2000 hour maintenance service of your compressor.

All-Season T30 Select lubricant, air filter elements, gaskets, drive belts, and instructions are standard with all maintenance paks.

PART NO.	MODEL
38485132	PAK, MAINTENANCE — 2340 (ALL UNITS)
38485157	PAK, MAINTENANCE — 2475N7.5
38485165	PAK, MAINTENANCE — 2475N5
38485173	PAK, MAINTENANCE — 2475F11G
38485181	PAK, MAINTENANCE — 2475F11GKA
38485082	PAK, MAINTENANCE — 2545E10
38485082	PAK, MAINTENANCE — 2545E10V

All Season T30 Select Lubricant

PART NO.	DESCRIPTION
32318875	LUBRICANT, ALL SEASON T30 SELECT - 1 Q (.946 L) BOTTLE
32318883	LUBRICANT, ALL SEASON T30 SELECT - CASE OF (12) 1 Q (.946 L) BOTTLES

Air Filter Elements

PART NO.	DESCRIPTION
32012957	ELEMENT, FILTER - STANDARD (2545)
32170979	ELEMENT, FILTER - STANDARD (2340, 2475)

Step Saver Kits. Step Saver Kits provide all of the parts required to perform common repair tasks such as piston ring replacement or valve replacement. An instruction sheet is provided with each Step Saver Kit.

	PART NO.	DESCRIPTION		
	2340	2475	2545	
32304610	32301426	32307118		KIT, VALVE/GASKET (1)
32304602	32301517	32307084		KIT, RING/GASKET (2)
32127359	32301509	32204307		KIT, BEARING/CONNECTING ROD (3)
	32301434	32307126		KIT, GASKET (4)
32319451	32319469	32319477		KIT, OVERHAUL (5)

(1) Valve wearing parts and head gaskets that are destroyed in replacing valve parts.

(2) Complete set of piston rings, a crankshaft seal, and gaskets that are destroyed in breaking the unit down to replace the rings.

(3) Set of connecting rods, main bearings, and a crankpin bushing. A gasket set is recommended with this kit.

(4) Complete set of gaskets that are destroyed in breaking the unit down for inspection and service. Recommended with bearing/connecting rod kits.

(5) All of the above for complete overhaul service.

OTHER KITS & SERVICE PARTS

Automatic Drain Valve Timer Kits. An automatic drain valve timer kit resolves application problems in which an existing automatic drain valve cycles too infrequently. A timer generates the pneumatic signals for actuating the automatic drain valve. With a timer, the automatic drain valve operates independently of the compressor unload cycles.

This accessory is recommended for:

- Duplex units.
- 100% duty cycle applications.

- Extremely heavy duty cycles where unloading is too infrequent to permit effective use of an over-sized reservoir on compressor-controlled drain valves.
- Controlling multiple automatic drain valves used on air system devices such as self-draining filters, dryers and drip legs.

NOTE: The electric timer is available only in a NEMA 1 enclosure.

PART NO.	DESCRIPTION
32499964	KIT, ELECTRIC TIMER - AUTOMATIC DRAIN VALVE

Automatic Drain Valves, Kits & Service Parts. The automatic drain valve removes condensed water and oil from compressed air systems without restricting air flow, creating pressure drops or opening the system to the atmosphere. Its unique design maintains systems pressure and volume during operation, and increases productivity.

REF. NO.	PART NO.	DESCRIPTION
REF.	32296238	VALVE, AUTOMATIC DRAIN (SIMPLEX UNITS)
REF.	32310690	VALVE, AUTOMATIC DRAIN (DUPLIX UNITS)
1	32310971	KIT, WATER CAP ASSEMBLY
2	32314924	KIT, BODY/PISTON ASSEMBLY (FOR 32296238 VALVE)
2	32310989	KIT, BODY/PISTON ASSEMBLY (FOR 32310690 VALVE)
3	32310997	KIT, ONE WAY VALVE
4	32496317	RESERVOIR, STANDARD CAPACITY
4	32496309	RESERVOIR, HIGH CAPACITY *
5	32311060	ELBOW, TUBE — 1/4"

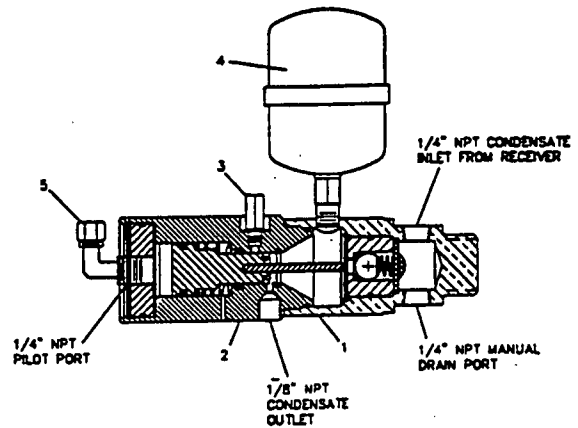
* The high capacity reservoir gives the automatic drain valve twice as much condensate storage capacity during the pumping cycle. This larger reservoir is available as an upgrade. A larger reservoir is recommended for use on heavily-loaded simplex compressors with long pumping cycles and/or operating in extremely humid environments. If the pumping cycle exceeds one hour, then an electric timer kit should be used.

Crankcase Heater Kits. Crankcase heaters are recommended when ambient temperatures are consistently below 32°F (0°C). An easy-to-install external crankcase heater kit is intended for aftermarket use. Two kits may be required for some applications.

PART NO.	DESCRIPTION
97330385	KIT, CRANKCASE HEATER

Vibration Isolator Kits. Vibration isolator kits are specifically designed for mounting gasoline engine driven compressors to truck beds.

PART NO.	DESCRIPTION
----------	-------------



PART NO.	DESCRIPTION
32309346	KIT, VIBRATION ISOLATOR

Vibration Isolator Pads. Vibration isolator pads are designed to absorb 40%-60% of the sound and vibration of your compressor.

PART NO.	DESCRIPTION
32320681	PAD, VIBRATION ISOLATOR - 4" X 4" SP-NR
32320699	PAD, VIBRATION ISOLATOR - 5" X 5" SP-NR
32321002	PAD, VIBRATION ISOLATOR - 4" X 4" NRC
32321028	PAD, VIBRATION ISOLATOR - 5" X 5" NRC
32321010	PAD, VIBRATION ISOLATOR - 6" X 6" NRC

SP-NR: Steel plate bonded between a NR pad and a non-skid oil-resistant ribbed neoprene top pad.
NRC: Two ribbed neoprene pads bonded to 1/2" cork pad.

TROUBLESHOOTING

This section provides a list of the more frequently encountered compressor malfunctions, their causes and corrective actions. Some corrective actions can be performed by the operator or maintenance personnel, and others may require the assistance of a qualified electrician or your Distributor.

PROBLEM	CHECK POINT	CHECK POINT	POSSIBLE CAUSE	POSSIBLE SOLUTION
Abnormal piston, ring or cylinder wear	4, 8, 9, 19, 28, 35	12	Improper line voltage.	Check line voltage and upgrade lines as required. Contact electrician.
Air delivery drops off	1, 6, 15, 16, 18, 19, 29		Wiring or electric service panel too small.	Install properly sized wire or service box. Contact electrician.
Automatic drain valve leaks or does not drain automatically	16		Poor contact on motor terminals or starter connections.	Ensure good contact on motor terminals or starter connections.
Auxiliary valve chatters or leaks around stem	23, 24	13	Improper starter overload heaters.	Install proper starter overload heaters. Contact electrician.
Broken intercooler or aftercooler tubes	36	14	Poor power regulation (unbalanced line).	Contact power company.
Compressor does not come up to speed	2, 6, 12, 15, 21	14	Drive belts too tight or misaligned.	Adjust belts to proper tension and alignment.
Compressor is slow to come up to speed	26, 27, 33, 34	15	Compressor valves leaky, broken, carbonized or loose.	Inspect valves. Clean or replace as required. Install Valve/Gasket Step Saver Kit. See KITS & SERVICE PARTS.
Compressor runs excessively hot	3, 14, 15, 22	16	Automatic drain valve clogged, leaking or defective.	Inspect valve and clean, repair or replace as required.
Compressor will not unload cycle	23, 24, 26	17	Carbon build-up on top of piston(s).	Clean piston(s). Repair or replace as required.
Compressor will not unload when stopped	26, 33	18	Piston rings damaged or worn (broken, rough or scratched).	Install Ring/Gasket Step Saver Kit.
Excessive noise during operation	2, 6, 15, 16, 21, 27, 32		Excessive end gap or side clearance.	Adjust piston rings.
Excessive starting and stopping	5, 11, 16, 32, 43	19	Piston rings not seated, are stuck in grooves or end gaps not staggered.	Repair or replace as required.
Knocks or rattles	2, 15, 17, 19, 20, 21	19	Cylinder(s) or piston(s) scratched, worn or scored.	Repair or replace as required.
Lights flicker or dim when running	12, 13	20	Connecting rod, piston pin or crankpin bearings worn or scored.	Inspect all. Repair or replace as required. Install Bearing/Connecting Rod Step Saver Kit. See KITS & SERVICE PARTS.
Moisture in crankcase or "milky" appearance in petroleum lubricant or rusting in cylinders	9, 10	21	Loose bearing spacer on crankshaft.	Inspect bearings and replace if required. Install Bearing/Connecting Rod Step Saver Kit. See KITS & SERVICE PARTS.
Motor overload trips or draws excessive current	5, 6, 12, 13, 14, 15, 16, 19, 20, 21, 34	22	Defective ball bearings on crankshaft or motor shaft.	Check motor wiring for proper connections. Reverse two leads on three-phase motors.
Oil in discharge air (oil pumping)	4, 7, 9, 18, 19, 25, 35	23	Wrong beltwheel direction of rotation.	Inspect parts and replace as required.
Oil leaking from shaft seal	25	24	Leaking, broken or worn inlet unloader parts.	Inspect parts. Clean, adjust or replace as required.
Safety/relief valve "pops"	1, 5, 29, 30	25	Auxiliary valve dirty or seats worn.	Replace seal. Install shaft sleeve if required. Install Bearing/Connecting Rod Step Saver Kit. See KITS & SERVICE PARTS.
High interstage pressure	30	26	Crankshaft seal worn or crankshaft scored.	Replace pilot valve o-ring. Adjust pilot valve.
Low interstage pressure	31	27	Leaking check valve or check valve seat blown out.	Replace check valve.
Engine cranks slowly or will not start	6, 14, 37, 38	28	Extremely dusty atmosphere.	Install remote air inlet piping and route to source of cleaner air. Install more effective filtration.
Motor will not start	12	29	Defective safety/relief valve.	Replace.
Engine will not start	39	30	High pressure inlet valve leaking.	Inspect, clean or repair as required.
Automatic drain valve leaks air at discharge after compressor is shut off	40	31	Low pressure discharge valve leaking.	Inspect, clean or repair as required.
Automatic drain valve leaks air at drain port while compressor is running	41	32	Automatic start and stop mode is not suitable for air demand.	Adjust auxiliary valve for constant speed operation.
Automatic drain valve cycles too infrequently	42	33	Pressure switch unloader leaks or does not work.	Realign stem or replace.
CHECK POINT	POSSIBLE CAUSE	POSSIBLE SOLUTION		
1	Clogged or dirty inlet and/or discharge line filter.	Clean or replace.	34	Ambient temperature too low.
2	Loose beltwheel or motor pulley, excessive end play in motor shaft or loose drive belts.	Check beltwheel, motor pulley, crankshaft, drive belt tension and alignment. Repair or replace as required.	35	Worn cylinder finish.
3	Inadequate ventilation around beltwheel.	Relocate compressor for better air flow.	36	Beltwheel out of balance, tubes not braced or secured, wrong pulley speed.
4	Lubricant viscosity too low.	Drain existing lubricant and refill with proper lubricant.		
5	Air leaks in air discharge piping.	Check tubing and connections. Tighten joints or replace as required.		
6	Lubricant viscosity too high.	Drain existing lubricant and refill with proper lubricant.		
7	Lubricant level too high.	Drain excess lubricant.		
8	Lubricant level too low.	Add lubricant to crankcase to proper level.		
9	Detergent type lubricant being used.	Drain existing lubricant and refill with proper lubricant.		
10	Extremely light duty cycles.	Run compressor for longer duty cycles.		
	Compressor located in damp or humid location.	Relocate compressor or install crankcase heater kit.		
11	Pressure switch differential too narrow.	Adjust pressure switch to increase differential, if differential adjustment is provided. Install pressure switch with differential adjustment feature if differential adjustment is desired.		

mecoAlarm Installation Instructions

STAND ALONE BATTERY INSTALLATION.

1. Remove four cover screws and remove cover.
2. Plug 9 V battery into terminals provided. For longest life and for use in climates with temperatures below -4° F, the Ultralife 9 V Lithium battery is recommended. Ultrafile batteries are available from Radio Shack.
3. Close cover using care not to pinch wires between the cover and the case and replace four screws.
4. Test unit for proper operation.
 - a. Press the Test/Reset Button and insure the alarm sounds while the button is depressed and the alarm stops when the button is released.
 - b. Turn unit upside down and insure alarm sounds. While unit is upside down, press and release the Test/Reset Button and insure the alarm stops.
5. Adjust the Float Switch for the proper trip point prior to installing into tank. To adjust the Float Switch, loosen the chrome nut and extend the switch to the desired length and tighten the chrome nut. **DO NOT OVER TIGHTEN THE CHROME NUT**, a snug fit is all that is required. The nut is properly tightened when the Float Switch cannot be moved in or out of the 1/2" pipe.
6. Install the alarm in the tank.

BEFORE FILLING ANY TANK WITH THE ALARM INSTALLED, ALWAYS TEST THE ALARM BY PRESSING THE TEST/RESET BUTTON AND INSURE THE ALARM SOUNDS.

To insure maximum battery life, after the tank is full and the alarm has sounded, turn off the alarm by pressing the Test/Reset Button. Battery life is significantly reduced if the alarm is left on.

EXTERNAL POWER SUPPLY INSTALLATION.

1. Remove Alarm head and nipple from 2" bushing.
2. Install a conduit tee and conduit to the Non-Hazardous location that the power supply is located in (see Figure 1). Install the power supply in accordance with CD200051.
3. Connect the Alarm to the power supply in accordance with CD200400-2. Remove four cover screws and remove cover. (see Figure 2 for Alarm internal connections.)
4. Close cover using care not to pinch wires between the cover and the case and replace four screws.
5. Test unit for proper operation.
 - a. Press the Test/Reset Button and insure the alarm sounds while the button is depressed and the alarm stops when the button is released.
 - b. Turn unit upside down and insure alarm sounds. While unit is upside down, press and release the Test/Reset Button and insure the alarm stops.
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12 V DC External Power Supply Installation

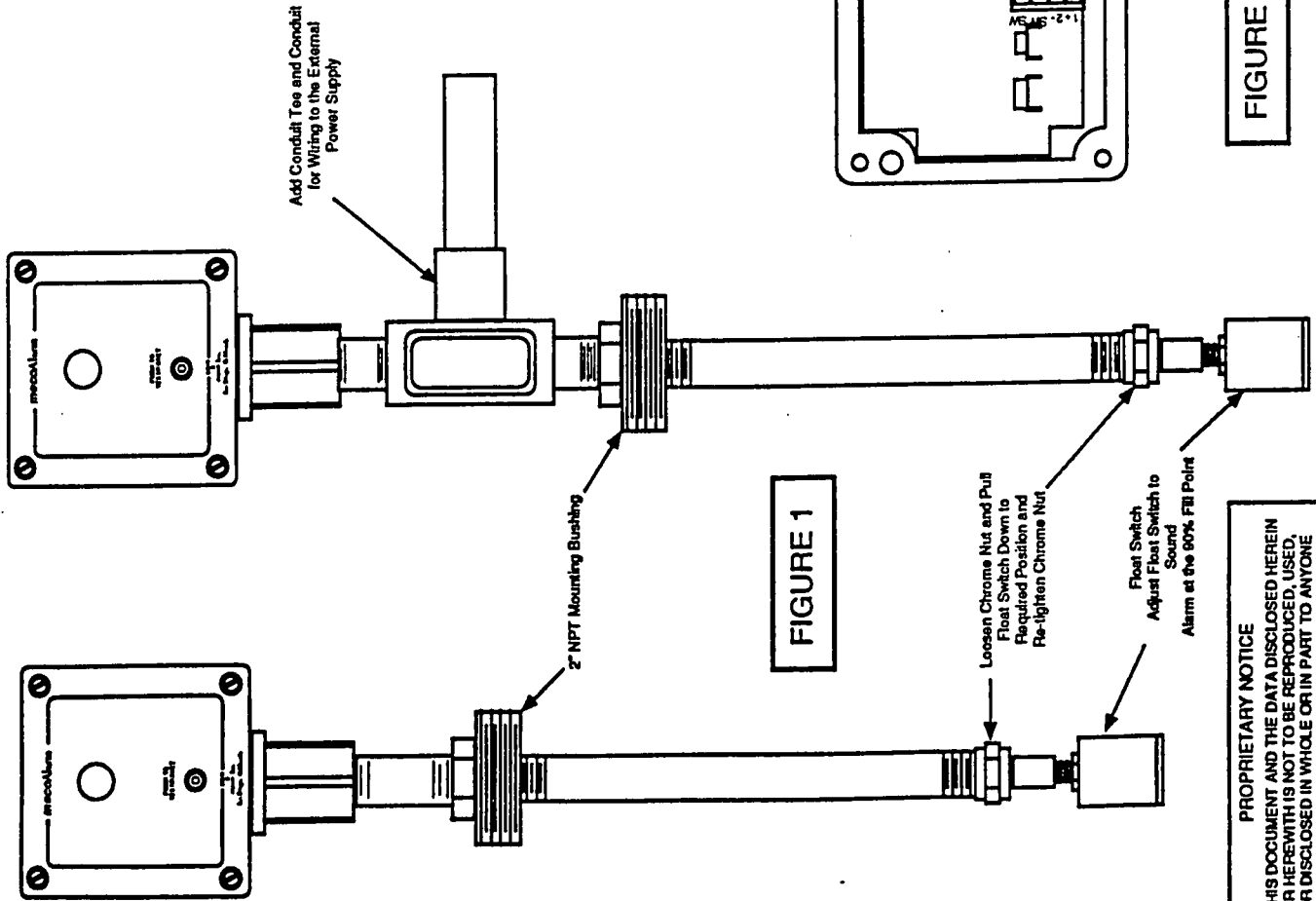


FIGURE 1

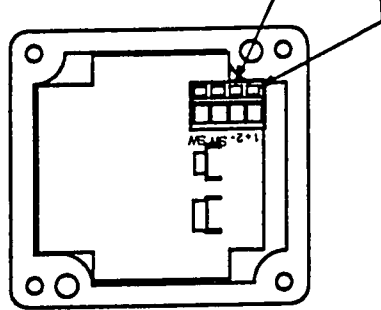
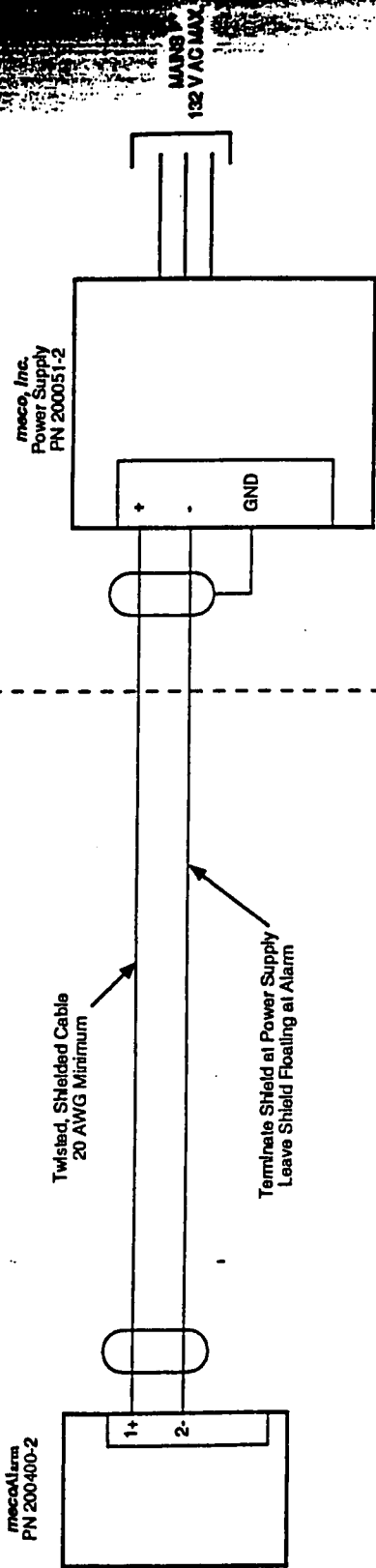


FIGURE 2

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 THIS DOCUMENT AND THE DATA DISCLOSED HEREIN OR HEREWITH IS NOT TO BE REPRODUCED, USED, OR DISCLOSED IN WHOLE OR IN PART TO ANYONE WITHOUT THE PERMISSION OF meco, Inc.

Hazardous Location

Non-Hazardous Location



NOTES:

A. FOR USE WITH EXTERNAL POWER SUPPLY:
 1. *mecoAlarm* REQUIRES THE *meco* 12 V DC POWER SUPPLY PART NUMBER 200051-2 HAVING THE FOLLOWING CHARACTERISTICS:
 $V_{max} = 22.1 \text{ V DC}$
 $I_{max} = .51 \text{ A}$

2. THE MAXIMUM CABLE LENGTH IS 1000 ft AND REQUIRES A CABLE MEETING THE FOLLOWING CHARACTERISTICS:

- Cable Capacitance = 60 pF/ft Maximum
- Cable Inductance = .20 $\mu\text{H/ft}$ Maximum
- 20 AWG Minimum

B. FOR USE WITH INTERNAL BATTERY:

1. FOR THE LONGEST BATTERY LIFE THE RECOMMENDED BATTERY FOR ALL INSTALLATIONS IS THE Ultralife 9 V DC LITHIUM BATTERY PART NUMBER USVL. IN CLIMATES HAVING A TEMPERATURE RANGE OF -40° F TO $+158^\circ \text{ F}$, THE Ultralife LITHIUM BATTERY IS REQUIRED.

2. IN CLIMATES WHERE THE MAXIMUM TEMPERATURE RANGE IS -4° F TO $+130^\circ \text{ F}$ THE FOLLOWING ALKALINE BATTERIES MAY BE USED (EXPECT MUCH SHORTER BATTERY LIFE THAN THE LITHIUM):
 DURACELL MN1604
 RAYOVAC MAXIMUM A1604
 EVEREADY ENERGIZER NO. 522

C. REFERENCE DOCUMENTS:

- 1. *mecoAlarm* INSTALLATION INSTRUCTIONS 200408.

PROPRIETARY NOTICE
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<i>meco, Inc.</i>		
6326 Lake Dora Ave., San Diego, CA. 92119		
CONTROL DRAWING, <i>mecoAlarm</i>		
DATE: 9/21/89	DWG. NO. CD200400-2	
REV. -	SCALE: NONE	SHEET 1 OF 1

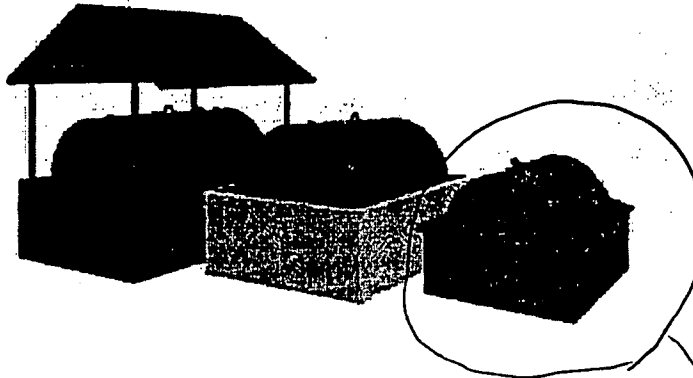
Clawson Tank for May 30, 2001

Clawson Tank Company, serving the liquid storage needs of its customers for over 50 years!



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Containment Dikes



An economical secondary containment system solution, Clawson's Open Top, Canopy and WaterGuard dikes are designed and built to nationally-recognized STI F911-93 fabrication standards for pre engineered secondary containment. To meet NFPA 30 2-3.3.3, dikes incorporate steel walls and can hold capacities from 300 to 20,000 gallons. Each dike provides 110% containment and overspill protection, and allows for easy visual inspection.

To protect the dike from filling up with debris and rain water, the WaterGuard is constructed with heavy-duty rain shields that divert water away from the tank. A roof has been added to an open top protecting Canopy Dike from external elements.

Sizes and Dimensions

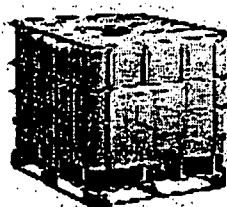
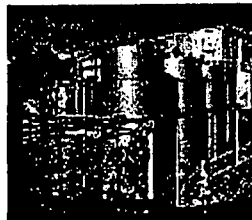
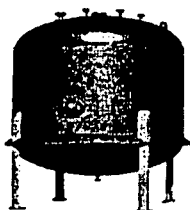
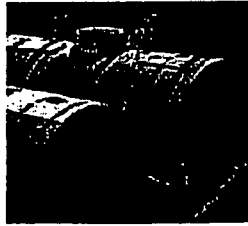
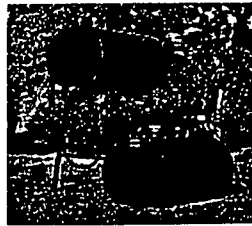
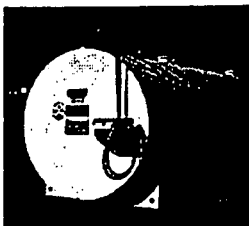
Capacity	Size	Dimensions	Thickness
330-gallon	300-gallon	72"x48"x22"	10ga
683-gallon	560-gallon	94"x60"x28"	10ga
1,100-gallon	1,000-gallon	94"x84"x36"	3/16"
1,256-gallon	1,100-gallon	156"x72"x28"	10ga

1,600-gallon	1,500-gallon	122"x84"x36"	3/16"
2,200-gallon	2,000-gallon	168"x84"x36"	3/16"
3,300-gallon	3,000-gallon	252"x84"x36"	3/16"
4,400-gallon	4,000-gallon	324"x96"x34" 216"x108"x48"	1/4"
5,500-gallon	5,009-gallon	204"x130"x48"	1/4"
6,600-gallon	6,000-gallon	249"x130"x48"	1/4"
8,800-gallon	8,000-gallon	332"x130"x48"	1/4"
11,000-gallon	10,000-gallon	420"x130"x48"	1/4"
13,200-gallon	12,000-gallon	432"x132"x54"	1/4"
16,500-gallon	15,000-gallon	372"x144"x72"	1/4"
22,000-gallon	20,000-gallon	495"x144"x72"	1/4"

The STI F911 standard dike has been designed and tested to withstand the secondary containment loads for the horizontal tank size indicated.

Need pricing, inventory or tech information?
[Click here!](#)

Which Tank do you need?



Clawson Tank Company
 4545 Clawson Tank Drive
 Clarkston, Michigan
 48346
 1.800.272.1367
 1.248.922.5053



APPENDIX C
WELL INSPECTION REPORT

WELL INSPECTION REPORT - RECOVERY WELL OM&M

Owner _____

City _____

Well No: _____ Location _____

PRODUCT THICKNESS: DTP _____ DTW _____

Date Drilled _____ Dates of Cleaning _____

Date Inspected _____ Person to Contact _____

Contact Location _____

Capacity	Date	DTP	DTW	GPM	Pumping Level	Pressure
Original						
After Last Cleaning						
After Last Test						
Current Pressure at Line						

Test Will Be Completed Through:

Hazardous Waste
 Tank Data: Date: _____ Level: _____
 Totalizer
 Reading: _____ Time: _____

Rated Capacity: GPM _____ Time _____ Operating Pressure _____

Date Installed _____ Dates of Overhaul _____

Is Gate Valve Leaking? Yes _____ No _____

THE FOLOWING IS TO BE PERFORMED DURING EACH INSPECTION:

Electrical Data With Pump In Operation: Amps: _____ Volts _____

Remarks (note any abnormal condition) _____

Inspected By: _____

APPENDIX D
GROUNDWATER SAMPLE RECORD SHEET

Sample No.: _____
 Sample Date: _____
 Sample Time: _____

SITE/SAMPLE LOCATION

Site Name: _____ Project No.: _____
 Personnel Present: _____
 Activity Start: _____ Activity End: _____
 Weather: _____
 Well Type and Location: _____

WATER LEVEL/WELL DATA

Well Depth: _____ feet using _____ Water Depth: _____ feet using _____
(from top of well casing) (measuring device) (from top of well casing) (measuring device)

Historical Well Depth: _____ feet Protective Casing Stickup: _____ feet Protect. Casing Well
(from ground surface) (for above-ground surface) Casing Difference: _____ feet

Floating Product Thickness: _____ feet using _____
(measuring device)

Well Condition (see Note 1): _____
 Measuring Device Decontamination Procedure: _____

PI Meter ID: _____ Ambient Air: _____ ppm Well Mouth: _____ ppm

PURGING PROCEDURES

Height of Water () .041 gal/ft (1 in)
 Column feet () .16 gal/ft (2 in) X _____ 3 casing volumes = _____ gallons to purge
 () .65 gal/ft (4 in)
 () 2.61 gal/ft (8 in)

Purge Method (see Note 2): _____

Purge Vol. (gal)	_____	_____	_____	_____
Time (Min.)	_____	_____	_____	_____
Temperature (C°)	_____	_____	_____	_____
pH (Units)	_____	_____	_____	_____
Conductivity at 25°C (mS/cm)	_____	_____	_____	_____
Total Volume Purged	_____	_____	_____	_____ gallons
Water Appearance (describe color, clarity odor):	_____			

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): _____

Sample Water Appearance (color, clarity, odor): _____

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field		Cool	
					Filtered?		to 4°C?	
_____	_____	_____	_____	_____	Y	N	Y	N
_____	_____	_____	_____	_____	Y	N	Y	N
_____	_____	_____	_____	_____	Y	N	Y	N
_____	_____	_____	_____	_____	Y	N	Y	N
_____	_____	_____	_____	_____	Y	N	Y	N

OTHER OBSERVATIONS

NAME (Print) _____

SIGNATURE: _____

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
 (2) Describe sequence of purging/sampling including equipment type and decontamination method.